TKM COLLEGE OF ENGINEERING

(Government Aided and Autonomous)

celebrating 60 years of excellence

COMPUTER SCIENCE AND ENGINEERING

B. Tech Curriculum 2024

Semester 3 and 4

THIRD SEMESTER													
Sl No	Slot	Code	Category	Title	L	T	P	J	S	No. of Hours	No. of Credits	Total Marks	
												CIA	ESE
1	A	24MAP301	BSC	Advanced Linear Algebra, Complex Analysis and Partial Differential Equations	3	1	2	0	5	6	5	60	40
2	K	24EST352	ESC	Probability, Statistics and Optimization	2	0	0	0	2	2	2	100	
3	B	24CSJ303	PBC	Advanced Programming	2	0	2	2	5	6	5	60	40
4	C	24CSP304	PCC	Data Structures and Algorithms	2	1	2	0	4	5	4	60	40
5	D	24CSP305	PCC	Computer Organization and Architecture	2	1	2	0	4	5	4	60	40
6	E	24HUT310	HSMC	Life Skills and Professional Ethics	3	0	0	0	3	3	3	40	60
7	I	24EST322	ESC	Basic Engineering Mechanics	2	0	0	0	2	2	2	100	
8	M/R	24CSM3XX	MR/RL	MINOR/REMEDIAL	4	0	0	0			4/0	40	60
TOTAL									**25**	**29**	**25**		

MINOR BUCKETS				
SEMESTER	**BUCKET 1**		**BUCKET 2**	
	Specialization - Machine Learning		**Specialization - Software Engineering***	
	Course Code	**Course Name**	**Course Code**	**Course Name**
S3	24CSM309	Python for Machine Learning	24CSM310	Object Oriented Programming*

		L	T	P	J	S	C	Year of Introduction
24MAP301	**Advanced Linear Algebra, Complex Analysis and Partial Differential Equations**	3	1	2	0	5	5	2024

Preamble:

This course introduces the concept of vector space, inner product, complex differentiation, complex integration and partial differential equations. The concepts discussed here are widely used in the modeling and analysis of a wide range of physical phenomena and has got application across all branches of engineering. After completing this course, students will acquire the ability to utilize the above concepts for solving mathematical problems more efficiently.

Prerequisite: A basic course in linear algebra, complex numbers and partial differentiation.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Implement many familiar systems as vector spaces and operate with them using vector space tools such as basis and dimension **(Apply level).**
CO 2	Apply the concept of real and complex Inner product spaces for constructing approximations and orthogonal projections **(Apply level).**
CO 3	Use Cauchy Riemann equations and Harmonic functions for solving Physical and Engineering problems **(Apply level).**
CO 4	Compute different types of contour integrals using Cauchy's residue theorem**(Apply level).**
CO 5	Demonstrate different type of Partial differential equations in engineering domains and solve it using appropriate methods **(Apply Level).**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓			✓				✓			✓
CO 2	✓	✓			✓				✓			✓
CO 3	✓	✓			✓				✓			✓
CO 4	✓	✓			✓				✓			✓
CO 5	✓	✓			✓				✓			✓

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate			✓	
Create			✓	

Assessment Pattern for Lab component

Bloom's Category	Continuous Assessment Tools	
	Class work	Test1
Remember		

Understand	✓	✓
Apply	✓	✓
Analyse	✓	✓
Evaluate	✓	
Create	✓	

Mark Distribution of CIA

Course Structure [L-T-P]	Attendance	Theory [L- T]			Practical [P]		Total Marks
		Assignment	Test-1	Test-2	Class work	Lab Exam	
	5	10	12.5	12.5	10	10	**60**

Total Marks distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	60	40	2.5 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 2		2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x 8 = 40 marks) Time: 2.5 hours	40
	Total Marks: 0	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: (Vector space)

(Text 1: Relevant topics from sections 2.1, 2.2, 2.3, 2.4, 2.5)
Vector Spaces, Subspaces -Definition and Examples. Linear independence of vectors, Linear span, Basis and dimension, Co-ordinate representation of vectors, Row space and Column space

MODULE II: (Inner Product)

(Text 1: Relevant topics from sections 5.1, 5.2, 5.5)
Inner Product: Inner product spaces, properties of inner product, length and

distance, Orthogonality, Cauchy-Schwarz inequality, Orthogonal projection, orthogonal compliment, Orthonormal basis, Gram Schmidt orthogonalization process.

MODULE III: (Complex differentiation)

(Text 2: Relevant topics from sections 13.3,13.4)
Circles and disks half planes, complex functions, limit, continuity and derivatives, analytic functions, Cauchy-Riemann equations, Laplace equation, Harmonic functions, harmonic conjugate functions

MODULE IV: (Complex Integration)

(Text 2- Relevant topics from sections 14.1,14.2,14.3,14.4,15.4,16.1,16.2,16.3)
Cauchy's integral theorem for simply connected domains (without proof), Cauchy's Integral formula for simply connected domains (without proof), Cauchy's Integral formula for derivatives of an analytic function, Taylor's series, Maclaurin series and Laurent's series, Poles and Residues, Evaluation of residues, Cauchy's residue theorem.

MODULE V: (Partial Differential Equations)

(Text 3: Relevant topics from sections 17.1,17.2,17.3,17.4,17.5)
Introduction, Formation of partial differential equations -elimination of arbitrary constants-elimination of arbitrary functions, Solutions of partial differential equations, Equations solvable by direct integration, Linear equations of the first order, Lagrange's linear equation

Text books

1. Richard Bronson, Gabriel B. Costa, Linear Algebra-an introduction, 2nd edition, Academic press, 2007
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10thEdition, John Wiley & Sons, 2016.
3. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44th Edition, 2018.

Reference books

1. Peter V. O'Neil, Advanced Engineering Mathematics, Cengage, 7th Edition, 2012
2. Gilbert Strang, Linear Algebra and It's Applications, 4th edition, Cengage Learning, 2006
3. Seymour Lipschutz, Marc Lipson, Schaum's outline of linear algebra, 3rd Ed., Mc Graw Hill Edn.2017
4. David C Lay, Linear algebra and its applications,3rd edition, Pearson
5. Prof. Premananda Bera, Advanced Linear Algebra, IIT Roorkee, [NPTEL], https://nptel.ac.in/courses/111107164 (Relevant sections)
6. Prof. Gilbert Strang, Linear Algebra [MITOPENCOURSEWARE], Massachusetts Institute of Technology, https://ocw.mit.edu/courses/18-06-linear-algebra-spring-2010/ (Relevant sections)

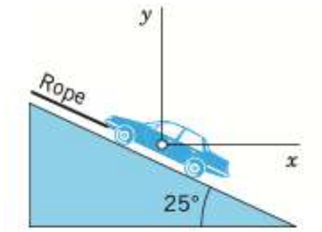
COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. ofHours [45 hours]
MODULE 1 [9 hours]		
1.1	Defining of vector spaces	1
1.2	Vector space examples	1
1.3	Subspaces	1
1.4	Linear dependence and independence	1
1.5	Basis and dimension	1
1.6	Basis and dimension(continued)	1
1.7	Row space, column space	1
1.8	Row space, column space(continued)	1
1.9	Co-ordinate representation	1
MODULE II [9 hours]		
2.1	Inner Product: inner product spaces	1
2.2	Inner Product: inner product spaces(continued)	1
2.3	Properties of inner product, length and distance	1
2.4	Properties of inner product, length and distance(continued)	1
2.5	Cauchy-Schwarz inequality	1
2.6	Orthogonality, Orthogonal complement, Orthonormal bases	1
2.7	Gram Schmidt orthogonalization process, orthogonal projection	1
2.8	Gram Schmidt orthogonalization process, orthogonal projection(continued)	1
2.9	Gram Schmidt orthogonalization process, orthogonal projection(continued)	1
MODULE III [9 hours]		
3.1	Complex function, limit	1
3.2	Continuity of complex functions	1
3.3	Derivatives of complex functions	1
3.4	Analytic functions	1
3.5	Cauchy-Riemann equations	1
3.6	Cauchy-Riemann equations(continued)	1

3.7	Harmonic functions	1
3.8	Finding harmonic conjugate	1
3.9	Finding harmonic conjugate(continued)	1
	MODULE IV [9 hours]	
4.1	Cauchy integral theorem (without proof) on simply connected domain	1
4.2	Cauchy Integral formula (without proof)	1
4.3	Cauchy Integral formula for derivatives of an analytic function	1
4.4	Taylor's series and Maclaurin series	1
4.5	Laurent series	1
4.6	Poles and Residues	1
4.7	Evaluation of residues	1
4.8	Evaluation of residues (continued)	1
4.9	Cauchy's residue theorem	1
	MODULE V [9 hours]	
5.1	Introduction to Partial differential equations	1
5.2	Formation of partial differential equations Elimination of arbitrary constants	1
5.3	Formation of partial differential equations -Elimination of arbitrary functions	1
5.4	Solutions of a partial differential equations	1
5.5	Equations solvable by direct integration	1
5.6	Equations solvable by direct integration(continued)	1
5.7	Linear equations of the first order- Lagrange's linear equation	1
5.8	Linear equations of the first order- Lagrange's linear equation(continued)	1
5.9	Linear equations of the first order- Lagrange's linear equation(continued)	1

LESSON PLAN FOR LAB COMPONENT

No.	Topic	No. of Hours	Experiment
1.	Linearly independence and dependence	2	Check the Linearly independence and dependence
2	Vector space	3	Finding basis, dimension of vector spaces
		3	Finding row space and column space
3	Inner product	2	Inner product: length and distance
4	Orthogonality	2	Finding orthogonal compliment
		2	Finding orthogonal projection
5	Line integral	2	Evaluating complex line integral
6	Taylor's and Maclaurin series	3	Evaluating Taylor's and Maclaurin series of functions
7	Solution of PDE	3	Solution of Lagrange's Linear Differential Equation

CO Assessment Questions	
1	1. Consider a three-phase power system with three phase voltages: V1 = 100∠0° V, V2 = 100∠-120° V, and V3 = 100∠120° V. (V1 = 100∠0° indicates that the first phase voltage in the system has a magnitude of 100 volts and a phase angle of 0 degrees) These voltages represent the three phases of a balanced power system. Show that the set of phase voltages forms a basis for the vector space of complex numbers C. Determine the dimension of the vector space spanned by the three phase voltages. Given a complex number Z = 50 + j50, express it as a linear combination of the phase voltages V1, V2, and V3. 2. Using MATLAB/SCILAB, how can you determine the basis vectors and the dimension of a vector space spanned by a given set of vectors? 3. **Team Work**: Consider a linear circuit with three electrical components: R1, L1, and C1. The impedance of R1 is 10 Ω, the impedance of L1 is j20 Ω, and the impedance of C1 is -j30 Ω. Define a vector space V that represents all possible combinations of the three impedances (R1, L1, C1). Show that V forms a vector space. Determine the dimension of the vector space V and provide an interpretation in the context of the circuit.

2	1. Explain how the Gram-Schmidt orthogonalization process can be applied to orthogonalize a set of non-orthogonal vectors. Discuss the steps involved in the process and the significance of obtaining orthogonal vectors in signal processing applications. 2. What force in the rope in Figure will hold a car of 5000 lb in equilibrium if the ramp makes an angle of 25° with the horizontal? Verify your answer using CAS (MATHLAB/SCILAB)  3. **Team Work**: Explore applications of orthogonal projection in different fields, such as engineering, physics, or computer science. Choose one application and explain how orthogonal projection is utilized to solve a specific problem in that field, using the CAS to demonstrate the calculations if applicable.
3	1. You are analyzing the flow of fluid in a river, and you want to understand the behavior of the velocity field. The velocity of the fluid is described by a complex function, where the real part represents the horizontal component and the imaginary part represents the vertical component. Apply the Cauchy-Riemann equations to determine the conditions under which the fluid flow is both irrotational (zero curl) and incompressible (zero divergence). 2. You are analyzing the flow of heat in a two-dimensional object, and the temperature distribution within the object is described by a harmonic function. For a particular case, let's consider a rectangular metal plate where the temperature distribution is given by $T(x, y) = sin(x)cos(y)$, where (x, y) represents the spatial coordinates. Find the harmonic conjugate of the temperature function $T(x, y)$ and determine the streamlines of heat flow based on the harmonic conjugate. Verify the answer using CAS(MATLAB/SCILAB) 3. **Team Work:** What are the critical points and equivalent resistances of a resistor with a nonlinear resistance described by the equation $R = a\|z\|^2 + b\|z\| + c$, where 'a', 'b', and 'c' are constants and 'z' is a complex variable representing the voltage across the resistor? Use complex differentiation to analyze the behavior of the resistor and find the critical points by differentiating the resistance equation with respect to 'z' and setting it equal to zero. Finally, substitute the critical points back into

	the resistance equation to determine the corresponding equivalent resistances.
4	1. In the study of a particle's motion along a curve, you aim to approximate the position function $x(t) = t^3 - 2t^2 + 3t - 1$ using a Taylor series expansion. Determine the Taylor series expansion of x(t) around t = 2 and use it to approximate the position of the particle at t = 2.2 up to the second-degree term. 2. The Maclaurin series $\frac{z}{e^z-1} = 1 + B_1 z + \frac{B_2}{2!}z^2 + \frac{B_3}{3!}z^3 + \cdots$ defines the Bernoulli numbers B_n. Using undetermined coefficients, show that $B_1 = \frac{-1}{2}, B_2 = \frac{1}{6}, B_3 = 0, B_4 = -\frac{1}{30}, B_5 = 0, B_6 = \frac{1}{42}$. Write a program for computing $B_n$using CAS(MATLAB/SCILAB). 3. **Team Work**: Research and find real-world applications of complex integration using the Cauchy Residue Theorem. Present your findings in a concise report or presentation, highlighting the applications and explaining how the theorem is used in each case.
5	1. How does the temperature distribution change over time in a metal rod as heat is conducted through it, and how long does it take for the rod to reach a specific temperature at a given location? 2. Verify that each u satisfies $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = f(x,y)$ with $f\ (x,y)$ as indicated using CAS(MATLAB/SCILAB) (a)$u = \frac{y}{x}\ and\ f = \frac{2y}{x^3}$ (b)$u = \sin(xy)\ and\ f = (x^2 + y^2)\sin xy.$ 3. **Team Work**: A tightly stretched string with fixed end points $x = 0$ and $x = l$ is initially in a position given by $y = y_0 \sin^3\left(\frac{\pi x}{l}\right)$. if it is released from rest, find the displacement $y(x,t)$.

24EST352	PROBABILITY, STATISTICS AND OPTIMIZATION	L	T	P	J	S	C	Year of Introduction
		2	0	0	0	2	2	2024

Course Objectives

This course introduces students to the modern theory of probability and statistics, covering important models of random variables, measures of central tendency, curve fitting, correlation, regression and optimization techniques. The concepts discussed here are widely used in engineering problems. After completing this course, students will acquire the ability to utilize the above concepts for applying in problems more efficiently.

Prerequisite: A basic course in probability theory and algebra.

Course Outcomes-After the completion of the course the student will be able to

CO 1	Apply the concept and properties of discrete and continuous random variables in evaluating the required probabilities**[Apply level]**
CO 2	Analyze suitable random phenomena using the properties and important models of discrete and continuous random variables. **[Apply level]**
CO 3	Apply concepts of measures of central tendency, dispersion to analyze data. **[Apply level]**
CO 4	Apply the concept of curve fitting for data visualization, predict function values when no data is provided, and describe the connections between two or more variables [**Apply level]**
CO 5	Apply different types of linear programming problems for scheduling and sequencing in industrial optimization problems. **[Apply level].**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓			✓				✓			✓
CO 2	✓	✓			✓				✓			✓
CO 3	✓	✓			✓				✓			✓
CO 4	✓	✓			✓				✓			✓
CO 5	✓	✓			✓				✓			✓

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	
Understand	✓	✓	✓	
Apply	✓	✓	✓	
Analyse			✓	
Evaluate			✓	
Create			✓	

Mark Distribution of CIA

Course Structure [L-T-P]	Attendance	Theory [L- T]			Practical [P]		Total Marks
		Assignment	Test-1	Test-2	Class work	Lab Exam	
	5	35	30	30			**100**

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	100		

SYLLABUS

MODULE I: (Random variables)

(Text 1: Relevant topics from sections 4.1, 4.4, 5.1).
Random Variables (discrete and continuous)-Probability density function, distribution function, Mathematical expectation, variance and their properties.

MODULE II: (Probability distributions)

(Text 1: Relevant topics from sections 4.2, 4.6, 5.2)
Binomial distribution, Poisson distribution, Normal distribution.

MODULE III: (Introduction to Statistics)

(Text 2: Relevant topics from sections 25.5,25.6,25.9,25.10,25.11)
Measures of central tendency, Measures of Dispersion-Mean deviation about median, standard deviation, Moments-Skewness-Kurtosis (Concept only) .

MODULE IV: (Applied Statistics)

(Text 2- Relevant topics from sections 24.4,24.5,25.12,25.13,25.14)
Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas, Correlation, linear regression.

MODULE V: (Optimization techniques)

(Text 3: Relevant topics from chapters 2,3 and 4)
Linear programming problems - Mathematical formulation, graphical method of solution, simplex method.

Text books

1. Richard A Johnson, Probability and Statistics for Engineers (Miller and Freund's)- Prentice Hall of India, 9th Edition.
2. B S Grewal, Higher Engineering Mathematics, Khanna Publishers (42nd edition), 2012.
3. Kanti Swarup, Gupta P.K., and Manmohan, (2008), Operations Research, S. Chand & sons

Reference books

1. Probability and Statistics for engineers and scientists, R.E.Walpole, R.H.Myers, S.L.Mayers and K.Ye, 9th Edition, Pearson Education (2012).
2. Fundamentals of Statistics, vol. I & II, A. Goon, M. Gupta and B. Dasgupta, World Press.
3. Hamdy Taha, (1999), Operations Research, PHI.
4. Prof. S Dharmaraja, Introduction to Probability Theory and Statistics, IIT Delhi [NPTEL] https://nptel.ac.in/courses/111102160 (Relevant sections)

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours [24 hours]
	MODULE 1 [5 hours]	
1.1	Introduction of Random Variables (discrete and continuous).	1
1.2	Probability density function, distribution function and their problems	1
1.3	Probability density function, distribution function and their problems-continued	1
1.4	Mathematical expectation, Variance and their properties.	1
1.5	Mathematical expectation, Variance and their properties-continued	1
	MODULE II [5 hours]	
2.1	Binomial distribution	1
2.2	Binomial distribution-continued	1
2.3	Poisson distribution	1
2.4	Normal distribution	1
2.5	Normal distribution-continued	1
	MODULE III [4 hours]	
3.1	Measures of central tendency	1
3.2	Measures of Dispersion-Mean deviation about median	1
3.3	Measures of Dispersion- standard deviation	1
3.4	Moments-Skewness-Kurtosis (Concept only)	1
	MODULE IV [5 hours]	
4.1	Curve fitting by the method of least squares	1
4.2	Fitting of straight lines, second degree parabolas	1
4.3	Fitting of straight lines, second degree parabolas-continued	1

4.4	Correlation, linear regression	1
4.5	Correlation, linear regression-continued	1
MODULE V [5 hours]		
5.1	Linear programming problems - Mathematical formulation	1
5.2	Linear programming problems - Mathematical formulation-continued	1
5.3	Graphical method of solution	1
5.4	Graphical method of solution	1
5.5	Simplex method-continued	1

CO Assessment Questions	
1	1.Three balls are drawn at random without replacement from a box containing 2 white,3 red and 4 black balls. If X denotes the number of white balls drawn, find the probability distribution of X. 2. A customer service representative can handle a customer call in one of three categories: technical support, billing inquiries, or general inquiries. The probabilities of receiving calls in these categories are 0.5, 0.3, and 0.2, respectively. The handling times (in minutes) for each category are as follows: Technical support: 15 minutes, Billing inquiries: 10 minutes And General inquiries: 5 minutes. Calculate the mathematical expectation and variance for the average handling time of a customer call. 3.**Team Work:** Determine the probability of obtaining at least two heads when tossing a fair coin three times. Once the team has solved this problem, explore variations such as the probability of obtaining at least two heads when tossing the coin four times, or when using a biased coin with a 70% chance of heads and a 30% chance of tails. Explore these variations as a team and discuss the changes in probabilities

2	1. A call center receives an average of 10 customer calls per hour. What is the probability that the call center receives exactly 15 customer calls in a given hour? 2. A manufacturer knows from experience that the resistance of resistors he produces is normal with mean $\mu = 150\Omega$ and standard deviations $\sigma = 5\Omega$. What percentage of the resistors will have resistance between 148 Ω and 152 Ω? Between 140 Ω and 160 Ω? 3. **Team Work**: A group of students is taking a multiple-choice test with 10 questions. Each question has 4 answer choices, and students randomly guess the answers. If there are 50 students in the group, what is the probability that at least 8 students get exactly 5 questions correct?
3	1. Suppose a store manager is analyzing the sales data for a particular product. The mean sale price of 200 items was calculated to be \$50. However, upon further investigation, it was revealed that two sales transactions were mistakenly recorded with incorrect values. The correct sale prices should have been \$192 and \$88, but they were initially misread as \$92 and \$8, respectively. Now, the store manager needs to determine the accurate mean sale price of the items after accounting for these corrections. 2. A manufacturing company produces a specific component, and they want to assess the consistency of the production process. They collected the weights of 50 randomly selected components in grams. The data is as follows: 22.5, 23.1, 22.8, 23.4, 22.9, 23.5, 23.2, 22.7, 23.3, 23.0, 23.1, 22.9, 23.4, 22.8, 23.0, 23.3, 23.5, 22.7, 23.2, 22.6, 23.3, 23.0, 22.9, 23.6, 22.8, 23.1, 23.0, 23.3, 22.7, 23.2, 22.5, 23.3, 23.0, 22.8, 23.1, 23.5, 22.9, 23.4, 22.6, 23.0, 23.3, 23.2, 22.7, 23.1, 22.9, 23.6, 22.8, 23.3, 22.7, 23.4 Calculate the standard deviation of the weights of the components to assess the variability in the manufacturing process. 3. **Team Work**: As a data analysis team, you have been provided with grouped data on the heights (in centimeters) of a group of students, categorized into intervals: 140-150, 150-160, 160-170, 170-180, and 180-190. Your team's task is to measure the height of each individual student within the group and then find the mean, median, and mode of the measured heights.

4	1. In a partially destroyed laboratory record of an analysis of a correlation data, the following results only are legible: Variance of x=9, Regression equations: 8x-10y+66=0, 40x-18y=214. What are (i) the mean values of x and y. (ii) the coefficient of correlation between x and y. 2. A high school physics teacher is conducting an experiment to study the trajectory of a projectile launched from a spring-loaded launcher. The teacher collected data on the horizontal distance traveled by the projectile at different launch angles and wants to fit a parabolic curve to the data using the method of least squares. Launch Angle (in degrees): 15, 30, 45, 60, 75 Horizontal Distance (in meters): 2.5, 10.2, 22.0, 38.5, 59.0 Using the method of least squares, fit a parabolic curve to the collected data and determine the equation of the parabola that best represents the relationship between the launch angle and the horizontal distance traveled by the projectile. 3. **Team Work**: A team is studying the growth of individuals' height over time. They have collected eight data points on the height of different individuals at different ages (in years). Your team's task is to collect data and fit a straight line corresponding to the data using the method of least squares.
5	1. A farmer owns a piece of land and wants to maximize the profit from crop production. The farmer can choose to grow three types of crops: Wheat, Corn, and Soybeans. Each crop requires different amounts of water, fertilizer, and labor hours per acre. The profit per acre for Wheat is $500, for Corn is $700, and for Soybeans is $600. To grow one acre of Wheat, the farmer needs 30 gallons of water, 10 kg of fertilizer, and 5 labor hours. For Corn, one acre requires 50 gallons of water, 15 kg of fertilizer, and 8 labor hours. Lastly, one acre of Soybeans needs 40 gallons of water, 12 kg of fertilizer, and 6 labor hours. The farmer has a total of 1500 gallons of water, 400 kg of fertilizer, and 300 labor hours available. The farmer wants to determine how many acres of each crop to plant in order to maximize the total profit while respecting the resource constraints. Formulate a linear programming problem to help the farmer determine the optimal allocation of land to each crop to maximize the total profit. 2. A manufacturing company produces two types of products: Product X and Product Y. For each unit of Product X, the company makes a profit of $6, and for each unit of Product Y, the profit is $8. The production process requires 3 labor hours and 2 kg of raw materials for one unit of Product X, while one unit of Product Y requires 4 labor hours and 3 kg of raw materials. The company has 40 hours of labor available and 30 kg of raw materials. To maximize profits while

	considering these resource constraints, the company wants to determine the optimal production quantities of Product X and Product Y using both the graphical method and the simplex method. Compare the results obtained from both methods and discuss any differences, if any, in the optimal production quantities and maximum profit achieved. 3. **Team Work**: A manufacturing company produces three types of products: Product A, Product B, and Product C. The company aims to maximize its profit while considering the available resources of labor hours and raw materials. The profit per unit of each product and the labor hours and raw materials required for one unit have not been provided. Your team's task is to collect relevant data on the profit per unit and resource requirements for each product. Using the simplex method, analyze the data and determine the optimal production quantities of Product A, Product B, and Product C that maximize the total profit. Additionally, state the maximum profit achieved by the optimal production quantities. Your team's findings will aid the company in making informed decisions about production and resource allocation to enhance profitability.

24CSJ303	Advanced Programming	L	T	P	J	S	C	Year of Introduction
		2	0	2	2	5	5	2024

Preamble: This course enables the learners to understand the fundamental principles of object-oriented programming and provide them with the necessary skills to develop robust and scalable Java applications. This course covers the basics of object-oriented concepts, UML Class Diagram and Usecase Diagram, Packages and Interfaces, Collection framework and Exception handling, Event Handling and GUI Programming which helps the students to design and develop application-based solutions for real world problems.

Prerequisite: Basics of Problem solving and Programming

Course Outcomes: After the completion of the course the student will be able to

CO1	Design a UML structural and behavioural model for solving real world problems (**Analyze Level**)
CO2	Develop programs to solve problems using object-oriented design techniques through Java (**Apply Level)**
CO3	Illustrate the creation and usages of packages and interfaces in Java. (**Understand Level**)
CO4	Demonstrate the exception handling mechanism to handle run time errors (**Apply Level**)
CO5	Make use of collection interfaces and classes to store and manipulate data effectively. (**Apply Level**)
CO6	Develop Java application to solve a real-world problem by using graphical user interfaces and Event handling techniques (**Create Level**)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3									3
CO5	3	3	3									3
CO6	3	3	3	3	3	3		3	3	3		3

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember		✓	✓	✓
Understand		✓	✓	✓
Apply		✓	✓	✓
Analyse			✓	

Evaluate			✓	
Create			✓	

Assessment Pattern for Lab component		
Bloom's Category	**Continuous Assessment Tools**	
	Class work	**Test1**
Remember		
Understand	✓	✓
Apply	✓	✓
Analyse	✓	✓
Evaluate		
Create		

Assessment Pattern for Project component			
Bloom's Category	**Continuous Assessment Tools**		
	Evaluation 1	**Evaluation 2**	**Report**
Remember			
Understand	✓	✓	
Apply	✓	✓	
Analyse	✓	✓	
Evaluate		✓	
Create		✓	

Mark Distribution of CIA

Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**		**Practical [P]**	**Project [J]**			**Total Marks**
		Assignment	**Test-2**	**Class work**	**Evaluation 1**	**Evaluation-2**	**Report**	
2-0-2-2	**5**	**10**	**15**	**10**	**5**	**10**	**5**	**60**

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	**60**	**40**	**2.5 hours**

End Semester Examination [ESE]: Pattern

PATTERN	**PART A**	**PART B**	**ESE Marks**
PATTERN 2		2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions.	

		Each question carries 8 marks. Marks: (5x 8 = 40 marks) Time: 2.5 hours	40
	Total Marks: 0	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Basics of Object-Oriented concepts and Java (5 hrs)

Approaches to Software Design - Functional Oriented Design, Object Oriented Design, Case Study of Payroll Program. Object-Oriented concepts. Object Modeling using Unified Modeling Language (UML) – Static and Dynamic models, UML diagrams- Use case diagram, Class diagram.

Introduction to Java- JRE, JDK, JVM, Program Structure, Primitive Data types, Arrays, Command-Line Arguments, Type conversions and promotion, Garbage collection.

MODULE II: Fundamentals of Core Java (5 hrs)

Classes and Objects. Constructors. Object class in Java. Use of static, this and final keywords. Method Overloading. Objects as Parameters to Methods. Access modifiers and Packages, Strings- Class and Methods, String Buffer and String Tokenizer. Reading Input from Console Using Scanner class.

MODULE III: Inheritance, Polymorphism (5 hrs)

Inheritance - Basics and Types, super keyword, calling superclass constructor from child class constructor, Method Overriding, using final with inheritance. Abstract Classes and methods. Interface- Basics, Multiple inheritance through interfaces, interface inheritance.

MODULE IV: Collection Framework and Exception Handling (5 hrs)

Collection Framework- concepts, Collection Interfaces and their Methods, List interface, Collections Class – Array List, Vector, Linked List. Accessing a Collection via an Iterator. Exception handling: Exception Basics and Types, try, catch, throw, throws, finally keywords, User defined exceptions.

MODULE V: Event Handling and GUI Programming (4 hrs)

Delegation Event Model, Event Classes, Listener Interfaces, Introduction to Java's Swing Package, Components, Containers and Layouts, Exploring Swings –JFrame, Jpanel, JLabel, JTextField, JTextArea, JButton, JToggleButton, Check Boxes, Radio Buttons, JScrollPane, JMenu, JMenuBar and JMenuItem, Designing Frames and Adding GUI Components, Event Handling in Swings, Swing vs JavaFX

Text books

1. Herbert Schildt, The Complete Reference -Java, Tata McGraw-Hill Education, Tenth Edition, 2017.
2. Grady Booch, Robert A. Maksimchuk, Michael W. Engle, Bobbi J. Young, Jim Conallen, Kelli A, Houston. Object-Oriented Analysis and Design with Applications, 2007.

Reference books

1. Paul Deitel Harvey Deitel, Java, How to Program, Prentice Hall; 9th edition , 2011.
2. Cay Horstmann BIG JAVA, 4th edition, John Wiley Sons,2009, Nicholas S. Williams, Professional Java for Web Applications, Wrox Press, 2014
3. J. Rumbaugh et al. The Unified Modeling Language Reference Manual, 2005.
4. Paul J. Deitel, Harvey Deitel, Java SE8 for Programmers (Deitel Developer Series) 3rd Edition, 2014
5. Y. Daniel Liang, Introduction to Java programming-comprehensive version-Tenth Edition, Pearson ltd 2015
6. JavaTM Design Patterns – A Tutorial, James W. Cooper, Addison-Wesley, 2000

NPTEL/SWAYAM Courses

1. Programming in Java, Prof. Debasis Samanta, IIT Kharagpur

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (24)
	MODULE 1	
1.1	Approaches to Software Design - Functional Oriented Design, Object Oriented Design, Case Study of Payroll Program	1
1.2	Object-Oriented Programming concepts-Classes, Objects, Encapsulation, Abstraction, Inheritance, Polymorphism	1
1.3	Object Modeling using Unified Modeling Language (UML) – Static and Dynamic models	1
1.4	UML diagrams- Use case diagram, Class diagram	1
1.5	Java Primitive Data types, Garbage collection- finalize()	1
	MODULE II	
2.1	Classes and Objects, Constructors, Object class in Java	1
2.2	Use of static, this and final keywords	1
2.3	Method Overloading, Objects as Parameters to Methods.	1
2.4	Access modifiers and Packages	1
2.5	Strings- Class and Methods, String Buffer and String Tokenizer	1
	MODULE III	
3.1	Inheritance- basics, Types- Single Level, Multilevel, Hierarchical Multiple and Hybrid.	1
3.2	super keyword, calling superclass constructor from child class constructor	
3.3	Method Overriding-Dynamic Method Dispatch, using final with inheritance	1

3.4	Abstract Classes and methods	1
3.5	Interface- Basics, Multiple inheritance through interfaces, interface inheritance.	1
MODULE IV		
4.1	Collection Framework- Basics, collection interfaces and methods- List	1
4.2	Collections Class – Array List, Vector, Linked List, Accessing a Collection via an Iterator	1
4.3	Exception handling: Exception Basics, Default Exception Handler in Java	1
4.4	Exception Types-Checked and Unchecked Exception, Keywords- try, catch, throw, throws, finally	1
4.5	User defined Exceptions	1
MODULE V		
5.1	Delegation Event Model, Event Classes, Listener Interfaces	1
5.2	Introduction to Java’s Swing Package, Components, Containers and Layouts	1
5.3	Exploring Swing- Exploring Swings ¬JFrame, Jpanel, JLabel, JTextField, JTextArea, JButton, JToggleButton, Check Boxes, Radio Buttons, JScrollPane , JMenu, JMenuBar and JMenuItem	1
5.4	Event Handling in Swing, Swing vs JavaFX	1

LESSON PLAN FOR LAB COMPONENT

No.	Topic	No. of Hours (24)	Experiment
1	UML Class Diagram and Usecase Diagram	2	i. Prepare class diagram showing at least 10 relationships among the following object classes. Include association, multiplicity, aggregation, composition, generalization. You may add additional objects. Also show attributes and operations. • School, playground, principal, school board, classroom, book, student, teacher, canteen, restroom, computer, desk, chair • Sink, Freezer, Refrigerator, Table, Light, ,switch, window, smoke Alarm,

			Burglar Alarm, Cabinet, Bread, Cheese, ice, door, Kitchen. ii. Draw a UML class diagram for a partial specification of the system described below: A library loans three different kinds of items to customers: books, video tapes and compact disks. Each item has a title, and publisher. In addition, books have an author, and CD's have an artist. The library may have multiple copies of the same book, video tape or compact disk. There are two different kinds of customer: student and staff. For both kinds of customers, the library has their name, sex and address. Students may borrow at most 20 items. iii. A ViaNet bank client can have two types of accounts: a checking account and savings account. For each checking account, one related savings account can exist. Access to the ViaNet bank accounts is provided by a PIN code consisting of four integer digits between 0 and 9. One PIN code allows access to all accounts held by a bank client. No receipts will be provided for any account transactions. The bank application operates for a single banking institution only. Neither a checking nor a savings account can have a negative balance. The system should automatically withdraw money from a related savings account if the requested withdrawal amount on the checking account is more than its current balance. If the balance on a savings account is less than the withdrawal amount requested, the transaction will stop and the bank client will be notified. Draw Usecase diagram and class diagram corresponding to this scenario
2	Introduction to Java- JRE, JDK JVM, Program Structure.	1	i. Familiarization of different JAVA IDE ii. Compiling & running of simple Java programs using command prompt/ terminal and using any one Java IDE a. Display "Hello World "Program b. Find the sum of two numbers Observe the output files created.

3	Primitive Data types, Arrays- 1D, 2D, Command Line Arguments, Type conversions and promotion	2	i. Read two strings through command line, concatenate it and check whether the concatenated string is palindrome or not. ii. Read set of numbers through command line and display the average of it iii. Find the second smallest element in an array. iv. Demonstrate the use of multidimensional arrays and looping constructs. v. Illustrate (a) Automatic & Explicit Type Conversion (b) Conversion of Integer and Double to Byte (c) Type promotion in Expressions
4	Constructors- Default and Parameterized Constructors, Use of static, this and final keywords, Method Overloading. Objects as Parameters to Methods	2	i. Create a class 'Account' with two overloaded constructors. The first constructor is used for initializing the name of account holder, the account number and the initial amount in the account. The second constructor is used for initializing the name of the account holder, the account number, the addresses, the type of account and the current balance. The Account class is having methods Deposit (), Withdraw (), and Get_Balance(). Make the necessary assumption for data members and return types of the methods. Create objects of Account class and use them. ii. Calculate the area of different shapes namely circle, rectangle, trapezoid and triangle. (Use the concepts like this keyword, method overloading) iii. Illustrate the working of Object as arguments and return types for the following cases (a) add two complex numbers (b) add two-time objects Create a class in Java that keep count of the number of its objects created. Every time an object of the class is created it assigned an id (1,2,3,..) and the total number object is displayed. The class should have a display method to display the id. In main Create n objects of the class.

<table>
<tr><td>5</td><td>Access modifiers and Packages Strings- Class and Methods, String Buffer and String Tokenizer. Reading Input from Console Using Scanner class</td><td>3</td><td>i. Create 2 packages; pack1 contains two classes Teacher and Course. Both classes have method to read corresponding information. Pack2 contains class college with method accept. Write a Java program to display all information
ii. Create n objects of the student class. Assign roll numbers in the ascending order. Accept name and percentage from the user for each object. Define a static method “sortStudent” which sorts the array on the basis of percentage.
iii. Read a line of integers, and then displays each integer, and the sum of all the integers. (Use String Tokenizer class
iv. Read data of various types using Scanner class and display it.
v. Perform the following string operations using string handling functions
(a) Insert a string into another string at specified position.
(b) Concatenation of two Strings
(c) Comparison of two strings
(d) Search the last occurrence of a character or substring
(e) Remove the leading and trailing white spaces in a string</td></tr>
<tr><td>6</td><td>Inheritance- Super class and Subclass, extends keyword, Types- Single Level, Multilevel, Hierarchical and Multiple.
super keyword, calling superclass constructor from child class constructor</td><td>2</td><td>i. Write a program to demonstrate the working of
a. Multilevel inheritance (use super to call constructors)
b. hybrid inheritance
ii. Illustrate the working of constructors in multi-level inheritance</td></tr>
</table>

7	Method Overriding- Dynamic Method Dispatch Abstract Classes and methods Interfaces- Basics, class vs interface	3	i. Write a Java program to create an abstract class named Shape that contains an empty method named numberOfSides (). Provide three classes named Rectangle, Triangle and Hexagon such that each one of the classes extends the class Shape. Each one of the classes contains only the method numberOfSides () that shows the number of sides in the given geometrical structures ii. Define an interface “Operations” which has method area (), volume (). Define a constant PI having value 3.14. Create class a Cylinder (with member variable height) which implements this interface. Create one object and calculate area and volume. Add Required Constructors. iii. Write a program that illustrates interface inheritance. Interface P is extended by P1 and P2. Interface P12 inherits from both P1 and P2. Each interface declares one constant and one method. class Q implements P12.Instantiate Q and invoke each of its methods. Each method displays one of the constants. iv. Derive class square from class Rect. Create another class Circle. Create an interface with only one method call area. Implement this interface in all classes. Include appropriate data members and construction in all classes. Write a program to accept details of square and circle and display the area.
8	Collection Framework concepts, Collection Interfaces and their Methods, Array List and LinkedList Classes, Iterators and List Iterators	3	i. a. Create an ArrayList of integers. b. Fill the ArrayList with a random set of integers. c. Find and print the second smallest integer from the ArrayList. ii. Write a Java program for the following: a. Create a doubly linked list of elements. b. Delete a given element from the above list. c. Display the contents of the list after deletion iii. Implement Quick sort algorithm for sorting a list of names in ascending order. iv. Illustrate the working of Set, Map, SortedSet and Sorted Map interface ***(Self learning)***

9	Exception handling: Exception Basics and Types, try, catch, throw, throws, finally keywords, user defined exceptions.	3	i. Write a Java code to simulate the way a stack mechanism works with exception handling, throwing and dealing with exceptions such as stack is full or Stack is empty. ii. Create a class Student with attributes roll no, name, age and course (use user inputs). If age of student is not in between 15 and 21 then generate an exception to handle it. iii. Write a Java program to define a class salesman with the attributes name, salesman code, sales amount and commission (use user inputs). The Company calculates the commission of a salesman according to the following formula: (i) 8% if sales <2000 (ii) 10% sales if sales>=2000 and but <=5000 (iii) 12% if sales exceeds 5000 Create salesman objects and find the commission of sales. **Generate and handle exceptions if sales amount is less than 0.**
10	Designing Frames and Adding GUI Components, Event Handling using SWING	3	i. Implement a program with a GUI that looks like the one shown below. Put the main method in a class named MyDemo1.  Make a copy of MyDemo1.java named MyDemo2.java. Add a menu bar to MyDemo2. Copy MyDemo1.java to MyDemo3.java. Add a button (JButton) to MyDemo3.java. Make it the default button. ii. Design a swing GUI that accepts two strings and perform the following operations. (Use Event Handling techniques) a. Output whether the two strings are same or not b. Output Reverse of the first string

			iii. Write a Java program that works as a simple calculator. Arrange Buttons for digits and the + - * % operations properly. Add a text field to display the result. Handle any possible exceptions like divide by zero. Use Java Swing. iv. Write a Java program that simulates a traffic light. The program lets the user select one of three lights: red, yellow, or green. When a radio button is selected, the light is turned on, and only one light can be on at a time. No light is on when the program starts. v. Design a Student Registration form using Swing GUI. Use Event handling mechanism to validate the user information

COURSE PROJECT

Students can choose projects that have real-world applications which help students to see the practical relevance of their coursework.
Sample project topics for students to work on:

1	Create a 2D platformer game with Java using JavaFX for graphics and game logic. Include character movement, obstacles, and level design.
2	Create a healthcare dashboard using Java to display and analyze patient data, appointments, and medical records.
3	Create a travel booking portal's front-end that allows users to book flights, hotels, and plan itineraries.
4	Build a match-3 puzzle game like Candy Crush in Java. Implement colorful graphics, special effects, and level progression.
5	Create an educational math game for children in Java. Include math challenges, quizzes, and a progress tracker.

<u>Note</u>:- Projects need not be restricted to the above topics. Students are encouraged to choose any application problems, in the course domain, which they desire to work on. When working on these game development projects, you can choose the appropriate game engine or libraries for Java, such as JavaFX, LibGDX, or other Java-based game development frameworks, depending on the type and complexity of the game you wish to create.

LESSON PLAN FOR PROJECT COMPONENT		
No.	**Topic**	**No. of Class Hours(24)**

1	Preliminary Design of the Project • Identify a societal real-world problem and design **UML class diagram and Use case Diagram**	4
2	Zeroth presentation (4^{th} week)	2
3	Project work - First Phase	4
4	Interim Presentation (7^{th} and 8^{th} weeks)	4
5	Project work - Final Phase & Report writing (discussions in class during project hours)	6
6	Final Evaluation and Presentation (11^{th} and 12^{th} weeks)	4

Note: 12 Hours of self-study hours should also be utilized for the development of the complete project.

CO Assessment Questions	
1	a. Design UML class diagram and use case diagram for a restaurant management system b. Design UML class diagram and use case diagram for an online bookstore system that allows customers to browse and purchase books.
2	a. Implement an object-oriented hospital management system to manage patient records, doctor schedules, and medical appointments. Use classes to represent patients, doctors, and administrative staff, and implement inheritance to handle various medical specialties. b. Implement object-oriented library catalog system where users can search for books, borrow or return them, and manage their reading lists. Implement classes for books, library patrons, and library staff.
3	a. Implement a program for a remote-control system that can control various devices (e.g., TV, DVD player, sound system). Use interfaces to define common control methods like powerOn, powerOff, and package the device classes in separate packages based on their types. b. Implement a program for vehicle rental system where customers can rent cars, bikes, or scooters. Use interfaces to define rental-related methods like calculateRentalCost and package the vehicle classes in separate packages based on their types.
4	a. Implement a program that takes user input and validates it to ensure it meets specific criteria. Implement exception handling for cases where the user enters invalid data or unexpected inputs. b. Implement program for banking application that performs financial transactions while handling exceptions related to insufficient funds, invalid account numbers, or other banking-specific errors.
5	a. Implement a program that reads a collection of music files and organizes them using ArrayList. Enable functionalities like searching

	for songs by title, artist, or genre. b. Implement a program to manage an online store's inventory using ArrayList. Allow the user to add, update, and remove products, as well as search for products based on various criteria.
6	a. Develop a GUI for object-oriented flight reservation system that allows users to search for flights, book tickets, and manage their reservations. b. Implement a maze or labyrinth game using Java where players navigate through intricate mazes and solve puzzles using GUI and Event handling.

24CSP304	Data Structures and Algorithms	L	T	P	J	S	C	Year of Introduction
		2	1	2	0	4	4	2024

Preamble:

The course is intended to provide the foundations of the practical implementation and usage of Data Structures and algorithms. This course covers basic concepts of Data Structures such as array, stack, queue, tree, graph and hash table that equip the students to solve problems, and design data structures that can tackle real-world challenges.

Prerequisite: Topics covered under the course Problem solving and Programming.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Estimate the time and space complexity and choose the most efficient data structure for specific tasks. **(Cognitive Level : Apply)**
CO 2	Explain and implement fundamental data structures such as arrays, linked lists, stacks, queues, trees and graph (**Cognitive Level : Apply)**
CO 3	Identify the appropriate Hash Function and memory management techniques to enable efficient access of data. **(Cognitive Level : Apply)**
CO 4	Explain various sorting algorithms and compare their time and space complexities. **(Cognitive Level : Apply)**
CO 5	Solve the real world problems using suitable data-structures and calculate the time and space complexity (**Cognitive Level : Apply)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	3	1								3
CO 2	3	3	3	1								3
CO 3	3	3	3	1								3
CO 4	3	3	3	1								3
CO 5	3	3	3	1								3

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate			✓	
Create			✓	

Assessment Pattern for Lab component

Bloom's Category	Continuous Assessment Tools

	Class work	Test1
Remember		✓
Understand	✓	✓
Apply	✓	✓
Analyse	✓	
Evaluate	✓	
Create	✓	

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Practical [P]		Total Marks
		Assignment	Test-1	Test-2	Class work	Lab Exam	
2-1-2-0	5	10	12.5	12.5	10	10	**60**

Total Marks distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	60	40	2.5 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
	Total Marks: 0	Total Marks: [5x8 = 40 marks]	
PATTERN 2		2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x 8 = 40 marks) Time: 2.5 hours	40
	Total Marks: 0	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Basic Concepts of Data Structures (7 hours)

Introduction: Abstract Data Types and Data Structures. Basic complexity analysis – Best, Worst, and Average Cases – Asymptotic Analysis -Analyzing Programs – Space Bounds, Complexity Calculation of Simple Algorithms.

MODULE II : Arrays and Linked List (9 hours)
Array - Stacks, Queues-Circular Queues, Double Ended Queues, Evaluation of Expressions. Linked List - Self Referential Structures, Dynamic Memory Allocation, Singly Linked List-Operations on Linked List. Doubly Linked List, Circular Linked List, Stacks and Queues using Linked List. Applications of array and linked list - Linear Search, Binary Search, Polynomial representation.
MODULE III : Trees and Graphs (8 hours)
Trees -Binary Trees - Binary Tree Representation, Tree Traversals, Priority Queues and Heaps, Binary Search Trees- Binary Search Tree Operations. Graphs, Representation of Graphs, Depth First Search and Breadth First Search on Graphs, Applications of Graphs.
MODULE IV : Sorting and Memory Allocation (5 hours)
Sorting – Internal Sorting -Bubble sort, insertion sort, selection sort— Merge Sort – Quick Sort. External Memory Sorting- The principle behind external sorting Sorting with tapes: balanced merge. Memory allocation and de-allocation-First-fit, Best-fit and Worst-fit allocation schemes.
MODULE V : Hashing Table
Map ADT - Hash Tables and implementation of Map using Hash Tables - Design of hash functions - Collision resolution schemes: chaining, open addressing schemes - linear probing, quadratic probing, double hashing. Applications of Hashing: finding duplicates, set intersection.
Text books 1. Horowitz, Ellis, Sartaj Sahni, and Susan Anderson-Freed. Fundamentals of data structures in C. Silicon Press, 2007. 2. Seymour Lipschutz , Data Structures, Schaum's Outlines Series, Tata McGraw-Hill.,1986. 3. Aaron M. Tenenbaum, Yedidyah Langsam and Moshe J. Augenstein , Data Structures Using C and C++, Prentice Hall of India, 1996. 4. Kruse, Robert, and C. L. Tondo. Data structures and program design in C. Pearson Education India, 2007.
Reference books 1. Cormen, Thomas H., Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. Introduction to algorithms. MIT press, 2022. 2. Richard F. Gilberg, Behrouz A. Forouzan, Data Structures: A Pseudocode Approach with C, 2/e, Cengage Learning,2001. 3. Aho A. V., J. E. Hopcroft and J. D. Ullman, Data Structures and Algorithms, Pearson Publication,1987 4. Tremblay J. P. and P. G. Sorenson, Introduction to Data Structures with Applications, Tata McGraw Hill,1984

5. Peter Brass, Advanced Data Structures, Cambridge University Press,2019
6. Lipschuts S., Theory and Problems of Data Structures, Schaum's Series, 1986
7. Wirth N., Algorithms + Data Structures = Programs, Prentice Hall,1986

Suggested MOOC Courses

1. Data Structures And Algorithms, by Prof. Naveen Garg IIT Delhi

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
MODULE 1		
1.1	Abstract Data Types and Data Structures.	1
1.2	Basic complexity analysis – Best, Worst, and Average Cases – Asymptotic Analysis	1
1.3	Basic complexity analysis – Best, Worst, and Average Cases – Asymptotic Analysis	1
1.4	Analyzing Programs – Space Bounds	1
1.5	Complexity Calculation of Simple Algorithms	1
1.6	Complexity Calculation of Simple Algorithms	1
1.7	Complexity Calculation of Simple Algorithms	1
MODULE II		
2.1	Array	1
2.2	Stacks, Queues	1
2.3	Circular Queues, Double Ended Queues	1
2.4	Evaluation of Expressions.	1
2.5	Linked List - Self Referential Structures, Dynamic Memory Allocation	1
2.6	Singly Linked List-Operations on Linked List.	1
2.7	Doubly Linked List, Circular Linked List	1
2.8	Stacks and Queues using Linked List.	1

2.9	Applications of array and linked list - Linear Search, Binary Search, Polynomial representation.	1
MODULE III		
3.1	Trees- Binary Trees	1
3.2	Binary Tree Representation	1
3.3	Tree Traversals	1
3.4	Priority Queues and Heaps	
3.5	Binary Search Trees- Binary Search Tree Operations.	1
3.6	Graphs- Representation of Graphs	1
3.7	Depth First Search	1
3.8	Breadth-First Search	1
MODULE IV		
4.1	Sorting – Linear Sorting	1
4.2	Merge Sort	1
4.3	Quick Sort	1
4.4	External Memory Sorting	1
4.5	Memory allocation and de-allocation-First-fit Best-fit and Worst-fit allocation schemes	1
MODULE V		
5.1	Map ADT	1
5.2	Hash Tables and implementation of Map using Hash Tables	1
5.3	Design of hash functions	1
5.4	Collision resolution schemes: chaining, open addressing schemes - linear probing, quadratic probing, double hashing.	1
5.5	Collision resolution schemes: chaining, open addressing schemes - linear probing, quadratic probing, double hashing.	1

5.6	Applications of Hashing: finding duplicates, set intersection.	1

LESSON PLAN FOR LAB COMPONENT

No.	Topic	No. of Hours	Nature of lab / assignment / practice
1	Worst-case, average case time/space complexity and their relative merits	1	• Worst/average case analysis for small pseudo-codes
2	Growth functions and application	1	• Recursive and iterative implementation of binary search with applications to problems.
3	Stacks, Queues	1	• Implementation of stacks with application to a problem. • Implement infix to postfix conversion using Stack • Implementation of queues with application to a problem.
4	Linked List	2	• Implement a linked list, and write functions to insert, delete, and traverse nodes in the list. • Write a program for swaping nodes in a linked list without swapping data. • Write a program to reverse a Linked List in groups of given size. • Let X = ($x1$, $x2$, … xn), Y = ($y1$, $y2$, … yn) be two lists with a sorted sequence of elements. Execute a program to merge the two lists together as a list Z with m + n elements. Implement the lists using singly linked list representations. • Suppose an unsorted linked list is in memory. Write a C program to search for an item, and if

			• the search is successful interchange the item with the element in the front of the list
5	Doubly linked lists	2	• Implementation of Doubly linked lists and write functions to insert, delete, and traverse nodes in the list. • Write a menu driven program which will maintain a list of car models, their price, name of the manufacturer, engine capacity, etc., as a doubly linked list. The menu should make provisions for inserting information pertaining to new car models, delete obsolete models, update data such as price, in addition to answering queries such as listing all car models within a price range specified by the client and listing all details, given a car model.
6	Circular Linked List	2	• Implementation of Circular Linked List and write functions to insert, delete, and traverse nodes in the list. • Execute a program that will split a circularly linked list P with n nodes into two circularly linked lists P1, P2 with the first $\lfloor n/2 \rfloor$ and the last n - $\lfloor n/2 \rfloor$ nodes of the list P in them.
7	Tree	2	• Implementation of trees and basic traversal algorithms • Implementation of trees with applications for storing and accessing hierarchical data. • Implement Inorder tree traversal without recursion.

8	Priority Queues and Heaps	2	• Implementation of Priority Queues using heaps and running time analysis. • Implement an algorithm for deleting the i^{th} indexed element in a given min-heap. • Implement an algorithm for finding the k^{th} smallest element in min-heap. • Implementation of Heap-sort.
9	Binary Search Trees	2	• Implementation of Dictionary ADTs using • Binary Search trees and running time analysis
10	Graph	3	• Implementation DFS and BFS traversal using adjacency list • Implement a graph data structure that can represent users in a social network as nodes and friendships as edges. Each user should have a unique identifier. • Count simple paths for a given graph G has simple path from source S to destination D? Assume the graph is represented using the adjacent matrix.
11	Sorting	2	• Implementation of sorting algorithms and compare the running times on large datasets. • You are given an array of n dates in dd-mm-yyyy format. Propose an algorithm to sort the array in chronological order.
12	Hash Table	2	• Implement a hash table using an array data structure. Design functions to handle overflows using linear probing, ii) quadratic

			probing and iii) rehashing. For a set of keys observe the performance when the methods listed above are executed. • Implement a hash table for a given set of keys using the chaining method of handling overflows. Maintain the chains in the ascending order of the keys. • Design a menu-driven front-end interface, to perform the insert, delete and search operations on the hash table. • The following is a list of binary keys: 0011, 1100, 1111, 1010, 0010, 1011, 0111, 0000, 0001, 0100, 1000, 1001, 0011. Design a hash function and an appropriate hash table to store and retrieve the keys efficiently. Compare the performance when the set is stored as a sequential list. • Store a dictionary of a limited set of words as a hash table. Implement a spell check program that, given an input text file, will check for the spelling using the hash table-based dictionary and in the case of misspelled words will correct the same.

CO Assessment Questions

1

i) If T1(n) and T2(n) are the time complexities of two program fragments P1 and P2, where T1(n) = O(f(n)) and T2(n) =O(g(n)), find T1(n) +T2(n) and T1(n).T2(n)

ii) Two algorithms *A* and *B* report time complexities expressed by the functions n^2 and 2^n, respectively. They are to be executed on a machine *M* that consumes 10^{-6} s to execute an instruction. What is the time taken by the algorithms to complete their execution on machine *A* for an input size of 50? If another machine *N* that is 10 times faster than machine *M* is provided for the execution, what is the largest input size that can be handled by the two algorithms on machine *N*? What are your observations?

iii) Analyse the behaviour of the following program, which computes the n^{th} Fibonacci number, for appropriate values of n. Obtain the frequency count of the statements (that are given line numbers) for various cases of n. ($n < 0$, $n = 0$, $n = 1$, $n > 1$)

```
procedure Fibonacci(n)
1.      read(n);
2-4.    if (n<0) then print ("error"); exit();
5-7.    if (n=0) then print ("Fibonacci number is 0");
                      exit();
8-10.   if (n=1) then print ("Fibonacci number is 1");
                      exit();
11-12. f1=0;
       f2=1;
13.     for i = 2 to n do
14-16.    f  = f1 + f2;
          f1 = f2;
          f2 = f;
17.     end
18.     print("Fibonacci number is", f);
end Fibonacci
```

2

i) Implement an abstract data type STAQUE, which is a combination of a linked stack and a linked queue. Develop procedures to perform an insert and delete operation, termed PUSHINS and POPDEL, respectively, on a non-empty STAQUE. PUSHINS inserts an element at the top or rear of the STAQUE based on an indication given to the procedure, and POPDEL deletes elements from the top/front of the list.

ii) Write a procedure to check if an input string is balanced or not. The string may have letters and the following characters “(“, “)”, “{“, “}”, “[“, “]”, “<”, and “>”.

3	i) Insert the following data into a hash table implemented using linear open addressing. Assume that the buckets have three slots each. Make use of the hash function h(X) = X mod 9. {17, 09, 34, 56, 11, 71, 86, 55, 22, 10, 4, 39, 49, 52, 82, 13, 40, 31, 35, 28, 44} ii) Comment on the statement: “To minimize collisions in a linear open addressed hash table it is recommended that the ratio of the number of buckets in a hash table to the number of keys to be stored in the hash table is made bigger”.
4	i) Quick sort the list L = {A, B, N, M, P, R}. What are your observations? How can the observations help you in determining the worst-case complexity of quick sort? ii) Trace the passes bubble sort algorithm on the list L = {K, Q, A, N, C, A, P, T, V, B}. Verify the stability of bubble sort over L.
5	Design a system to efficiently track and manage the inventory of a large e-commerce platform. The inventory consists of various products, each with a unique ID, a name, a category, a price, and a quantity in stock. The system should support the following operations: *Add Product:* Add a new product to the inventory with its details (ID, name, category, price, quantity). *Update Product*: Update the details of an existing product, such as its price or quantity. *Remove Product:* Remove a product from the inventory when it's no longer available. *Search Product:* Search for products based on criteria such as category, price range, or availability. *Get Product Details:* Retrieve detailed information about a specific product given its ID. *Restock Product:* Increase the quantity of a product in stock. *Track Low Stock:* Identify and report products with a quantity below a certain threshold. *Generate Sales Report:* Generate a report of all products sold within a specified time frame. *Calculate Revenue:* Calculate the total revenue earned from product sales. *Top Selling Products:* Identify and display the top-selling products.

24CSP305	COMPUTER ORGANIZATION AND ARCHITECTURE	L	T	P	J	S	C	Year of Introduction
		2	1	2	0	4	4	2024

Preamble: The course is prepared with the view of enabling the learners capable of understanding the fundamental architecture of a digital computer. Study of Computer Organization and Architecture is essential to understand the hardware behind the code and its execution at physical level by interacting with existing memory and I/O structure. It helps the learners to understand the fundamentals about computer system design so that they can extend the features of computer organization to detect and solve problems occurring in computer architecture.

Prerequisite: Topics covered under the course Logic System Design

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the organization and architecture of computer systems with machine instructions and programs **(Cognitive Level: Understand)**
CO 2	Characterize the concept of parallel processing and evaluate cost performance and design trade-offs in designing a pipelined processor. **(Cognitive Level: Evaluate)**
CO 3	Demonstrate the functions of different levels of memory hierarchy and critique the performance issues. **(Cognitive Level: Evaluate)**
CO 4	Familiarize architectural simulators and use them to collect the performance statistics of different technologies. **(Cognitive Level: Apply)**
CO 5	Analyze the input/output devices communicating with computer system. **(Cognitive Level: Analyze)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	1	3								3
CO 2	3	2	2	2						1		3
CO 3	2	2	3	1						2		2
CO 4	3	3	1	2						2		1
CO 5	3	2	3							1		3

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate			✓	
Create			✓	

Assessment Pattern for Lab component

Bloom's Category	Continuous Assessment Tools	
	Class work	Test1
Remember		

Understand	✓	✓
Apply	✓	✓
Analyse	✓	✓
Evaluate	✓	
Create	✓	

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Practical [P]		Total Marks
		Assignment	Test-1	Test-2	Class work	Lab Exam	
2-1-2-0	5	10	12.5	12.5	10	10	**60**

Total Marks distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	60	40	2.5 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 2		2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x 8 = 40 marks) Time: 2.5 hours	40
	Total Marks: 0	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Instruction Set Architecture (7 hours)

Review of number representation and operations. Basic operational concepts. Instruction Set Architecture - CPU registers, Memory location and addresses, Instruction sequencing, Instruction format and encoding, addressing modes.

MODULE II: The Processor (11 hours)

Reduced Instruction Set Computer (RISC) vs Complex Instruction Set Computer (CISC), RISC-V instructions overview.
CPU Performance - Amdahl's law, Building a data path and control, Single cycle processor, Multi-cycle processor, An Overview of Pipelining - Instruction pipelining, Notion of ILP, Data and control hazards and their mitigations.

Module III: Introduction to Memory Hierarchy (6 hours)
Memory Technologies- SRAM/DRAM/Flash. Memory Hierarchy, Locality of reference, The Basics of Caches – handling misses and writes. Trade-offs related to block size, associativity, and cache size.
MODULE IV: Memory Level Optimization (7 hours)
Measuring and improving cache performance - Average memory access time, Basic optimizations - Reducing Cache Misses, Reducing miss penalty, Software optimization. Cache replacement policies (LRU). Introduction to multicore systems and cache coherence
MODULE V: Storage and I/O (5 hours)
Introduction to magnetic disks (notion of tracks, sectors). Accessing I/O devices, Interrupts, I/O mapped I/O, Memory mapped I/O. I/O data transfer techniques - programmed I/O, Interrupt-driven I/O, and DMA.
Text books 1. "Computer Organization and Design: The Hardware/Software Interface", David A. Patterson and John L. Hennessy, 5th Edition, Elsevier. 2. "Computer Organization and Embedded Systems", Carl Hamacher, 6th Edition, McGraHill Education.
Reference books 1. "Computer Organization & Architecture", Smruti Ranjan Sarangi, McGraw Hill. 2. "Computer System Architecture", Mano M. Morris, Pearson. 3. "Computer Architecture and Organization", 3rd Edition by John P. Hayes, WCB/McGraw-Hill 4. "Computer Organization and Architecture: Designing for Performance", 10th Edition by William Stallings, Pearson Education.

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
	MODULE 1	
1.1	Review of number representation and operations.	1
1.2	Basic operational concepts.	1
1.2	CPU registers, Memory location and addresses	1
1.3	Instruction sequencing (Lecture 1)	1
	Instruction sequencing (Lecture 2)	1
1.4	Instruction format and encoding	1
1.5	Addressing modes	1
	MODULE II	
2.1	RISC vs CISC**,** RISC-V instructions (Lecture 1)	1
	RISC vs CISC**,** RISC-V instructions (Lecture 2)	1
2.2	Comparison of RISC-V with X86 Instruction set	1

2.3	CPU Performance- Amdahl's law	1
2.4	Building a data path and control	1
2.5	Single-cycle processor and Multi-cycle processor	1
2.6	An Overview of Pipelining	1
2.7	Instruction pipelining, Notion of ILP	1
2.8	Data hazards and its mitigations (Lecture 1)	1
	Data hazards and its mitigations (Lecture 2)	1
2.9	Control hazards	1
	MODULE III	
3.1	Memory Technologies - SRAM/DRAM/Flash (Lecture1)	1
	Memory Technologies - SRAM/DRAM/Flash (Lecture2)	1
3.2	Memory Hierarchy**,** Locality of reference	1
3.3	The Basics of Caches - handling misses and writes (Lecture1)	1
	The Basics of Caches - handling misses and writes (Lecture2)	1
3.4	Trade-offs related to block size, associativity, and cache size.	1
	MODULE IV	
4.2	Measuring and improving cache performance - Average memory access time (Lecture1)	1
	Measuring and improving cache performance - Average memory access time (Lecture2)	1
4.3	Basic optimizations - Reducing Cache Misses, Reducing miss penalty, Software optimization (Lecture1)	1
	Basic optimizations - Reducing Cache Misses, Reducing miss penalty, Software optimization (Lecture2)	1
4.4	Cache replacement policies (LRU)	1
4.5	Introduction to multicore systems and cache coherence (Lecture1)	1
	Introduction to multicore systems and cache coherence (Lecture2)	1
	MODULE V	
5.1	Introduction to magnetic disks (the notion of tracks, sectors).	1
5.2	Accessing I/O devices, I/O mapped, and memory mapped I/O.	1
5.3	Interrupts	1
5.4	I/O data transfer techniques: programmed I/O, Interrupt-driven I/O	1
5.5	DMA.	1

SYLLABUS FOR LAB COMPONENT

No.	Topic	No. of Hours	Pool of Experiments
1	Introduction to a RISC-V simulator	6	• Generate some interesting numbers (for example - Happy numbers/ Autonomic numbers/ Hardy Ramanujan numbers, etc.) • Implement a 4-function calculator. • Sort an integer array using merge sort (recursive) • Evaluate an arithmetic expression specified as a string (using recursive functions)
2	Introduction to an architectural simulator like gem5.	4	• Familiarization of gem5 • Configure gem5
3	Statistical Collection from gem5 for various pipeline configurations.	8	• Write or generate a sequence of instructions and observe the overall pipeline stalls with and without data hazards, control hazards, and with/without data forwarding. • Rearrange the sequence of instructions or the program so that the pipeline stalls will be minimized.
4	Modelling cache memory and collecting statistics from gem5.	6	• Run a program and examine the IPC, cache hit rate, number of conflict misses and block replacements. • Vary the cache size, block size, and associativity and analyze the metrics and reason the changes observed.

CO Assessment Questions	
CO1	List the steps needed to execute the machine instruction: Add R4, R2, R3 in terms of transfers between the components of processor and some simple control commands. Assume that the address of the memory-location containing this instruction is initially in register PC.

CO2	Assume that 20% of the dynamic count of the instructions executed for a program are branch instructions. There are no pipeline stalls due to data data dependencies. Static branch prediction is used with a non-taken assumption. Determine the execution times for two cases: when 30% of the branches are taken, and when 70% of the branches are taken.
CO3	The purpose of using an L2 cache is to reduce the miss penalty of the L1 cache, and in turn to reduce the memory access time as seen by the processor. An alternative is to increase the size of the L1 cache to increase the hit rate. What limits the utility of this approach?
CO4	Run gem5 simulations with different pipeline configurations (e.g., varying pipeline depth or width). Record and analyze the statistics related to IPC (Instructions Per Cycle)
CO5	Design a parallel priority interrupt hardware for a system with eight interrupt sources.

24HUT310	LIFE SKILLS AND PROFESSIONAL ETHICS	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The objective of this course is to enhance the employability and maximize the potential of the students by introducing them to the principles underlying personal and professional success. It equips them with the necessary skills to apply these principles effectively in their lives and careers. This course covers essential life skills for personal and professional success, introduces creative problem-solving techniques, fosters teamwork and leadership qualities, highlights the core values of professional ethics, and explains how individuals play a crucial role in technological development while maintaining personal and legal ethical standards.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Describe different life skills required in personal and professional life (Understand Level)
CO2	Illustrate appropriate thinking and problem-solving techniques to solve new problems creatively (Apply Level)
CO3	Demonstrate the basics of teamwork and leadership qualities (Apply Level)
CO4	Identify the core values that shape the ethical behaviour of a professional. (Understand Level)
CO5	Explain the role and responsibility in technological development upholding personal ethics and legal ethics (Understand Level)

CO – PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						✓		✓			✓	✓
CO2		✓	✓	✓				✓	✓		✓	✓
CO3								✓				✓
CO4								✓				✓
CO5						✓		✓				✓

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				

<table>
<tr><th colspan="6">Mark Distribution of CIA</th></tr>
<tr><th rowspan="2">Course Structure [L-T-P-J]</th><th rowspan="2">Attendance</th><th colspan="3">Theory [L-T]</th><th rowspan="2">Total Marks</th></tr>
<tr><th>Assignment</th><th>Test-1</th><th>Test-2</th></tr>
<tr><td>3-0-0-0</td><td>5</td><td>15</td><td>10</td><td>10</td><td>40</td></tr>
</table>

<table>
<tr><th colspan="4">Total Mark distribution</th></tr>
<tr><th>Total Marks</th><th>CIA (Marks)</th><th>ESE (Marks)</th><th>ESE Duration</th></tr>
<tr><td>100</td><td>40</td><td>60</td><td>3 hrs</td></tr>
</table>

<table>
<tr><th colspan="4">End Semester Examination [ESE]: Pattern</th></tr>
<tr><th>Pattern</th><th>Part A</th><th>Part B</th><th>ESE Marks</th></tr>
<tr><td>PATTERN 1</td><td>10 Questions, each question carries 2 marks

Marks: (2×10 =20 marks)</td><td>2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions.
Each question carries 8 marks.
Marks: (5×8 = 40 marks)
Time: 3 hours</td><td>60</td></tr>
<tr><td></td><td>Total Marks: 20</td><td>Total Marks: [5×8 = 40 marks]</td><td></td></tr>
</table>

SYLLABUS

MODULE 1 (FOUNDATION OF LIFE SKILLS)

Understanding Life Skills*:* Meaning and Significance of Life Skills-WHO-Identified Life Skills-Life skills for professionals

Self-awareness: Definition and Need-Tools and Techniques of Self-awareness

Stress Management: Stress, reasons and effects- stress diaries- Four A's of stress management

Coping with emotions: Identifying and managing emotions- PATH method and relaxation techniques

(Group activities for self awareness and stress management)

MODULE 2 (21ST CENTURY SKILLS AND PROBLEM-SOLVING TECHNIQUES)

21st Century Skills*:* Creativity, Critical Thinking, Collaboration, Problem Solving, Decision Making- Lateral Thinking- Critical thinking Vs Creative thinking

Problem Solving Techniques: Six Thinking Hats- Mind Mapping- Forced Connections-Scientific temperament and Logical thinking with case studies. (Activity based learning)

MODULE 3 (GROUP DYNAMICS AND LEADERSHIP)
Group and Team Dynamics: Composition, Formation-Problem Solving in Groups-Group vs Team, Team Dynamics- Managing team performance(Activity based learning) Leadership: Leadership Framework -Types of Leadership- VUCA Leadership- Transactional vs Transformational Leaders
MODULE 4 (HUMAN VALUES)
Morals, values and Ethics – Integrity- Academic integrity-Work Ethics- Service Learning-Civic Virtue- Respect for others- Living peacefully- Caring and Sharing- Honestly- courage-Cooperation commitment- Empathy-Self Confidence -Social Expectations. Case study on Engineering disasters (Include study of Ethical issues in a recent disaster) Code of Conduct in Engineering profession.
MODULE 5 (RESPONSIBILITIES & RIGHTS)
Collegiality and loyalty – Managing conflict- Respect for authority- Collective bargaining-Confidentiality-Role of confidentiality in moral integrity-Conflicts of interest- Occupational crime- Professional rights-Employee right- IPR Discrimination Global ethical issues- Business ethics, Computer Ethics, Environment ethics – Role in technological development-Engineers as Managers- Consulting Engineers- Engineers as Expert witnesses and advisors.
Text books 1. Remesh S., Vishnu R.G., "Life Skills for Engineers", Ridhima Publication, First Edition 2016 2. ICT Academy of Kerala, "Life Skills for Engineers", McGraw Hill Education (India) Private Ltd., 2016 3. Mike W Martin and Roland Schinzinger, Ethics in Engineering,4th edition, Tata McGraw Hill Publishing Company Pvt. Ltd, New Delhi,2014.
Reference books 1. Shiv Khera, You Can Win, Macmillan Books, New York, 2003 2. Barun K. Mitra, “Personality Development & Soft Skills”, Oxford Publishers, Third impression, 2017. 3. Shalini Verma, “Development of Life Skills and Professional Practice”; First Edition; Sultan Chand (G/L) & Company, 2014 4. Charles D Fleddermann, Engineering Ethics, Pearson Education/ Prentice Hall of India, New Jersey, 2004. 5. Charles E Harris, Michael S Protchard and Michael J Rabins, Engineering Ethics-Concepts and cases, Wadsworth Thompson Learning, United states,2005. 6. Guidelines for Professional Conduct for Civil Engineers ASCE, 2008

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours (36 hours)
MODULE 1 (8 Hours)		
1.1	Understanding Life Skills: Meaning and Significance of Life Skills-WHO-Identified Life Skills-Life skills for professionals	1
1.2	Self-awareness: Definition and Need-Tools and Techniques of Self-awareness	1
1.3	Activity based on Self-awareness	1
1.4	Activity based on Self-awareness	1
1.5	Stress Management: Stress, reasons and effects- stress diaries- Four A's of stress management	1
1.6	Coping with emotions: Identifying and managing emotions- PATH method and relaxation techniques	1
1.7	Activity based on Stress Management	1
1.8	Activity based on Stress Management	1
MODULE 2 (7 Hours)		
2.1	21st Century Skills: Creativity, Critical Thinking, Collaboration, Problem Solving	1
2.2	Decision Making- Lateral Thinking- Critical thinking Vs Creative thinking (1 hour for exercise)	1
2.3	Activity based on Lateral Thinking, Critical and Creative thinking	1
2.4	Problem Solving Techniques: Six Thinking Hats- Mind Mapping-Forced Connections (2 hours for activity)	1
2.5	Activity based on problem solving techniques	1
2.6	Activity based on problem solving techniques	1
2.7	Scientific temperament and Logical thinking with case studies	1
MODULE 3 (7 Hours)		
3.1	Group and Team Dynamics: Composition, Formation-Problem Solving in Groups	1
3.2	Group vs. Team, Team Dynamics- Managing team performance (2 hours for activity)	1
3.3	Activity based on Team Dynamics	1
3.4	Activity based on Team Dynamics	1
3.5	Leadership: Leadership Framework -Types of Leadership	1
3.6	VUCA Leadership	1
3.7	Transactional vs. Transformational Leaders	1
MODULE 4 (7 Hours)		
4.1	Morals, values and Ethics – Integrity- Academic integrity	1

4.2	Work Ethics- Service Learning- Civic Virtue- Respect for others- Living peacefully	1
4.3	Honestly- courage-Cooperation commitment- Empathy	1
4.4	Self Confidence -Social Expectations.	1
4.5	Case study on Engineering disasters	1
4.6	Case study on Engineering disasters	1
4.7	Code of Conduct in Engineering profession	1
MODULE 5 (7 Hours)		
5.1	Collegiality and loyalty – Managing conflict- Respect for authority	1
5.2	Collective bargaining- Confidentiality-Role of confidentiality in moral integrity	1
5.3	Conflicts of interest- Occupational crime	1
5.4	Professional rights-Employee right- IPR Discrimination	1
5.5	Global ethical issues- Business, Engineering, Environment.	1
5.6	Role in technological development-Engineers as Managers-Consulting Engineers	1
5.7	Engineers as Expert witnesses and advisors.	1

CO Assessment Questions	
CO1	1. List 'life skills' as identified by WHO. 2. Explain the essential life skills required by a professional.
CO2	1. Illustrate the creative thinking process with the help of a suitable example 2. "Imagine you are tasked with addressing a complex environmental issue, such as reducing plastic waste in a coastal community”. How would you apply the Six Thinking Hats technique to explore different facets of the problem and generate potential solutions?
CO3	1. “A group focuses on individual contribution, while a team must focus on synergy.” Explain. 2. "Imagine you are part of a diverse team tasked with addressing a complex organizational challenge in a VUCA environment. Apply your knowledge of group formation and composition to strategically assemble a team that can effectively tackle the issue.
CO4	1. Define integrity and point out ethical values 2. Explain the role of engineers in modern society
CO5	1. Distinguish between self-interest and conflicts of interest 2. Explain the role of professional ethics in technological development.

24EST322	BASIC ENGINEERING MECHANICS	L	T	P	J	S	C	Year of Introduction
		2	0	0	0	2	2	2024

Preamble:
The objective this course is to expose the students to the fundamental concepts of mechanics and enhance their problem-solving skills. It introduces students to the influence of applied force system and the geometrical properties of the rigid bodies. After this course students will be able to recognize similar problems in real-world situations and respond accordingly.

Prerequisite: Nil

Course Outcomes:

CO	After the completion of the course the student will be able to
CO 1	Recall principles and theorems related to rigid body mechanics.[Remember level]
CO 2	Identify and describe the components of system of forces acting on a rigid body. [Understand level]
CO 3	Apply the conditions of equilibrium to various practical problems involving different force systems. [Apply level]
CO 4	Analyse linear, curvilinear and rotary motion of rigid bodies. [Apply level]
CO 5	Determine the properties of distributed areas. [Apply level]

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	1	-	-	-	-	-	-	-	-	-	-	-
CO 2	1	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	2	-	-	-	-	-	-	-	-	-	-
CO 4	3	2	-	-	-	-	-	-	-	-	-	-
CO 5	2	1	-	-	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	
Understand	✓	✓	✓	
Apply	✓	✓	✓	
Analyse			✓	
Evaluate			✓	
Create			✓	

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L-T]			Total Marks
		Assignment	Test-1	Test-2	
2-0-0-0	5	35	30	30	100

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	100	--	--

End Semester Examination [ESE] Pattern
There is no End Semester Examination.

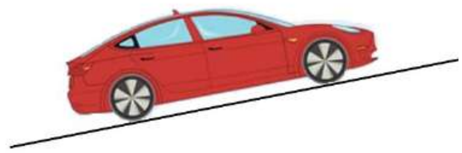
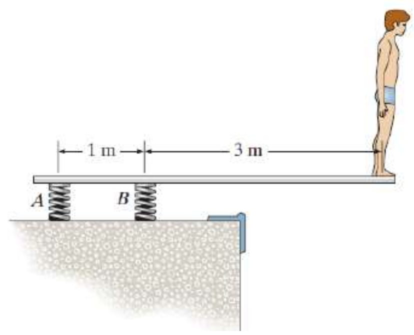
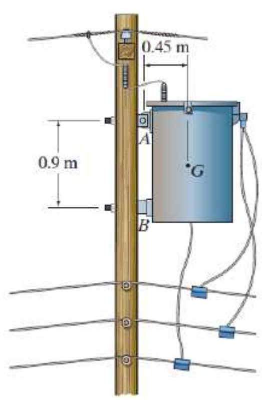
SYLLABUS
Module I **(Resultant of Concurrent Force Systems)**
Introduction to Engineering Mechanics-statics-basic principles of statics- principles of superposition and transmissibility, law of action and reaction(review). Free body diagrams. Parallelogram law, equilibrium law. Concurrent coplanar forces-composition and resolution of forces, resultant – methods of projections. Equilibrium – equations. Equilibrant.
Module II-Resultant of Non-concurrent Force Systems, Equilibrium of Rigid Bodies
Non-Concurrent coplanar forces – Varignon's Theorem of moments. Parallel coplanar forces – couple. Resultant of non-Concurrent coplanar forces. Equilibrium of bodies subjected to general coplanar force system - equilibrium equations. Friction – sliding friction - Coulomb's laws of friction – analysis of single bodies, ladder friction.
Module III-Centroid and Moment of Inertia, Support Reaction of Beams
Centroid of composite areas– Moment of inertia-parallel axis and perpendicular axis theorems. Polar moment of inertia, radius of gyration. Support reaction of simple beams subject to concentrated vertical loads and UDL.
Module IV-Kinetics of Translation
Mass moment of inertia-ring, cylinder and disc. (Concept only) Dynamics – review of Newton's Laws –D'Alembert's principle. – motion on horizontal and inclined surfaces, motion of connected bodies.
Module V-Kinematics and Kinetics of Rotation
Impulse momentum equation and work energy equation (concepts only). Curvilinear translation – Review of Kinematics- kinetics – equation of motion. Rotation – kinematics of rotation- equation of motion for a rigid body rotating about a fixed axis – rotation under a constant moment. Plane motion of rigid body – instantaneous centre of rotation (concept only).
Text Books: 1. Timoshenko and Young, Engineering Mechanics, McGraw Hill Publishers.

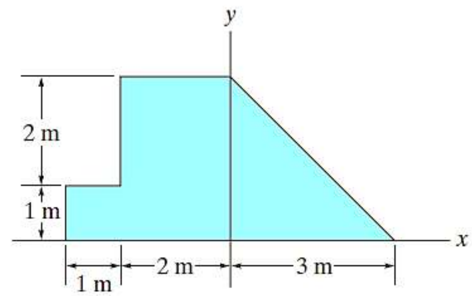
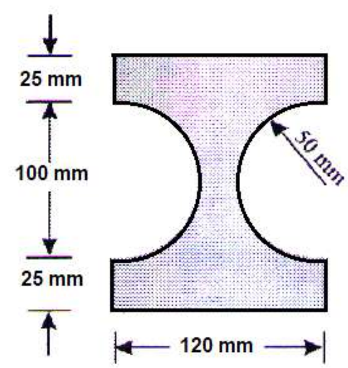
2. Shames, I. H., Engineering Mechanics - Statics and Dynamics, Prentice Hall of India. 2. R. C. Hibbeler and Ashok Gupta, Engineering Mechanics, Vol. I statics, Vol II Dynamics, Pearson Education. **Reference Books:** 1. Merriam J. L and Kraige L. G., Engineering Mechanics - Vols. 1 and 2, John Wiley. 2. Tayal A K, Engineering Mechanics – Statics and Dynamics, Umesh Publications. 3. Bhavikkatti, S.S., Engineering Mechanics, New Age International Publishers 4. F.P.Beer abd E.R.Johnston (2011), Vector Mechanics for Engineers, Vol.I-Statics, Vol.II-Dynamics, 9th Ed, Tata McGraw Hill 5. Rajasekaran S and Sankarasubramanian G, Engineering Mechanics - Statics and Dynamics, Vikas Publishing House Pvt Ltd.

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
Module 1 (6 Hours)		
1.1	Introduction to Mechanics – Mechanics of Rigid Bodies (EMS), Mechanics of deformable Bodies (MoS) and Mechanics of fluids (FM). Relevance of Engineering Mechanics, introduction to studies of bodies at rest (Statics) and studies of bodies in motion (Dynamics). Rigid bodies, Principle of transmissibility of forces, Principle of superposition, law of action and reaction.	1
1.2	Free body diagrams (FBDs) – concept and examples, Exercise problems on drawing FBDs.	1
1.3	Resolution of forces – rectangular components. Resultant of two forces - Parallelogram law.	1
1.4	System of coplanar forces – concurrent and non- concurrent forces. Resultant force of a system of concurrent coplanar forces – method of projections.	1
1.5	Teacher assisted problem solving on resultant of system of concurrent coplanar forces.	1
1.6	Equilibrium – equations for a body subjected to a system of concurrent coplanar forces. Equilibrant.	1
Module II (5 Hours)		
2.1	Moment of a force, Varignon's Theorem of moments. Parallel coplanar forces – couple.	1
2.2	Resultant of non-concurrent coplanar forces	1
2.3	Equilibrium of bodies subjected to general coplanar force system - equilibrium equations.	1

2.4	Introduction to Friction – sliding friction - Coulomb's laws of friction – analysis of single bodies. Ladder friction	1
2.5	Teacher assisted problem solving	1
Module III (5 Hours)		
3.1	Centroid – Concept, Centroid of simple and regular geometrical shapes – Rectangle, right angled triangle, circle, semi-circle.	1
3.2	Location of centroids using principle of moments. Centroid of composite areas- examples for illustration – problems	1
3.3	Moment of inertia-Concept, Moment of inertia of simple figures using integration. Parallel axis theorem – Demonstration. Perpendicular axis theorem – polar moment of inertia. Radius of gyration.	1
3.4	Beams- Types, Support conditions, Loads on beams- Concentrated and UDL. Simple beam subject to concentrated vertical loads and UDL- support reactions.	1
3.5	Teacher assisted problem solving.	1
Module IV (4 Hours)		
4.1	Mass moment of inertia – ring, disc, cylinder (concept and equation). Introduction to dynamics – kinematics and kinetics. Newtons Laws – review.	1
4.2	D'Alembert's principle - Illustration of the concepts using one numerical exercise from motion on horizontal and inclined surfaces	1
4.3	Motion of connected bodies – problems.	1
4.4	Teacher assisted problem solving.	1
Module V (4 Hours)		
5.1	Concepts of impulse momentum equation and work energy equation. Curvilinear translation – Review of Kinematics.	1
5.2	Curvilinear translation – Kinetics – equations.	1
5.3	Rotation – kinematics and kinetics of rotation- equation of motion for a rigid body rotating about a fixed axis, motion of cylinder/disc – rolling without slip. Plane motion of rigid body – instantaneous centre of rotation (concept only).	1
5.4	Teacher assisted problem solving.	1

CO Assessment Questions		
CO 1	1	State and explain principle of superposition of forces.
	2	Explain D'Alembert's principle.

CO 2	1	A person is standing on the rung of a ladder placed on a smooth horizontal floor against a rough vertical wall. Identify all forces acting on the ladder and draw its free body diagram.
	2	A car is resting on an inclined plane as shown in figure. Identify all forces acting on the car and draw the free body diagram of the car. 
CO 3	1	A boy stands out at the end of the diving board, which is supported by two springs *A* and *B*, each having a stiffness of k = 15 kN/m. In the position shown the board is horizontal. If the boy has a weight of 400 N, determine the angle of tilt which the board makes with the horizontal after he jumps off. Neglect the weight of the board and assume it is rigid. 
	2	The 1500-N electrical transformer with center of gravity at *G* is supported by a pin at *A* and a smooth pad at *B*. Determine the horizontal and vertical components of reaction at the pin *A* and the reaction of the pad *B* on the transformer. 
CO 4	1	An engine of weight 500 kN pull a train weighing 1500 kN up an incline of 1 in 100. The train starts from rest and moves with constant acceleration against a resistance of 5 N/kN. It attains a maximum speed of 36 kmph in 1 km distance. Determine the tension in the coupling between train and engine and the traction force developed by the engine.

	2	A right circular cylinder of mass *m* and radius *r* is suspended from a cord that is wound round its circumference. If the cylinder is allowed to fall freely, find the acceleration of its mass centre and tension in the cord.
CO 5	1	Locate the centroid of the plate shown in figure. 
	2	The cross section of a beam is shown in figure. Determine the moments of inertia of the section about its horizontal and vertical axes passing through the centroid. 

MINOR – S3

		L	T	P	J	S	C	Year of Introduction
24CSM309	**Python for Machine Learning**	**4**	**0**	**0**	**0**	**4**	**4**	**2024**

Preamble: This course enables the learners to develop web applications, Machine Learning, and Artificial Intelligence-based applications and tools, Data Science and Data Visualization applications. It covers programming environment, important instructions, data repressentations, intermediate level features, Object Oriented Programming and file data processing of Python. The objective of the course is to provide learners an insight into Python programming, and develop programming skills to manage the development of software systems.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Write, test and debug Python programs (**Apply Level**)
CO2	Illustrate uses of conditional (if, if-else, if-elif-else and switch-case) and iterative (while and for) statements in Python programs (**Apply Level**)
CO3	Develop programs by utilizing the modules Lists, Tuples, Sets and Dictionaries in Python (**Apply Level**)
CO4	Implement Object Oriented programs with exception handling (**Apply Level**)
CO5	Write programs in Python to process data stored in files by utilizing the modules Numpy, Matplotlib, and Pandas (**Apply Level**)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**3**	**3**									**3**
CO2	**3**	**3**	**3**									**3**
CO3	**3**	**3**	**3**									**3**
CO4	**3**	**3**	**3**									**3**
CO5	**3**	**3**	**3**	**1**	**3**							**3**

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

	Attendance	Theory [L- T]	

Course Structure [L-T-P-J]		Assignment	Test-1	Test-2	Total Marks
4-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : <<Programming Environment and Python Basics>>

Getting Started with Python Programming - Running code in the interactive shell, Editing, Saving, and Running a script. Using editors - IDLE, Jupyter. The software development process - Case Study. Basic coding skills - Working with data types, Numeric data types and Character sets, Keywords, Variables and Assignment statement, Operators, Expressions, Working with numeric data, Type conversions, Comments in the program. Input, Processing, and Output. Formatting output. How Python works. Detecting and correcting syntax errors. Using built in functions and modules in math module.

MODULE II : <<Building Python Programs>>

Control statements - Selection structure (if-else, switch-case), Iteration structure(for, while), Testing the control statements, Lazy evaluation. Functions - Hiding redundancy and complexity, Arguments and return values, Variable scopes and parameter passing, Named arguments, Main function, Working with recursion, Lambda functions. Strings and number systems - String function, Handling numbers in various formats.

MODULE III : <<Data Representation>>
Lists - Basic list Operations and functions, List of lists, Slicing, Searching and sorting list, List comprehension. Work with tuples. Sets. Work with dates and times. Dictionaries - Dictionary functions, dictionary literals, adding and removing keys, accessing and replacing values, traversing dictionaries, reverse lookup. Case Study - Data Structure Selection.
MODULE IV : <<Object Oriented Programming>>
Design with classes - Objects and Classes, Methods, Instance Variables, Constructor, Accessors and Mutators. Structuring classes with Inheritance and Polymorphism. Abstract Classes. Exceptions - Handle a single exception, handle multiple exceptions.
MODULE V : <<Data Processing>>
The os and sys modules. Introduction to file I/O - Reading and writing text files, Manipulating binary files. NumPy - Basics, Creating arrays, Arithmetic, Slicing, Matrix Operations, Random numbers. Plotting and visualization. Matplotlib - Basic plot, Ticks, Labels, and Legends. Working with CSV files. – Pandas - Reading, Manipulating, and Processing Data.

Text books

1. Kenneth A Lambert., Fundamentals of Python : First Programs, 2/e, Cengage Publishing, 2016.
2. Wes McKinney, Python for Data Analysis, 2/e, Shroff / O'Reilly Publishers, 2017.

Reference books

1. Allen B. Downey, Think Python: How to Think Like a Computer Scientist, 2/e, Schroff, 2016.
2. Michael Urban and Joel Murach, Python Programming, Shroff/Murach, 2016.
3. David M.Baezly, Python Essential Reference. Addison-Wesley Professional; 4/e, 2009.

Suggested MOOC Courses

1. NPTEL Course - Python for Data Science by Prof. Raghunathan Rengaswamy, IIT Madras.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1 (10)		
1.1	Getting Started with Python Programming: Running code in the interactive shell Editing, Saving, and Running a script	1
1.2	Using editors: IDLE	1
1.3	Jupyter	1
1.4	The software development process: Case Study	1

1.5	Basic coding skills: Working with data types, Numeric data types and Character sets, Keywords, Variables and Assignment statement, Operators, Expressions	1
1.6	Working with numeric data, Type conversions, Comments in the program	1
1.7	Input, Processing, and Output, Formatting output – How Python works	1
1.8	How Python works – Detecting and correcting syntax errors	1
1.9	Using built in functions and modules: Case – Using math module	1
1.10	Using built in functions and modules: Case – Using math module (Examples)	1
MODULE II (8)		
2.1	Control statements: Selection structure (if-else, switch-case)	1
2.2	Iteration structure (for, while), Testing the control statements, Lazy evaluation	1
2.3	Functions: Hiding redundancy and complexity, Arguments and return values,	1
2.4	Variable scopes and parameter passing	1
2.5	Named arguments, Main function,	1
2.6	Working with recursion, Lambda functions	1
2.7	Strings and number systems: String function	1
2.8	Handling numbers in various format	1
MODULE III (9)		
3.1	Lists: Basic list Operations and functions, List of lists	1
3.2	Slicing, Searching and sorting list	1
3.3	List comprehension	1
3.4	Work with tuples, Sets	1
3.5	Work with tuples, Sets	1
3.6	Dictionaries: Dictionary functions,	1

3.7	Dictionaries: Dictionary functions,	1
3.8	Traversing dictionaries, reverse lookup	1
3.9	Case Study: Data Structure Selection	1
	MODULE IV (8)	
4.1	Design with classes : Objects and Classes, Methods, Instance Variables	1
4.2	Constructor, Accessors and Mutators	1
4.3	Structuring classes with Inheritance	1
4.4	Polymorphism	1
4.5	Abstract Classes	1
4.6	Abstract Classes	1
4.7	Exceptions : Handle a single exception	1
4.8	Handle multiple exceptions	1
	MODULE V (10)	
5.1	The os and sys modules	1
5.2	Introduction to file I/O: Reading and writing text files	1
5.3	Manipulating binary files	1
5.4	NumPy : Basics, Creating arrays, Arithmetic, Slicing	1
5.5	Matrix Operations, Random numbers	1
5.6	Matplotlib : Basic plot	1
5.7	Matplotlib - Ticks, Labels, and Legends	1
5.8	Working with CSV files	1
5.9	Pandas : Reading, Manipulating	1
5.10	Pandas : Processing Data and Visualize.	1

CO Assessment Questions	
1	1. Implement a Python program to print the value of 22n+n+5 for n provided by the user. 2. Implement a python program to convert temperature in degree Fahrenheit to Celsius. ((farenheit-32) *5/9= Celsius))
2	1. Input 4 integers (+ve and −ve). Implement a Python code to find the sum of negative numbers, positive numbers, and print them. Also, find the averages of these two groups of numbers and print. 2. Implement a Python Program to reverse a number and also find the sum of digits of the number (prompt the user for input).
3	1. Given is a list of of words, wordlist, and a string, name. Write a Python function which takes wordlist and name as input and returns a tuple. The first element of the output tuple is the number of words in the wordlist which have name as a substring in it. The second element of the tuple is a list showing the index at which the name occurs in each of the words of the wordlist and a 0 if it doesn't occur. 2. Implement a Python program to find the largest and second largest of n numbers in a list. Assume n>=3 and all the numbers are distinct.
4	1. Consider a Rectangle Class and create two Rectangle Objects. Write Python program to check whether the area of the first rectangle is greater than second by overloading > operator. 2. Create a class student with name, roll number, marks of 3 subjects and total marks as attributes. Read_data() ,display_data() and compute_total() should be the three methods. Write a python program to create 2 objects of the class, read, display and calculate the total marks
5	1. Given a file "auto.csv" of automobile data with the fields index, company, body-style, wheel-base, length, engine-type, num-of-cylinders, horsepower, average mileage, and price, write python code to a. Clean and Update the CSV file b. Print total cars of all companies c. Find the average mileage of all companies d. Find the highest priced car of all companies 2. Given the sales information of a company as CSV file with the following fields month_number, facecream, facewash, toothpaste, bathingsoap, shampoo, moisturizer, total_units, total_profit. Write Python codes to visualize the data as follows a. Toothpaste sales data of each month and show it using a scatter plot b. Face cream and face wash product sales data and show it using the bar chart. c. Calculate total sale data for last year for each product and show it using a Pie chart.

24CSM310	Object Oriented Programming	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	4	4	2024

Preamble: This course enables the learners to understand the fundamental principles of object-oriented programming and provide them with the necessary skills to develop robust and scalable Java applications. This course covers the basics of object-oriented concepts, UML Class Diagram and Usecase Diagram, Packages and Interfaces, Collection framework and Exception handling, Event Handling and GUI Programming which helps the students to design and develop application-based solutions for real world problems.

Prerequisite: Basics of Problem solving and Programming.

Course Outcomes: After the completion of the course the student will be able to

CO1	Design a UML structural and behavioural model for solving real world problems. **(Analyze Level)**
CO2	Develop programs to solve problems using object-oriented design techniques through Java. **(Apply Level)**
CO3	Illustrate the creation and usages of packages and interfaces in Java.(**Understand Level)**
CO4	Demonstrate the exception handling mechanism to handle run time errors. **(Apply Level**)
CO5	Make use of collection interfaces and classes to store and manipulate data effectively**. (Apply Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3									3
CO5	3	3	3									3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test 1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA						
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
4-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I :Basics of Object-Oriented concepts and Java `(10 hrs)

Approaches to Software Design - Functional Oriented Design, Object Oriented Design, Case Study of Payroll Program. Object-Oriented concepts. Object Modeling using Unified Modeling Language (UML) – Static and Dynamic models, UML diagrams- Use case diagram, Class diagram.

Introduction to Java- JRE, JDK, JVM, Program Structure, Primitive Data types, Arrays, Command-Line Arguments, Type conversions and promotion, Garbage collection.

MODULE II :Fundamentals of Core Java (10 hrs)

Classes and Objects. Constructors. Object class in Java. Use of static, this and final keywords. Method Overloading. Objects as Parameters to Methods. Access modifiers and Packages, Strings- Class and Methods, String Buffer and String Tokenizer. Reading Input from Console Using Scanner class.

MODULE III :Inheritance, Polymorphism (8 hrs)

Inheritance - Basics and Types, super keyword, calling superclass constructor from child class constructor, Method Overriding, using final with inheritance. Abstract Classes and methods. Interface- Basics, Multiple inheritance through interfaces, interface inheritance.

MODULE IV :Collection Framework and Exception Handling (9 hrs)

Collection Framework- concepts, Collection Interfaces and their Methods, List interface, Collections Class – Array List, Vector, Linked List. Accessing a Collection via an Iterator. Exception handling: Exception Basics and Types, try, catch, throw, throws, finally keywords, User defined exceptions.

MODULE V :Event Handling and GUI Programming (8 hrs)

Delegation Event Model, Event Classes, Listener Interfaces, Introduction to Java's Swing Package, Components, Containers and Layouts, Exploring Swings – JFrame, Jpanel, JLabel, JTextField, JTextArea, JButton, JToggleButton, Check Boxes, Radio Buttons, JScrollPane, JMenu, JMenuBar and JMenuItem, Designing Frames and Adding GUI Components, Event Handling in Swings,Swing vs JavaFX.

Text books

1. Herbert Schildt, The Complete Reference -Java, Tata McGraw-Hill Education, Tenth Edition, 2017.
2. G Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides, and Grady Booch. Design Patterns: Elements of Reusable Object-Oriented Software.
3. Object Oriented Design & Patterns, Cay Horstmann, John Wiley & Sons, 2004
4. Grady Booch, Robert A. Maksimchuk, Michael W. Engle, Bobbi J. Young, Jim Conallen, Kelli A, Houston. Object-Oriented Analysis and Design with Applications.

Reference books

1. Y. Daniel Liang, Introduction to Java Programming, 7/e, Pearson, 2013.
2. Nageswararao R., Core Java: An Integrated Approach, Dreamtech Press, 2008.
3. Flanagan D., Java in A Nutshell, 5/e, O'Reilly, 2005.
4. Barclay K., J. Savage, Object Oriented Design with UML and Java, Elsevier, 2004.
5. Sierra K., Head First Java, 2/e, O'Reilly, 2005.
6. Balagurusamy E., Programming JAVA a Primer, 5/e, McGraw Hill, 2014.

NPTEL/SWAYAM Courses

1. Programming in Java, Prof. Debasis Samanta | IIT Kharagpur

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (hrs)
MODULE 1		

1.1	Approaches to Software Design - Functional Oriented Design, Object Oriented Design	1
1.2	Case Study of Payroll Program	1
1.3	Object-Oriented concepts.	1
1.4	Object Modeling using Unified Modeling Language (UML) – Static and Dynamic models	1
1.5	UML diagrams- Use case diagram, Class diagram.	1
1.6	Introduction to Java- JRE, JDK	1
1.7	JVM, Program Structure	1
1.8	Primitive Data types, Arrays	1
1.9	Command-Line Arguments	1
1.10	Type conversions and promotion, Garbage collection.	1
MODULE II		
2.1	Classes and Objects.	1
2.2	Constructors.	1
2.3	Object class in Java, Use of static, this and final keywords – Lecture 1	1
2.4	Object class in Java, Use of static, this and final keywords – Lecture 2	1
2.5	Method Overloading	1
2.6	Objects as Parameters to Methods.	1
2.7	Access modifiers and Packages.	1
2.8	Strings - Class and Methods.	1
2.9	String Buffer and String Tokenizer.	1
2.10	Reading Input from Console Using Scanner class.	1
MODULE III		

3.1	Inheritance - Basics and Types.	1
3.2	Super keyword, calling superclass constructor from child class constructor.	1
3.3	Method Overriding.	1
3.4	Using final with inheritance.	1
3.5	Abstract Classes and methods.	1
3.6	Interface- Basics.	1
3.7	Multiple inheritance through interfaces.	1
3.8	Interface inheritance.	1
	MODULE IV	
4.1	Collection Framework - concepts.	1
4.2	Collection Interfaces and their Methods.	1
4.3	List interface.	1
4.4	Collections Class – Array List, Vector.	1
4.5	Collections Class – Linked List.	1
4.6	Accessing a Collection via an Iterator.	1
4.7	Exception handling: Exception Basics and Types, try, catch	1
4.8	throw, throws, finally keywords.	1
4.9	User defined exceptions.	1
	MODULE V	
5.1	Delegation Event Model.	1
5.2	Event Classes, Listener Interfaces.	1
5.3	Introduction to Java's Swing Package	1

5.4	Components, Containers and Layouts.	1
5.5	Exploring Swings –JFrame, Jpanel, JLabel, JTextField, JTextArea, JButton, JToggleButton	1
5.6	Check Boxes, Radio Buttons, JScrollPane, JMenu, JMenuBar and JMenuItem	1
5.7	Designing Frames and Adding GUI Components.	1
5.8	Event Handling in Swings,Swing vs JavaFX.	1

CO Assessment Questions	
1	1. Implement a Java program that checks whether a given string is a palindrome or not: MALAYALAM is palindrome. 2. Implement a Java Program to find the frequency of a given character in a string. 3. Implement a Java program to multiply two given matrices. 4. Design UML class diagram and use case diagram for a restaurant management.
2	1. Implement a Java program which creates a class named 'Employee' having the following members: Name, Age, Phone number, Address, Salary. It also has a method named 'print-Salary( )' which prints the salary of the Employee. Two classes 'Officer' and 'Manager 'inherits the 'Employee' class. The 'Officer' and 'Manager' classes have data members 'specialization' and 'department' respectively. Now, assign name, age, phone number, address and salary to an officer and a manager by making an object of both of these classes and print the same. (Exercise to understand inheritance). 2. Implement a java program to create an abstract class named Shape that contains an empty method named numberOfSides( ). Provide three classes named Rectangle, Triangle and Hexagon such that each one of the classes extends the class Shape. Each one of the classes contains only the method numberOfSides( ) that shows the number of sides in the given geometrical structures. (Exercise to understand polymorphism). 3. Implement a Java program to demonstrate the use of garbage collector.
3	1. Implement a file handling program in Java with reader/writer. 2. Implement a Java program that read from a file and write to file by handling all file related exceptions. 3. Write a Java program that reads a line of integers, and then displays each integer, and the sum of all the integers (Use StringTokenizer class

	of java.util).
4	1. Implement a Java program that shows the usage of try, catch, throws and finally. 2. Implement a Java program that implements a multi-threaded program which has three threads. First thread generates a random integer every 1 second. If the value is even, second thread computes the square of the number and prints. If the value is odd the third thread will print the value of cube of the number. 3. Implement a Java program that shows thread synchronization.
5	1. Implement a Java program that works as a simple calculator. Arrange Buttons for digits and the + - * % operations properly. Add a text field to display the result. Handle any possible exceptions like divide by zero. Use Java Swing. 2. Implement a Java program that simulates a traffic light. The program lets the user select one of three lights: red, yellow, or green. When a radio button is selected, the light is turned on, and only one light can be on at a time. No light is on when the program starts. 3. Implement a Java program to display all records from a table using Java database Connectivity (JDBC).

FOURTH SEMESTER													
Sl No	Slot	Code	Category	Title	L	T	P	J	S	No. of Hours	No. of Credits	Total Marks	
												CIA	ESE
1	A	24CST401	PCC	Discrete Mathematics	2	1	0	0	2	3	3	40	60
2	B	24CSP402	PCC	Computer Networks	2	1	2	0	4	5	4	60	40
3	C	24CSP403	PCC	Operating Systems	2	1	2	0	4	5	4	60	40
4	D	24CSJ404	PBC	Introduction to Database Systems	2	0	2	2	5	6	5	60	40
5	E	24HUT455	HSMC	Management- I (Organizational Behavior)	3	0	0	0	3	3	3	40	60
6	F	24MCT406	MC	Environmental Sciences	3	0	0	0	3	3	1	40	60
7	I	24BYT407	ESC	Biology for Engineers	2	0	0	0	2	2	2	100	
8	M /H /R	24CSM4XX/ 24CSH4XX	MR/ HR/RL	MINOR/HONORS/ REMEDIAL	4	0	0	0			4/ 4/ 0	40	60
TOTAL									**23**	**27**	**22**		

MINOR BUCKETS				
SEMESTER	**BUCKET 1**		**BUCKET 2**	
	Specialization - Machine Learning		**Specialization - Software Engineering***	
	Course Code	**Course Name**	**Course Code**	**Course Name**
S4	24CSM409	Mathematics for Machine Learning	24CSM410	Software Engineering *

HONORS BUCKETS						
SEMESTER	**BUCKET 1**		**BUCKET 2**		**BUCKET 3**	
	Specialization - Data Structures and Algorithms		**Specialization - Systems Engineering**		**Specialization - Data Science**	
	Course Code	**Course Name**	**Course Code**	**Course Name**	**Course Code**	**Course Name**
S4	24CSH409	Computational Geometry	24CSH410	System Software	24CSH411	Data and Web Mining

24CST401	Discrete Mathematics	L	T	P	J	S	C	Year of Introduction
		2	1	0	0	2	3	2024

Preamble: The purpose of this course is to create awareness in students about the basic terminologies used in advanced courses in Computer Science and develop rigorous logical thinking for solving different kinds of problems in Computer Science. This course helps the learner to apply the theory and applications of elementary Counting Principles, Propositional Logic, Predicate Logic, Lattices, Algebraic Structures and graph concepts eventually in practical applications.

Prerequisite:NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Check the validity of predicates in Propositional and Quantified Propositional Logic using truth tables, deductive reasoning and inference theory on Propositional Logic **(Apply Level)**
CO2	Illustrate the abstract algebraic systems - Semigroups, Monoids, Groups, Homomorphism and Isomorphism of Monoids and Groups **(Understand Level)**
CO3	Illustrate the applications for Relations, Partially Ordered Sets and Complete Lattices, in Computer Science **(Apply Level)**
CO4	Solve counting problems by applying the elementary counting techniques - Rule of Sum, Rule of Product, Permutation, Combination, Binomial Theorem, Pigeonhole Principle and Principle of Inclusion and Exclusion **(Apply Level)**
CO5	Explain the basic concepts of graph theory and its applications in computer science domain **(Understand Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2									3
CO2	3	3	2									3
CO3	3	3	2									3
CO4	3	3	2									3
CO5	3	3	2									3

Assessment Pattern

Bloom'sCategory	ContinuousAssessmentTools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✔	✔	✔	✔
Understand	✔	✔	✔	✔
Apply	✔	✔	✔	✔
Analyse				

Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
2-1-0-0	5	15	10	10	40

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Mathematical Logic (8 hours)

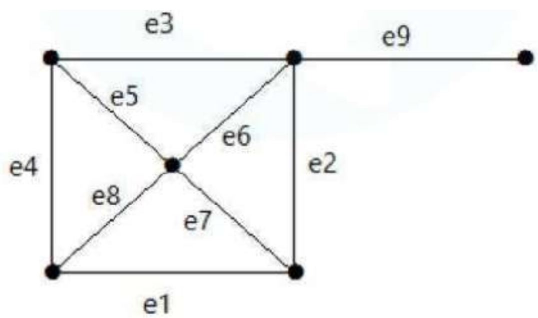
Statements and Notation-Connectives-Negation-Conjunction-Disjunction-Statement Formulas and Truth tables, Conditional and Biconditional-Tautologies-Equivalence of Formulas-Duality Law-Tautological implications- Normal Forms-Theory of inference for statement Calculus-Rules of inference, Predicate Calculus.

MODULE II : Algebraic Structures (6 hours)
Semigroups and Monoids, Homomorphism of semigroups and monoids, Sub semigroups and sub monoids, Groups, Subgroups and homomorphisms, Cosets and Lagrange's theorem.
MODULE III : Sets, Relations, Posets and Lattice (8 hours)
Sets and Relations, Partial Order relations, Equivalence Relation- irreflexive relations. Partially ordered Set – Hasse Diagram-Maximal-Minimal Element- Least upper bound (lub)- Greatest Lower bound(glb). Equivalence Relations and Partitions - Equivalence Class, Lattice- Dual Lattice – Sub lattice –Properties of glb and lub – Properties of Lattice - Special Lattice : Complete Lattice – Bounded Lattice – Completed Lattice – Distributive Lattice.
MODULE IV : Counting Theory (7 hours)
The Rule of Sum – Extension of Sum Rule - The Rule of Product - Extension of Product Rule – Permutations, Combinations, The Binomial Theorem, Combination with Repetition. The Pigeonhole Principle, The principle of Inclusion and Exclusion Theorem Generalisation of the principle, Derangements.
MODULE V : Fundamentals of Graphs (7 hours)
Basic Concepts of Graph Theory: Definition, Finite and infinite Graphs, Incidence and Degree, Isolated vertex, pendant vertex and null graph. Graph Isomorphism –Subgraphs, Walk, Path and Circuits, Euler Graphs, Hamiltonian paths and circuits (Concepts only). Cut sets, Connectivity- Edge connectivity, vertex connectivity. Planar Graphs, Bipartite graphs, Chromatic Number, Matchings, Coverings, Four color problem.
Text books 1. Discrete Mathematical Structures with Applications to Computer Science, J .P. Trembleyand R. Manohar, Tata McGraw Hill-35th reprint, 2017. 2. Graph theory with application to Engineering and Computer Science, Narasing Deo, Prentice Hall India 2016. 3. Discrete and Combinatorial Mathematics (An Applied Introduction), Ralph P Grimaldi, B V Ramana , 5th Edition, Pearson, 2019
Reference books 1. Kenneth H. Rosen, Discrete Mathematics and Its Applications with Combinatorics and Graph Theory, Eighth Edition, MGH, 2021.
Online Course https://nptel.ac.in/courses/106106094

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
MODULE 1		
1.1	Statements and Notation-Connectives-Negation-Conjunction-Disjunction	1

1.2	Statement Formulas and Truth tables- Conditional and Biconditional	1
1.3	Tautologies- Equivalence of Formulas-Duality Law	1
1.4	Tautological implications	1
1.5	Normal Forms	1
1.6	Theory of inference for statement Calculus	1
1.7	Rules of inference	1
1.8	Predicate Calculus	1
	MODULE II	
2.1	Semigroups and Monoids	1
2.2	Homomorphism of semigroups and monoids	1
2.3	Sub semigroups and sub monoids	1
2.4	Groups and Subgroups	1
2.5	Groups, Subgroups-homomorphisms	1
2.6	Cosets and Lagrange's theorem.	1
	MODULE III	
3.1	Sets and Relations	1
3.2	Partial Order relations, Equivalence Relation- irreflexive relations.	1
3.3	Partially ordered Set – Hasse Diagram-Maximal-Minimal Element- Least upper bound (lub)- Greatest Lower bound(glb)	1
3.4	Equivalence Relations and Partitions - Equivalence Class	1
3.5	Lattice- Dual Lattice – Sub lattice	1
3.6	Properties of glb and lub	1
3.7	Properties of Lattice - Special Lattice : Complete Lattice	1

3.8	Bounded Lattice – Completed Lattice – Distributive Lattice	1
MODULE IV		
4.1	The Rule of Sum – Extension of Sum Rule	1
4.2	The Rule of Product - Extension of Product Rule	1
4.3	Permutations, Combinations, The Binomial Theorem	1
4.4	Combination with Repetition	1
4.5	The Pigeonhole Principle	1
4.6	The principle of Inclusion and Exclusion Theorem, Generalisation of the principle	1
4.7	Derangements	1
MODULE V		
5.1	Basic Concepts of Graph Theory: Definition, Finite and infinite Graphs, Incidence and Degree, Isolated vertex, pendent vertex and null graph	1
5.2	Graph Isomorphism –Subgraphs, Walk, Path and Circuits	1
5.3	Euler Graphs, Hamiltonian paths and circuits (Concepts only).	1
5.4	Cut sets, Connectivity- Edge connectivity, vertex connectivity.	1
5.5	Planar Graphs, Bipartite graphs	1
5.6	Chromatic Number, Matchings, Coverings	1
5.7	Four color problem	1

<table>
<tr><th colspan="2">CO Assessment Questions</th></tr>
<tr><td>1</td><td>1. Show that RVM , ¬RVS , ¬M , ¬S cannot exist simultaneously (without using truth table)
2. Represent the following statement in symbolic form “Not every city in Canada is clean”.</td></tr>
<tr><td>2</td><td>1. Prove that the group { 1,-1, i, -i } is cyclic with generators i and –i.
2. State and prove Lagrange’s Theorem.</td></tr>
<tr><td>3</td><td>1. Assume A ={ a, b, c}. Let P(A) be its power set and ‘≤ ‘ be the subset relation on the power set. Draw the Hasse diagram of (P(A), ≤).
2. What is meant by Bounded Lattice? Give an example.</td></tr>
<tr><td>4</td><td>1.How many possible arrangements are there for the letters in MASSASAUGA in which 4 A’ s are together?
2. Find the number of integers between 1 and 1000 inclusive, which are not divisible by 5, 6 or 8.</td></tr>
<tr><td>5</td><td>1. Is it possible to have simple graphs with the following degree sequences? If yes, draw the graphs
a) 2,3,3,3,3,3,4,5
b) 1,3,3,4,5,6,6
c) 1,2,3,3,4,5,6
2. Find all cutsets of the graph G given below and also find the edge connectivity of G.


3. Identify the applications where the graph coloring concept can be used and prepare a write up on it.</td></tr>
</table>

24CSP402	COMPUTER NETWORKS	L	T	P	J	S	C	Year of Introduction
		2	1	2	0	4	4	2024

Preamble: This course provides the learners a clear understanding of computer networks from local area networks to the global Internet. This course covers the physical aspects of computer networks, layers of OSI Reference model, and inter-networking. The course helps the learners to compare and analyze the existing network technologies and choose a suitable network design for a given system.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the fundamentals of different layered architectures and physical layer characteristics of computer networks. **(Understand Level)**
CO2	Describe the basics of different application layer protocols. **(Apply Level)**
CO3	Illustrate the working of transport layer protocols and congestion control methods. **(Apply level)**
CO4	Explain the principles of network layer and network layer protocols. **(Apply level)**
CO5	Explain the design issues of data link layer, link layer protocols, bridges and Switches. **(Understand level)**
CO6	Use different tools to illustrate the working of different network protocols. (**Apply Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									3
CO2	3	3	3		2							3
CO3	3	3	3		2							3
CO4	3	3	3		2							3
CO5	3	3	3		2							3
CO6	3	3	3		3							3

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✔	✔	✔	✔
Understand	✔	✔	✔	✔
Apply	✔	✔	✔	✔
Analyse			✔	
Evaluate				
Create				

Assessment Pattern for Lab component

Bloom's Category	Continuous Assessment Tools	
	Class work	Test1

Remember		
Understand	✔	✔
Apply	✔	✔
Analyse	✔	✔
Evaluate	✔	
Create		

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Practical [P]		Total Marks
		Assignment	Test-1	Test-2	Class work	Lab Exam	
2-1-2-0	5	10	12.5	12.5	10	10	60

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	60	40	2.5 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 2		2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x 8 = 40 marks) Time: 2.5 hours	40
	Total Marks: 0	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Introduction to Data Communication and Internet

Introduction to Data Communication - Modes of communication, Physical topologies, Signal encoding, Multiplexing, Transmission media overview. Performance indicators – Bandwidth, Throughput, Latency, Queuing time, Bandwidth–Delay product. Basics of Internet, The Network Edge, The Network Core, Protocol layers and their service models - The OSI reference model, The TCP/IP reference model.

MODULE II : Application Layer

Principles of network applications, The Web and the HTTP, Electronic mail, Multipurpose Internet Mail Extension (MIME), File Transfer Protocol (FTP), Domain Name System (DNS), Simple Network Management Protocol. Peer-to-peer applications - P2P file distribution. Video streaming and Content Distribution Networks.

MODULE III : Transport Layer

Introduction and Transport Layer services, Multiplexing and Demultiplexing, UDP, Principles of Reliable Data transfer – Go-Back-N and Selective Repeat, TCP, Principles of Congestion Control, TCP Congestion control.

MODULE IV : Network Layer

Overview, Router, IPv4 and Addressing, Network Address Translation, IPv6, Routing Algorithms – Link state and Distance Vector Routing, Open Shortest Path First Protocol (OSPF), Border Gateway Protocol (BGP), Internet Control Message Protocol (ICMP), Address Resolution Protocol (ARP), Reverse Address Resolution Protocol (RARP), Bootstrap Protocol (BOOTP), Dynamic Host Configuration Protocol (DHCP).

MODULE V : Data link layer

Services provided by DLL, Error Detection and Correction Techniques, Sliding window protocols, High-Level Data Link Control (HDLC) protocol. Medium Access Control (MAC) sublayer – Channel allocation problem, Multiple access protocols, Ethernet, Wireless LANs - 802.11, Repeaters, Hubs, Bridges, Switches, Routers and Gateways.

Text books

1. J.F. Kurose and K.F. Ross, Computer networking: A top-down approach, 6th edition, Pearson, 2017.
2. Andrew S. Tanenbaum, Computer Networks, 4/e, PHI (Prentice Hall India), 2003.
3. Behrouz A Forouzan, Data Communication and Networking, 4/e, Tata McGraw Hill, 2007.

Reference books

1. Larry L Peterson and Bruce S Dave, Computer Networks – A Systems Approach, 5/e, Morgan Kaufmann, 2011.
2. Fred Halsall, Computer Networking and the Internet, 5/e, 2005.
3. James F. Kurose, Keith W. Ross, Computer Networking: A Top-Down Approach, 6/e, 2013.
4. Keshav, An Engineering Approach to Computer Networks, Addison Wesley, 1998.
5. W. Richard Stevens. TCP/IP Illustrated Volume 1, Addison-Wesley, 2005.
6. William Stallings, Computer Networking with Internet Protocols, Prentice-Hall, 2004.
7. Request for Comments (RFC) Pages - IETF -ttps://www.ietf.org/rfc.html
8. The Network Simulator - ns-2, https://www.isi.edu/nsnam/ns/
9. E. Altman and T. Jimenez, NS2 Simulator for Beginners, 2003.
10. ns-3 network simulator. https://www.nsnam.org/

NPTEL/SWAYAM Course

Computer Networks and Internet Protocols, By Prof. Soumya Kanti Ghosh, Prof. Sandip Chakraborty, IIT Kharagpur

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Introduction to Data Communication - Modes of communication, Physical topologies	1
1.2	Signal encoding, Multiplexing	1
1.3	Transmission media overview.	1
1.4	Performance indicators – Bandwidth, Throughput, Latency, Queuing time, Bandwidth–Delay product.	1
1.5	Basics of Internet, The Network Edge, The Network Core	1
1.6	Protocol layers and their service models : The OSI reference model	1
1.7	The TCP/IP reference model	1
	MODULE II	
2.1	Principles of network applications, The Web and the HTTP	1
2.2	Electronic mail, Multipurpose Internet Mail Extension (MIME)	1
2.3	File Transfer Protocol (FTP)	1

2.4	Domain Name System (DNS)	1
2.5	Simple Network Management Protocol	1
2.6	Peer-to-peer applications - P2P file distribution	1
2.7	Video streaming and Content Distribution Networks	1

MODULE III		
3.1	Introduction and Transport Layer services	1
3.2	Multiplexing and Demultiplexing	1
3.3	UDP	1
3.4	Principles of Reliable Data transfer	1
3.5	Go-Back-N and Selective Repeat	1
3.6	TCP	1
3.7	Principles of Congestion Control	1
3.8	TCP Congestion control	1

MODULE IV		
4.1	Overview, Router, IPv4 and Addressing,	1
4.2	Network Address Translation, IPv6	1
4.3	Routing Algorithms – Link state and Distance Vector Routing	1
4.4	Open Shortest Path First Protocol (OSPF)	1
4.5	Border Gateway Protocol (BGP) and Internet Control Message Protocol (ICMP)	1
4.6	Address Resolution Protocol (ARP), Reverse Address Resolution Protocol (RARP)	1
4.7	Bootstrap Protocol (BOOTP) and Dynamic Host Configuration Protocol (DHCP)	1

MODULE V		
5.1	Services provided by DLL	1
5.2	Error Detection and Correction Techniques	1
5.3	Sliding window protocols	1
5.4	High-Level Data Link Control (HDLC) protocol	1
5.5	Medium Access Control (MAC) sublayer – Channel allocation problem, Multiple access protocols	1
5.6	Ethernet	1
5.7	Wireless LANs - 802.11, Repeaters, Hubs, Bridges, Switches, Routers and Gateways.	1

LESSON PLAN FOR LAB COMPONENT

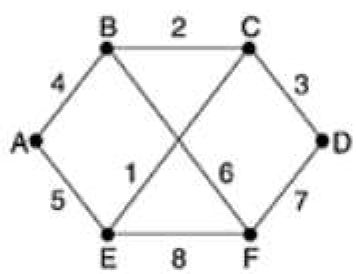
No.	Topic	No. of Hours	Experiment
1	Introduction to the Internet and Service Models	1 1	1. Use Linux tools like ifconfig, dig, ethtool, route, netstat, nslookup, and ip to understand the networking configuration of the computer that the student is working on. 2. Use Wireshark to capture packets when browsing the Internet. Examine the structure of packets: the various layers, protocols, headers, payload
2	Application Layer	1 1 1	1. Use Wireshark packet capture to analyze various header fields and their usage in different application layer protocols like HTTP, SMTP and FTP. 2. Develop a concurrent file server which will provide the file requested by a client if it exists. If not, the server sends appropriate message to the client. Server should also send its process ID (PID) to clients for display along with the file or the message. 3. Implement Simple Mail Transfer Protocol.

3	Transport Layer	1 1 1 1 1 1	1. Using Wireshark, observe three way handshaking connection establishment, three way handshaking connection termination and Data transfer in client server communication using TCP. 2. Write the system calls used for creating sockets and transferring data between two nodes. 3. Write a program to find the maximum, minimum and average of an array of integers using socket programming. 4. (a)Create three programs, two of which are clients to a single server. Client1 will send a string to the server process using datagram socket and stream socket. The server will reverse the string and send the result to Client2. Client2 prints the reversed string it receives and then all the processes terminate. (b) Follow the same procedure as in part a except that the data type of the message should be integer and the server should square the integer before transmitting it to Client2. (c) Write a socket program to enable Client1 to send a float value to the server. The server process should increase the value of the number it receives by a power of 1.5. The server should print both the value it receives and the value that it sends. Client2 should print the value it receives from the server. 5. Implement a multi-user chat server using TCP as transport layer protocol.

		1 1	6. Implement a Concurrent Time Server application using UDP to execute the program at a remote server. Client sends a time request to the server, server sends its system time back to the client. Client displays the result. 7. Measure TCP throughput between two hosts in a network using tools like **iperf/iperf3**. Modify TCP configuration parameters. Use the **tc** Linux utility or similar to control bandwidth, delay, loss. Observe impact on measured throughput. 8. Implement leaky bucket algorithm for congestion control.
4	Network Layer	1 1 1 1 1	1. Use tools like **ping and traceroute** to explore various Internet paths to popular servers. 2. Use web-based tools like the **whois** utility to query Internet registries, and understand which IP addresses are allocated to the student's network. Find out which are the major ISPs, and which is the ISP of the student's network. **3.** Configure a simple mesh network using computers in the lab, or using **Mininet**. Setup static routes to conform to the desired mesh topology. **4.** Implement Distance Vector Routing algorithm and Link State Routing algorithm. 5. Find the hardware/MAC address of another computer in the network using ARP.

5	Data link layer	1 1 1 1 1	1. Use Linux network tools like **ethtool** to observe and analyze link layer packet statistics and errors. 2. Implement Stop-and-Wait ARQ flow control protocol. 3. Implement Go-Back--N ARQ flow control protocol. 4. Implement Selective Repeat ARQ flow control protocol. 5. Implement the Error detecting and Correcting codes.

CO Assessment Questions	
1	A. Protocol layering can be found in many aspects of our lives such as air travelling. Imagine you make a round-trip to spend some time on vacation at a resort. You need to go through some processes at your city airport before flying. You also need to go through some processes when you arrive at the resort airport. Show the protocol layering for the round trip using some layers such as baggage checking/claiming, boarding/unboarding, takeoff/landing. B. The purpose of the physical layer is to transport a raw bit stream from one machine to another. Justify.
2	A. List five nonproprietary Internet applications and the application layer protocols they use. B. During the weekend, Alice often needs to access files stored on her office desktop from her home laptop. Last week, she installed a copy of the ftp server process on her desktop at her office and a copy of the ftp client process on her laptop at home. She was disappointed when she could not access her files during the weekend. What could have gone wrong?

3	A. Can Transmission Control Protocol(TCP) be used directly over a network (e. g. an Ethernet) without using IP? Justify your answer. B. A computer on a 6-Mbps network is regulated by a token bucket. The token bucket is filled at a rate of 1 Mbps. It is initially filled to capacity with 8 megabits. How long can the computer transmit at the full 6 Mbps? C. Assume that a Selective-Repeat sliding-window protocol is to be designed for a network in which the bandwidth is 1 Gbps and the average distance between the sender and receiver is 5,000km. Assume the average packet size is 50,000 bits and propagation speed is $2*10^8$m. Find the maximum size of the sender and receiver windows, the number of bits in the sequence number field and an appropriate time-out value for the timer?
4	A. Explain the address resolution problem using Address Resolution Protocol (ARP) and Reverse Address Resolution Protocol (RARP)with an example network. B. A network on the Internet has a subnet mask of 255.255.240.0. What is the maximum number of hosts it can handle? C. Consider the given subnet in which distance vector routing is used, and the vectors just come in to router C as follows: from B: (5, 0, 8, 12, 6, 2); from D: (16, 12, 6, 0, 9, 10); and from E: (7, 6, 3, 9, 0, 4). The measured delays from C to B, D, and E, are 6, 3, and 5 respectively. What is C's new routing table? Give both the outgoing line to use and the expected delay. 
5	A. What are some of the possible services that a link layer protocol can offer to the network layer? Which of these link layer services have corresponding services in IP and TCP? B. Ethernet frames must be at least 64 bytes long to ensure that the transmitter is still going in the event of a collision at the far end of the cable. Fast Ethernet has the same 64-byte minimum frame size but can get the bits out ten times faster. How is it possible to maintain the same minimum frame size?

6	A. Implement a simple web proxy server, which is able to cache Web pages. B. Use Wireshark packet capture to analyze various header fields and their usage in different application layer protocols like HTTP, SMTP and FTP. C. Implement Distance Vector Routing algorithm and Link State Routing algorithm.

24CSP403	OPERATING SYSTEMS	L	T	P	J	S	C	Year of Introduction
		2	1	2	0	4	4	2024

Preamble: This course enables the students to learn the basic concepts and functions of operating systems. This course introduces the concepts of process management, memory management, file management and device management APIs and mechanisms available in an operating system. The course helps the learners to understand the foundation of operating system design so that they can extend their knowledge to detect and solve many problems occurring in operating system and to manage the computer resources appropriately.

Prerequisite: Programming in C,Computer Organization & Architecture

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the role, functionality and layering of the systems software components. (**Understand level**)
CO 2	Demonstrate the concept of process management, process scheduling and the design of OS API. (**Apply level**)
CO 3	Demonstrate the memory management algorithms using the details of the abstractions and interfaces provided by the OS . (**Apply level**)
CO 4	Illustrate process synchronization mechanisms using Mutex Locks, Semaphores and Monitors. (**Apply level**)
CO 5	Describe methods for effectively handling deadlocks in Operating Systems, including its detection, prevention, mitigation, and recovery methods. (**Understand level**)
CO 6	Explain the concepts of File System, secondary storage management and Disk Scheduling. (**Understand level**)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3											1
CO 2	3	3	3					3				1
CO 3	3	3	3					3				1
CO 4	3	3	3					3				1
CO 5	3	3	3					3				1
CO 6	3	3	3									1

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓

Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate				
Create				

Assessment Pattern for Lab component		
Bloom's Category	**Continuous Assessment Tools**	
	Class Work	**Test 1**
Remember	✓	✓
Understand	✓	✓
Apply	✓	✓
Analyse	✓	
Evaluate		
Create		

Mark Distribution of CIA

Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Practical[P]**		**Total**
		Assignment	**Test-1**	**Test-2**	**Classwork**	**Lab exam**	
2-1-2-0	**5**	**10**	**12.5**	**12.5**	**10**	**10**	**60**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	**60**	**40**	**2.5 hrs**

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 2		2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x 8 = 40 marks) Time: 2.5 hours	**40**
	Total Marks: 0	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Introduction to Operating Systems (6 hrs)

Introduction to Operating Systems: Virtualizing the CPU, Virtualizing the memory, Concurrency, Persistence, Design Goals. Components of an OS, Types of OS, Operating System structure - Simple structure, Layered approach, Microkernel, Modules, Generalized view of System Calls, System boot process.

(T1 Chapter 1 and T2 Chapter 1 and 2)

MODULE II : Process Management (8 hrs)

Process Abstraction- A Process, Process Creation, Process states, Process control block and Context Switch, Process control system calls - fork, wait, exec, getpid, getppid and variants. The limited direct execution model. Process Scheduling- Basic concepts, Scheduling queues, Schedulers, Scheduling algorithms- First come First Served, Shortest Job First, Priority scheduling, Round robin scheduling, Multilevel feedback queue scheduling. Inter-process communication - shared memory systems, Message passing systems.

(T1 Chapter 4,5,6,7 and 8 T2 Chapter 3,5)

MODULE III : Memory Management (8 hrs)

Address spaces, Memory view of a process -heap, stack, code, data Review of malloc and free system calls. Address Translation – Introduction Dynamic Relocation Hardware Support. Segmentation, Free space Management, Paging, Virtual Memory – Demand Paging, Page Replacement Algorithms, Allocation, Thrashing.

(T1 Chapter 13 to 22 and T2 Chapter 8,9)

MODULE IV : Process Synchronization and Deadlock (7 hrs)

Concurrency - Threads, Single threaded and multithreaded programming, Thread API, Process Synchronization – critical-section problem, Synchronization hardware, Mutex locks, Semaphores, Critical regions, Monitors. Deadlock – System model, Deadlock characterization, Methods for handling deadlocks, Deadlock prevention, Deadlock avoidance, Detection, Recovery.

(T1 Chapter 26 to 31 and T2 Chapter 4, 6 and 7)
MODULE V : File and Storage Management (7 hrs)
File System: File concept - Attributes, Operations, types. File Structure – Access methods, Protection. File system implementation-Allocation methods.Crash Consistency-Crash Consistency problem, FileSystem Checker, File System Journaling,Recovery. Storage Management: Disk Structure, Disk scheduling. **(T1 Chapter 42 and T2 Chapter 10,11 and 12)**

Text books

1. Remzi H. Arpaci-Dusseau and Andrea C. Arpaci-Dusseau Arpaci , "Operating Systems: Three Easy Pieces", -Dusseau Books, LLC ,2017 https://pages.cs.wisc.edu/~remzi/OSTEP/(online version)
2. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, "Operating System Concepts", John Wiley & Sons, Inc., 10th Edition, 2021.

Reference books

1. William Stallings, "Operating Systems – Internals and Design Principles", 9th Edition, Pearson, 2017.
2. Maurice J. Bac , "Design of the UNIX Operating System", Pearson Education India; First edition, 1990.
3. W. Richard Stevens, Stephen A. Rago, "Advanced Programming in the UNIX® Environment" ,Pearson Education India; Third edition, 1992.
4. Frans Kaashoek, Robert Morris, and Russ Cox,"Xv6, a simple Unix-like teaching operating system", 2022.
   https://github.com/mit-pdos/xv6-public (x86 version)
5. Andrew S. Tannenbaum and Herbert Bos , "Modern Operating Systems", Pearson Education India; 4th edition,2015 .

NPTEL/SWAYAM Course

1. Introduction to Operating Systems,IIT Madras – Prof.Chester Rebeiro

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours **(36)**
	MODULE 1	
1.1	Introduction to Operating Systems: Virtualizing the CPU, Virtualizing the memory	1
1.2	Concurrency, Persistence, Design Goals	1
1.3	Components of an OS, Types of OS	1
1.4	Operating System structure - Simple structure, Layered approach, Microkernel	1
1.5	Modules, Generalized view of System Calls	1
1.6	System boot process.	1

MODULE II		
2.1	The Abstraction - A Process, Process Creation	1
2.4	Process states, Process control block and Context Switch	1
2.3	Process control system calls - fork, wait, exec, getpid, getppid and variants.	1
2.4	The limited direct execution model.	1
2.5	Process Scheduling- Basic concepts, Scheduling queues, Schedulers	1
2.6	Scheduling algorithms- First come First Served, Shortest Job First, Priority scheduling.	1
2.7	Round robin scheduling, Multilevel feedback queue scheduling	1
2.8	Inter-process communication - shared memory systems, Message passing systems	1
MODULE III		
3.1	Address spaces, Memory view of a process -heap, stack, code, data .Review of malloc and free system calls.	1
3.2	Address Translation – Introduction. Dynamic Relocation Hardware Support.	1
3.3	Segmentation, Free space Management	1
3.4	Paging	1
3.5	Virtual Memory – Demand Paging	1
3.6	Page Replacement Algorithms- Lecture 1	1
3.7	Page Replacement Algorithms- Lecture 2	1
3.8	Allocation, Thrashing.	1
MODULE IV		
4.1	Concurrency - Threads, Single threaded and multithreaded programming, Thread API,	1
4.2	Process Synchronization – critical-section problem, Synchronization hardware, Mutex locks	1
4.3	Semaphores, Critical regions, Monitors	1
4.4	Synchronization problem examples	1
4.5	Deadlock – System model, Deadlock characterization, Methods for handling deadlocks	1
4.6	Deadlock prevention, Deadlock avoidance.	1
4.7	Deadlock Detection, Recovery	1
MODULE V		
5.1	File concept - Attributes, Operations, types	1

5.2	File Structure – Access methods, Protection	1
5.3	File system implementation-Allocation methods	1
5.4	Crash Consistency-Crash Consistency problem, FileSystem Checker	1
5.5	File System Journaling,Recovery	1
5.6	Storage Management: Disk Structure	1
5.7	Disk scheduling	1

LESSON PLAN FOR LAB COMPONENT

No.	Topic	No. of Hours	Experiment
1	Introduction to Operating Systems	2	1. Understand Linux and practice Linux permissions, special permissions and authentication (various options of chmod, setuid, setgid) 2. Write a shell script to create a file in $USER/class/batch directory and display the list of files in a directory. 3. Write a shell script to count lines, words & characters in its input.(do not use wc) 4. Write a shell script to print end of a Glossary file in reverse order using array. 5. Write a shell script to check whether a user has logged in, continue checking further after every 30 seconds till success. 6. Write a shell script to test file integrity. Create hash for files and check changes.
2	Process Management – Process control system calls	2	1. Write programs using the following system calls of LINUX operating system (fork, exec, getpid, exit, wait, close, stat, opendir, readdir) 2. Write a program that calls fork(). Before calling fork(), have the

			main process access a variable (e.g., x) and set its value to something (e.g., 100). What value is the variable in the child process? What happens to the variable when both the child and parent change the value of x? 3. Write a program that creates two children, and connects the standard output of one to the standard input of the other, using the pipe() system call. 4. Write a program using fork(). The child process should print “hello”; the parent process should print “goodbye”. You should try to ensure that the child process always prints first (a) Implement the program using wait()system call. (b) Can you do this without calling wait() in the parent?
3	Process Management – Scheduling Algorithms	2	Write a program that allows you to see how different schedulers perform under scheduling metrics such as response time, turnaround time, and total wait time. 1. Compute the response time and turnaround time when running three jobs of length 200 with the SJF and FIFO schedulers. 2. Now do the same but with jobs of different lengths: 100, 200, and 300. 3. Now do the same, but also with the RR scheduler and a time-slice of 1. 4. For what types of workloads does SJF deliver the same turnaround times as FIFO? 5. For what types of workloads and quantum lengths does SJF deliver the same response times as RR? 6. What happens to response time with SJF as job lengths increase?

			7. What happens to response time with RR as quantum lengths increase? Can you write an equation that gives the worst-case response time, given N jobs?
4	Process Management – Inter process Communication	2	1. Implement a program to create a message queue with read and write permissions to write 3 messages to it with different priority numbers 2. Implement a program to read details of n students in one process and display rank details of students in another process using shared memory
5	Concurrency - Threads, Single threaded and multithreaded programming, Thread API,	2	1. Familiarization of **Helgrind tool** for detecting synchronisation errors in C, C++ and Fortran programs that use the POSIX pthreads threading primitives. 2. Implement matrix multiplication using multithreading. Application should have pthread_create, pthread_join, pthread_exit. In the program, every thread must return the value and must be collected in pthread_join in the main function. Final sum of row-column multiplication must be done by main thread (main function).
6	The Abstraction – Address spaces	2	1. Familiarization of *free* and *pmap* commands in Linux and answer the following questions. ❖ How much memory is in your system? ❖ How much is free? ❖ Do these numbers match your intuition? ❖ Run pmap on some of these processes, using various flags (like -X) to reveal many details about the process. What do you see? How many different entities make up a modern

			address space, as opposed to our simple conception of code/stack/heap? 2. Create a little program that uses a certain amount of memory. This program should take one command line argument: the number of megabytes of memory it will use. When run, it should allocate an array, and constantly stream through the array, touching each entry. The program should do this indefinitely, or, perhaps, for a certain amount of time also specified at the command line.
7	Free space Management	2	Implementation of the following Memory Allocation Methods for fixed partition a) First Fit b) Worst Fit c) Best Fit
8	Page Replacement algorithms	2	Implementation of the following Page Replacement Algorithms a) FIFO b) LRU c) LFU
9	Process Synchronization and Semaphores	2	Implement the solution to the following concurrency problems. 1. Producer consumer problem
10	Deadlocks	2	Implement Bankers Algorithm for Deadlock Detection & Avoidance
11	File System Implementation	2	1. Write a program that lists files in the given directory. When called without any arguments, the program should just print the file names. When invoked with the -l flag, the program should print out information about each file, such as the owner, group, permissions, and other information obtained from the stat() system call. The program should take one additional argument, which is the directory to read, e.g., myls -l directory. If no directory is given, the program should just use the

			current working directory. Useful interfaces: stat(), opendir(), readdir(), getcwd().
12	Disk scheduling	2	Implement the following disk scheduling algorithms a. FCFS b. SCAN c. C-SCAN

CO Assessment Questions	
1	(1) Explain the different types of types of OS and its purpose. (2) Differentiate the following (i)Multiprogramming (ii)Multitasking (iii) Multiprocessing (3)How the bootstrap program helps in ensuring the correct working of OS?
2	(1) Consider a process P which invokes the default wait system call. For each of the scenarios described below, state the expected behavior of the wait system call, i.e., whether the system call blocks P or if P returns immediately. (a) P has no children at all. (b) P has one child that is still running. (c) P has one child that has terminated and is a zombie. (d) P has two children, one of which is running and the other is a terminated zombie. (2) Which of the following pieces of information in the PCB of a process are changed when the process invokes the exec system call. Explain. (a) Process identifier (PID) (b) Page table entries (c) The value of the program counter stored within the user space context on the kernel stack (3) Consider the following set of processes, assumed to have arrived at time 0. Consider the CPU scheduling algorithms Shortest Job First (SJF) and Round Robin (RR). For RR, assume that the processes are scheduled in the order P 1 , P 2 ,P 3 , P 4 . <table><tr><td>Processes</td><td>P_1</td><td>P_2</td><td>P_3</td><td>P_4</td></tr><tr><td>Burst time (in ms)</td><td>8</td><td>7</td><td>2</td><td>4</td></tr></table> If the time quantum for RR is 4 ms, then the absolute value of the difference between the average turnaround times (in ms) of SJF and RR (round off to 2 decimal places) is _________ .
3	(1) Consider six memory partitions of size 200 KB, 400 KB, 600 KB, 500 KB, 300 KB and 250 KB. These partitions need to be allocated to four processes of sizes 357 KB, 210 KB, 468 KB and 491 KB in that order. Perform the allocation of processes using-

	i. First Fit Algorithm ii. Best Fit Algorithm iii. Worst Fit Algorithm (2) Consider the following page reference string 1,2,3,4,2, 1,5,6,2,1,2,3,7,6,3,2,1,2,3, 6. Find out the number of page faults if there are 4 page frames, using the following page replacement algorithms i) LRU ii) FIFO iii) Optimal

4	(1) The following two functions P1 and P2 that share a variable B with an initial value of 2 execute concurrently.
	P1( ) {
	  C = B – 1;
	  B = 2 * C;
	}
	
	P2( ) {
	  D = 2 * B;
	  B = D - 1;
	}
	The number of distinct values that B can possibly take after the execution is___________.
	
	(2) A counting semaphore was initialized to 10. Then 6 P (wait) operations and 4 V (signal) operations were completed on this semaphore. The resulting value of the semaphore is _______

5	(1)Suppose that a disk drive has 5000 cylinders, numbered 0 to 4999. the drive currently services a request at cylinder 143, and the previous request was at cylinder 125. The queue of pending request in FIFO order is 86, 1470, 913, 1774, 948, 1509, 1022, 1750, 130. Starting from the current position, what is the total distance (in cylinders) that the disk arm moves to satisfy all pending requests for each of the following algorithms i) FCFS ii) SSFT iii) SCAN iv) LOOK v) C-SCAN (2)Explain the use of access matrix in protection mechanism?

24CSJ404	INTRODUCTION TO DATABASE SYSTEMS	L	T	P	J	S	C	Year of Introduction
		2	0	2	2	5	5	2024

Preamble: This course provides a clear understanding of fundamental principles of Database Management Systems (DBMS) with special focus on relational databases to the learners. The topics covered in this course are basic concepts of DBMS, Entity Relationship (ER) model, Relational Database principles, Relational Algebra, Structured Query Language (SQL), Physical Data Organization, Normalization, Transaction Processing Concepts, and an alternative data management model, NoSQL. This course helps the learners to manage data efficiently by identifying suitable structures to maintain data assets of organizations and to develop applications that utilize database technologies.

Prerequisite: Topics covered under the course Data Structures, Exposure to a High-Level Language like C.

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the need and basic characteristics of database management systems **(Understand Level)**
CO2	Construct ER models for real-life database applications **(Apply Level)**
CO3	Develop PL/SQL programs to perform multiple database operations **(Apply Level)**
CO4	Explain the fundamental principles of database storage structures and access techniques **(Understand Level)**
CO5	Explain the concepts of transaction processing, concurrency, and recovery **(Understand Level)**
CO6	Able to design, analyze, and develop database application programs for some real-life scenarios using appropriate database management system: **(Create Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1									3
CO2	3	3										3
CO3	3	3			3			3				3
CO4	3	1	1									3
CO5	3	3	3									3
CO6	3	3	3		3			3	3	3		3

Assessment Pattern for Theory Component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember		✓	✓	✓
Understand		✓	✓	✓

Apply		✓	✓	✓
Analyze			✓	
Evaluate			✓	
Create			✓	

Assessment Pattern for Lab Component

Bloom's Category	Continuous Assessment Tools	
	Classwork	**Test1**
Remember		
Understand	✓	✓
Apply	✓	✓
Analyse	✓	✓
Evaluate		
Create		

Assessment Pattern for Project Component

Bloom'sCategory	Continuous Assessment Tools		
	Evaluation 1	**Evaluation 2**	**Report**
Remember			
Understand	✓	✓	
Apply	✓	✓	
Analyse	✓	✓	
Evaluate		✓	
Create		✓	

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]		Practical [P]	Project [J]			Total Marks
		Assignment	Test-2	Class work	Evaluation 1	Evalaution-2	Report	
2-0-2-2	5	10	15	10	5	10	5	60

Total Marks distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	60	40	2 .5

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
		2 questions will be given from each module, out of which 1 question should be answered.	

PATTERN 2		Each question can have a maximum of 2 sub-divisions. Each question carries 8 marks. Marks: (5x 8 = 40 marks) Time: 2.5 hours	40
	Total Marks: 0	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Introduction & Entity Relationship Model (4hrs)

Concept & Overview of Database Management Systems (DBMS) - Characteristics of Database system, Database Users, structured, semi-structured and unstructured data. Data Models and Schema - Three Schema architecture. Database Languages, Database architectures, and classification.ER model - Basic concepts, entity set and attributes, notations, Relationships and constraints, cardinality, participation, notations, weak entities, relationships of degree 3.

MODULE II: Relational Model and SQL DDL (5hrs)

Structure of Relational Databases - Integrity Constraints, Synthesizing ER diagram to relational schema. Introduction to Relational Algebra - select, project, cartesian product operations, join - Equi-join, natural join. query examples, introduction to Structured Query Language (SQL), SQL data types, Data Definition Language (DDL), Table definitions and operations – CREATE, DROP, ALTER, INSERT, DELETE, UPDATE.

MODULE III: SQL DML and Physical Data Organization (5hrs)

SQL DML (Data Manipulation Language) - SQL queries on single and multiple tables, Nested queries (correlated and non-correlated), Aggregation and grouping, Views, and Assertions. PL/SQL-Functions, Procedures, Triggers, and Cursors. Physical Data Organization - Review of terms: physical and logical records, blocking factor, pinned and unpinned organization. Heap files, Indexing, Singe level indices, numerical examples, Multi-level indices, numerical examples, B-Trees & B+-Trees (structure only, algorithms not required), Extendible Hashing.

MODULE IV: Database Normalization (4hrs)

Different anomalies in designing a database, The idea of normalization, Functional dependency, Armstrong's Axioms (proofs not required), Closures and their computation, Equivalence of functional Dependencies (FD), and Minimal Cover (proofs not required). First Normal Form (1NF), Second Normal Form (2NF), Third Normal Form (3NF), Boyce Codd Normal Form (BCNF).

MODULE V: Transactions, Concurrency and Recovery, NoSQL, JDBC (6hrs)

Transaction Processing Concepts - Overview of concurrency control, Transaction Model, Significance of concurrency control and recovery, Transaction States, System Log, and Desirable Properties of Transactions. Serial schedules, Concurrent and Serializable Schedules, Conflict equivalence and conflict serializability, Recoverable and cascade-less schedules, Locking, Two-phase locking, and its variations. Log-based recovery, Deferred database modification, check-pointing.

Introduction to NoSQL Databases, Main characteristics of Key-value DB (examples from Redis), Document DB (examples from MongoDB) Main characteristics of Column-Family DB (examples from Cassandra), and Graph DB (examples from: Arango DB)
Java Database Connectivity (JDBC) - JDBC overview, Creating and Executing Queries – create table, delete, insert, select.

Textbooks

1. Elmasri R. and S. Navathe, Database Systems: Models, Languages, Design and Application Programming, Pearson Education, 2013.
2. Sliberschatz A., H. F. Korth and S. Sudarshan, Database System Concepts, 6/e, McGraw
Hill, 2011.

Reference Books

1. Adam Fowler, NoSQL for Dummies, John Wiley & Sons, 2015
2. NoSQL Data Models: Trends and Challenges (Computer Engineering: Databases and BigData), Wiley, 2018
3. Web Resource: https://www.w3resource.com/redis/
4. Web Resource: https://www.w3schools.in/category/mongodb/
5.WebResource:https://www.tutorialspoint.com/cassandra/cassandra_introduction.htm
6. Web Resource: https://www.tutorialspoint.com/arangodb/index.htm

NPTEL/SWAYAM Courses

1. Data Base Management System, IIT Kharagpur - Prof. Partha Pratim Das, Prof. Samiran Chattopadhyay, Prof. Kausik Datta

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
	MODULE I (4)	
1.1	Concept & Overview of Database Management Systems (DBMS) - Characteristics of Database system	1
1.2	Database Users, structured, semi-structured, and unstructured data	1
1.3	Data Models and Schema - Three Schema architecture. Database Languages	1

1.4	Database architectures and classification	1
MODULE II (5)		
2.1	Structure of Relational Databases - Integrity Constraints	1
2.2	Synthesizing ER diagram to relational schema	1
2.3	Introduction to Relational Algebra - select, project, cartesian product operations	1
2.4	Join - Equi-join, natural join. Query examples	1
2.5	Introduction to Structured Query Language (SQL), SQL data types, Data Definition Language (DDL)	1
MODULE III (5)		
3.1	SQL DML (Data Manipulation Language) - SQL queries on single and multiple tables	1
3.2	Nested queries (correlated and non-correlated), Aggregation and grouping	1
3.3	Review of terms: physical and logical records, blocking factor, pinned and unpinned organization. Heap files	1
3.4	Singe level indices, numerical examples	1
3.5	Multi-level indices, numerical examples	1
MODULE IV (4)		
4.1	Different anomalies in designing a database, Functional Dependencies, Armstrong's Axioms (proofs not required)	1
4.2	Closures and their computation, Equivalence functional Dependencies (FD), Minimal Cover (proofs not required)	1
4.3	First Normal Form (1NF), Second Normal Form (2NF)	1
4.4	Third Normal Form (3NF), Boyce Codd Normal Form (BCNF)	1
MODULE V (6)		
5.1	Transaction Processing Concepts - Overview of Concurrency Control, Transaction Model	1
5.2	Significance of concurrency Control and Recovery, Transaction States, System Log, Desirable Properties of transactions	1
5.3	Serial Schedules, Concurrent and Serializable Schedules, Conflict Equivalence, and Conflict Serializability	1

5.4	Recoverable and cascade-less schedules	1
5.5	Locking, Two-phase locking and its variations	1
5.6	Log-based recovery, Deferred Database Modification, Check-pointing.	1

LESSON PLAN FOR LAB COMPONENT

No.	Topic	No. of Hours (24)	Experiment
.			
1	ER modeling and Synthesizing ER diagram to a relational schema.	3	1. Simple Pen + Paper/web-based database modeling tool on ER modeling and conversion to relational schema.(e.g.: ***ERDPlus)*** 2. Model the ER diagram for your project and synthesize it into a relational schema.
2	Introduction to Relational Algebra	1	Simple pen + paper on relational algebra queries
			Usage of Relax Relational algebra calculator https://dbis-uibk.github.io/relax/landing
3	Introduction to Structured Query Language (SQL)	5	Usage of web-based database modeling tools like ***ERDPlus*** to generate SQL from Relational Schemas and Star Schemas.
			Creation, modification, configuration, and deletion of databases using SQL commands(insertion, updating, altering, deletion of data, and viewing/querying records based on conditions in databases)
			Apply the DDL commands to access the database identified for your project.

4	SQL DML (Data Manipulation Language)	9	1. Implementation of various aggregate functions in SQL. 2. Implementation of Order By, Group By & Having clause. 3. Implementation of set operators, nested queries, and join queries. 4. Practice SQL TCL commands like Rollback, Commit, and Save point. 5. Practice SQL DCL commands for granting and revoking user privileges. 6. Practice SQL commands for the creation of views and assertions. 7. Creation of Procedures, Functions, Triggers and Cursors
4	File Structures and Indexing	2	Small exercises to show the blocking factor, and indexing benefit of indices. Use a B+-tree visualization system to understand its structure and its working. https://www.cs.usfca.edu/~galles/visualization/BPlusTree.html
5	Normalization for Relational databases	2	1. Pen-and-paper exercises with FDs and normalization 2. Use of web-based Normalization tools to make the database normalized and free of redundancy 3. Apply database normalization to the databases in your project, if needed.
8	Transaction Management	1	Pen-and-paper exercises on conflicts, cycles, and conflict serializability.
9	Concurrency Control Techniques	1	Pen-and-paper exercises on recoverability, variations of 2PL, etc.

COURSE PROJECT

Students can choose projects that have real-world applications which help students to see the practical relevance of their coursework.

Sample project topics for students to work on:

1	Inventory Control System.
2	Material Requirement Processing.
3	Hospital Management System.
4	Railway Reservation System.

5	Personal Information System.

Note:- Projects need not be restricted to the above topics. Students are encouraged to choose any application problems, in the course domain, which they desire to work on.

LESSON PLAN FOR PROJECT COMPONENT		
No.	**Topic**	**No. of Class Hours [24]**
1	Familiarization of NoSQL databases • Small exercises on the latest databases like MongoDB	3
2	JDBC overview, creating and executing queries	3
3	Preliminary Design of the Project • Identify a societal real-world problem and design **ER diagram**	2
2	Zeroth presentation (4th week)	2
3	Project work - First Phase	3
4	Interim Presentation (7th and 8th weeks)	3
5	Project work - Final Phase & Report writing (discussions in class during project hours)	5
6	Final Evaluation and Presentation (11th and 12th weeks)	3

Note: 12 Hours of self-study hours also should be utilized for the development of the complete project.

CO Assessment Questions	
1	1. Discuss the functionalities that should be provided by a DBMS. 2. Give one example each for logical and physical data independence.
2	1. Assume we have the following application that models soccer teams, the games they play, and the players in each team. In the design, we want to capture the following: • We have a set of teams, each team has an ID (unique identifier), name, main stadium, and to which city this team belongs. • Each team has many players, and each player belongs to one team. Each player has a number (unique identifier), name, DoB, start year, and shirt number that he uses. • Teams play matches, in each match there is a host team and a guest team. The match takes place in the stadium of the host team. • For each match we need to keep track of the following: The date on which the game is played The result of the match

	The players participated in the match. For each player, how many goals he scored, whether he took the yellow card, and whether he took the red card. During the match, one player may substitute another player. We want to capture this substitution and the time at which it took place. • Each match has exactly three referees. For each referee, we have an ID (unique identifier), name, DoB, and years of experience. One referee is the main referee and the other two are assistant referees. Design an ER diagram to capture the above requirements.
3	1. Answer each of the following questions briefly. The questions are based on the following relational schema: ***Emp (eid: integer, ename: string, age: integer, salary: real)*** ***Works (eid: integer, did: integer, pct time: integer)*** ***Dept (did: integer, dname: string, budget: real, managerid: integer)*** a. Write the SQL statements required to create the above relations, including appropriate versions of all primary and foreign key integrity constraints. b. Write an SQL statement to add 'John Doe' as an employee with eid = 101, age = 32, and salary = 15, 000. c. Write an SQL statement to give every employee a 10% raise. d. Write an SQL statement to delete the 'Toy' department. Given the referential integrity constraints you chose for this schema, explain what happens when this statement is executed.
4	1. Consider a file with 2,00,000 records stored in a disk with fixed-length blocks of size 256 bytes. Each record is of size 50 bytes. The primary key is 4 bytes and the block pointer is 6 bytes. Compute the following, assuming that a multi-level primary index is used as the access path: a. Blocking factor for data records b. Blocking factor for index records c. Number of data blocks d. Number of First level index blocks e. Number of levels of multi-level index
5	1. Determine if the following schedule is recoverable. Is the schedule cascade-less? Justify your answer. r1(X), r2(Z), r1(Z), r3(X), r3(Y), w1(X), c1, w3(Y), c3, r2(Y), w2(Z), w2(Y),c2. (Note: ri(X)/wi(X) means transaction Ti issues read/write on item X; ci means transaction Ti commits.) 2. Prove that two-phase locking always gives serializable schedules.
6	1. Identify a societal, real-world database-related problem to implement as a project.

24HUT455	Management – 1 (Organizational Behavior)	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course enables students to adapt to the culture of an organization and foster behaviors conducive to the survival and effectiveness of the organization. This course covers social cognitive theory in terms of both environmental, contextual events and internal cognitive factors, as well as the dynamics and outcomes of the organizational behavior. It helps the learners to apply the principles of organizational behavior to increase the productivity and profitability of the organization to which they belong.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Examine the creation, maintenance and updation of organizational behavior, culture and characteristics. **(Analyze Level)**
CO2	Appraise the role of different reward systems in an organizational context. **(Evaluate Level)**
CO3	Categorize the cognitive processes of organizational behavior. **(Analyze Level)**
CO4	Design appropriate concepts, theories, models and other tools to make better understanding of behavioral dynamics. **(Create level)**
CO5	Illustrate various leadership styles and the role of leaders in a decision making process. **(Analyze Level)**
CO6	Explain various organizational culture and adapt to organizational change. **(Understand level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			3			1		3	3			3
CO2			3			1		3	3			3
CO3			3			1		3	3			3
CO4			3			1		3	3	3		3
CO5			3			1		3	3			3
CO6			3			1		3	3			3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate			✓	
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Introduction to Organizational behavior (8 hrs)

Organizational behavior-Definition, Nature and Scope, Theoretical foundations of organizational behavior. Environmental context – Diversity in the workplace, Ethics and ethical behavior in organizations. Organizational context – Foundations, Modern Organizational Design, Organizational Culture, Reward Systems.

MODULE II : Cognitive Processes of Organizational behavior (8 hrs)

Personality, Role of Heredity and the brain, Perception process, Social Perception, Employee Attitudes. Motivational needs and processes- Motivation process, Theories of Motivation. Positive organizational behavior- Positive Psychology, Self efficacy, Optimism, Hope, Resiliency, Psychological Capital, Emotional intelligence.

MODULE III : Communication, Decision making, Stress and Conflict

Management (7 hrs)

Communication - Definition, Types, Interactive communication in organizations. Decision Making- Decision making process, Behavioral and Participative decision making, Creativity and group decision making. Stress and Conflict-Emergence, Causes, Meaning and types of conflict, Strategies to cope with stress and conflict.

MODULE IV : Empowerment and Team work (6 hrs)

Power and Politics- Meaning and types of power, Contingency approaches to power, Empowerment, Political implications of power. Groups and Teams – Meaning and types of groups, Dynamics of informal groups, Dysfunctions of groups and teams, Work teams.

MODULE V : Leadership and Organizational Culture (7 hrs)

Leadership - Introduction, Traditional and modern theories of Leadership. Organizational culture - Elements of Organizational Culture, Hofstede's culture typology. Organizational change- Resistance to change, Four approaches to organizational change.

Text books

1. Organizational Behavior - An Evidence Based Approach, Fred Luthans, 12th edition, McGraw-Hill, 2011.
2. Organizational Behavior, Steven L. McShane, Mary Ann Von Glinow, 3rd edition, Tata McGraw Hill, 2015.

Reference books

1. Organizational Behavior: Science, The Real World, and You, Debra L. Nelson, James Campbell Quick, 8th edition, South-Western Thomson Publishing, 2012.
2. Organizational Behavior - Human Behavior at Work, Newstrom W. John & Davis Keith,12/e,TMH, 2009.
3. Management and Organizational Behavior: An Integrated perspective, Pierce and Gardner, South-Western Thomson Publishing, 2001.
4. Organizational Behavior, Neharika Vohra, Stephen P. Robbins, Timothy A. Judge, 18th edition, PHI/Pearson, 2022.

Suggested MOOC Courses

1. Organizational behavior by M.P. GANESH, IIT MADRAS.
2. Organizational behavior by Dr. Susmita Mukhopadhyay,IIT KHARAGPUR.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. ofHours
	MODULE 1	
1.1	Organizational behavior-Definition, Nature and Scope	1
1.2	Theoretical foundations of organizational behavior	1
1.3	Environmental context – Diversity in the workplace	1

1.4	Ethics and ethical behavior in organizations	1
1.5	Organizational context – Foundations	1
1.6	Modern Organizational Design	1
1.7	Organizational Culture	1
1.8	Reward Systems	1
MODULE II		
2.1	Personality, Role of Heredity and the brain	1
2.2	Perception process, Social Perception, Employee Attitudes	1
2.3	Motivational needs and processes- Motivation process	1
2.4	Theories of Motivation	1
2.5	Positive organizational behavior- Positive Psychology, Self efficacy,	1
2.6	Optimism, Hope	1
2.7	Resiliency, Psychological Capital	1
2.8	Emotional intelligence	1
MODULE III		
3.1	Communication – Definition and Types	1
3.2	Interactive communication in organizations	1
3.3	Decision Making- Decision making process	1
3.4	Behavioral and Participative decision-making techniques	1
3.5	Creativity and group decision making	1
3.6	Stress and Conflict-Emergence, Causes, Meaning and types of conflict	1
3.7	Strategies to cope with stress and conflict	1
MODULE IV		

4.1	Power and Politics- Meaning and types of power	1
4.2	Contingency approaches to power	1
4.3	Empowerment and Political implications of power	1
4.4	Groups and Teams – Meaning and types of groups	1
4.5	Dynamics of informal groups	1
4.6	Dysfunctions of groups and teams, Work teams	1
	MODULE V	
5.1	Leadership –Introduction	1
5.2	Traditional theories of Leadership	1
5.3	Modern theories of Leadership	1
5.4	Organizational culture - Elements of Organizational Culture	1
5.5	Hofstede's culture typology	1
5.6	Organizational change- Resistance to change	1
5.7	Four approaches to organizational change	1

CO Assessment Questions	
1	1. One dimension of this environment has been the dramatic increase in the number of non job or "telecommuters," those that work from home or at least outside the organization. Inexpensive computers, the changing nature of jobs, and workers' demands for a more flexible schedule have all contributed to this trend. Visit different company websites that offers telecommuting jobs and consider the following questions. A. Would you consider a job that kept you at home for a significant part of the workweek? What would be the advantages of this? Disadvantages? B. As a manager, consider the challenges of managing those who work at home or virtually out of the organization. What are your challenges? Consider, for example, how to monitor performance,

	motivate workers, and help them manage workplace problems. C. Do you think the trend toward telecommuting will increase or decrease in the coming years? What impact will this have on some of the major topics in this text? 2. Jane Arnold wants to be a manager. She enjoyed her accounting, finance, and marketing courses. Each of these provided her with some clear-cut answers. Now the professor in her organizational behavior course is telling her that there are really very few clear-cut answers when it comes to managing people. The professor has discussed some of the emerging challenges and the historical background and ways that behavioral science concepts play a big role in the course. Jane is very perplexed. She came to school to get answers on how to be an effective manager, but this course surely doesn't seem to be heading in that direction. A. How would you relieve Jane's anxiety? How is a course in organizational behavior going to make her a better manager? What implications does an evidence-based approach have? B. Why did the professor start off with a brief overview of emerging challenges? C. How does a course in organizational behavior differ from courses in fields such as accounting, finance, or marketing? 3. Visit some corporate Web sites that describe various structural design components and corporate values. Try to determine what the company's structure and culture may be. A. Compare structure and culture of two or more firms in the same industry. Which would you prefer to work for? B. What other issues do the structure and culture have for other topics of organizational behavior (motivation, reward systems, etc.)?
2	1. Using a search engine to go to specific companies, what types of reward systems can you find? Give the specifics and critique their value to improving performance in the workplace. 2. Is pay an effective organizational reward? Does the fact that the chief executive officer makes 20 times as much as the lowest-paid member of the company have any effect on the value of pay as a determinant of organizational performance? 3. Why have many organizations begun to supplement their traditional pay systems with "payfor-performance" plans? Of these plans, what about individual versus group incentives?
3	1. Many organizations are using outside resources to assess employee personalities in an effort to get them into jobs that fit their characteristics. Visit http://www.queendom.com/alltests.html. They have many different types of assessment tools that you can

take online. Many of them are related to the workplace. Identify similar websites and take some of the tests. Then consider the following questions:

   A. Did you learn anything that you didn't already know about yourself? If so, what? How do you think your personality will affect your work performance?
   B. Is there anything you would like to change about yourself in order to improve yourself? If so, what? If not, what type of job would seem to be most suited to your personality?
   C. See if you can locate still other Web sites that assess personality. How, if at all, do these personality assessments match up with what you have covered in this chapter on personality and attitudes?

2. Many companies have employment opportunities listed on their Web site. Go to http://www .southwest.com/careers/ and look at the job openings at Southwest Airlines. Using the Hackman and Oldham job design model with identity, significance, skill variety, autonomy, and feedback, analyze the jobs listed according to each characteristic.
   A. From a job design standpoint, which job would seem to have the most motivation potential? The least?
   B. Of the jobs that you consider poorly designed, discuss some ways that they might be improved.
   C. Compare these jobs to other companies that post jobs on their Web sites. Now go to company Web sites in manufacturing and the public sector in your local area that provide job openings and/or descriptions. Do you think some industries tend to have more motivating potential jobs than others?
3. Visit http://www.queendom.com for some cognitive exercises including an IQ test. To assess your happiness, visit http://www.authentichappiness.com, http://www.positivepsychology.org for a comprehensive site on positive psychology and http://www.bus.umich.edu/Positive for background and updates on positive organizational scholarship.
   A. Did the results of your IQ test surprise you? Considering that EQ can be learned, are there any areas you should try to improve on?
   B. How do you think your close coworkers and/or friends would respond to these tests? Does that help you understand their behaviors better?
   C. Do you agree that EQ (EI) may be more important than IQ and may be applicable to effective interpersonal relations and

	performance in the workplace? Why? D. What impact does authentic happiness and/or positive organizational scholarship and behavior have on applications to the workplace?
4	1. Although decisions are made in organizations every day, it is oftentimes either the large decisions, such as laying off many workers, or bad decisions, such as evidenced in the corporate scandals involving Enron, Arthur Andersen, or WorldCom, that receive all the attention. Using your search engine, come up with several organizations that have recently had a decision with negative or positive outcomes in the national news. Then, take these decisions, and consider the following: A. What were the reasons behind the poor decisions? Which framework did the poor decisions fall under (rational or social)? Were the poor decisions the result of using an incorrect decision-making model? Analyze the same issues for the good decisions that you found. B. Could the decisions be improved by using one of the group decision-making techniques discussed in your text? Don't forget to consider the downside to this, such as increased time to make the decision. C. Did you find any specific organizations that had a pattern of wrong decisions? If so, discuss the possible reasons for this. 2. Job stress can have physiological, psychological, and behavioral effects. Give an example of each and cite some research findings on the relationship between job stress and these outcomes. 3. Using the Kelman contingency model of power and influence, who would you use to advertise products in the fall, winter, spring, and summer? Explain your choices.
5	1. Why do you think the "Big Five" personality traits have been recently found to relate to effective leaders whereas over the years personality traits in general have not? 2. What is the GLOBE project? What cultural dimensions have been identified by the GLOBE researchers? What findings have been found by this GLOBE research effort in terms of the six major leadership dimensions found in various cultures?
6	1. Divide the class into 10 groups, each with 6-8 students. Each group should identify the organizational culture followed by at least five reputed organizations all over the world. Prepare a conclusive report and present it before the class. 2. Suppose that you are applying for a position in change management in a firm. The interviewer may ask the following

	change management questions. Prepare a report on how you will answer to each of these questions. a. What are the main challenges a manager should face in adopting changes? b. Implementing changes is expensive and hazardous to your economic health. Comment on this argument. c. What do you believe is the most effective change management model and why?

24MCT406	Environmental Sciences	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	1	2024

Preamble: Environmental Sciences is a specialized course designed to provide engineering students with a solid foundation in environmental principles and their application to engineering practice. The course aims to enhance students' understanding of the environmental challenges associated with engineering activities and equip them with the knowledge and skills to integrate environmental considerations into their future engineering work.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Identify ecosystem components and threats (Apply level)
CO 2	Describe the air and noise pollution problems and their sustainable solutions (Understand level)
CO 3	Discuss the water and wastewater qualities and its treatment (Understand level)
CO 4	Explain the various types of solid waste and its management strategies (Understand level)
CO 5	Associate causes and effects of climate change and suggest climate actions (Evaluate level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	1	3					1			2		1
CO 2	3					2	1					
CO 3	3					2	1					
CO 4	3					2	1					
CO 5	3	3		2		3	2			2		2

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate			✓	
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks. Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Environment and Ecosystem)

Introduction-Definition and scope of environmental science - Interdisciplinary nature of the field

Ecosystem structure and function- Biodiversity and its importance - Threats to biodiversity (habitat loss, invasive species, overexploitation) - Man and Environment – Health and Environment – Environmental Ethics.

Sustainable development – Social, economic and environmental dimensions- Need for Sustainable development, Sustainable Development Goals (SDGs)

MODULE II (Air and Noise pollution)

Air pollutants – classification, sources and impacts - Clean air act and national

ambient air quality standards (NAAQS) - Air quality index - Emission reduction strategies - Understanding and controlling indoor air pollution.
Ground level ozone and photochemical smog - Ozone layer depletion and the Montreal Protocol, Global warming
Noise Pollution: Sources and effects of noise; quantification of noise pollution (Leq, LAeq, etc.); Control and regulation rules in India

MODULE III (Water and Wastewater)

Sources and availability of freshwater- Water conservation strategies - Water pollution and its impacts – Water Quality Standards (IS 10500) - Water quality index; Overview of water treatment plant- Sustainable water use and conflicts over water resources.
Wastewater sources and quality –wastewater disposal – Oxygen sag curve - Applicable wastewater discharge standards and typical flow schemes for sewage treatment plant – Decentralized wastewater treatment- natural methods of wastewater treatment

MODULE IV (Solid and Hazardous Waste Management)

Waste Management: Consumerism and our throw-away culture; Characteristics of municipal solid waste; CPHEEO guidelines for solid waste management (overview only); Waste disposal methods (landfill, incineration, recycling)
Sustainable practices in waste management - Transition to zero waste lifestyle – Circular Economy
Hazardous and e-waste identification and management - Recycling and waste-to-energy technologies – regulations for hazardous waste management in India (overview only); Biomedical waste and its management

MODULE V (Climate Action)

Climate Change: Evidence, causes and effects, Carbon footprint, Global warming potential; Role of IPCC in the understanding of climate change; Global climate agreements – The United Nations Framework Convention on Climate Change, the Kyoto Protocol, and the Paris Agreement
Mitigation strategies – carbon capture, utilization, and storage; adapting to climate change.
Renewable Energy- solar energy, Biomass, Wind energy, New Energy sources

Text books

1. Gilbert M. Masters, Wendell P. Ela, Introduction to Environmental Engineering and Science, 3rd Edition (2013), Pearson Education
2. Mark Brusseau, Ian Pepper, Charles Gerba, Environmental and Pollution Science, 3rd Edition (2019), Elsevier
3. Mackenzie L Davis, Introduction to Environmental Engineering, 5th Edition(2012), McGraw hill Education (India)

Reference books

1. Robert A Corbett, Standard Handbook of Environmental Engineering, 2nd

edition (1999), McGraw Hill 2. B.C Punmia, Wastewater Engineering, 2nd edition (1998), Laxmi Publications Pvt. Ltd 3. Mackenzie Davis and Susan Masten, Principles of Environmental Engineering & Science, 4th Edition (2004), McGraw Hill		
COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours 36
MODULE 1 (5 hours)		
1.1	Introduction-Definition and scope of environmental science - Interdisciplinary nature of the field	1
1.2	Ecosystem structure and function- Biodiversity and its importance	1
1.3	Threats to biodiversity (habitat loss, invasive species, overexploitation)	1
1.4	Man and Environment – Health and Environment – Environmental Ethics	1
1.5	Sustainable development – Social, economic and environmental dimensions – Need for Sustainable development, Sustainable Development Goals (SDGs)	1
MODULE II (7 hours)		
2.1	Air pollutants – classification, sources and impacts -	1
2.2	Clean air act and national ambient air quality standards (NAAQS) - Air quality index	1
2.3	Emission reduction strategies - Understanding and improving indoor air quality	1
2.4	Ground level ozone and photochemical smog	1
2.5	Ozone layer depletion and the Montreal Protocol, Global warming	1
2.6	Noise Pollution: Sources and effects of noise; quantification of noise pollution (Leq, LAeq, etc.)	1
2.7	Control and regulation rules in India	1
MODULE III (9 hours)		
3.1	Sources and availability of freshwater- Water conservation strategies.	1
3.2	Water pollution and its impacts – Water Quality Standards (IS 10500)	1
3.3	Water quality index; Overview of water treatment plant	1

3.4	Sustainable water use and conflicts over water resources	1
3.5	Wastewater sources and quality	1
3.6	Wastewater disposal – Oxygen sag curve	1
3.7	Applicable wastewater discharge standards and typical flow schemes for sewage treatment plant	1
3.8	Decentralized wastewater treatment	1
3.9	Natural methods of wastewater treatment	1
MODULE IV (7 hours)		
4.1	Waste Management: Consumerism and our throw-away culture	1
4.2	Characteristics of municipal solid waste; CPHEEO guidelines for solid waste management (overview only);	1
4.3	Waste disposal methods (landfill, incineration, recycling)	1
4.4	Sustainable practices in waste management - Transition to zero waste lifestyle – Circular Economy	1
4.5	Hazardous and e-waste identification and management - Recycling	1
4.6	Waste-to-energy technologies – regulations for hazardous waste management in India (overview only)	1
4.7	Biomedical waste and its management	1
MODULE V (8 hours)		
5.1	Climate Change: Evidence, causes and effects, Carbon footprint, Global warming potential	1
5.2	Role of IPCC in the understanding of climate change	1
5.3	Global climate agreements – The United Nations Framework Convention on Climate Change, the Kyoto Protocol, and the Paris Agreement	1
5.4	Mitigation strategies – carbon capture, utilization and storage	1
5.5	Adapting to climate change	1
5.6	Renewable Energy- Solar energy	1
5.7	Biomass, Wind energy	1

5.8	New Energy sources	1

CO Assessment Questions	
CO1	a) Visit any wetland ecosystem and identify the major threats faced. b) How can mangroves aid in coastal protection?
CO2	a) What are the sources and effects of CO pollution? b) What are the main factors in indoor air quality? c) Explain the impacts of global warming. d) Discuss the control measures for noise pollution
CO3	a) List and explain any three water conservation strategies b) Describe the impacts of wastewater discharge to inland water bodies. c) With a neat layout, explain the treatment units in a conventional water treatment plant. d) Writeshort note on natural methods for wastewater treatment.
CO4	a) Explain the concept of circular economy. How does it help in achieving zero waste? b) Discuss the management strategies for biomedical waste. c) Classify solid waste based on source. d) Write a short note on Landfills. e) Discuss the e-waste management regulations in India
CO5	a) Estimate the carbon footprint of a brick kiln and suggest appropriate climate action. b) Suggest appropriate mitigation strategies for pollution from transportation sector

24BYT407	Biology for Engineers	L	T	P	J	S	C	Year of Introduction
		2	0	0	0	2	2	2024

Preamble: This course enables students to develop a foundational grasp of biological concepts and their applications within engineering. This course covers the fundamental topics in cell biology, human organ systems, nature-inspired biodesign, contemporary trends in bioengineering, and the utilization of biological databases and search engines. It helps the learners to apply biological principles to craft innovative solutions for real-world challenges.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Illustrate the relationship between Science and Engineering **(Understand Level)**
CO2	Explain the evolution of modern inventions from nature. **(Understand Level)**
CO3	Demonstrate the concepts of biomolecules applied in modern technology. **(Apply Level)**
CO4	Explain the architectural features of the human organ to work as an engineering system with proper examples. **(Apply level)**
CO5	Explain about the development and applications of artificial organs. **(Understand Level)**
CO6	Search and identify the features of biological databases and biological search engines. **(Understand Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											3
CO2	3											3
CO3	3											3
CO4	3											3
CO5	3											3
CO6	3											3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	--

Understand	✓	✓	✓	--
Apply			✓	--
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
2-0-0-0	**5**	**35**	**30**	**30**	**100**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	100	---	---

SYLLABUS

MODULE I : Nature BioInspired Designs (6 hrs)

Science and Engineering - Phylogeny, Motivation, Methods, Literature, Synthesis Four phases of technology. Scientific Method, Mathematical modeling, Biological Engineering, Biological Predictions. Nature Inspired Designs - Kingfisher Beak: Bullet Train, Shark skin: Friction reducing swim suits and Aquatic Vehicles, Bird Flying: GPS and Aircraft, Whales: Wind Turbines, Spiders: Protective Glasses, Echolocation: Ultrasonography and Sonars, Photosynthesis: Photovoltaic cells and bionic leaf, Human Blood substitutes: Hemoglobin-Based Oxygen Carriers (HBOCs) and PerFlouroCarbons (PFCs).

MODULE II : Cell Biology (5 hrs)

Prokaryotic and Eukaryotic cell structure, Biomembrane, Transport across cell membranes – Passive diffusion, Facilitated diffusion, co-transport and active transport. Carbohydrates: Organization, Cellulose-based water filters, Nucleic acids: Organization of DNA and RNA, DNA Vaccine for Rabies and RNA vaccines for Covid19, Forensics: DNA fingerprinting, Proteins: Organization of Proteins, Plant based proteins, lipids, Biodiesel, Enzymes: Glucose-oxidase in biosensors.

MODULE III : Human Organ Systems and Biodesigns - I (5 hrs)

Brain as a CPU system- Architecture, CNS and Peripheral Nervous System, Signal transmission, EEG, Robotic arms for prosthetics. Eye as a Camera system- Architecture of Rod and Cone cells, Optical corrections, Cataract, Lens materials. Heart as a pump system - Architecture, Electrical signaling: ECG monitoring and heart related issues, Reasons for blockages of blood vessels, Design of stents.

MODULE IV : Human Organ Systems and Biodesigns -II (4 hrs)

Lungs as purification system- Architecture, Gas exchange mechanisms, Spirometry, Ventilators, Heart-lung machine. Kidney as a filtration system: Architecture, Mechanism of filtration, Dialysis systems. Muscular and Skeletal Systems as scaffolds- Architecture, Mechanisms, Bioengineering solutions for osteoporosis.

MODULE V : Bioengineering, Biological Databases & Search Engines (4 hrs)

Bioprinting techniques and materials, 3D printing of ear, bone and skin, 3D printed foods, Electrical tongue and electrical nose in food science, DNA origami and Biocomputing, Bioimaging and Artificial Intelligence for disease diagnosis. Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Introduction of biological search engine- Entrez.

Text books

1. Biology for Engineers, Arthur T. Johnson, CRC Press, Taylor and Francis, 2011.
2. Molecular Cell Biology, Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, Matthew P. Scott. 2012, 7th edition.
3. Biology for Engineers, Thyagarajan S., Selvamurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W., Barathi S, 2013.
4. Biomimetics: Nature-Based Innovation, Yoseph Bar-Cohen, 1st edition, 2012, CRC Press.

Reference books

1. Human Physiology, Stuart Fox, Krista Rompolski, McGraw-Hill eBook. 16th Edition, 2022.
2. Biology for Engineers, G.K Suraishkumar, Oxford University Press, 2019.
3. Jaganthan M.K., Tata McGraw-Hill, New Delhi, 2012.
4. Biomedical Instrumentation, Leslie Cromwell, Prentice Hall 2011.
5. Biology for Engineers, Sohini Singh and Tanu Allen, Vayu Education of India, New Delhi, 2014.
6. Bio-Inspired Artificial Intelligence: Theories, Methods and Technologies, D. Floreano and C. Mattiussi, MIT Press, 2008.

Suggested MOOC Courses

1. NPTEL Course: Biology for engineers and other non-biologists by Dr. Madhulika Dixit, Prof. G.K. Suraishkumar, IIT Madras.

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
MODULE I		
1.1	Science and Engineering - Phylogeny, Motivation, Methods, Literature, Synthesis Four phases of technology.	1
1.2	Scientific Method, Mathematical modeling, Biological Engineering, Biological Predictions.	1
1.3	Kingfisher Beak: Bullet Train, Shark skin: Friction reducing swim suits and Aquatic Vehicles, Bird Flying: GPS and Aircraft	1
1.4	Whales: Wind Turbines, Spiders: Protective Glasses, Echolocation: Ultrasonography and Sonars	1
1.5	Photosynthesis: Photovoltaic cells and bionic leaf	1
1.6	Human Blood substitutes: Hemoglobin-Based Oxygen Carriers (HBOCs) and PerFlouroCarbons (PFCs).	1
MODULE II		
2.1	Prokaryotic and Eukaryotic cell structure, Biomembrane, Transport across cell membranes – Passive diffusion, Facilitated diffusion, co-transport and active transport.	1
2.2	Carbohydrates: Organization, Cellulose-based water filters	1
2.3	Nucleic acids: Organization of DNA and RNA, DNA Vaccine for Rabies and RNA vaccines for Covid19, Forensics: DNA fingerprinting	1

2.4	Proteins: Organization of Proteins, Plant based proteins, lipids, Biodiesel	1
2.5	Enzymes: Glucose-oxidase in biosensors.	1
	MODULE III	
3.1	Brain as a CPU system- Architecture, CNS and Peripheral Nervous System, Signal transmission	1
3.2	EEG, Robotic arms for prosthetics	1
3.3	Eye as a Camera system- Architecture of Rod and Cone cells, Optical corrections, Cataract, Lens materials.	1
3.4	Heart as a pump system - Architecture, Electrical signaling: ECG monitoring and heart related issues	1
3.5	Reasons for blockages of blood vessels, Design of stents	1
	MODULE IV	
4.1	Lungs as purification system- Architecture, Gas exchange mechanisms, Spirometry	1
4.2	Ventilators, Heart-lung machine	1
4.3	Kidney as a filtration system: Architecture, Mechanism of filtration, Dialysis systems.	1
4.4	Muscular and Skeletal Systems as scaffolds- Architecture, Mechanisms, Bioengineering solutions for osteoporosis.	1
	MODULE V	
5.1	Bioprinting techniques and materials, 3D printing of ear, bone and skin	1
5.2	3D printed foods, Electrical tongue and electrical nose in food science	1
5.3	DNA origami and Biocomputing, Bioimaging and Artificial Intelligence for disease diagnosis.	1
5.4	Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Introduction of biological search engine- Entrez.	1

CO Assessment Questions	
1	A. Make a list of engineering contributions that have enabled scientific progress. B. Why is the scientific method so powerful? Can any kind of science proceeds without using the scientific method?

2	A. Explain the nature inspired aspect in the designing of bullet train. Is there any alternative solution to the design of bullet train? Explain. B. Identify a potential real-world problem and suggest a solution based on the inspirations from nature**. (Group Project)**
3	A. Identify any five potential applications of biomolecules in designing engineering solutions. **(Group Project)** B. Explain the organization of DNA and elucidate how this arrangement aids in the process of DNA fingerprinting.
4	A. Prepare a report on the state-of-the-art progress in the Brain Computer Interface field over the last decades and highlight the critical challenges faced in the design. B. Illustrate the architectural features that enable the lungs to function as a purification system and provide an example of a bio-design application inspired by their operation. C. Identify the engineering solution based on biological concepts for any of the following cases. • Parkinson’s Disease • Bionic Eye • Design of pacemakers • Muscular dystrophy
5	A. How does bioengineering intersect with other disciplines, such as nanotechnology, robotics, and artificial intelligence, to advance healthcare and biotechnology? B. Explore the recent research and innovations in bioprinting materials, such as bioinks with embedded sensors or stimuli-responsive capabilities. C. Describe the concept of bioink in bioprinting. What are the criteria for selecting an appropriate bioink for a specific tissue or organ?
6	A. Describe the role of the National Center for Biotechnology Information (NCBI) in biological databases and its major resources. B. Explain the emerging trends and technologies in the field of biological databases and search engines. C. Outline the ethical and privacy considerations related to biological data sharing in databases.

HONORS – S4

24CSH409	Computational Geometry	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	4	4	2024

Preamble: This course enables the learners to understand fundamental problems of computational geometry, their mathematical foundations, and algorithmic solutions. It also compares several approaches to a problem that optimize different measures of efficiency, such as storage space, running time, or algorithmic complexity. It also enables the learners to work on various application domains including computer graphics, visualization, robotics, computational biology, data mining, parallel computing, and scientific computing.

Prerequisite: Basic knowledge of data structures and algorithms

Course Outcomes: After the completion of the course the student will be able to

CO1	Analyze randomized algorithms for small domain problems. **(Analyze Level)**
CO2	Use line-point duality to develop efficient algorithms. (**Apply Level)**
CO3	Design efficient algorithms by exploiting geometric properties, and using appropriate data structures and geometric techniques.**(Apply Level)**
CO4	Implement geometric algorithms.**(Apply Level)**
CO5	Apply geometric techniques to real-world problems in graphics.**(Apply Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1					3			3
CO2	3	3	3	1					3			3
CO3	3	3	3	1					3			3
CO4	3	3	3	1					3			3
CO5	3	3	3	1					3			3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✔	✔	✔	✔
Understand	✔	✔	✔	✔
Apply	✔	✔	✔	✔
Analyse			✔	
Evaluate			✔	
Create			✔	

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
4-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS
MODULE I : Introduction to Computational Geometry (12 hrs)
Points, lines, circles and ellipses as primitives, scan conversion algorithms for primitives, Fill area primitives including scan-line polygon filling, inside-outside test, boundary and flood-fill, character generation, line attributes, area-fill attributes, character attributers. The Digital Differential Analyzer (DDA), Bresenham's Algorithm, Generation of Circles. Geometric Preliminaries - General definitions and notations, General definitions and notations, Geometry duality. Polarity

MODULE II : Introduction to Geometric Searching (10 hrs)

Introduction to Geometric Searching, Point-Location Problems, General considerations. Simple cases, Location of a point in a planar subdivision, The slab method, The chain method, Optimal techniques: the planar-separator method, the triangulation refinement method, and the bridged chain method, The trapezoid method, Range-Searching Problems. 1D Range search, Kd Trees.

MODULE III : Triangulation and Geometric Data Structures (7 hrs)

Delaunay Triangulations - Triangulations and planar point sets, The Delaunay Triangulation, Computing the Delaunay Triangulation. Geometric Data Structures - Interval Trees, Priority Search Trees, Segment Trees

MODULE IV : Art Gallery Theorems and Algorithms (8 hrs)

Art Gallery Theorem, Guarding Art Gallery, Fisk's proof using three colouring.
Arrangements of Lines – Duality, Combinatorics of arrangements, Zone Theorem, Algorithm for Constructing arrangements of lines.

MODULE V : Basic Planar Problems (8 hrs)

Convex Hulls- Convex Hull Algorithms in the Plane -Graham's Scan Algorithm, Jarvi's March, Divide and Conquer Algorithm. Voronoi Diagrams- Properties and applications in the plane. Proofs of properties related to vertices and edges of voronoi diagrams. Algorithm for constructing voronoi diagram. Delaunay Triangulation.

Text books

1. Franco P. Preparata and Michael Ian Shamos, Computational Geometry an Introduction. Texts and Monographs in Computer Science, Springer Verlag,1985
2. Mark. de Berg, Marc. van Kreveld, Mark. Overmars and Otfried Cheong, Computational Geometry- Algorithms and Applications. Springer- Verlag 3rd Edn, 1998

Reference books

1. Joseph O'Rourke, Computational Geometry in C. Cambridge University Press 2nd Edn, 1998
2. Herbert Edelsbrunner, Algorithms in Combinatorial Geometry, EATCS Monographs on Theoretical Computer Science, Springer Verlag, 1987
3. Joseph O' Rourke, Art Gallery Theorems. Oxford Press publications, 1987

Suggested MOOC Courses

1. Computational Geometry By Prof. Amit Kumar,IIT Delhi

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Points, lines, circles and ellipses as primitives	1
1.2	Fill area primitives including scan-line polygon filling	1

1.3	inside-outside test, boundary and flood-fill	1
1.4	character generation, line attributes	1
1.5	area-fill attributes,character attributers	1
1.6	The Digital Differential Analyzer (DDA)	1
1.7	Bresenham’s Algorithm	1
1.8	Generation of Circles	1
1.9	Geometric Preliminaries - General definitions and notations	1
1.10	General definitions and notations	1
1.11	Geometry duality	1
1.12	Polarity	1
MODULE II		
2.1	Introduction to Geometric Searching	1
2.2	Point-Location Problems, General considerations.	1
2.3	Simple cases, Location of a point in a planar subdivision	1
2.4	The slab method	1
2.5	The chain method	1
2.6	Optimal techniques: the planar-separator method	1
2.7	The triangulation refinement method and the bridged chain method	1
2.8	The trapezoid method	1
2.9	Range-Searching Problems	1
2.10	1D Range search, Kd Trees	1
MODULE III		

3.1	Delaunay Triangulations - Triangulations and planar point sets	1
3.2	The Delaunay Triangulation	1
3.3	Computing the Delaunay Triangulation	1
3.4	Geometric Data Structures - Interval Trees (Lecture - 1)	1
3.5	Geometric Data Structures - Interval Trees (Lecture - 2)	1
3.6	Priority Search Trees	1
3.7	Segment Trees	1
MODULE IV		
4.1	Art Gallery Theorem, Guarding Art Gallery	1
4.2	Fisk's proof using three colouring (Lecture - 1)	1
4.3	Fisk's proof using three colouring (Lecture - 2)	1
4.4	Arrangements of Lines – Duality	1
4.5	Combinatorics of arrangements	1
4.6	Zone Theorem	1
4.7	Algorithm for Constructing arrangements of lines (Lecture - 1)	1
4.8	Algorithm for Constructing arrangements of lines (Lecture - 2)	1
MODULE V		
5.1	Convex Hulls- Convex Hull Algorithms in the Plane -Graham's Scan Algorithm (Lecture -1)	1
5.2	Convex Hulls- Convex Hull Algorithms in the Plane -Graham's Scan Algorithm (Lecture -2)	1
5.3	Jarvi's March	1
5.4	Divide and Conquer Algorithm	1

5.5	Voronoi Diagrams- Properties and applications in the plane.	1
5.6	Proofs of properties related to vertices and edges of voronoi diagrams	1
5.7	Algorithm for constructing voronoi diagram	1
5.8	Delaunay Triangulation	1

CO Assessment Questions	
1	1) Give a randomized algorithm to compute in O(n log n + A) expected time all pairs of intersecting segments in a set of n line segments, where A is the number of intersecting pairs. 2) Use a plane sweep argument to prove that the trapezoidal map of n line segments in general position has at most 3n + 1 trapezoids. (Imagine a vertical line sweeping over the plane from left to right, stopping at all endpoints of segments. Count the number of trapezoids that are encountered by the sweep line.)
2	1) Prove that any polygon admits a triangulation, even if it has holes. Can you say anything about the number of triangles in the triangulation? 2) A rectilinear polygon is a simple polygon of which all edges are horizontal or vertical. Let P be a rectilinear polygon with n vertices. Give an example to show that ceil(n/4) cameras are sometimes necessary to guard it. 3) Prove or disprove: The dual graph of the triangulation of a monotone polygon is always a chain, that is, any node in this graph has degree at most two.
3	1) Show that Ω(n log n) is a lower bound for computing Voronoi diagrams by reducing the sorting problem to the problem of computing Voronoi diagrams. You can assume that the Voronoi diagram algorithm should be able to compute for every vertex of the Voronoi diagram its incident edges in cyclic order around the vertex. 2) Show that for some set P of n points, there can be Ω(n2) intersections between the edges of the Voronoi diagram and the farthest site Voronoi diagram.
4	Consider the following alternative approach to computing the convex hull of a set of points in the plane: We start with the rightmost point. This is the first point p1 of the convex hull. Now imagine that we start with a vertical line and rotate it clockwise until it hits another point p2 . This is

	the second point on the convex hull. We continue rotating the line but this time around p2 until we hit a point p3 . In this way we continue until we reach p1 again. a. Give pseudocode for this algorithm. b. What degenerate cases can occur and how can we deal with them? c. Prove that the algorithm correctly computes the convex hull. d. Prove that the algorithm can be implemented to run in time $O(n \cdot h)$, where h is the complexity of the convex hull. e. What problems might occur when we deal with inexact floating point arithmetic?
5	Let S be a set of n (possibly intersecting) unit circles in the plane. We want to compute the convex hull of S. a. Show that the boundary of the convex hull of S consists of straight line segments and pieces of circles in S. b. Show that each circle can occur at most once on the boundary of the convex hull. c. Let S' be the set of points that are the centers of the circles in S . Show that a circle in S appears on the boundary of the convex hull if and only if the center of the circle lies on the convex hull of S' . d. Give an $O(n \log n)$ algorithm for computing the convex hull of S. e. Give an $O(n \log n)$ algorithm for the case in which the circles in S have different radii.

24CSH410	System Software	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	4	4	2024

Preamble: The purpose of this course is to create awareness about the low-level codes which are very close to the hardware and about the environment where programs can be developed and executed. This course helps the learner to understand the machine dependent and machine independent system software features and to design/implement system software like assembler, loader, linker, macroprocessor and device drivers. Study of system software develops the ability to design interfaces between software applications and computer hardware**.**

Prerequisite: A sound knowledge in Data structures and Computer organization

Course Outcomes: After the completion of the course the student will be able to

CO1	Distinguish softwares into system and application software categories. **(Understand Level)**
CO2	Identify standard and extended architectural features of machines. (**Apply Level)**
CO3	Identify machine dependent features of system software. **(Apply Level)**
CO4	Identify machine independent features of system software. **(Understand level)**
CO5	Design algorithms for system softwares and analyze the effect of data structure. **(Apply Level)**
CO6	Understand the features of device drivers and editing & debugging tools. **(Understand level**)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3			1							3
CO2	3	3	1									3
CO3	3	3	1									3
CO4	3	3										3
CO5	3	3	3	3					1			3
CO6	3	1			3							3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✔	✔	✔	✔
Understand	✔	✔	✔	✔
Apply	✔	✔	✔	✔
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
4-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Introduction (9 hrs)

System Software vs Application Software, Different System Software– Assembler, Linker, Loader, Macro Processor, Text Editor, Debugger, Device Driver, Compiler, Interpreter, Operating System (Basic Concepts only). SIC & SIC/XE Architecture - Addressing modes, SIC & SIC/XE Instruction set, Assembler Directives.

MODULE II : Assembly language programming and Assemblers (8 hrs)

SIC/XE Programming, Basic Functions of Assembler, Assembler Output Format – Header, Text and End Records. Assembler Data Structures, Two Pass Assembler

Algorithm, Hand Assembly of SIC/XE Programs.

MODULE III : Assembler Features and Design Options (10 hrs)

Machine Dependent Assembler Features-Instruction Format and Addressing Modes, Program Relocation. Machine Independent Assembler Features –Literals, Symbol Defining Statements, Expressions, Program Blocks, Control Sections and Program Linking. Assembler Design Options - One Pass Assembler, Multi Pass Assembler.

MODULE IV : Loader and Linker (8 hrs)

Basic Loader Functions - Design of Absolute Loader, Simple Bootstrap Loader. Machine Dependent Loader Features - Relocation, Program Linking, Algorithm and Data Structures of Two Pass Linking Loader. Machine Independent Loader Features - Automatic Library Search, Loader Options. Loader Design Options.

MODULE V : Macro Preprocessor, Device driver,Text editor and Debuggers (9 hrs)

Macro Preprocessor - Macro Instruction Definition and Expansion, One pass Macro processor Algorithm and data structures, Machine Independent Macro Processor Features, Macro processor design options. Device drivers - Anatomy of a device driver, Character and block device drivers, General design of device drivers. Text Editors - Overview of Editing, User Interface, Editor - Structure. Debuggers - Debugging Functions and Capabilities, Relationship with other parts of the system, Debugging Methods - By Induction, Deduction and Backtracking.

Text books

1. Leland L. Beck, System Software: An Introduction to Systems Programming, 3/E, Pearson Education Asia, 1997.

Reference books

1. D.M. Dhamdhere, Systems Programming and Operating Systems, Second Revised Edition, Tata McGraw Hill, 2001
2. John J. Donovan, Systems Programming, Tata McGraw Hill Edition 1991.
3. George Pajari, Writing UNIX Device Drivers, Addison Wesley Publications, 1991 (Ebook : http://tocs.ulb.tu-darmstadt.de/197262074.pdf).
4. Peter Abel, IBM PC Assembly Language and Programming, Third Edition, Prentice Hall of India, 1995.
5. Jonathan Corbet, Alessandro Rubini, Greg Kroah-Hartman, Linux Device Drivers, Third Edition, O. Reilly Books, 2005.
6. M. Beck, H. Bohme, M. Dziadzka, et al., Linux Kernel Internals, Second Edition, Addison Wesley Publications, 1998.
7. J Nithyashri, System Software, Second Edition, Tata McGraw Hill, 2009.

8. The C Preprocessor http://gcc.gnu.org/onlinedocs/gcc-2.95.3/cpp_1.html -

Suggested MOOC Courses

Nil

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
MODULE 1		
1.1	System Software Vs. Application Software , Different System software – Assembler, Linker, Loader, Macro Processor	1
1.2	Text Editor, Debugger, Device Driver, Compiler, Interpreter, Operating System (Basic Concepts only)	1
1.3	SIC Architecture	1
1.4	SIC Addressing modes	1
1.5	SIC Instruction set and & Assembler directives	1
1.6	SIC/XE Architecture	1
1.7	SIC/XE Instruction format	1
1.8	SIC/XE Addressing modes	1
1.9	SIC/XE Instruction set	1
MODULE II		
2.1	SIC Programming	1
2.2	SIC/XE Programming	1
2.3	Basic Functions of Assembler	1
2.4	Assembler output format- Header, Text and End Records	1
2.5	Assembler data structures	1
2.6	Pass 1 of two pass SIC assembler algorithm	1
2.7	Pass 2 of two pass SIC assembler algorithm	1

2.8	Hand assembly of SIC program	1
	MODULE III	
3.1	Machine dependent assembler features-Instruction format and addressing modes, program relocation	1
3.2	Hand assembly of SIC/XE program- Lecture 1	1
3.3	Hand assembly of SIC/XE program- Lecture 2	1
3.3	Machine Independent assembler features – Literals	1
3.4	Machine Independent assembler features – Symbol defining statements, expression	1
3.5	Machine Independent assembler features – program blocks	1
3.6	Machine Independent assembler features – program blocks illustration with examples	1
3.7	Machine Independent assembler features – Control sections and program linking.	1
3.8	Machine Independent assembler features – Control sections and program linking. Illustration with example	1
3.9	Assembler design options- One Pass assembler	1
3.10	Multi pass assembler	1
	MODULE IV	
4.1	Basic Loader functions - Design of absolute loader	1
4.2	Simple bootstrap Loader	1
4.3	Machine dependent loader features- Relocation	1

4.4	Machine dependent loader features- Program Linking algorithm and data structures of First pass of two pass Linking Loader	1
4.5	Machine dependent loader features- Program Linking algorithm and data structures of Second pass of two pass Linking Loader	1
4.6	Machine independent loader feature - Automatic library search	1
4.7	Machine independent loader features - Loader options	1
4.8	Loader Design Option- Linking Loader, Linkage Editor, Dynamic Linking	1
	MODULE V	
5.1	Macro Preprocessor- Macro Instruction Definition and Expansion	1
5.2	One pass Macro processor algorithm and data structures	1
5.3	One pass Macro processor Algorithm and data structures illustration with example	1
5.4	Machine Independent Macro Processor Features- generation of unique labels, Concatenation of macro parameter, Keyword macro parameters	1
5.5	Machine Independent Macro Processor Features- Conditional Macro Expansion	1
5.6	Macro processor design options	1
5.7	Device drivers- Anatomy of a device driver, Character and block device drivers, General design of device drivers	1
5.8	Text Editors- Overview of Editing, User Interface , Editor Structure	1
5.9	Debuggers :- Debugging Functions and Capabilities, Debugging Methods- By Induction, Deduction and Backtracking	1

CO Assessment Questions	
1	1. List out two system software and two application software. 2. Differentiate system software and application software. 3. Explain three functions of operating systems.
2	1. How is upward compatibility between SIC and SIC/XE machines maintained? 2. Write a sequence of instructions for SIC/XE to divide BETA by GAMMA, setting ALPHA to the integer portion of the quotient and DELTA to the remainder. Use register- to-register instructions to make the calculation as

	efficient as possible
3	1. With a suitable example, explain the concept of Program Relocation. 2. Suppose the address associated with the symbol RETADR is 0030 and the machine equivalent code for STL is 14. Assemble the given SIC/XE instruction, by clearly indicating the instruction format, addressing mode and the setting of different flag bits, given the address value assigned to RETADR is 0030. <table><tr><th>Location</th><th>Label</th><th>Opcode</th><th>Operand</th></tr><tr><td>0000</td><td>FIRST</td><td>STL</td><td>RETADR</td></tr></table>
4	1. What are literals used for? Does the use of literals change the design of an assembler? 2. How do control sections and program blocks differ? 3. Can an assembler incorporating program blocks function using the same data structures as that of a normal two pass assembler? Justify your answer.
5	1. Design an assembler that can assemble a source program with different control sections. 2. Employ multipass assembler to evaluate the following expressions. <table><tr><th>Expression No</th><th>Location</th><th>Source statement</th></tr><tr><td>1</td><td></td><td>HALFSZ EQU MAXLEN/2</td></tr><tr><td>2</td><td></td><td>MAXLEN EQU BFEND-BUFR</td></tr><tr><td>3</td><td></td><td>PREVBT EQU BUFR-1</td></tr><tr><td>4</td><td>4034</td><td>BUFR RESB 4096</td></tr><tr><td>5</td><td>5034</td><td>BFEND EQU *</td></tr></table>
6	1. Describe any one commonly used debugging method. 2. Distinguish between character and block device drivers

24CSH411	Data and Web Mining	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	4	4	2024

Preamble: This course helps the learner to understand the concepts of data mining and web mining. It covers the key processes of data mining, data preprocessing techniques, fundamentals and advanced concepts of classification, clustering, association rule mining, web mining and text mining. It enables the learners to develop new data mining algorithms and apply the existing algorithms in real-world scenarios.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Employ the key process of data mining and data warehousing concepts in application domains. **(Understand Level)**
CO2	Make use of appropriate preprocessing techniques to convert raw data into suitable format for practical data mining tasks. **(Apply Level)**
CO3	Illustrate the use of classification and clustering algorithms in various application domains. **(Apply level)**
CO4	Comprehend the use of association rule mining techniques. **(Apply level)**
CO5	Explain advanced data mining concepts and their applications in emerging domains. **(Understand Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1										1
CO2	1	3	3	3	1							1
CO3	1	1	1	1	1							1
CO4	1	1	3	1	1							
CO5	1	1										1

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember		✓	✓	✓
Understand		✓	✓	✓
Apply		✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
4-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

<u>End Semester Examination [ESE]: Pattern</u>

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: <<Introduction to Data Mining and Data Warehousing>>

Data warehouse-Differences between Operational Database Systems and Data Warehouses, Multidimensional data model- Warehouse schema, OLAP Operations, Data Warehouse Architecture, Data Warehousing to Data Mining, Data Mining Concepts and Applications, Knowledge Discovery in Database Vs Data mining, Architecture of typical data mining system, Data Mining Functionalities, Data Mining Issues.

MODULE II: <<Data Preprocessing>>

Data Preprocessing-Need of data preprocessing, Data Cleaning- Missing values, Noisy data, Data Integration and Transformation, Data Reduction-Data cube aggregation, Attribute subset selection, Dimensionality reduction, Numerosity reduction, Discretization and concept hierarchy generation.

MODULE III: <<Advanced classification and Cluster analysis>>

Classification- Introduction, Decision tree construction principle, Splitting indices - Information Gain, Gini index Decision tree construction algorithms-ID3, Decision tree construction with presorting- SLIQ, Classification Accuracy-Precision, Recall.
Introduction to clustering- clustering Paradigms, Partitioning Algorithm- PAM, Hierarchical Clustering- DBSCAN, Categorical Clustering- ROCK

MODULE IV: <<**Association Rule Analysis>>**

Association Rules-Introduction, Methods to discover Association rules, Apriori(Level-wise algorithm), Partition Algorithm, Pincer Search Algorithm, Dynamic Itemset Counting Algorithm, FP-tree Growth Algorithm.

MODULE V: <<**Web Mining>>**

Web Mining - Web Content Mining, Web Structure Mining- Page Rank, Clever, Web Usage Mining- Preprocessing, Data Structures, Pattern Discovery, Pattern Analysis. Text Mining-Text Data Analysis and information Retrieval, Basic measures for Text retrieval, Text Retrieval methods, Text Indexing Techniques, Query Processing Techniques.

Text books

1. Dunham M H, "Data Mining: Introductory and Advanced Topics", Pearson Education, New Delhi, 2003.
2. Arun K Pujari, "Data Mining Techniques", Universities Press Private Limited,2008.
3. Jaiwei Han and Micheline Kamber, "Data Mining Concepts and Techniques", Elsevier, 2006
4. Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data, 2nd Edition, Springer July 2011, Bing Liu.

Reference books

1. M Sudeep Elayidom, "Data Mining and Warehousing", 1st Edition, 2015, Cengage Learning India Pvt. Ltd.
2. MehmedKantardzic, "Data Mining Concepts, Methods and Algorithms", John Wiley and Sons, USA, 2003.
3. Pang-Ning Tan and Michael Steinbach, "Introduction to Data Mining", Addison Wesley, 2006.
4. Web Data Mining: Exploring Hyperlinks, Content, and Usage Data, by Bing Liu, 2nd Edition, Springer, 2011 (Note: parts of the 1st edition will be available electronically for the reading assignments).

Suggested MOOC Courses

1. Data mining by Pabitra Mitra, IIT Kharagpur.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Data warehouse-Differences between Operational Database Systems and Data Warehouses, Multidimensional data model- Warehouse	1

	schema	
1.2	OLAP Operations	1
1.3	DataWarehouse Architecture, Data Warehousing to Data Mining	1
1.4	Data mining Concepts and Applications, Knowledge Discovery in Database Vs Data mining	1
1.5	Architecture of typical data mining system, Data Mining Functionalities	1
1.6	Data Mining Functionalities, Data Mining Issues	1
	MODULE II	
2.1	Data Preprocessing: Need of Data Preprocessing, Data Cleaning-Missing values, Noisy data- Lecture I	1
2.2	Data Preprocessing: Need of Data Preprocessing, Data Cleaning-Missing values, Noisy data- Lecture II	1
2.3	Data integration	1
2.4	Data transformation	1
2.5	Data Reduction-Data cube aggregation, Attribute subset selection	1
2.6	Data Reduction-Dimensionality reduction	1
2.7	Numerosity reduction, Discretization and concept hierarchy generation	1
	MODULE III	
3.1	Classification- Introduction, Decision tree construction principle, Splitting indices-Information Gain, Gini index	1
3.2	Decision Tree- ID3- Lecture I	1
3.3	Decision Tree- ID3- Lecture II	1
3.4	Decision tree construction with presorting	1
3.5	Decision tree construction with presorting- SLIQ	1
3.6	Accuracy and error measures, evaluation	1
3.7	Introduction to clustering, Clustering Paradigms	1

3.8	Partitioning Algorithm- PAM	1
3.9	Hierarchical Clustering-DBSCAN	1
3.10	Categorical Clustering-ROCK	1
	MODULE IV	
4.1	Association Rules: Introduction, Methods to discover association rules	1
4.2	Apriori algorithm (Level-wise algorithm) - Lecture I	1
4.3	Apriori algorithm (Level-wise algorithm) - Lecture II	1
4.4	Partition Algorithm- Lecture I	1
4.5	Partition Algorithm- Lecture II	1
4.6	Pincer Search Algorithm- Lecture I	1
4.7	Pincer Search Algorithm- Lecture II	1
4.8	Dynamic Itemset Counting Algorithm- Lecture I	1
4.9	Dynamic Itemset Counting Algorithm- Lecture II	1
4.10	FP-tree Growth Algorithm- Lecture I	1
4.11	FP-tree Growth Algorithm- Lecture II	1
	MODULE V	
5.1	Web Mining - Web Content Mining	1
5.2	Web Structure Mining- Page Rank	1
5.3	Web Structure Mining	1
5.4	Web Structure Mining –Clever algorithm	1
5.5	Web Usage Mining- Preprocessing, Data structures	1
5.6	Web Usage Mining -Pattern Discovery	1

5.7	Web Usage Mining - Pattern Analysis	1
5.8	Text Mining-Text Data Analysis and information Retrieval	1
5.9	Text Mining- Basic measures for Text retrieval	1
5.10	Text Retrieval methods, Text Indexing Techniques	1
5.11	Query Processing Techniques	1

CO Assessment Questions	
1	1. (a) Explain the OLAP operations in a multidimensional model. (b) Compare the techniques used in ROLAP, MOLAP and HOLAP 2. Explain the various data mining issues with respect to mining methodology, user interaction and diversity of data types. 3. Suppose that a data warehouse consists of the three dimensions time, doctor, and patient, and the two measures count and charge, where charge is the fee that a doctor charges a patient for a visit. (a) Draw star and snowflake schema diagrams for the data warehouse. (b) Starting with the base cuboid [day; doctor; patient], what specific OLAP operations should be performed in order to list the total fee collected by each doctor in 2004?
2	1. Use the methods below to normalize the following group of data:100, 200, 300, 400,550, 600, 680, 850, 1000 (a) min-max normalization by setting min = 0 and max = 1 (b) z-score normalization (c) Normalization by decimal scaling Comment on which method you would prefer to use for the given data, giving reasons as to why. 2. Identify a suitable dataset from any available resources and apply different preprocessing steps that you have learned. Observe and analyze the output obtained. (Assignment)

3

1. Illustrate the working of ID3 algorithm with the following example

MOTOR	WHEEELS	DOORS	SIZE	TYPE	CLASS
NO	2	0	small	cycle	bicycle
NO	3	0	small	cycle	tricycle
YES	2	0	small	cycle	motorcycle
YES	4	2	small	automobile	Sports car
YES	4	3	medium	automobile	minivan
YES	4	4	medium	automobile	sedan
YES	4	4	large	automobile	sumo

2. Illustrate the working of K medoid algorithm for the given dataset. A1=(3,9), A2=(2,5), A3=(8,4), A4=(5,8), A5=(7,5), A6=(6,4), A7=(1,2), A8=(4,9).
3. Take a suitable dataset from available resources and apply all the classification and clustering algorithms that you have studied on original and preprocessed datasets. Analyze the performance variation in terms of different quality metrics. Give a detailed report based on the analysis. (Assignment)

4

1. A database has five transactions. Let min sup = 60% and min con f = 80%.

TID	*items_bought*
T100	{M, O, N, K, E, Y}
T200	{D, O, N, K, E, Y }
T300	{M, A, K, E}
T400	{M, U, C, K, Y}
T500	{C, O, O, K, I ,E}

   (a) Find all frequent item sets using Apriori and FP-growth, respectively. Compare the efficiency of the two mining processes.

   (b) List all of the strong association rules (with support s and confidence c) matching the following metarule, where X is a variable representing customers, and denotes variables representing items (e.g., “A”, “B”, etc.)

   $\forall x \in transaction,\ buys(X, item_1) \wedge buys(X, item_2) \Rightarrow buys(X, item_3)\ [s, c]$

2. Identify and list some scenarios in which association rule mining can be used, and then use at least two appropriate association rule mining techniques in one of the two scenarios. (Assignment)

5

1. Consider an e-mail database that stores a large number of electronic mail (e-mail) messages. It can be viewed as a semistructured database consisting mainly of text data. Discuss the following.

   (a) How can such an e-mail database be structured so as to facilitate multidimensional search, such as by sender, by receiver, by subject, and by time?

(b) What can be mined from such an e-mail database?

(c) Suppose you have roughly classified a set of your previous e-mail messages as junk, unimportant, normal, or important. Describe how a data mining system may take this as the training set to automatically classify new e-mail messages or unclassified ones.

2. Precision and recall are two essential quality measures of an information retrieval system.

   (a) Explain why it is the usual practice to trade one measure for the other.

   (b) Explain why the F-score is a good measure for this purpose.

   (c) Illustrate the methods that may effectively improve the F-score in an information retrieval system.

3. Explain HITS algorithm with an example.

MINOR – S4

24CSM409	Mathematics for Machine Learning	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	4	4	2024

Preamble: The purpose of this course is to introduce mathematical foundations of basic machine learning concepts among learners, on which machine learning systems are built. This course covers Linear Algebra, Vector Calculus, Probability and Distributions, Optimization and machine learning problems. Concepts in this course help the learners to understand the mathematical principles in machine learning and aid in the creation of new machine learning solutions, understand & debug existing ones, and learn about the inherent assumptions & limitations of the current methodologies.

Prerequisite: Basic understanding in Python and Elementary Engineering Mathematics

Course Outcomes: After the completion of the course the student will be able to

CO1	Make use of the concepts, rules and results about linear equations, matrix algebra, vector spaces, eigenvalues & eigenvectors and orthogonality & diagonalization to solve computational problems. **(Apply Level)**
CO2	Perform calculus operations on functions of several variables and matrices, orthogonality and decomposition. **(Apply Level)**
CO3	Employ partial derivatives and gradients for back propagation algorithm. **(Apply Level)**
CO4	Utilize the concepts, rules and results about probability, random variables, additive & multiplicative rules, conditional probability, probability distributions and Bayes' theorem to find solutions of computational problems. **(Apply Level)**
CO5	Train machine learning models using unconstrained and constrained optimization methods. **(Apply Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1				3				3
CO2	3	3	3					3				3
CO3	3	3	3	1				3				3
CO4	3	3	3	1				3				3
CO5	3	3	3	1		1		3				3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✔	✔	✔	✔
Understand	✔	✔	✔	✔
Apply	✔	✔	✔	✔
Analyse				

Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
4-0-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Linear Algebra (9 Hrs)

Systems of Linear Equations – Matrices, Solving Systems of Linear Equations. Vector Spaces – Vector Spaces, Linear Independence, Basis and Rank. Linear Mappings – Matrix Representation of Linear Mappings, Basis Change, Image and Kernel.

MODULE II : Analytic Geometry, Matrix Decompositions (11 Hrs)

Norms, Inner Products, Lengths and Distances, Angles and Orthogonality, Orthonormal Basis, Orthogonal Complement, Orthogonal Projections – Projection into One Dimensional Subspaces, Projection onto General Subspaces, Gram-Schmidt Orthogonalization. Determinant and Trace, Eigenvalues and Eigenvectors, Cholesky Decomposition, Eigen decomposition and Diagonalization, Singular Value Decomposition, Matrix Approximation.

MODULE III : Vector Calculus (9 Hrs)

Differentiation of Univariate Functions - Partial Differentiation and Gradients, Gradients of Vector Valued Functions, Gradients of Matrices, Useful Identities for Computing Gradients. Back propagation and Automatic Differentiation – Gradients in Deep Network, Automatic Differentiation. Higher Order Derivatives- Linearization and Multivariate Taylor Series.

MODULE IV : Probability and Distributions (8 Hrs)

Construction of a Probability Space - Discrete and Continuous Probabilities, Sum Rule, Product Rule, and Bayes' Theorem. Summary Statistics and Independence – Gaussian Distribution - Conjugacy and the Exponential Family – Change of Variables/Inverse Transform.

MODULE V : Optimization (9 Hrs)

Optimization Using Gradient Descent - Gradient Descent With Momentum, Stochastic Gradient Descent. Constrained Optimization and Lagrange Multipliers – Convex Optimization - Linear Programming - Quadratic Programming.

Text books

1. Mathematics for Machine Learning by Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong published by Cambridge University Press ,2020 (freely available at https:// mml - book.github.io)

Reference books

1. Linear Algebra and Its Applications, 4th Edition by Gilbert Strang, 2005.
2. Linear Algebra Done Right by Axler, Sheldon, published by Springer, 2015.
3. Introduction to Applied Linear Algebra by Stephen Boyd and Lieven Vandenberghe, published by Cambridge University Press, 2018.
4. Convex Optimization by Stephen Boyd and Lieven Vandenberghe, published by Cambridge University Press, 2004.
5. Pattern Recognition and Machine Learning by Christopher M Bishop, published by Springer, 2006.
6. Learning with Kernels – Support Vector Machines, Regularization, Optimization, and Beyond by Bernhard Scholkopf and Smola, Alexander J Smola, published by MIT Press, 2002.
7. Information Theory, Inference, and Learning Algorithms by David J. C MacKay, published by Cambridge University Press, 2003.

8. Machine Learning: A Probabilistic Perspective by Kevin P Murphy, published by MIT Press, 2012.
9. The Nature of Statistical Learning Theory by Vladimir N Vapnik, published by Springer, 2000.

Suggested MOOC Courses

1. NPTEL Course: Essential Mathematics for Machine Learning by Prof. Sanjeev Kumar, IIT Roorkee.
2. NPTEL Course: Introduction to Machine Learning by Prof. Arun Rajkumar, IIT Madras.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1		
1.1	Systems of Linear Equations – Matrices	1
1.2	Solving Systems of Linear Equations	1
1.3	Vector Spaces – Lecture I	1
1.4	Vector Spaces – Lecture II	1
1.5	Linear Independence, Basis and Rank	1
1.6	Linear Mappings	1
1.7	Matrix Representation of Linear Mappings	1
1.8	Basis Change	1
1.9	Image and Kernel	1
MODULE II		
2.1	Norms, Inner Products, Lengths and Distances	1
2.2	Angles and Orthogonality	1
2.3	Orthonormal Basis, Orthogonal Complement	1
2.4	Orthogonal Projections, Projection into One Dimensional Subspaces	1
2.5	Gram-Schmidt Orthogonalization	1
2.6	Determinant and Trace, Eigenvalues and Eigenvectors	1
2.7	Cholesky Decomposition, Eigen decomposition	1
2.8	Diagonalization	1
2.9	Singular Value Decomposition-Lecture I	1
2.10	Singular Value Decomposition-Lecture II	1
2.11	Matrix Approximation	1
MODULE III		

3.1	Differentiation of Univariate Functions	1
3.2	Partial Differentiation and Gradients	1
3.3	Gradients of Vector Valued Functions	1
3.4	Gradients of Matrices, Useful Identities for Computing Gradients.	1
3.5	Back propagation and Automatic Differentiation - Lecture 1	1
3.6	Back propagation and Automatic Differentiation - Lecture 2	1
3.7	Gradients in Deep Network, Automatic Differentiation	1
3.8	Higher Order Derivatives	1
3.9	Linearization and Multivariate Taylor Series.	1
MODULE IV		
4.1	Construction of a Probability Space - Discrete and Continuous Probabilities - Lecture I	1
4.2	Discrete and Continuous Probabilities - Lecture 2	1
4.3	Sum Rule, Product Rule, and Bayes' Theorem	1
4.4	Summary Statistics and Independence	1
4.5	Gaussian Distribution	1
4.6	Conjugacy	1
4.7	Exponential Family	1
4.8	Change of Variables/Inverse Transform.	1
MODULE V		
5.1	Optimization Using Gradient Descent - Lecture 1	1
5.2	Optimization Using Gradient Descent - Lecture 2	1
5.3	Gradient Descent With Momentum	1
5.4	Stochastic Gradient Descent	1
5.5	Constrained Optimization	1
5.6	Lagrange Multipliers	1
5.7	Convex Optimization	1
5.8	Linear Programming	1
5.9	Quadratic Programming	1

CO Assessment Questions	
1	1. Find the set S of all solution $sinx$ of the following in homogeneous linear systems $Ax = b$, where A and b are defined as follows: $A = [1 \ -1 \ 0 \ 0 \ 1 \ 1 \ 1 \ 0 \ -3 \ 0 \ 2 \ -1 \ 0 \ 1 \ -1 \ -1 \ 2 \ 0 \ -2 \ -1 \ ]$, $B = [3 \ 6 \ 5 \ -1 \ ]$ 2. Determine the inverse of the following matrix if possible. $A = [1 \ 0 \ 1 \ 0 \ 0 \ 1 \ 1 \ 0 \ 1 \ 1 \ 0 \ 1 \ 1 \ 1 \ 1 \ 0 \ ]$ 3. Reduce the matrix $A = [2 \ 3 \ 1 \ 5 \ 3 \ 2 \ 1 \ 4 \ -1 \ 6 \ 1 \ 8]$ to row echelon form and find its rank.
2	1. Diagonalize the following matrix $A = [4 \ -3 \ 0 \ 2 \ -1 \ 0 \ 1 \ -1 \ 1]$ 2. Compute the singular value decomposition of the matrix $A = [3 \ 2 \ 2 \ 2 \ 3 \ -2]$
3	1. Find the partial derivative for the following $i)\ z = (4x + 9)(8x + 5y)$ $ii)\ z = \frac{2x+y}{x+y}$ 2. Explain back propagation algorithm. 3. Compute the gradient of the Rectified Linear Unit (ReLU) function $ReLU(z) = max\,(0, z)$. 4. Find the second order Taylor series expansion for $f(x, y) = (x + y)^2$ about $(0, 0)$.

4	1. Let A and B be independent events, where $P(A)$ =0.4 and $P(B)$ =0.7. i. Find $P(A\cap B)$ ii. Find $P(A\cup B)$ iii. Find $P(A\cap B')$ 2. A biased coin (with probability of obtaining a head equal to ***p> 0***) is tossed repeatedly and independently until the first head is observed. Compute the probability that the first head appears at an even numbered toss. 3. Two players A and B are competing at a trivia quiz game involving a series of questions. On any individual question, the probabilities that A and B give the correct answer are p and q respectively, for all questions, with outcomes for different questions being independent. The game finishes when a player wins by answering a question correctly. Compute the probability that A wins if i. A answers the first question, ii. B answers the first question.
5	1. Find the extrema of $f(x, y) = x$ subject to $g(x, y) = x^2 + 2y^2 = 3$. 2. A manufacturer of furniture makes two products, chairs and tables. Processing of these products is done on two machines A and B. A chair requires 2 hours on machine A and 6 hours on machine B. A table requires 5 hours of machine A and no time on machine B. There are 16 hours of time per day available on machine A and 30 hours on machine B. Profit gained by the manufacturer from a chair is Re. 1 and from a table is Rs. 5 respectively. Formulate the problem into L. P. P. in order to maximize the total profit. 3. Using graphical method , Maximize $f(x) = 2x_1 + 3x_2 - x_1^2 - x_2^2$ subject to $x_1 + x_2 \leq 2$ $2x_1 + x_2 \leq 3$ $x_1, x_2 \geq 0$ 4. Solve the following LP problem with the simplex method. $5x_1 + 6x_2 + 9x_3 + 8x_4$ Subject to the constraints $x_1 + 2x_2 + 3x_3 + x_4 \leq 5$ $x_1 + x_2 + 2x_3 + 3x_4 \leq 3$ $x_1, x_2, x_3, x_4 \geq 0$

		L	T	P	J	S	C	Year of Introduction
24CSM410	**Software Engineering**	**4**	**0**	**0**	**0**	**4**	**4**	**2024**

Preamble: This course provides fundamental knowledge in the Software Development Process. It covers Software Development, Quality Assurance and Project Management concepts. This course enables the learners to apply state of the art industry practices in Software development.

Prerequisite: Basic understanding of Object-Oriented Design and Development.

Course Outcomes: After the completion of the course the student will be able to

CO1	Differentiate Traditional and Agile Software Development approaches. **(Understand Level)**
CO2	Prepare Software Requirement Specification and Software Design for a given problem. **(Apply Level)**
CO3	Justify the significance of design patterns and licensing terms in software development, prepare testing and maintenance. **(Apply Level)**
CO4	Make use of software project management concepts while planning, estimation, scheduling, tracking and change management of a project, with proper application of SCRUM, Kanban and Lean frameworks. **(Apply Level)**
CO5	Utilize SQA practices, Process Improvement techniques and Technology improvements namely cloud based software model and containers & microservices in a Software Development Process. **(Apply Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	1	2		1						1
CO2	2	2	2	2		1				2	1	1
CO3	1	1	1	1				1		1	1	1
CO4	1	2	1	2		1			1	1	2	1
CO5	1	1	1	1		1						1

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✔	✔	✔	✔
Understand	✔	✔	✔	✔
Apply	✔	✔	✔	✔
Analyse			✔	
Evaluate			✔	
Create			✔	

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
4-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Introduction to Software Engineering (8 Hrs)

Introduction to Software Engineering - Professional software development, Software engineering ethics. Software process models - The waterfall model, Incremental development. Process activities - Software specification, Software design and implementation, Software validation, Software evolution. Coping with change Prototyping, Incremental delivery, Boehm's Spiral Model. Agile software development-Agile methods, agile manifesto - values and principles. Agile development techniques, Agile Project Management. Case studies: An insulin pump control system. Mentcare-a patient information system for mental health care.

MODULE II: Requirement Analysis and Design (10 Hrs)

Functional and non-functional requirements, Requirements engineering processes.

Requirements elicitation, Requirements validation, Requirements change, Traceability Matrix. Developing use cases, Software Requirements Specification Template, Personas, Scenarios, User stories, Feature identification. Design concepts - Design within the context of software engineering, Design Process, Design concepts, Design Model. Case study: The Ariane 5 launcher failure.

MODULE III: Implementation and Testing (12 Hrs)

Review Techniques - Cost impact of Software Defects, Code review and statistical analysis. Informal Review, Formal Technical Reviews, Post-mortem evaluations. Software testing strategies - Unit Testing, Integration Testing, Validation testing, System testing, Debugging, White box testing, Path testing, Control Structure testing, Black box testing. Product metrics- Software quality, metrics for analysis model, metrics for design model, metrics for source code, metrics for testing, metrics for maintenance. Software measurement, metrics for software quality.

MODULE IV: Software Project Management (8 Hrs)

Software Project Management - Risk management, Managing people, Teamwork. Project Planning, Software pricing, Plan-driven development, Project scheduling, Agile planning. Estimation techniques, COCOMO cost modeling. Configuration management, Version management, System building, Change management, Release management, Agile software management - SCRUM framework. Kanban methodology and lean approaches.

MODULE V: Software Quality and Process Improvement (6 Hrs)

Software Quality, Software Quality Dilemma, Achieving Software Quality Elements of Software Quality Assurance, SQA Tasks, Software measurement and metrics. Software Process Improvement (SPI), SPI Process CMMI process improvement framework, ISO 9001:2000 for Software.

Text books

1. Book 1 - Ian Sommerville, Software Engineering, Pearson Education, Tenth edition, 2015.
2. Book 2 - Roger S. Pressman, Software Engineering: A practitioner’s approach, McGraw Hill publication, Eighth edition, 2014.
3. Book 3 - Ian Sommerville, Engineering Software Products: An Introduction to Modern Software Engineering, Pearson Education, First Edition, 2020.

Reference books

1. IEEE Std 830-1998 - IEEE Recommended Practice for Software Requirements Specifications.
2. IEEE Std 1016-2009 IEEE Standard for Information Technology—Systems Design— Software Design Descriptions.
3. David J. Anderson, Kanban, Blue Hole Press 2010.
4. David J. Anderson, Agile Management for Software Engineering, Pearson, 2003.
5. Walker Royce, Software Project Management: A unified framework, Pearson Education,1998.
6. Steve. Denning, The age of agile, how smart companies are transforming the way work gets done. New York, Amacom, 2018.

7. Satya Nadella, Hit Refresh: The Quest to Rediscover Microsoft's Soul and Imagine a Better Future for Everyone, Harper Business, 2017.
8. Mary Poppendieck, Implementing Lean Software Development: From Concept to Cash, Addison-Wesley Signature Series, 2006.

Suggested MOOC Courses

1. NPTEL Course - Software Engineering by Prof. Rajib Mall, IIT Kharagpur.
2. NPTEL Course - Software Engineering by Prof. Rushikesh K Joshi, Prof. Umesh Bellur, Prof. N.L. Sarda, IIT Bombay.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Introduction to Software Engineering.	1
1.2	Software process models	1
1.3	Process activities	1
1.4	Coping with change	1
1.5	Agile software development	1
1.6	Agile development techniques	1
1.7	Agile Project Management.	1
1.8	Case studies: An insulin pump control system. Mentcare - a patient information system for mental health care.	1
	MODULE II	
2.1	Functional and non-functional requirements	1
2.2	Requirements engineering processes	1
2.3	Requirements elicitation, Requirements validation	1
2.4	Requirements change, Traceability Matrix	1
2.5	Developing use cases, Software Requirements Specification Template	1
2.6	Personas, Scenarios	1
2.7	User stories, Feature identification	1

2.8	Design concepts	1
2.9	Design Model	1
2.10	Case study: The Ariane 5 launcher failure.	1
	MODULE III	
3.1	Review Techniques - Cost impact of Software Defects, Code review	1
3.2	Informal Review, Formal Technical Reviews, Post-mortem evaluations	1
3.3	Software testing strategies- Unit Testing, Integration Testing	1
3.4	Software testing strategies- Validation testing, System testing, Debugging	1
3.5	White box testing	1
3.6	Path testing	1
3.7	Control Structure testing	1
3.8	Black box testing	1
3.9	Product metrics- Software quality, metrics for analysis model	1
3.10	Metrics for design model, Metrics for source code	1
3.11	Metrics for testing, metrics for maintenance	1
3.12	Software measurement, metrics for software quality	1
	MODULE IV	
4.1	Software Project Management - Risk management, Managing people, Teamwork	1
4.2	Project Planning - Software pricing, Plan-driven development, Project scheduling, Agile planning	1
4.3	Estimation techniques	1
4.4	Configuration management	1
4.5	Agile software management - SCRUM framework – Lecture 1	1

4.6	Agile software management - SCRUM framework – Lecture 2	1
4.7	Kanban methodology and lean approaches - Lecture 1	1
4.8	Kanban methodology and lean approaches - Lecture 2	1
	MODULE V	
5.1	Software Quality, Software Quality Dilemma, Achieving Software Quality	1
5.2	Elements of Software Quality Assurance, SQA Tasks	1
5.3	Software measurement and metrics.	1
5.4	Software Process Improvement (SPI), SPI Process - Lecture 1	1
5.5	Software Process Improvement (SPI), SPI Process - Lecture 2	1
5.6	CMMI process improvement framework, ISO 9001:2000 for Software.	1

CO Assessment Questions	
1	1. What are the advantages of an incremental development model over a waterfall model? 2. Compare agile software development with traditional software development?
2	1. How to prepare a software requirement specification? 2. Using your knowledge of how an ATM is used, develop a set of use cases that could serve as a basis for understanding the requirements for an ATM system. 3. Prepare a use case diagram for a library management system. 4. Suggest how an engineer responsible for drawing up a system requirements specification might keep track of the relationships between functional and non-functional requirements.
3	1. Explain why testing can only detect the presence of errors, not their absence. 2. How do design patterns help software architects communicate the design of a complex system effectively? 3. Some people argue that developers should not be involved in testing their own code but that all testing should be the responsibility of a separate team. Give arguments for and against testing by the developers themselves. 4. A common approach to system testing is to test the system until the

	testing budget is exhausted and then deliver the system to customers. Discuss the ethics of this approach for systems that are delivered to external customers.
4	1. Analyse the need for SCRUM, Kanban and Lean methodologies? 2. Explain how company size and software size are factors that affect software project management. 3. Discuss the benefits of rolling level planning in software project management and how would you implement it? 4. Explain how the principles underlying agile methods lead to the accelerated development and deployment of software. 5. How would you assess the risks in your software development project? How would you plan for risk mitigation and contingency?
5	1. Explain what happens during the software quality review process and the software quality inspection process. 2. How will retrospectives help in improving the software development process? 3. How would you use project history data as a prediction tool to plan future projects? 4. What problems are likely to arise if formalized program inspections are introduced in a company where some software is developed using agile methods. 5. A colleague who is a very good programmer produces software with a low number of defects but consistently ignores organizational quality standards. How should her managers react to this behavior?

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COMPUTER SCIENCE AND ENGINEERING

B. Tech Curriculum 2024

Semester 5 and 6

FIFTH SEMESTER														
Sl No	**Slot**	**Code**	**Category**	**Title**	**L**	**T**	**P**	**J**	**S**	**No. of Hours**	**No. of Credits**	**Total Marks**	
												CIA	**ESE**
1	A	24CST501	PCC	Design & Analysis of Algorithms	2	1	0	0	2	3	3	40	60
2	B	24CST502	PCC	Software Engineering	2	1	0	0	2	3	3	40	60
3	C	24CSP503	PCC	Artificial Intelligence & Machine Learning	2	1	2	0	4	5	4	60	40
4	D	24CSJ504	PBC	Advanced Web Technologies	2	0	2	2	5	6	5	60	40
5	E	24HUT555	HSMC	Finance and Accounting	3	0	0	0	3	3	3	40	60
6	F	24MCT506	MC	Constitution of India	MOOC				3		1		
7	I	24HUL507	HSMC	Technical writing	0	0	2	0	2	2	1	50	
8	J	24HUL508	HSMC	Soft Skills	0	0	2	0	2	2	1	50	
9	M/H/R	24CSM5XX/ 24CSH5XX		MINOR/HONORS /REMEDIAL	4	0	0	0			4/4/0	40	60
TOTAL									**23**	**24**	**21**		

MINOR BUCKETS				
SEMESTER	**BUCKET 1**		**BUCKET 2**	
	Specialization - Machine Learning		**Specialization - Software Engineering***	
	Course Code	**Course Name**	**Course Code**	**Course Name**
S5	24CSM509	Concepts in Machine Learning	24CSM510	Software Testing *

HONORS BUCKETS						
SEMESTER	**BUCKET 1**		**BUCKET 2**		**BUCKET 3**	
	Specialization - Data Structures and Algorithms		**Specialization - Systems Engineering**		**Specialization - Data Science**	
	Course Code	**Course Name**	**Course Code**	**Course Name**	**Course Code**	**Course Name**
S5	24CSH509	Advanced Data structures and Algorithms	24CSH510	Advanced Operating Systems	24CSH511	Business Analytics

24CST501	Design and Analysis of Algorithms	L	T	P	J	S	C	Year of Introduction
		2	1	0	0	2	3	2024

Preamble: The course introduces students to the design of computer algorithms, as well as analysis of algorithms. Algorithm design and analysis provide the theoretical backbone of Computer Science and are a must in the daily work of the successful programmer. The goal of this course is to provide a solid background in the design and analysis of the major classes of algorithms. At the end of the course students will be able to develop their own versions for a given computational task and to compare and contrast their performance.

Prerequisite: Strong Foundation in Mathematics, Programming Concepts, Data Structures and Graph Theory.

Course Outcomes: After the completion of the course the student will be able to

CO1	Analyse the asymptotic performance of algorithms. **(Cognitive Level: Analyse)**
CO2	Establish the correctness of algorithms. **(Cognitive Level: Apply)**
CO3	Demonstrate familiarity with major algorithms and data structures. **(Cognitive Level: Apply)**
CO4	Apply important algorithmic design paradigms and methods of analysis. **(Cognitive Level: Apply)**
CO5	Synthesize efficient algorithms in common engineering design situations. **(Cognitive Level: Evaluate)**
CO6	Understanding limits of efficient computation. **(Cognitive Level: Understand)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1								2
CO2	3	3	2	1								1
CO3	3	3	2	2								2
CO4	3	3	2	2								1
CO5	3	3	2									3
CO6	3	3										3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	✓
Evaluate			✓	
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
2-1-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

Module I:Computational Tractability and Applications of Graph Search (8 hours)

Review of Asymptotic notations and Order of Growth- upper, lower and tight bounds - properties.
Graph Traversal- BFS, DFS. Strongly connected components, Directed Acyclic Graphs and Topological Ordering. Balanced Binary Search trees – AVL tree

Module II: Divide-and-Conquer and Greedy Algorithms (8 hours)

Divide-and-conquer - Introduction, Solving Recurrence Equations – Substitution method, Recursion Tree Method, and Master's Theorem. Karatsuba algorithm for Matrix Multiplication-Analysis.
Introduction to the greedy paradigm, Fractional Knapsack Problem, Minimum Cost Spanning Tree Computation- Prim's and Kruskal's Algorithms - Analysis,

Single Source Shortest Path Algorithm - Dijkstra's Algorithm-Analysis.

Module III: Dynamic Programming Algorithms (6 hours)

The Optimality Principle - Notion of sub problems and optimal substructure. Matrix Chain Multiplication-Analysis. Longest Common Subsequence, Bellman-Ford algorithm for Single Source Shortest Paths with negative weights. Floyd-Warshall Algorithm for All Pairs Shortest Path Algorithm - Analysis.

Module IV: Network Flow (7 hours)

Flow Networks, The Maximum-Flow Problem and the Ford-Fulkerson Algorithm, Maximum Flows and Minimum Cuts in a Network, Maximum bipartite matching, Max disjoint paths.

Module V: Metaheuristic and Parallel Algorithms (7 hours)

Back Tracking – Sum of subsets, The N Queen's Problem. Branch and Bound – 0/1 Knapsack problem. Randomized Algorithms - Contention Resolution, Randomized Divide and Conquer - Quicksort. Parallel Algorithms - Fork-join parallelism, Parallel matrix multiplication.

Text books

1. Introduction to Algorithms, 4th Edition, Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, MIT Press/McGraw-Hill (2022)
2. Algorithm Design, 1st Edition, Jon Kleinberg and Éva Tardos, Pearson (2005)
3. Fundamentals of Computer Algorithms, 2nd Edition, Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran, Orient Longman Universities Press (2008)

Reference books

1. Algorithms, Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani (2006)
2. Algorithm Design: Foundations, Analysis, and Internet Examples, Second Edition, Michael T Goodrich and Roberto Tamassia, Wiley (2006)

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Review of Asymptotic notations and Order of Growth	1
1.2	Graph Representation, Graph Traversal, BFS**,** Analysis	2
1.3	DFS -Analysis	2
1.4	Strongly connected components	1
1.5	Directed Acyclic Graphs and Topological Ordering.	1

1.6	Balanced Binary Search trees – AVL tree	1
MODULE II		
2.1	Divide-and-conquer- introduction, Recurrence Equations – Substitution method	1
2.2	Recursion Tree Method - Examples	1
2.3	Master's Theorem - Examples	1
2.4	Karatsuba algorithm for Matrix Multiplication	1
2.5	Introduction to the greedy paradigm, Fractional Knapsack Problem, - Analysis	1
2.6	Minimum Cost Spanning Tree Computation- Prim's Algorithm Kruskal's Algorithm	1
2.7	Kruskal's Algorithm	1
2.8	Single Source Shortest Path Algorithm - Dijkstra's Algorithm- Analysis	1
MODULEIII		
3.1	The Optimality Principle - Notion of sub problems and optimal substructure	1
3.2	Matrix Chain Multiplication-Analysis	2
3.3	Longest Common Subsequence	1
3.4	Bellman-Ford algorithm for SSSP	1
3.5	Floyd-Warshall Algorithm for APSP - Analysis.	1
MODULE IV		
4.1	Flow Networks- introduction	1
4.2	The Maximum-Flow Problem and the Ford-Fulkerson Algorithm	2
4.3	Maximum Flows and Minimum Cuts in a Network	2
4.4	Maximum bipartite matching	1
4.5	Max disjoint paths	1
MODULE V		
5.1	Back Tracking – Sum of subsets	1
5.2	The N Queen's Problem	1
5.3	Branch and Bound – 0/1 Knapsack problem	1
5.4	Randomized Algorithms - Contention Resolution	1
5.5	Randomized Divide and Conquer - Quicksort	1
5.6	Parallel Algorithms - Fork-join parallelism,	1
5.7	Parallel matrix multiplication.v	1

CO Assessment Questions

CO1	Show that the n/k sublists, each of length k, can be sorted by insertion sort in θ(nk) worst-case time.
CO2	Let A' denote the output of BUBBLESORT (A). To prove that BUBBLESORT is correct, we need to prove that it terminates and that $A'[1] \leq A'[2] \leq \cdots \leq A'[n]$, where n = length[A]. What else must be proved to show that BUBBLESORT actually sorts?
CO3	Show how to modify the Bellman-Ford algorithm slightly so that when it is used to solve a system of difference constraints with m inequalities on n unknowns, the running time is O(nm).
CO4	Give a recursive algorithm MATRIX -CHAIN -MULTIPLY (A, s, i, j) that actually performs the optimal matrix-chain multiplication, given the sequence of matrices <A1 , A 2 , . . . , An>, the stable computed by MATRIX -CHAIN -ORDER , and the indices i and j .
CO5	Give an efficient algorithm to find the length (number of edges) of a minimum-length negative-weight cycle in a graph.
CO6	Prove that the class NP of languages is closed under union, intersection, concatenation, and Kleene star. Discuss the closure of NP under complement.

24CST502	Software Engineering	L	T	P	J	S	C	Year of Introduction
		2	1	0	0	2	3	2024

Preamble: This course aims to provide a comprehensive understanding of the software development process, covering various aspects such as software development, quality assurance, project management, and technology trends. This course enables the learners to apply state of the art industry practices in Software development.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Demonstrate Traditional and Agile Software Development approaches **(Apply level)**
CO2	Prepare Software Requirement Specification and Software Design for a given problem. **(Apply level)**
CO3	Justify the significance of design patterns and licensing terms in software development, prepare testing, maintenance and DevOps strategies for a project. **(Apply level)**
CO4	Identify the software project management concepts required while planning, estimation, scheduling, tracking and change management of a project, with a traditional/agile framework**. (Apply level)**
CO5	Utilize SQA practices, Process Improvement techniques and Technology advancements in cloud based software models and containers & microservices. **(Understand level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1		3						3
CO2	3	3	3	1		3				1	1	1
CO3	3	3	3	1						1	1	1
CO4	3	3	3	3	3	3			3	3	3	3
CO5	3	3	3	1		1						1

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
2-1-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Introduction,Software Process Models (7 hrs)

Introduction to software engineering- scope of software engineering – historical aspects, economic aspects, maintenance aspects, specification and design aspects, team programming aspects. Software engineering a layered technology – processes, methods and tools. Software process activities- software specification, software development, software validation, software evolution. Software process models – waterfall model, incremental models, prototyping models, spiral model. Agile software development- agile methods, values and principles. Agile development techniques, Agile project management.

MODULE II : Analysis,design and Coding (7 hrs)

Analysis phase- functional and non-functional requirements, Requirements engineering processes, Requirements elicitation techniques, Software Requirements Specification Template. Design phase – design process, principles, concepts. Architectural Design - Software Architecture, Architectural Styles, Architectural considerations, Architectural Design, Component level design, User interface design- rules. Coding – programming practice, verification, size measures, complexity analysis, coding standards.

MODULE III : Testing and Maintenance (7 hrs)

Testing – fundamentals, white box testing, control structure testing, black box testing, basis path testing, code walkthroughs and inspection, testing strategies-Issues, Unit testing, integration testing, Validation testing, System testing. Maintenance-Overview of maintenance process, types of maintenance. Overview of DevOps and Code Management - Code management, DevOps automation, Continuous Integration, Delivery, and Deployment (CI/CD/CD).

MODULE IV : Project Management, Risk Management (7 hrs)

Project Management concept- People, Product, Process. Project. Project scheduling and tracking- Basic concepts-relation between people and effort-defining task set for the software project-selecting software engineering task. Estimation techniques- COCOMO cost modeling. Software configuration management: Basics and standards. Risk management: software risks-risk identification-risk monitoring and management.

MODULE V : Software Process Improvement (7 hrs)

Software process improvement- Software Quality, Software Quality Dilemma, Achieving Software Quality Elements of Software Quality Assurance, SQA Tasks, Software measurement and metrics. Software Process Improvement- SPI Process, CMMI process improvement framework, ISO 9001:2000 for Software. Cloud-based Software - Virtualisation and containers, Everything as a service(IaaS, PaaS), Software as a service.

Text books

1. Ian Sommerville, Software Engineering, Pearson Education, Tenth edition, 2015.
2. Roger S. Pressman, Software Engineering : A practitioner's approach, McGraw Hill publication, Eighth edition, 2014
3. Ian Sommerville, Engineering Software Products: An Introduction to Modern Software Engineering, Pearson Education, First Edition, 2020.

Reference books

1. David J. Anderson, Agile Management for Software Engineering, Pearson, 2003
2. Walker Royce, Software Project Management : A unified framework, Pearson Education, 1998
3. Steve. Denning, The age of agile, how smart companies are transforming the way work gets done. New York, Amacom, 2018.
4. Satya Nadella, Hit Refresh: The Quest to Rediscover Microsoft's Soul and Imagine a Better Future for Everyone, Harper Business, 2017
5. Henrico Dolfing, Project Failure Case Studies: Lessons learned from other people's mistakes, Kindle edition
6. Mary Poppendieck, Implementing Lean Software Development: From Concept to Cash, Addison-Wesley Signature Series, 2006.

Suggested MOOC Courses

1. Software Engineering,IIT Kharagpur-Prof.Rajib mall

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
MODULE 1		
1.1	Introduction to Software Engineering	1
1.2	Software engineering a layered technology	1
1.3	Software process activities	1
1.4	Software process models(Lecture 1)	1
1.4	Software process models(Lecture 2)	1
1.5	Agile software development	1
1.6	Agile development techniques	1
1.7	Agile Project Management	1
MODULE II		
2.1	Analysis phase- functional and non-functional requirements	1
2.2	Requirements engineering processes, Requirements elicitation techniques, Software Requirements Specification Template.	1
2.3	Design phase – design process, principles, concepts.	1
2.4	Architectural Design	1
2.5	Component level design	1
2.6	User interface design	1
2.7	Coding – programming practice, verification, size measures, complexity analysis, coding standards	1
MODULE III		
3.1	Testing – fundamentals, white box testing, control structure testing	1
3.2	Black box testing, basis path testing, code walkthroughs and inspection	1

3.3	Testing strategies-Issues, Unit testing, integration testing	1
3.4	Validation testing, System testing.	1
3.5	Maintenance-Overview of maintenance process, types of maintenance	1
3.6	Overview of DevOps and Code Management - Code management, DevOps automation	1
3.7	Continuous Integration, Delivery, and Deployment (CI/CD/CD).	1
MODULE IV		
4.1	Project Management concept- People, Product, Process. Project.	1
4.2	Project scheduling and tracking- Basic concepts-relation between people and effort	1
4.3	Defining task set for the software project-selecting software engineering task.	1
4.4	Estimation techniques- COCOMO cost modeling.	1
4.5	Software configuration management: Basics and standards.	1
4.6	Risk management: software risks-risk identification.	1
4.7	Risk monitoring and management.	1
MODULE V		
5.1	Software process improvement- Software Quality, Software Quality Dilemma	1
5.2	Achieving Software Quality Elements of Software Quality Assurance, SQA Tasks, Software measurement and metrics.	1
5.3	Sotware Process Improvement- SPI Process	1
5.4	CMMI process improvement framework	1
5.5	ISO 9001:2000 for Software	1
5.6	Cloud-based Software - Virtualisation and containers	1
5.7	Everything as a service(IaaS, PaaS), Software as a service	1

CO Assessment Questions	
1	1. Illustrate how the process differs in agile software development and traditional software development with a socially relevant case study. 2. What are the advantages of incremental model over software model? 3. Imagine you are leading a software development team tasked with creating a new web application for a client. Apply the principles of agile software development to outline a detailed project plan. Include key activities, roles and responsibilities, and highlight how agile values and principles will guide your team throughout the development lifecycle. Additionally, discuss how you would manage changes in requirements and ensure continuous collaboration with the client throughout the project.
2	1. With a suitable example demonstrate the relevance of the SRS specification in software development. 2. Identify and document functional and non-functional requirements of a school management system. 3. Prepare a use case diagram and UML diagram for a library management system.
3	1. Differentiate between the different types of software testing strategies. 2. Justify the need for DevOps practices? 3. Calculate cyclomatic complexity for the given code- IF A = 354 THEN IF B > C THEN A = B ELSE A = C END IF END IF PRINT A
4	1. Illustrate the activities involved in software project management for a socially relevant problem. 2. Is rolling level planning in software project management beneficial? Justify the answer.
5	1. Justify the importance of Software Process improvement. 2. Explain the benefits of cloud based software development, containers and microservices. 3. llustrate the use of project history data as a prediction tool to plan future socially relevant projects.

24CSP503	Artificial Intelligence & Machine Learning	L	T	P	J	S	C	Year of Introduction
		2	1	2	0	4	4	2024

Preamble: This course aims to introduce the concept of artificial intelligence (AI) and practical applications of machine learning (ML). It covers various algorithms of fundamental AI, basic theory underlying machine learning as well as ML categories and applications. It enables the students to identify and select suitable intelligent models corresponding to different real-world applications. The course also develops an ability in students to compare ML algorithm performance and apply the algorithms to a real-world problem, optimize the models learned and report on the expected accuracy.

Prerequisite: Sound knowledge in Linear algebra, Probability and Optimization

Course Outcomes: After the completion of the course the student will be able to

CO 1	Demonstrate the fundamental concepts of Artificial Intelligence (AI) and identify AI applications in various domains. **(Understand Level)**
CO 2	Identify various Machine Learning Schemes and the concepts of supervised and unsupervised and reinforcement learning, and forecasting models. **(Understand Level)**
CO 3	Distinguish between Linear Regression, Logistic regression and their scope of application in ML problems **(Apply level)**
CO 4	Illustrate the working of classifier models like SVM, Neural Networks and probabilistic classification methods and use these models analyzing with performance metrics (**Apply level)**
CO 5	Demonstrate unsupervised Machine learning models and identify its applicability in real life problems. **(Apply level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	2	3						3
CO2	2	1	3	3	2	3						3
CO3	2	1	3	3	2	3						3
CO4	2	1	3	3	2	3						3
CO5	2	1	3	3	2	2						3

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate				
Create				

Assessment Pattern for Lab component		
Bloom's Category	**Continuous Assessment Tools**	
	Class work	**Test1**
Remember		
Understand	✓	✓
Apply	✓	✓
Analyse	✓	✓
Evaluate	✓	
Create		

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Practical [P]		Total Marks
		Assignment	Test-1	Test-2	Class work	Lab Exam	
2-1-2-0	5	10	12.5	12.5	10	10	**60**

Total Marks distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	60	40	2.5 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 2		Two questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x 8 = 40 marks) Time: 2.5 hours	40
	Total Marks: 0	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Overview of Artificial Intelligence

Introduction to AI, Intelligent agents-Agents and Environment, Problem solving agents-Search algorithms, Uninformed search, Informed search, Adversarial

Search-Games, Constraint satisfaction problem (CSP), AI Applications.

MODULE II : Overview of machine learning

Introduction to Machine Learning (ML), Types of Machine Learning- Supervised, Unsupervised, Reinforcement. Types of ML problems: Association, Classification and Regression. General Steps or Process of Machine Learning, Objective (Minimize Error or Cost Function), Cost functions: Definition and Types

Linear regression: with single and multiple variables (features), Least Squares Gradient descent, Bias-Variance trade off.

MODULE III : Logistic Regression and Neural Networks

Logistic Regression: Hypothesis representation, Decision boundary, Sigmoid Function and its differentiation, Gradient Descent.

Neural Networks: Concept of perceptron and Artificial neuron, Activation Functions, Feed Forward Neural Network, Introduction to back propagation

Classification metrics: Cross validation and re-sampling methods, Classifier performance measures- Precision, recall, ROC curves.

MODULE IV : Kernel machines and Instant Based Learning

Kernel Machines- Support Vector Machine- Optimal Separating hyperplane, Kernel functions.

Decision Trees- Entropy, Information Gain, ID3, Random Forest

Ensemble methods: Boosting, Bagging, and Stacking

MODULE V : Bayesian method and Unsupervised learning

Probability and classification: Naive Bayes and Gaussian class-conditional distribution, Bayes' Rule and Naive Bayes Model, Maximum Likelihood estimation. Discrete Markov Processes, Hidden Markov models.

Unsupervised Learning - Introduction to Clustering Methods-Categories, k-Means, Expectation-Maximization Algorithm.

Dimensionality Reduction: PCA and LDA

Text books

1. Stuart Russell and Peter Norvig. Artificial Intelligence: A Modern Approach, 3rd Edition. Prentice Hall.
2. Tom M. Mitchell, Machine Learning, McGraw Hill Education, 2017
3. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
4. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning (Adaptive Computation and Machine Learning series), The MIT Press, 2016
5. Richard O Duda, Peter E Hart, David G Stork, Pattern Classification, Second Edition. Wiley.
6. Ethem Alpaydın, Introduction to Machine Learning (Adaptive Computation and Machine Learning), MIT Press, 2004.

Reference books

1. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.

2. Aggarwal, Charu C., Neural Networks and Deep Learning, Springer International Publishing AG, part of Springer Nature 2018.
3. Michael Nielsen, Neural Networks and Deep Learning, 2018.

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
MODULE 1		
1.1	Introduction to AI, Intelligent agents-Agents and Environment	1
1.2	Problem solving agents-Search algorithms	1
1.3	Uninformed search	1
1.4	Informed search	1
1.5	Adversarial search-Games	1
1.6	Constraint satisfaction problem (CSP)	1
1.7	AI Applications	1
MODULE II		
2.1	Introduction to Machine Learning (ML), Types of Machine Learning- Supervised, Unsupervised, Reinforcement.	1
2.2	Types of ML problems: Association, Classification and Regression-Lecture I	1
2.3	Types of ML problems: Association, Classification and Regression-Lecture II	1
2.4	General Steps or Process of Machine Learning, Objective (Minimize Error or Cost Function)	1
2.5	Cost functions: Definition and Types	1
2.6	Linear regression: with single and multiple variables (features)	1
2.7	Least Squares Gradient descent and Bias-Variance trade off.	1

MODULE III		
3.1	Logistic Regression: Hypothesis representation, Decision boundary, Sigmoid Function and its differentiation, Gradient Descent	2

3.2	Neural Networks: Concept of perceptron and Artificial neuron, Activation Functions, Feed Forward Neural Network	1
3.3	Introduction to back propagation	1
3.4	Classification: Cross validation and re-sampling methods	1
3.5	Classifier performance measures- Precision, recall, ROC curves.	1

MODULE IV		
4.1	Kernel Machines- Support Vector Machine	1
4.2	Optimal Separating hyperplane	1
4.3	Kernel functions	1
4.4	Decision Trees- Entropy, Information Gain	1
4.5	ID3 Algorithm	1
4.6	Random Forest	1
4.7	Ensemble methods: Boosting, Bagging, and Stacking - Lecture I	1
4.8	Ensemble methods: Boosting, Bagging, and Stacking - Lecture II	1

MODULE V		
5.1	Probability and classification: Naive Bayes and Gaussian class-conditional distribution	1
5.2	Bayes' Rule and Naive Bayes Model	1
5.3	Maximum Likelihood estimation.	1
5.4	Discrete Markov Processes	1
5.5	Hidden Markov models.	1
5.6	Unsupervised Learning - Introduction to Clustering Methods	1
5.7	Expectation-Maximization Algorithm	1

5.8	Dimensionality Reduction: PCA, LDA	1

LESSON PLAN FOR LAB COMPONENT

No.	Topic	No. of Hours	Experiment
1	Searching Method in Artificial Intelligence	2	Implement and FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.
2	Backpropagation in ANN	3	Build an Artificial Neural Network by implementing the Backpropagation Algorithm and test the same using appropriate data sets.
3	Linear and Logistic Regression	3	Implement Simple i) Multiple Linear Regression Models ii) Logistic Regression Model
4	Decision Tree Algorithms	3	Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
5	Ensemble Learning	4	a) Implement Random forest ensemble method on a given dataset. b) Implement Boosting ensemble method on a given dataset.
6	Naive Bayes Classification	3	Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.
7	Unsupervised Learning: Clustering	4	Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering.

CO Assessment Questions	
1	1. Explain about basic types of agent programs in intelligent systems. 2. Distinguish informed and uninformed search strategy. 3. Discuss about the applications in AI.

4. Define the various components of Constraint satisfaction problem? Explain with an example.

2

1. Suppose that you are asked to perform linear regression to learn the function that outputs y, given the D-dimensional input x. You are given N independent data points, and that all the D attributes are linearly independent. Assuming that D is around 100, would you prefer the closed form solution or gradient descent to estimate the regressor?
2. Predict the price of a 1000 square feet house using the regression model generated from the following data.

No.	Square feet	Price(Lakhs)
1	500	5
2	900	10
3	1200	13
4	1500	18
5	2000	25
6	2500	32
7	2700	35

3. Given the sales data of a product of all the months.

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Actual	67	50	36	74	84	84	64	34	23	72	62	42
Forecasted	70	44	38	44	64	80	54	44	43	90	56	38

Calculate Mean Squared Error(MSE) for the above data.

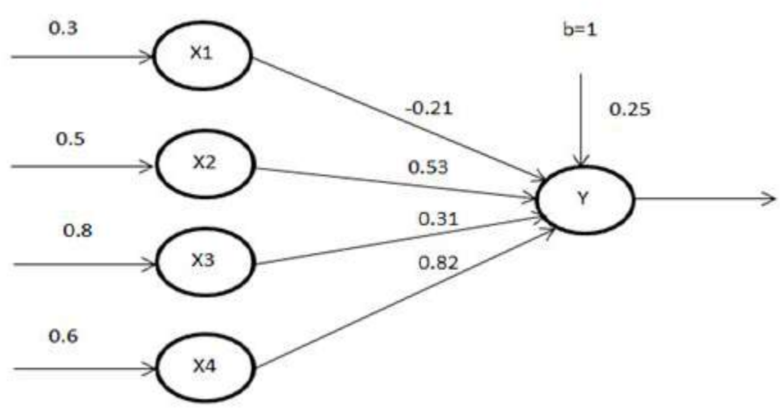
4. The Least Squares Model for a set of data (x_1, y_1), (x_2, y_2), (x_3, y_3), …, (x_n, y_n) passes through the point (x_a, y_a) where x_a is the average of the

x_i's and y_a is the average of the y_i's. Find the equation of a straight line or a least square line using the least square method.

xi	8	3	2	10	11	3	6	5	6	8
yi	4	12	1	12	9	4	9	6	1	14

3

1. Explain the hypothesis of logistic regression using suitable equations.
2. Calculate the output of the following neuron Y with the activation function as
    A. Binary sigmoid
    B. tanh
    C. ReLU
    D. Bipolar sigmoid



3. Suppose 15000 patients get tested for covid; out of them, 10000 are actually healthy and 5000 are actually sick. For the sick people, a test was positive for 3150 and negative for 1850. For healthy people, the same test was positive for 280 and negative for 9720. Construct a confusion matrix for the data and compute the accuracy, precision and recall for the data.

4. Construct ROC curve using given values.

Threshold	Sensitivity	Specificity
1	0	1
2	0.5	0.75

3	0.75	0.5
4	1.0	0

4

1. What are support vectors and list any three properties of the support vector classifier solution?
2. Why do you use kernels to model a projection from attributes into a feature space, instead of simply projecting the dataset directly?
3. Identify the first splitting attribute for decision tree by using ID3 algorithm with the following dataset.

Toothed	Hair	Breathes	Legs	species
Toothed	Hair	Breathes	Legs	Mammal
Toothed	Hair	Breathes	Legs	Mammal
Toothed	Not Hair	Breathes	Not Legs	Reptile
Not Toothed	Hair	Breathes	Legs	Mammal
Toothed	Hair	Breathes	Legs	Mammal
Toothed	Hair	Breathes	Legs	Mammal
Toothed	Not Hair	Not Breathes	Not Legs	Reptile
Toothed	Not Hair	Breathes	Not Legs	Reptile
Toothed	Not Hair	Breathes	Legs	Mammal
Not Toothed	Not Hair	Breathes	Legs	Reptile

4. Define the working of AdaBoost Algorithm using a suitable example.

5

1. Find the probability to play tennis on 15th day where conditions are, temperature=cool, humidity=high, wind=strong and outlook=sunny.

Day	Outlook	Temperature	Humidity	Wind	Play Tennis?
1	Sunny	Hot	High	Weak	No
2	Sunny	Hot	High	Strong	No
3	Overcast	Hot	High	Weak	Yes
4	Rain	Mild	High	Weak	Yes
5	Rain	Cool	Normal	Weak	Yes
6	Rain	Cool	Normal	Strong	No
7	Overcast	Cool	Normal	Strong	Yes
8	Sunny	Mild	High	Weak	No
9	Sunny	Cool	Normal	Weak	Yes
10	Rain	Mild	Normal	Weak	Yes
11	Sunny	Mild	Normal	Strong	Yes
12	Overcast	Mild	High	Strong	Yes
13	Overcast	Hot	Normal	Weak	Yes
14	Rain	Mild	High	Strong	No

	2. A coin is tossed 100 times and lands heads 62 times. What is the maximum likelihood estimate for θ, the probability of heads. 3. Suppose data x1, ..., xn are independent and identically distributed drawn from an exponential distribution exp(λ). Find the maximum likelihood for λ. 4. Construct a dendrogram for the following data using single linkage hierarchical agglomerative clustering. {18,22,25,42,27,43} 5. Cluster the following eight points (with (x, y) representing locations) into three clusters: A1(2, 10), A2(2, 5), A3(8, 4), A4(5, 8), A5(7, 5), A6(6, 4), A7(1, 2), A8(4, 9)

24CSJ504	Advanced Web Technologies	L	T	P	J	S	C	Year of Introduction
		2	0	2	2	5	5	2024

Preamble: This course enables the students to understand the key technologies and frameworks that power modern responsive web applications. The syllabus covers the topics like JavaScript, MongoDB, building a RESTful API with Node.js & Express.js and front-end User Interface design using React.js. This helps the students to design and develop web application for real world problems and make them industry ready.

Prerequisite: Application Development Lab

Course Outcomes: After the completion of the course the student will be able to

CO1	Develop interactive HTML web pages and validate form data using JavaScript. (**Apply Level**)
CO2	Employ the concepts of MongoDB for database management in web applications. (**Understand Level**)
CO3	Develop server-side applications using Express.js and Node.js. (**Apply Level**)
CO5	Build dynamic and responsive user interfaces for web applications using React.js (**Apply Level**)
CO6	Design and develop web applications using the MERN Stack. (**Create Level**)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3									3
CO5	3	3	3									3
CO6	3	3	3	3	3	3	3	3	3	3		3

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember		✓	✓	✓
Understand		✓	✓	✓
Apply		✓	✓	✓
Analyse			✓	
Evaluate			✓	
Create			✓	

Assessment Pattern for Lab component

Bloom'sCategory	ContinuousAssessment Tools	
	Class work	Test1
Remember		

Understand	✓	✓
Apply	✓	✓
Analyse	✓	✓
Evaluate		
Create		

Assessment Pattern for Project component

Bloom'sCategory	Continuous Assessment Tools		
	Evaluation 1	Evaluation 2	Report
Remember			
Understand	✓	✓	
Apply	✓	✓	
Analyse	✓	✓	
Evaluate		✓	
Create		✓	

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]		Practical [P]	Project [J]			Total Marks
		Assignment	Test-2	Class work	Evaluation 1	Evaluation-2	Report	
2-0-2-2	5	10	15	10	5	10	5	60

Total Marks distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	60	40	2 .5 hours

<u>End Semester Examination [ESE]: Pattern</u>

PATTERN	PART A	PART B	ESE Marks
PATTERN 2		2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x 8 = 40 marks) Time: 2.5 hours	40
	Total Marks: 0	Total Marks: [5x8 = 40 marks]	

SYLLABUS
MODULE I: JavaScript Basics & Event Handling (6 hrs)
Overview of JavaScript. Object orientation in JavaScript. General syntactic characteristics. primitive operations and expressions. Control statements. Screen output and Keyboard input. Object creation and modification. Arrays. Functions. Regular Expressions. Asynchronous Programming. The Document Object Model. Handling Events. HTTP and Forms.
MODULE II: Introduction to MongoDB (4 hrs)
Introduction to MongoDB. Installation and Configuration. create and drop database. MongoDB Data Model- Collections and Documents, Fields and Data types. CRUD (Creating, Reading & Updating Data) operations. Indexing and back up. Query processing.
Module III: Introduction to REST and Node.js (4 hrs)
Introduction to REST principles and constraints. The role of APIs in web development. Introduction to Node, Node.js and its event-driven, non-blocking architecture. Node.js Installation & configuration. Role of NPM. Server using Node JS- Creating a simple server using the http module, handling different HTTP methods (GET, POST, PUT, DELETE).
Module IV: Introduction to Express.js & Building a RESTful API (5 hrs)
Overview of Express.js. Installation. Routing in Express: Understanding routes and route parameters, Creating routes for different endpoints. Middleware in Express: - Introduction to middleware and how it fits into the Express application flow, Creating custom middleware. Handling Validation Errors. File Uploads & Static Resources. Database connectivity-Connecting to MongoDB with Mongoose, CRUD operations using Mongoose.
MODULE V: Introduction to React.js (5 hrs)
React JS overview. Getting started with react. State management with react. Event handling. Conditional rendering. Components in react. Styling react components. State in component tree. React context. Introduction to useEffects. Hooks in react. React router. Forms in react. Deployment and/or Testing.
Text books 1. Programming the World Wide Web, 8th Edition, Robet W Sebesta, Pearson, 2020. 2. Marijn Haverbeke, “Eloquent JavaScript: A modern Introduction to programming”, 3rd edition (2018) 3. Greg Lim, Beginning MERN Stack Development, First Edition, 2021. 4. Vasan Subramanian, Pro MERN Stack Full Stack Web App Development with Mongo, Express, React, and Node, 2019. 5. Alex Banks & Eve Porcello, Learning React Modern Patterns for Developing React Apps, 2020.

Reference books

1. Node.js, MongoDB and Angular Web Development: The definitive guide to using the MEAN stack to build web applications by Brad Dayley, Brendan Dayley, Caleb Dayley, 2018.
2. Express.js: Guide Book on Web framework for Node.js by Rick L, 2016.
3. Introduction to React by Cory Gackenheimer, 2015.

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
MODULE 1		
1.1	Overview of JavaScript. Object orientation in JavaScript	1
1.2	General syntactic characteristics.	1
1.3	primitive operations and expressions, Control statements.	
1.4	Screen output and Keyboard input. Object creation and modification.	1
1.5	Object creation and modification	1
1.6	Arrays. Functions	1
MODULE II		
2.1	Introduction to mongoDB- Nosql, Difference between Mysql and NoSql	1
2.2	MongoDB Data Model- Collections and Documents	1
2.3	Fields and Data types. CRUD (Creating, Reading & Updating Data) operations.	1
2.4	Query processing- Basic Query operations	1
MODULEIII		
3.1	Introduction to REST principles and constraints. The role of APIs in web development.	1
3.2	Introduction to Node, Node.js and its event-driven, non-blocking architecture.	
3.3	Server using Node JS- Creating a simple server using the http module	1
3.4	Handling different HTTP methods (GET, POST, PUT, DELETE).	1
MODULE IV		
4.1	Overview of Express.js.	1
4.2	Routing in Express: Understanding routes and route parameters	1
4.3	Middleware in Express: -Introduction to middleware and how it fits into the Express application flow	1
4.4	Handling Validation Errors	1
4.5	File Uploads & Static Resources.	1
MODULEV		
5.1	React JS overview. Getting started with react	1

5.2	State management with react. Event handling.	1
5.3	React context. Introduction to useEffects.	1
5.4	Hooks in react.	1
5.5	React router.	1

LESSON PLAN FOR LAB COMPONENT

No.	Topic	No. of Hours (24)	Experiment
1	Object orientation in JavaScript. General syntactic characteristics. primitive operations and expressions. Control statements. Screen output and Keyboard input. Object creation and modification. Arrays. Functions	2	i. Write a JavaScript program to find the area of a circle using radius (var and let - reassign and observe the difference with var and let) and PI (const) ii. Write JavaScript code to display the movie details such as movie name, starring, language, and ratings. Initialize the variables with values of appropriate types. Use template literals wherever necessary. iii. Create an Employee class extending from a base class Person. Hints: (a) Create a class Person with name and age as attributes. (b) Add a constructor to initialize the values (c) Create a class Employee extending Person with additional attributes role iv. Create an array of objects having movie details. The object should include the movie name, starring, language, and ratings. Render the details of movies on the page using the array. v. Generate a table of the numbers from 5 to 15 and their squares and cubes, using ***alert.*** vi. Implement a Javascript program that takes three numbers as input, using prompt to get each and outputs the largest of the three input numbers. Hint: Use the predefined function Math.max.
2	Regular Expressions. Asynchronous Programming	1	i. Simulate a periodic stock price change and display on the console. Hints: (i) Create a method which returns a random number - use Math.random, floor and other methods to return a rounded value. (ii) Invoke the method for every three seconds and stop when you get 10 prices.

			ii. Write a JavaScript function to validate an email address using a regular expression. The function should return true if the email is valid and false otherwise. iii. Create a JavaScript function that checks the strength of a password using a regular expression. The function should return a strength rating (weak, medium, strong) based on criteria such as length, presence of numbers, and special characters.
3	The Document Object Model. Handling Events. HTTP and Forms.	2	i.Write JavaScript to validate the following fields of the registration page. a. Name (Name should contains alphabets and the length should not be less than 6 characters). b. Password (Password should not be less than 6 characters length). c. Confirm password (Password and confirm password should be same). d. E-mail id (should not contain any invalid and must follow the standard pattern name@domain.com). e. Phone number (Phone number should contain 10 digits only). ii. Develop and test an HTML document radio_click.html that have five buttons, labeled red, blue, green, yellow, and orange. The event handlers for these buttons must produce messages stating the chosen favorite color. The event handler must be implemented as a function whose name must be assigned to the onclick attribute of the radio button elements. The chosen color must be sent to the event handler as a parameter iii. Create an HTML document with Javascript code that has three Textboxes and Button. Read Principal amount, rate of interest and duration in years as input through Textboxes. When a user clicks the OK Button, a message box appears showing the simple interest of principal amount.
4	Installation and Configuration. create and drop database. MongoDB Data Model- Collections and Documents,	2	i. Install MongoDB on your machine and verify the installation. Start the MongoDB server and connect to the MongoDB shell. ii. Perform basic operations in the MongoDB shell, such as creating a database, creating collections, and inserting documents. iii. Design a MongoDB document structure for a

	Fields and Data types. CRUD (Creating, Reading & Updating Data) operations.		simple application, considering the relationships between entities (a) Design a MongoDB document structure to represent a user profile. Consider including fields such as username, email, password, and date of registration. How would you handle relationships between a user and their posts or comments? (b) Design a MongoDB document structure for an e-commerce product catalog. Include information such as product name, description, price, and inventory. How would you model the relationship between products and categories? iv. Implement CRUD Operations on MongoDB
	Indexing and back up.	2	i. Create an index on a specific field in a MongoDB collection. Use the create Index method to demonstrate how it improves query performance. ii. Create a text index on a collection for full-text search. Perform text search queries using the $text operator. iii. Implement a unique index on a field to enforce uniqueness. Insert duplicate values and observe how MongoDB handles the violation of the unique constraint. iv. Use the mongodump tool to create a backup of a MongoDB database. Explore options such as specifying the output directory and excluding collections.
	Query processing	1	i. Write MongoDB queries to retrieve documents from a collection based on various criteria (e.g., equality, range). ii. Use the find () method to retrieve all documents from a collection. Experiment with different query options, including projections and limit.
	Node.js Installation & configuration. Role of NPM	1	i. Install Node.js on your machine and verify the installation using the command line. Create a simple "Hello, Node.js!" script and run it. ii. Initialize a new Node.js project using npm init and install a popular package (e.g., lodash). Utilize the installed package in a simple script.

	Server using Node JS- Creating a simple server using the http module, handling different HTTP methods (GET, POST, PUT, DELETE)	2	i. Create a basic Node.js script that creates an HTTP server. Listen on a specific port and respond with a "Hello, Node.js!" message for all incoming requests. ii. Modify the server to handle different types of HTTP requests (GET, POST, etc.). Respond with appropriate messages for each type of request. iii. Extend the HTTP server to serve an HTML page. Create a simple HTML file and send it as the response when a client accesses the server. iv. Modify the server to serve static files (e.g., CSS, images). Create a directory for static files and handle requests accordingly.
	Express.js installation, Creating routes for different endpoints	1	i. Install Express.js using NPM. Create a basic Express application and verify the installation ii. Define a route in Express to handle a basic GET request. Respond with a simple message. iii. Create a route that accepts dynamic parameters. Extract and use these parameters in the route handler. iv. Define multiple routes for different endpoints (e.g., /home, /about, /contact). Implement unique responses for each endpoint.
	Introduction to middleware and how it fits into the Express application flow, Creating custom middleware	1	i. Explore built-in middleware in Express (e.g., express. Json()). Implement middleware functions for parsing JSON data in incoming requests. ii. Develop and apply custom middleware in Express. Log information about incoming requests using a middleware function.
	Handling Validation Errors, File Uploads & Static Resources	2	i. Create a route that validates incoming data. Implement error handling middleware to handle validation errors gracefully. ii. Develop custom error-handling middleware to manage and log errors. Test the middleware by intentionally causing validation errors. iii. Implement a route for file uploads using multer middleware. Test the file upload functionality with different file types. iv. Configure Express to serve static resources (e.g., CSS, images). Create a directory for static files and serve them using the express.static middleware.

	Database connectivity- Connecting to MongoDB with Mongoose, CRUD operations using Mongoose.	1	i. Set up a connection to MongoDB using Mongoose in your Express application. Log a message upon successful connection. ii. Implement CRUD operations (Create, Read, Update, Delete) using Mongoose. Define a schema, create documents, query data, update records, and delete entries.
	Getting started with react. State management with react. Event handling.	2	i. Use create-react-app to initialize a new React project. Verify the installation and explore the project structure. ii. Create a simple React component and render it in the app. iii. Understand and implement JSX syntax. iv. Explore the basic structure of a React component (functional and class components) v. Integrate state into a React component. Create a state variable and dynamically update the component based on state changes. vi. Compare and contrast stateful and stateless components. Create examples of both types and understand their use cases. vii. Implement event handlers in React components. Capture and respond to user interactions (e.g., button clicks, form submissions). viii. Pass data between parent and child components using events. Understand how to lift state up in React.
	Conditional rendering. Components in react. Styling react components. State in component tree.	2	i. Conditionally render components based on a simple condition (e.g., if a variable is true, render one component; otherwise, render another). ii. Render dynamic content based on state or props. Use conditional statements to display different content. iii. Compose multiple React components. Understand how to structure and organize components in a React application. iv. Design and create reusable components. Use props to make components configurable and versatile. v. Apply inline styles to React components. Experiment with dynamic styling based on component state

			vi. Utilize CSS Modules for styling React components. Understand how to encapsulate styles for individual components. vii. Implement state management using the Context API. Share state between components without prop drilling.
	React context. Introduction to useEffects. Hooks in react. React router. Forms in react. Deployment and/or Testing.	2	i. Integrate the **useEffect** hook into a component. Understand its role in handling side effects. ii. Implement cleanup functions with **useEffect** to handle component unmounting and avoid memory leaks. iii. Install React Router and set up basic routing in a React application. iv. Implement form validation in React. Validate user input and provide feedback to the user. v. Deploy a React application to a hosting platform (e.g., Netlify, Vercel). Verify that the deployed app functions correctly.

COURSE PROJECT

Students can choose projects that have real-world applications which help students to see the practical relevance of their coursework.
Sample project topics for students to work on:

1	Develop a fitness tracker application that allows users to log workouts, set goals, and track progress.
2	Develop an online learning platform with features for course creation, enrollment, and progress tracking.
3	Develop a blog platform where users can create, edit, and delete blog posts.
4	Build a full-fledged e-commerce platform with features such as product listing, shopping cart, and user authentication.
5	Build a job board platform where employers can post job listings, and job seekers can apply

Note:- Projects need not be restricted to the above topics. Students are encouraged to choose any application problems, in the course domain, which they desire to work on.

LESSON PLAN FOR PROJECT COMPONENT		
No.	**Topic**	**No. of Class Hours (24)**

1	Preliminary Design of the Project • Identify a societal real-world problem and design the schema of database and GUI.	4
2	Zeroth presentation (4th week)	2
3	Project work - First Phase	4
4	Interim Presentation (7th and 8th weeks)	4
5	Project work - Final Phase & Report writing (discussions in class during project hours)	6
6	Final Evaluation and Presentation (11th and 12th weeks)	4

Note: 12 Hours of self-study hours should also be utilized for the development of the complete project.

CO Assessment Questions	
1	i. An online blog platform wants to gather feedback from users about the content and user experience. Design a feedback form and implement a JavaScript-based solution to validate the input provided by users. Consider the types of feedback that users might provide and how validation can enhance data quality. ii. An event management company needs to create an online registration form for a conference. Propose a JavaScript-based solution for validating attendee information on the registration form. What specific validation checks are necessary for different fields (e.g., name, email, affiliation)?
2	An e-commerce company is planning to migrate its existing database management system to MongoDB for improved scalability and flexibility. As the database administrator, you are tasked with understanding and employing MongoDB concepts for effective database management in this web application scenario. a) Analyze the specific requirements of the e-commerce company that would make MongoDB a suitable choice for database management. How does MongoDB's document-oriented model align with the nature of e-commerce data? b) Describe the key features of MongoDB, such as sharding and indexing, and explain how they address the scalability needs of the online retail platform. What advantages do these MongoDB features offer compared to traditional relational databases? c) Explain the importance of BSON (Binary JSON) in MongoDB and its role in efficiently storing and querying diverse data types commonly

	encountered in an e-commerce environment. Provide specific examples to illustrate its utility.
3	Imagine you are a software engineer tasked with developing a server-side application for an online food delivery platform a) Design the architecture of the server-side application using Express.js and Node.js for an online food delivery platform. Include key components, such as routing, middleware, and error handling, and explain how they contribute to the overall functionality. b) Develop a set of API endpoints using Express.js to handle various aspects of the food delivery platform, such as user registration, menu retrieval, and order processing. c) Apply middleware in your Express.js application to handle tasks like logging, request parsing, and authentication verification
4	Imagine you are a front-end developer tasked with improving the user interface of an existing e-learning platform. a) Propose a strategy for implementing dynamic content loading in the e-learning platform's course catalog. b) Design and implement a responsive navigation bar for the e-learning platform. c) Develop a React component that allows users to filter and sort courses based on different criteria (e.g., relevance, popularity, date). d) Integrate a real-time notification system using React.js to alert users about new course announcements or updates.
6	a) Design and develop a travel planning app that helps users create itineraries, find accommodations, and explore points of interest. b) Create an inventory management system for tracking products, managing stock levels, and generating reports.

24HUT555	Finance and Accounting	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course enables the learners to understand the basic principles of accounting and the need of personal finance management from investment to retirement plans. Major topics covered under this course are introduction to accounting, financial planning, investment fundamentals, and personal taxation and of retirement planning. It helps the learners to manage money efficiently through the proper control of expenses and through wise investments, to enjoy peace of mind at their post retirement phase without burdening others.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the concepts and conventions in accounting system. **(Understand level)**
CO2	Explain the key concepts, tools, and techniques of contemporary personal finance. **(Understand level)**
CO3	Examine the importance of time value of money and saving to avoid financial problems. **(Understand level)**
CO4	Justify the correct use of credit, and credit cards, the establishment of financial goal. **(Understand level)**
CO5	Explain the dynamics of Real Estate and retirement planning. **(Understand level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3							3				3
CO2	3							3				3
CO3	3							3				3
CO4	3							3				3
CO5	3							3				3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

<u>End Semester Examination [ESE]: Pattern</u>

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Introduction to Accounting (6 hrs)

Introduction to Accounting - Importance, Objectives, Principles. GAAP - Accounting Concepts and Conventions. Accounting System - Double Entry System, Recording Business Transactions, Classification of Accounts, Accounting Cycle, Users of Accounting Information.

MODULE II : Finance Planning (8 hrs)

Financial Planning - Basics of personal finance and time Value of Money, Need and Importance of Personal Financial Planning, Principles of Personal Finance, Financial Planning Process, Factors influencing Personal Financial Planning. Financial Statements and Ratios Analysis - Personal Financial Statements, Income and Expenditure Statement, Balance Sheet, Budget, Analyzing Financial Statements via Ratios.

Investor Profiling: Investor's life Cycle, Financial goals of Investor, Risk Profiling.
MODULE III : Investment Fundamentals (9 hrs)
Investment Fundamentals - Saving plans and Investment plans, Rules of Investing, Debt and Equity. Banking Products - Deposit and Loan Products, Other special products for Senior Citizens and NRIs, Understanding credit Score and Credit Information Report. Insurance Products - Meaning and features of Insurance, Principles of Insurance, Types of Insurance - Life, Health, Personal Accident Insurance. Investment in Equity: NSE/BSE, Investment strategies and Portfolio construction, Fundamental and Technical Analysis, Demat Account, Derivatives. Investment in Mutual Funds - Meaning, Structure of Mutual Funds in India, Mutual Funds Schemes, Systematic Investment Plan (SIP). Investment in Debt Market - Types of Debt Instruments, Government Securities, Corporate Bonds, Certificate of Deposits, Commercial Paper, PO Saving Schemes.
MODULE IV : Personal Taxation (7 hrs)
Personal Taxation - Introduction to Personal Income Tax Planning, Methods of Accounting for Various Heads of Income, Tax Avoidance, Tax Evasion and Tax Planning, Income Tax Deductions, Gift Tax, Wealth Tax. Regulatory Guidelines - Know Your Customer (KYC) Norms, Anti Money Laundering (AML) Standards, Permanent Account Number (PAN).
MODULE V : Dynamics of Real Estate and Retirement Planning (6 hrs)
Dynamics of Real Estate - Documentation, Verification, Real Estate and Bank Loan, Buying vs. Renting, Tax Implications of Real Estate. Introduction to Retirement Planning - Need of Retirement Planning, Rules of Retirement Planning, Retirement Planning Process, Estimation of Retirement Expenses, Basic Retirement Plans.

Text books

1. Personal Finance + Connect Plus. Kapoor, J. R., Dlabay, L. R., & Hughes, R. J., McGrawHill/Irwin., 2012.
2. Financial Markets and Institutions Saunders, Anthony and Cornett, Marcia Millon, Tata McGraw Hill, 2007.
3. Accounting Information Systems : Basic Concepts and Current Issues, Robert L. Hurt McGraw-Hill Education, 2015.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Introduction to Accounting: Importance, Objectives, Principles	1
1.2	GAAP - Accounting Concepts and Conventions	1
1.3	Accounting System - Double Entry System	1

1.4	Recording Business Transactions	1
1.5	Classification of Accounts, Accounting Cycle	1
1.6	Users of Accounting Information	1
	MODULE II	
2.1	Financial Planning: Basics of personal finance and time Value of Money	1
2.2	Need and Importance of Personal Financial Planning	1
2.3	Principles of Personal Finance	1
2.4	Financial Planning Process, Factors influencing Personal Financial Planning	1
2.5	Financial Statements and Ratios Analysis: Personal Financial Statements	1
2.6	Income and Expenditure Statement, Balance Sheet, Budget, Analyzing Financial Statements via Ratios – Lecture 1	1
2.7	Income and Expenditure Statement, Balance Sheet, Budget, Analyzing Financial Statements via Ratios – Lecture 2	1
2.8	Investor Profiling: Investor's life Cycle, Financial goals of Investor, Risk Profiling.	1
	MODULE III	
3.1	Investment Fundamentals: Saving plans and Investment plans, Rules of Investing, Debt and Equity	1
3.2	Banking Products: Deposit and Loan Products, Other Special products for Senior Citizens and NRIs	1
3.3	Understanding credit Score and Credit Information Report	1
3.4	Insurance Products: Meaning and Features of Insurance, Principles of Insurance	1
3.5	Types of Insurance - Life, Health, Personal Accident Insurance	1
3.6	Investment in Equity: NSE/BSE, Investment Strategies and Portfolio Construction, Fundamental and Technical Analysis, Demat Account, Derivatives	1
3.7	Investment in Mutual Funds: Meaning, Structure of Mutual Funds in India, Mutual Funds Schemes, Systematic Investment Plan (SIP)	1
3.8	Investment in Debt Market: Types of Debt Instruments, Government Securities	1
3.9	Corporate Bonds, Certificate of Deposits, Commercial Paper, PO Saving Schemes	1

MODULE IV		
4.1	Personal Taxation: Introduction to Personal Income Tax Planning	1
4.2	Methods of Accounting for Various Heads of Income, Tax Avoidance, Tax Evasion and Tax Planning – Lecture 1	1
4.3	Methods of Accounting for Various Heads of Income, Tax Avoidance, Tax Evasion and Tax Planning – Lecture 2	1
4.4	Methods of Accounting for Various Heads of Income, Tax Avoidance, Tax Evasion and Tax Planning – Lecture 3	1
4.5	Income Tax Deductions, Gift Tax, Wealth Tax	1
4.6	Regulatory Guidelines: Know Your Customer (KYC) Norms	1
4.7	Anti Money Laundering (AML) Standards, Permanent Account Number (PAN).	1
MODULE V		
5.1	Dynamics of Real Estate: Documentation, Verification	1
5.2	Real Estate and Bank Loan, Buying vs. Renting	1
5.3	Tax Implications of Real Estate	1
5.4	Introduction to Retirement Planning: Need of Retirement Planning	1
5.5	Rules of Retirement Planning, Retirement Planning Process	1
5.6	Estimation of Retirement Expenses, Basic Retirement Plans	1

CO Assessment Questions	
1	1. Describe Accounting concepts and conventions. 2. Explain different classification of accounts in detail.
2	1. Describe the objectives of personal financial planning. 2. Discuss the role of Income and Expenditure statement and Balance sheet in financial planning.
3	1. Explain about Life, Health and Personal Accident Insurance policies. List out any 5 policies of each category available in India and compare them. 2. Describe the structure of Mutual Funds and its schemes in India. 3. Explain the objectives of portfolio. 4. Discuss the major rules of investing in detail.

4	1. Explain about 'personal tax planning'. 2. Describe about tax avoidance, tax evasion and tax planning. 3. Discuss in detail the methods of accounting for various heads of income.
5	1. Explain the process of 'retirement planning'. 2. Describe the reasons why you should not take a bank loan for the purchase of your assets. 3. Discuss about the major tax implications of real estate agreements in detail.

24MCT506	Constitution of India	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	1	2024

Preamble: This course enables the learners to understand the fundamental rights and duties of a citizen, political code of conduct, structure, power, and duties of all organizations. It covers the fundamentals of Indian Constitution, fundamental rights and duties, working of the union and state executive, parliament, legislature and judiciary. It helps the learner to become an active and responsible citizen.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the significance of Indian Constitution as the fundamental law of the land. **(Understand Level)**
CO2	Identify the importance of fundamental rights and duties. **(Understand Level)**
CO3	Describe the Indian political system, the working of the union executive, parliament and judiciary. **(Understand Level)**
CO4	Understand the functioning of the state executive, legislature and judiciary. **(Understand Level)**
CO5	Describe the electoral process, emergency provisions and amendment procedure. **(Understand Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						2		2		2		3
CO2						3		3		3		3
CO3						3		3		3		3
CO4						3		3		3		3
CO5						3		3		2		3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply				
Analyze				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignmen t	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hrs

<u>End Semester Examination [ESE]: Pattern</u>

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I <<Introduction>>

Definition of constitution, Historical background, Salient features of the Indian constitution. Preamble of the constitution, Union and its territory. Meaning of citizenship, Types, Termination of citizenship.

MODULE II : << Fundamental Rights and Duties >>

Definition of state, Fundamental rights, General nature, Classification, Right to equality, Right to freedom, Right against exploitation. Right to freedom of religion, Cultural and educational rights, Right to constitutional remedies, Protection in respect of conviction for offences. Directive principles of state policy, Classification of directives, Fundamental duties.

MODULE III <<Union Executive and the Parliament>>

The Union executive, The President, the Vice President, the Council of Ministers, the Prime Minister, Attorney-General, functions. The Parliament, composition, Rajya Sabha, Lok Sabha, qualification and disqualification of membership, functions of Parliament. Union judiciary, The Supreme court, jurisdiction, appeal by special leave.

MODULE IV <<State Executive and the State legislature>>

The State executive, the Governor, the Council of Ministers, the Chief Minister, advocate general, union territories. The state legislature, composition, qualification and disqualification of membership, functions. The State Judiciary, the High court, jurisdiction, writs jurisdiction. Local government-Panchayat raj system- with special reference to 73rd and 74th amendment.

MODULE V <<Electoral process, emergency provisions and amendment procedure>>

Relations between the Union and the States, legislative relation, administrative relation, financial relations, Inter State council, finance commission. Emergency provision, freedom of trade and commerce. Comptroller and auditor general of India, public services, public service commission, administrative Tribunals. Amendment of the constitution-meaning, procedure and limitations. Election provisions and electoral process.

Text books

1. D.D.Basu, "Introduction to the constitution of India", Lexis Nexis, New Delhi, 25e, 2021
2. P M Bhakshi, "The Constitution of India", Universal Law, 14e ,2017
3. M.V. Pylee, "Introduction to the Constitution of India", 4th Edition, Vikas publication, 2005.
4. K. Sharma , "Introduction to the Constitution of India", Prentice Hall of India, New Delhi, 2002.

Reference books

1. Granville Austin, The Indian Constitution: cornerstone of a Nation. Melbourne: Oxford University Press, 2000.
2. Merunandan, "Multiple Choice Questions on Constitution of India" , 2nd Edition, Meraga publication, 2017
3. D.C. Gupta, Indian Government and Politics, Vikas publishing House, New Delhi.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1		
1.1	Definition of Constitution- Historical background	1
1.2	Salient features of the Constitution	1
1.3	Preamble of the Constitution-Union and its territory.	1

1.4	Meaning of Citizenship-types- termination of citizenship	1
MODULE II		
2.1	Definition of state, Fundamental rights - General nature	1
2.2	Fundamental rights - Classification, right to equality	1
2.3	Right to freedom, right against exploitation	1
2.4	Right to freedom of religion	1
2.5	Cultural and educational rights, right to constitutional remedies	1
2.6	Protection in respect of conviction for offences	1
2.7	Directive principles of state policy, classification of directives	1
2.8	Fundamental duties	1
MODULE III		
3.1	The Union executive, The President, Vice President – Lecture 1	1
3.2	The Union executive, The President, Vice President – Lecture 2	1
3.3	The council of ministers, The Prime minister, Attorney - General, Functions – Lecture 1	1
3.4	The council of ministers, The Prime minister, Attorney - General, Functions – Lecture 2	1
3.5	The Parliament, composition, Rajya Sabha, Lok Sabha	1
3.6	Qualification and disqualification of membership, functions of parliament – Lecture 1	1
3.7	Qualification and disqualification of membership, functions of parliament – Lecture 2	1
3.8	Union judiciary, the Supreme court, Jurisdiction, appeal by special leave – Lecture 1	1
3.9	Union judiciary, the Supreme court, Jurisdiction, appeal by special leave – Lecture 2	1
MODULE IV		
4.1	The state executive, the governor, the council of ministers.	1
4.2	The Chief minister, advocate general, union territories.	1

4.3	The state Legislature, composition, qualification and disqualification of membership, functions.	1
4.4	The state judiciary, the high court, jurisdiction, writs jurisdiction.	1
4.5	Local government, Panchayat raj system-with special reference to 73rd and 74th amendment.	1
MODULE V		
5.1	Relation between the union and the states, legislative relation, administrative relation.	1
5.2	Financial relations, Inter -State council, finance commission	1
5.3	Emergency provision, freedom of trade and commerce.	1
5.4	Comptroller and Auditor General of India	1
5.5	Public services, public service commission, administrative tribunals	1
5.6	Amendment of the constitution-meaning, procedure and limitations	1
5.7	Election provisions and electoral process	1

CO Assessment Questions	
1	a. Examine the salient features of Indian constitution. b. "Secularism is the foundation of democracy". Explain.
2	" The constitution has ensured certain rights to the minorities under Article 30"- Examine.
3	Point out the difference between a bill and an act. Explain the various steps involved in the passage of a bill in the Parliament.
4	Explain the procedure for the formation of state Legislative council? Also examine its relevance vis-à-vis legislative assembly.
5	Discuss the effect of proclamation of emergency.

24HUL507	Technical Writing	L	T	P	J	S	C	Year of Introduction
		0	0	2	0	2	1	2024

Preamble: This course enables the learners to understand various aspects of writing technical papers, thesis reports, research and project proposals, and progress & utilization reports. This course covers research paper writing, thesis writing, tools and techniques used for technical writing, and miscellaneous report writing. It helps the learners to write thesis and research papers during their UG and higher studies, and create research and project proposals throughout their careers, when and where the need arise.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the need of technical writing. **(Understand Level)**
CO2	Write technical papers with the scientific approach. **(Apply Level)**
CO3	Explain the format of a thesis report. **(Apply Level)**
CO4	Illustrate the use of various tools in the preparation of technical reports. **(Apply Level)**
CO5	Write research proposals, project proposals, progress report and utilization report. **(Apply Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								3	3	3		3
CO2					3			3	3	3		3
CO3					3			3	3	3		3
CO4					3			3	3	3		3
CO5					3	3		3	3	3	3	3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools	
	Class work	Test1
Remember	✓	✓
Understand	✓	✓
Apply	✓	✓
Analyse	✓	
Evaluate		
Create		

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Class work	Lab Exam	Total Marks
0-0-2-0	5	35	10	50

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
50	**50**	**-**	**-**

SYLLABUS- DETAILS OF EXPERIMENTS

Introduction (4 hours)

Importance of report writing in academics and research. Various kinds of academic and research activities. Necessity of report writing for achievement of academic and research goals. Various kinds of reports / presentations. Characteristics of academic and research reports / presentations.

Research paper writing (5 hours)

Types of research papers, Structure of research papers, Research paper formats, Abstract writing, Methodology, Results and discussions, Different formats for referencing, Ways of communicating a research paper

Thesis writing (5 hours)

Structure of a thesis, Scope of the work, Literature review, Experimental / computational details, Preliminary studies, Results and Discussions, Figures and Tables preparation, Conclusions and future works, Bibliography, Appendices

Tools and Techniques (5 hours)

Various word processors, e.g, MS Word, Libra-office, Latex, Macro media robohelp, adobe frame maker, snag IT, MS Visio, Photoshop etc. Making effective presentations using Power Point and Beamer, Uses of plagiarism detection tools.

Miscellaneous Reports (5 hours)

Writing research proposals, Writings project proposals, Lecture notes, Progress reports, Utilization reports, Scientific reports.

Text books

1. A Step-by-Step Guide to Writing Academic Papers, Anne Whitaker, September 2009.
2. Advanced Technical Communication, Tyagi K, Prentice Hall India, 2011.
3. On Writing a Thesis, C P Ravikumar, IETE Journal of Education, 2000
4. Microsoft Office 2016, Joan Lambert and Curtis Frye, Microsoft Press, Washington, 1/e, 2015.
5. LATEX for Beginners: Workbook, Document Reference, 3722-2014, 5/e, March

2014 6. Essential LATEX++, Jon Warbrick with additions by David Carlisle, Michel Goossens, Sebastian Rahtz, Adrian Clark January 1994.
Suggested MOOC/NPTEL Course 1. Academic & Research Report Writing, By Dr. Samir Roy | National Institute of Technical Teachers Training and Research , Kolkata

LIST OF EXPERIMENTS

No.	Experiments
I	1. Reading exercise and submitting report on - Importance of report writing in academics and research, Various kinds of academic and research activities. 2. Group Discussion on "Necessity of report writing for achievement of academic and research goals". 3. Presentation on "Various kinds of reports / presentations, Characteristics of academic and research reports / presentations".
II	1. Illustrate the concept of the following topics with a Role-play/Reverse Quiz/Crossword puzzle. Types of research papers Structure of research papers Research paper formats Abstract writing Methodology Results and discussions Different formats for referencing 2. Write a report on "Different ways of communicating a research paper".
III	1. Illustrate the process of writing a thesis based on Structure of a thesis Scope of the work Literature review Experimental / computational details Preliminary studies Results and discussions Figures and Tables preparation Conclusions and future works Bibliography

	Appendices 2. Illustrate how thesis format can be fixed in Latex based on the B.Tech final year project report format of Computer Science and Engineering, by considering all the points specified in the above exercise. (You can use sample figures, tables, equations, citations and text content with different levels of titles.)
IV	1. Familiarization of various word processors and powerpoint presentation tools like a. MS Word b. Libra-office, Latex c. Macro media robohelp d. Adobe frame maker, e. Snag IT, f. MS Visio, g. Photoshop 2. Presentation and illustration of various online and proprietary plagiarism detection tools using any of the assignment submitted for the courses.
V	1. Give a presentation on a. Research proposals b. Project proposals c. Progress reports d. Utilization reports e. Scientific reports 2. Prepare a project proposal that can be submitted to KTU - CERD funding agency and prepare its utilization certificate, progress reports and scientific reports.(Group Activity)

Sample CO Assessment Questions	
I	Explore the necessity of report writing for the achievement of academic and research goals, and submit a written document.
II	Write a technical paper in the technical domain of your own interest by reviewing five technical papers.
III	Illustrate how thesis format can be fixed in Latex based on the B.Tech final year project report format of Computer Science and Engineering, by

	considering all the points specified in Module III. (You can use sample figures, tables, equations, citations and text content with different levels of titles.)
IV	Explain the need of plagiarism tools and identify different online and proprietary plagiarism tools.
V	Prepare a project proposal that can be submitted to KTU - CERD funding agency and prepare its utilization certificate, progress reports and scientific reports.**(Group Activity)**

24HUL508	Soft Skills	L	T	P	J	S	C	Year of Introduction
		0	0	2	0	2	1	2024

Preamble: This course enables the learners to understand the need and the methods of acquiring soft skills. This course covers numerical aptitude problems, non verbal reasoning problems, simple engineering aptitude problems and data interpretation problems. It help the learners to face campus recruitments, national and state level competitive exams with confidence.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the importance of soft skills. **(Understand Level)**
CO2	Solve different numerical aptitude problems of various categories related to competitive exams. **(Apply Level)**
CO3	Analyze non-verbal reasoning and simple engineering aptitude problems. **(Apply Level)**
CO4	Solve placement and competitive test questions related to data interpretation. **(Apply Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								3	3	3		3
CO2	3							3				3
CO3	3							3				3
CO4	3							3				3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools	
	Class work	Test1
Remember	✓	✓
Understand	✓	✓
Apply	✓	✓
Analyse	✓	
Evaluate		
Create		

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Class work	Lab Exam	Total Marks
0-0-2-0	5	35	10	50

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
50	50	-	-

SYLLABUS- DETAILS OF EXPERIMENTS

Soft skills and its importance, Number system, LCM &HCF, Divisibility test, Surds and indices, Logarithms, Ratio, proportions and variations, Partnership, Time speed and distance, work time problems, Money related problems, Mixtures, Symbol based problems, Clocks and calendars, Simple, linear, quadratic and polynomial equations, Special equations, Inequalities, Functions and graphs, Sequence and series, Set theory, Permutations and combinations, Probability, Statistics. Non-verbal reasoning and simple engineering aptitude: Mirror image, Water image, Paper folding, Paper cutting, Grouping of figures, Figure formation and analysis, Completion of incomplete pattern, Figure matrix, Miscellaneous. Data interpretation: Numerical data tables, Line graphs, Bar charts and Pie charts, Caselet forms, Mix diagrams, Geometrical diagrams and other forms of data representation.

Text books

1. Gulati S., "Corporate Soft Skills", New Delhi, India: Rupa & Co., 2006.
2. R.S Agarwal & S. Chand, "Quantitative Aptitude", 2024.

Reference books

1. Peggy Klaus, "The Hard Truth about Soft Skills", 2008.
2. Abijith Guha, "Quantitative Aptitude for All Competitive Examinations, TMH, 6/e, 2016.
3. Arun Sharma, "Quantitative Aptitude for Cat", TMH, 2022.

LIST OF EXPERIMENTS

No.	Experiments
I	1. Presentation on " Soft skills and its importance, Pleasure and pains of transition from an academic environment to work environment". 2. Case study on "Need for change. Fears, stress and competition in the professional world. Importance of positive attitude". 3. Group Discussion on "Self motivation and continuous knowledge, upgradation".
II	Multiple choice based quiz on the following topics and discussion on them to get an understanding of the topic. 1. Number system

	2. LCM & HCF, Divisibility test, Surds and indices 3. Logarithms, Ratio, proportions and variations 4. Partnership, Time, speed and distance, work time problems
III	Multiple choice based quiz on the following topics and discussion on them to get an understanding of the topic. 1. Money related problems, Mixtures, Symbol based problems 2. Clocks and calendars 3. Simple, linear, quadratic and polynomial equations 4. Special equations, Inequalities, Functions and graphs 5. Sequence and series, Set theory 6. Permutations and combinations, 7. Probability, Statistics.
IV	Multiple choice based quiz on the following topics and discussion on them to get an understanding of the topic. 1. Non-verbal reasoning and simple engineering aptitude: Mirror image, Water image, Paper folding 2. Paper cutting, Grouping of figures 3. Figure formation and analysis 4. Completion of incomplete pattern, Figure matrix 5. Miscellaneous
V	Multiple choice based quiz on the following topics and discussion on them to get an understanding of the topic. 1. Data interpretation: Numerical data tables, Line graphs 2. Bar charts and Pie charts, Caselet forms 3. Mix diagrams 4. Geometrical diagrams 5. Other forms of data representation.

CO Assessment
Give specific training and prepare questions based on campus recruitment papers, national level and state level competitive examination papers, Speed mathematics, tackling aptitude problems asked in interview, techniques to remember (In mathematics), Lateral thinking problems, Quick checking of answers techniques, techniques on elimination of options, estimating and predicting correct answer, Time management in aptitude tests and test taking strategies.

Honors- S5

24CSH509	Advanced Data structures and Algorithms	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	4	4	2024

Preamble: The purpose of this course is to understand advanced data structures, analyze and establish the correctness of algorithms, and comprehend the theories behind various classes of algorithms.

Prerequisite: a solid understanding of data structures and algorithms.

Course Outcomes: After the completion of the course the student will be able to

CO1	To analyze algorithmic efficiency through amortized analysis methods and apply advanced data structures. **(Understand Level)**
CO2	To acquire the skills necessary for modeling, analyzing, and solving network flow problems using various algorithms, and to apply these concepts to address real-world challenges. **(Apply Level**)
CO3	To possess a comprehensive understanding of probabilistic algorithms, gaining proficiency in numerical methods. **(Apply Level)**
CO4	To acquire the skill of designing and analyzing new algorithms. **(Apply Level)**
CO5	To acquire the skills in number-theoretic problem-solving and efficient pattern matching. **(Apply Level)**
CO6	To Compare various classes of algorithms. **(Apply Level).**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3	3								3
CO5	3	3	3	3				3	1			3
CO6	3	3	3	1								3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate			✓	
Create			✓	

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
4-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: << Amortized Analysis >>

Amortized Analysis – aggregate, accounting, potential methods- Case studies. Advanced data structures: binomial heap, Fibonacci heap, disjoint sets - applications.

MODULE II: << Network flow algorithms >>

Network flow algorithms: properties, Ford-Fulkerson method, maxflow-mincut theorem, Edmonds-Karp heuristics, push-relabel, relabel-to-front algorithms, maximum bipartite matching - analysis of associated algorithms - applications.

MODULE III: << Probabilistic algorithms >>

Probabilistic algorithms: Numerical algorithms, integration, counting, Monte-Carlo algorithms - verifying matrix multiplication, min-cut in a network. Las Vegas algorithms, selection, quicksort, Dixon's factorization

MODULE IV: << Geometric Algorithms >>

Geometric Algorithms: Plane sweep technique, role of sweep- line - status and event-point-schedule, line segment intersection problem. Convex Hull: Graham's scan algorithm, Jarvismarch algorithm. Finding closest pair of points, proof of correctness.

MODULE V: << Number-Theoretic algorithms >>

Number-Theoretic algorithms: GCD algorithm, primality testing, Miller-Rabin test, integer factorization - Pollard Rho heuristic, string matching: Rabin-Karp, Knuth-Morris-Pratt algorithms.

Overview of Complexity classes – P, NP, Co-NP, NP-hard, NP complete, Space complexity. Complexity classes in randomized algorithms – RP, PP, ZPP, BPP.

Text books

1. T. H. Cormen, C. E. Leiserson, R. L. Rivest and C. Stein, "Introduction to algorithms", Prentice-hall of India Private Limited, New Delhi, 2010.
2. SartajSahni, "Data Structures, Algorithms, and Applications in C++", Mc-GrawHill, 1999.

Reference books

1. Gilles Brassard and Paul Bratley, "Fundamentals of algorithms", Prentice-hall of India Private Limited, New Delhi, 2001.
2. R.C.T. Lee, S.S. Tesng, R.C. Cbang and Y.T. Tsai "Design and Analysis of Algorithms, A strategic Approach", TMH, 2010
3. Rajeev Motwani, PrabhakarRaghavan, "Randomized Algorithms", Cambridge University Press, 2000.

Suggested MOOC Courses

1. NPTEL Course: Data Structures And Algorithms, IIT Delhi by Prof. Naveen Garg.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1		
1.1	Amortized Analysis – aggregate	1
1.2	accounting	1
1.3	potential methods- Case studies. Lecture I	1
1.4	potential methods- Case studies. Lecture II	1
1.5	Advanced data structures: Introduction	1
1.6	binomial heap	1
1.7	Fibonacci heap	1

1.8	disjoint sets	1
1.9	disjoint sets - applications.	1
MODULE II		
2.1	Introduction to Network flow algorithms	1
2.2	Properties of Network flow algorithms	1
2.3	Ford-Fulkerson method	1
2.4	maxflow-mincut theorem	1
2.5	Edmonds-Karp heuristics	1
2.6	push-relabel	1
2.7	relabel-to-front algorithms	1
2.8	maximum bipartite matching	1
2.9	analysis of associated algorithms- applications.	1
MODULE III		
3.1	Probabilistic algorithms: Numerical algorithms,	1
3.2	integration, counting	1
3.3	Monte-Carlo algorithms - verifying matrix multiplication	1
3.4	min-cut in a network.	1
3.5	Las Vegas algorithms	1
3.6	Selection sort	1
3.7	quicksort	1
3.8	Dixon's factorization	1
MODULE IV		
4.1	Geometric Algorithms: Plane sweep technique	1

4.2	role of sweep- line - status and event-point-schedule	1
4.3	line segment intersection problem	1
4.4	Convex Hull: Graham's scan algorithm	1
4.5	Jarvismarch algorithm	1
4.6	Finding closest pair of points	1
4.7	proof of correctness	1
MODULE V		
5.1	Number-Theoretic algorithms: GCD algorithm	1
5.2	primality testing	
5.3	Miller-Rabin test	
5.4	integer factorization - Pollard Rho heuristic	1
5.5	string matching	1
5.6	Rabin-Karp	1
5.7	Knuth-Morris-Pratt algorithms	1
5.8	Overview of Complexity classes – P, NP, Co-NP	1
5.9	NP-hard,	1
5.10	NP complete,	1
5.11	Space complexity	1
5.12	Complexity classes in randomized algorithms – RP, PP, ZPP, BPP.	1

CO Assessment Questions	
1	1. Explain the structure and operations of a binomial heap. Provide step-by-step details of the merge and extract-min operations. Compare the time complexity of these operations with other heap types. 2. Discuss the union-find (disjoint sets) data structure. Explain the union and find operations and their time complexities. Provide an example problem where disjoint sets are used, and explain how the data structure is applied.
2	1. Given a network flow graph with capacities on each edge, apply the Ford-Fulkerson algorithm to find the maximum flow. Illustrate each iteration of the algorithm, including the residual graph and augmenting paths. 2. Consider a network with the following capacities: Source -> A: 10 Source -> B: 5 A -> C: 15 B -> C: 10 C -> Sink: 15 Apply the Ford-Fulkerson algorithm to find the maximum flow. Provide the final flow values on each edge. 3. Consider a bipartite graph with the following edges: Left Set: 1, 2, 3 Right Set: A, B, C Edges: (1, A), (1, B), (2, B), (3, C) Apply an augmenting path algorithm to find the maximum bipartite matching. Provide the final matching and explain the process.
3	3. Given a function f(x)=x2 defined over the interval [0,1], use Monte Carlo integration to estimate the value of the definite integral $\int_0^1 x^2 dx$. Describe the procedure and provide your estimate. 4. Design a Las Vegas algorithm to find the k-th smallest element in an unsorted array. Explain the algorithm, and analyze its expected time complexity.
4	1. Explain the concept of the plane sweep technique in geometric algorithms. Discuss the roles of the sweep line, status structure, and event-point-schedule. Apply this technique to solve a problem, such as detecting line segment intersections. 2. Explain the Jarvis march algorithm for computing the convex hull. Compare it with Graham's scan in terms of complexity and performance. Provide an example where Jarvis march is particularly effective.
5	1. Implement the Miller-Rabin primality test. Discuss its probabilistic nature and how it improves upon deterministic primality tests. Analyze its time complexity and accuracy.

	2. Implement the Knuth-Morris-Pratt (KMP) string-matching algorithm. Discuss how it avoids unnecessary character comparisons and improves the efficiency of string matching. Analyze the time complexity and compare it with other string-matching algorithms.
6.	1. Given a specific NP-complete problem, design a polynomial-time reduction from a known NP-complete problem to the given problem. Discuss the implications of this reduction. 2. Choose an NP-complete problem and design a PP algorithm for it. Explain the properties of the PP algorithm and discuss how it compares to deterministic polynomial-time algorithms.

24CSH510	Advanced Operating Systems	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	4	4	2024

Preamble: The students will be able to get comprehensive knowledge on the architecture of distributed systems. Also understand the deadlock and shared memory issues and their solutions in distributed environments. They will get to know the security issues and protection mechanisms for distributed environments. This course will also enable them to gain knowledge of multiprocessor operating systems and database operating systems.

Prerequisite: Operating Systems

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the design approaches of advanced operating systems. **(Understand Level)**
CO 2	Apply various mutual exclusion algorithms to solve the concurrency design issue of distributed operating systems. **(Apply Level)**
CO 3	Apply distributed deadlock detection algorithms and strategies to effectively manage and resolve deadlocks in complex distributed systems. **(Apply Level)**
CO 4	Understand the fundamental design principles and mechanisms related to multiprocessor system architectures, multiprocessor operating systems, and distributed file systems. **(Understand Level)**
CO 5	Formulate the solutions to schedule the real time applications. **(Apply Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	3							3		3
CO 2	3	3	3							3		3
CO 3	3	3	3							3		3
CO 4	3	3	3							3		3
CO 5	3	3	3							3		3

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✔	✔	✔	✔
Understand	✔	✔	✔	✔
Apply	✔	✔	✔	✔
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
4-0-0-0	5	15	10	10	**40**

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Architectures of Distributed Systems & Theoretical Foundations (9 hrs)

Architectures of Distributed Systems - System Architecture Types, Distributed Operating Systems, Issues in Distributed Operating Systems, Communication Primitives. Theoretical Foundations - Inherent Limitations of a Distributed System, Lamport's Logical Clocks, Vector Clocks, Causal Ordering of Messages, Termination Detection.

MODULE II : Distributed Mutual Exclusion (9 hrs)

Distributed Mutual Exclusion - The Classification of Mutual Exclusion Algorithms, Non-Token Based Algorithms - Lamport's Algorithm, The Ricart-Agrawala Algorithm, Maekawa's Algorithm. Token-Based Algorithms - Suzuki-Kasami's Broadcast Algorithm, Singhal's Heuristic Algorithm, Raymond's Heuristic Algorithm.

MODULE III : Distributed Deadlock Detection (9 hrs)

Distributed Deadlock Detection - Preliminaries, Deadlock Handling Strategies in Distributed Systems, Issues in Deadlock Detection and Resolution, Control Organizations for Distributed Deadlock Detection, Centralized- Deadlock – Detection Algorithms, Distributed Deadlock Detection Algorithms, Hierarchical Deadlock Detection Algorithms.

MODULE IV : Multiprocessor Operating Systems & Distributed File Systems (9 hrs)

Multiprocessor System Architectures - Introduction, Motivation for multiprocessor Systems, Basic Multiprocessor System Architectures. Multiprocessor Operating Systems - Introduction, Structures of Multiprocessor Operating Systems, Operating Design Issues, Threads, Process Synchronization, Processor Scheduling. Distributed File Systems - Architecture, Mechanisms for Building Distributed File Systems, Design Issues.

MODULE V : Distributed Scheduling (9 hrs)

Distributed Scheduling - Issues in Load Distributing, Components of a Load Distributed Algorithm, Stability, Load Distributing Algorithms, Requirements for Load Distributing, Task Migration, Issues in task Migration. Distributed Shared Memory - Architecture and Motivation, Algorithms for Implementing DSM, Memory Coherence, Coherence Protocols, Design Issues.

Text books

1. Advanced Concepts in Operating Systems, Mukesh Singhal, Niranjan G. Shivaratri, Tata McGraw-Hill Edition 2001.

Reference books

1. Distributed Systems, Andrew S. Tanenbaum, Maarten Van Steen, Pearson Prentice Hall, Edition – 2, 2007.
2. Distributed Operating Systems and Algorithm Analysis, Randy Chow, Theodore Johnson, Pearson Prentice Hall, 2009.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1		
1.1	System Architecture Types.	1
1.2	Distributed Operating Systems.	1
1.3	Issues in Distributed Operating Systems.	1
1.4	Communication Primitives.	1
1.5	Inherent Limitations of a Distributed System.	1
1.6	Lamport's Logical Clocks.	1
1.7	Vector Clocks.	1
1.8	Causal Ordering of Messages.	1
1.9	Termination Detection.	1
MODULE II		
2.1	Distributed Mutual Exclusion - The Classification of Mutual Exclusion Algorithms.	1
2.2	Non-Token Based Algorithms - Lamport's Algorithm.	1
2.3	The Ricart-Agrawala Algorithm (Lecture 1).	1
2.4	The Ricart-Agrawala Algorithm (Lecture 2).	1
2.5	Maekawa's Algorithm(Lecture 1).	1
2.6	Maekawa's Algorithm(Lecture 2).	1

2.7	Token-Based Algorithms:Suzuki-Kasami's Broadcast Algorithm.	1
2.8	Singhal's Heuristic Algorithm.	1
2.9	Raymond's Heuristic Algorithm.	1
	MODULE III	
3.1	Distributed Deadlock Detection: Preliminaries.	1
3.2	Deadlock Handling Strategies in Distributed Systems.	1
3.3	Issues in Deadlock Detection and Resolution.	1
3.4	Control Organizations for Distributed Deadlock Detection (Lecture 1).	1
3.5	Control Organizations for Distributed Deadlock Detection (Lecture 2).	1
3.6	Centralized- Deadlock – Detection Algorithms (Lecture 1).	1
3.7	Centralized- Deadlock – Detection Algorithms (Lecture 2).	1
3.8	Distributed Deadlock Detection Algorithms.	1
3.9	Hierarchical Deadlock Detection Algorithms.	1
	MODULE IV	
4.1	Multiprocessor System Architectures - Introduction, Motivation for multiprocessor Systems.	1
4.2	Basic Multiprocessor System Architectures.	1
4.3	Multi Processor Operating Systems: Introduction, Structures of Multiprocessor Operating Systems.	1
4.4	Operating Design Issues.	1
4.5	Threads.	1
4.6	Process Synchronization.	1
4.7	Processor Scheduling.	1
4.8	Mechanisms for Building Distributed File Systems.	1
4.9	Design Issues.	1
	MODULE V	
5.1	Distributed Scheduling - Issues in Load Distributing.	1
5.2	Components of a Load Distributed Algorithm.	1
5.3	Stability, Load Distributing Algorithms.	1
5.4	Requirements for Load Distributing.	1
5.5	Task Migration, Issues in task Migration.	1
5.6	Distributed Shared Memory: Architecture and Motivation.	1
5.7	Algorithms for Implementing DSM.	1
5.8	Memory Coherence.	1
5.9	Coherence Protocols, Design Issues.	1

CO Assessment Questions	
CO1	1. How to overcome inherent limitations of distributed systems? 2. Modify the global state recording to record global state in a FIFO communication environment. State any assumption that you make.
CO2	1. Show that in Lamport's algorithm if a site S1 is executing the critical section, then Si's request need not be at the top of the request queue another side Sj is this still true when there are no messages in transit. 2. Illustrate with an example that in Lamport's algorithm the critical session is accessed according to the increasing order of time stamps.
CO3	1. Discuss the impact of message loss on the various deadlock detection algorithms. 2. Identify the potential issues in deadlock detection and resolution in a generic distributed system. Use an example to illustrate challenges and discuss possible solutions.
CO4	1. What features should a multiprocessing operating system have? 2. Discuss the design issues in building Distributed File Systems.
CO5	1. How to maintain consistency among the caches of a distributed system? 2. Given a real-world scenario with dynamic changes in workload, propose a load distributing algorithm that ensures stability and optimal resource utilization in a distributed system. 3. Discuss the design considerations involved in implementing a distributed shared memory system, emphasizing how these considerations impact the overall performance of the system.

24CSH511	Business Analytics	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	4	4	2024

Preamble: The purpose of this course is to enable the learner to understand the basic concepts of business analytics**.** This course helps the learner to make use of business analytics to formulate and solve business problems and to support managerial decision making. Study of business analytics is to leverage data-driven insights to make informed business decisions.

Prerequisite: A sound knowledge in data and Web Mining.

Course Outcomes: After the completion of the course the student will be able to

CO1	To know the use of business analytics to formulate and solve business problems and to support managerial decision making. **(Understand Level)**
CO2	To familiarize the practices needed to develop, report and analyze business data. **(Apply Level)**
CO3	To Learn to clean and prepare data, build and evaluate data models, and visualize data to generate meaningful insights. **(Apply Level)**
CO4	To learn about Data mining for business. **(Apply Level)**
CO5	To learn the techniques that allow businesses to predict future outcomes. **(Apply Level)**
CO6	To define goals for business and how can optimize solutions to achieve those goals through the techniques associated with prescriptive analytics. **(Apply Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3	3								3
CO5	3	3	3	3				3	1			3
CO6	3	3	3	1								3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate			✓	
Create			✓	

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
4-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Descriptive Analytics (9 Hrs)

Introduction to Business Analytics-Evolution, Scope, Models, Data Visualization, Statistical Methods for Summarizing Data, Measures of Central Tendency, Measures of Dispersion, Measures of Shape, Measures of Association, Probability Distributions and Data Modeling- Discrete and Continuous Probability Distributions, Random Sampling from Probability Distributions, Data Modeling and Distribution Fitting.

MODULE II: Sampling, Estimation and Statistical Inference (9 Hrs)

Sampling and Estimation - Statistical Sampling, Estimating Population Parameters, Sampling Distributions, Confidence Intervals, Prediction Intervals. Statistical Inference- Hypothesis Testing, Confidence Intervals, one sample and two sample tests, z-test, t-test, Chi-square test. Analysis of Variance: Theory and computations of ANOVA, ANOVA table, Two-way ANOVA, Blocking designs, Design of Experiments.

MODULE III: Predictive Analytics (8 Hrs)
Predictive Analytics- Modeling Relationships and Trends in Data, Simple Regression and Correlation: Introduction, Estimation using the regression line, Correlation Analysis. Multiple Regression: The k-variable multiple regression model, The F-test of a Multiple Regression model.
MODULE IV: Forecasting Techniques (7 Hrs)
Forecasting Techniques- Qualitative and Judgmental Forecasting, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality. Introduction to Data Mining, Monte Carlo Simulation and Risk Analysis.
MODULE V: Prescriptive Analytics (12 Hrs)
Prescriptive Analytics - Linear Programming Problem-Formulation, Graphical solutions, Simplex method, Revised Simplex method and Sensitivity Analysis, Transportation Problem-Formulation and solution, Assignment Problem-Formulation and solution. Deterministic Dynamic Programming problem- Bellman's principle of optimality - Computational procedure for Shortest Route problem, Reliability Problem, Equipment Replacement Problem. Integer Programming Problem-Formulation, Branch and Bound algorithm, Cutting Plane Algorithm.

Text books

1. James R. Evans, Business Analytics, Pearson Education Limited, 2017.
2. Amir D. Aczel and J. Sounderpandian, Complete Business Statistics, Tata McGraw Hill, 2006.
3. Wayne L. Winston, Operations Research: Applications and Algorithms, PWS-Kent Pub 2004.

Reference books

1. Ben Fry- Visualizing Data. Released December 2007. Publisher(s): O'Reilly Media, Inc 2016.
2. An Introduction to Business Analytics, Ger Koole, Lulu.com, 2019.
3. Business Analytics, Methods, Models, and Decisions James R. Evans University of Cincinnati, Second Edition, 2016.
4. Business Statistics McGraw−Aczel−Sounderpandian, 7th Edition 2009.

Suggested MOOC Courses

1. NPTEL Course: Business Analytics for Management Decision by Prof. Rudra P Pradahan-IIT Kharagpur
2. Simplilearn Course: Business Analytics for Strategic Decision Making by Prof. Ramesh Anbanandam, Prof. Amit Upadhyay and Prof. Tarun Sharma-IIT Roorkee

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	

1.1	Introduction to Business Analytics-Evolution, Scope, Models.	1
1.2	Data Visualization, Statistical Methods for Summarizing Data	1
1.3	Measures of Central Tendency, Measures of Dispersion	1
1.4	Measures of Shape, Measures of Association	1
1.5	Probability Distributions and Data Modeling- Discrete and Continuous Probability Distributions - Lecture 1	1
1.6	Probability Distributions and Data Modeling- Discrete and Continuous Probability Distributions - Lecture 2	1
1.7	Random Sampling from Probability Distributions- Lecture 1	1
1.8	Random Sampling from Probability Distributions- Lecture 2	1
1.9	Data Modeling and Distribution Fitting.	1
MODULE II		
2.1	Sampling and Estimation -Statistical Sampling, Estimating Population Parameters	1
2.2	Sampling Distributions, Confidence Intervals, Prediction Intervals	1
2.3	Statistical Inference- Hypothesis Testing, Confidence Intervals	1
2.4	One sample and Two sample tests	1
2.5	z-test, t-test, Chi-square test - Lecture 1	1
2.6	z-test, t-test, Chi-square test - Lecture 2	1
2.7	Analysis of Variance: Theory and computations of ANOVA	1
2.8	ANOVA table, Two-way ANOVA	1
2.9	Blocking designs, Design of Experiments	1
MODULE III		
3.1	Predictive Analytics- Modeling Relationships and Trends in Data-Lecture 1	1
3.2	Predictive Analytics- Modeling Relationships and Trends in Data-Lecture 2	1

3.3	Simple Regression and Correlation: Introduction	1
3.4	Estimation using the regression line	1
3.5	Correlation Analysis	1
3.6	Multiple Regression: The k-variable multiple regression model – Lecture 1	1
3.7	Multiple Regression: The k-variable multiple regression model – Lecture 2	1
3.8	The F-test of a Multiple Regression model.	1
	MODULE IV	
4.1	Forecasting Techniques- Qualitative and Judgmental Forecasting	1
4.2	Forecasting Models for Stationary Time Series	1
4.3	Forecasting Models for Time Series with a Linear Trend	1
4.4	Forecasting Time Series with Seasonality	1
4.5	Introduction to Data Mining	1
4.6	Monte Carlo Simulation and Risk Analysis – Lecture 1	1
4.7	Monte Carlo Simulation and Risk Analysis – Lecture 2	1
	MODULE V	
5.1	Prescriptive Analytics - Linear Programming Problem-Formulation	1
5.2	Graphical solutions, Simplex method	1
5.3	Revised Simplex method and Sensitivity Analysis	1
5.4	Transportation Problem-Formulation and solution	1
5.5	Assignment Problem- Formulation and solution	1
5.6	Deterministic Dynamic Programming problem-Bellman’s principle of optimality.	1
5.7	Computational procedure for Shortest Route problem	1

5.8	Reliability Problem	1
5.9	Equipment Replacement Problem	1
5.10	Integer Programming Problem- Formulation	1
5.11	Branch and Bound algorithm	1
5.12	Cutting Plane Algorithm	1

CO Assessment Questions

1

1. Explain the various scales and their importance in Analytics.
2. Explain how Data Visualization is important in Descriptive Analytics with suitable example.
3. A fitness center collects data on its members, including age, gender, membership type (e.g. monthly, annual), frequency of visits per week, duration of each visit, and number of classes attended per month. What are some appropriate charts or visualizations that could be used to analyze this data? Justify your selection of charts.

2

1. Probability Distributions and Data Modeling

r	1	2	3	4	5
P(r=r)	0.2	a	B	0.25	0.15

i. Given that E(R)= 2.85, find a and b.
ii. Find P(R>2).

2. The magazine Forbes publishes annually a list of the world's wealthiest individuals. For 2007, the net worth of the 20 richest individuals, in billions of dollars, in no particular order, is as follows: 33, 26, 24, 21, 19, 20, 18, 18, 52, 56, 27, 22, 18, 49, 22, 20, 23, 32, 20, 18. Find the 50th and 80th percentiles of this set of the world's top 20 net worths.
3. What are the key principles underlying the theory and computations of Analysis of Variance (AVOVA)?

3

1. A study was reported about the effects of the number of hours worked, on average, and the average hourly income on unemployment in different countries. Suppose that the regression analysis resulted in SSE 8,650, SSR 988, and the sample size was 82 observations. Is there a regression relationship between the unemployment rate and at least one of the explanatory variables?

2. In a multiple regression model with 12 independent variables, what are the degrees of freedom for error? Explain.
3. Consider the following data, obtain the two regression equations.

X	6	2	10	4	8
Y	9	11	5	8	7

Also, estimate Y when X is equal to 20.

4

1. We are using Winter's method and monthly data to forecast the GDP. (All numbers are in billions of dollars.) At the end of January 2005, L_t=600 and T_t=5. We are given the following seasonalities: January, 0.80; February, 0.85; December, 1.2. During February 2005, the GDP is at a level of 630. At the end of February what is the forecast for the December 2005 level of the GDP? Use $\alpha=$□$=\gamma$ 0.5.
2. How can market basket analysis using data mining techniques uncover associations among products in our retail store, and how might this knowledge be leveraged to optimize product placement or promotional strategies for increased sales and customer satisfaction?

5

1. A manufacturer employs three inputs: man hours, machine hours and cloth material to manufacture two types of dresses. Type A dress fetches him a profit of Rs. 160 per piece, while type B, that of Rs. 180 per piece. The manufacturer has enough man hours to manufacture 50 pieces of type A or 20 pieces of type B dresses per day while the machine hours possess suffice only for 36 pieces of type A or for 24 pieces for type B dresses. Cloth material available per day is limited but sufficient enough for 30 pieces of either type of dress. Formulate the linear programming problem.

2. Consider a linear programming problem with the following constraints:

$$2x_1 + 3x_2 \leq 10$$
$$4x_1 - 2x_2 \geq 5$$
$$2x_1 + 3x_2 \leq 10$$

The objective function to be maximized is $Z=5x_1+2x_2$

   1. Apply revised simplex method to find the optimal solution.
   2. Perform sensitivity analysis on the solution obtained. Explain how changes in coefficients or constraints or affect the optimal solution and the objective function value.

6.

1. How does the revised simplex method contribute to linear programming,

	and what role does sensitivity analysis play in optimizing solutions within this framework? 2. How would you apply Bellman's Principle of Optimality to solve a real-world problem involving sequential decision-making, and what cognitive processes would be involved in implementing this principle effectively?

MINOR- S5

24CSM509	Concepts in Machine Learning	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	0	4	2024

Preamble: This course enables the learners to understand the fundamental concepts and algorithms in machine learning. The course covers the standard and most popular supervised learning algorithms such as linear regression, logistic regression, decision trees, Bayesian learning & the naive Bayes algorithm, support vector machines & kernels, basic clustering algorithms and dimensionality reduction methods. This course helps the students to provide machine learning based solutions to real world problems.

Prerequisite: Familiarity with basics in linear algebra, probability and Python programming.

Course Outcomes: After the completion of the course the student will be able to

CO1	Illustrate Machine Learning concepts and basic parameter estimation methods. **(Apply Level)**
CO2	Demonstrate supervised learning concepts (regression, linear classification). **(Apply Level)**
CO3	Illustrate the concepts of Multilayer neural network and Support Vector Machine. **(Apply Level)**
CO4	Describe unsupervised learning concepts and dimensionality reduction techniques. **(Apply Level)**
CO5	Solve real life problems using appropriate machine learning models and evaluate the performance measures. **(Apply Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3					3				3
CO2	3	3	3					3				3
CO3	3	3	3					3				3
CO4	3	3	3					3				3
CO5	3	3	3	1				3				3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✔	✔	✔	✔
Understand	✔	✔	✔	✔
Apply	✔	✔	✔	✔
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
4-0-0-0	5	15	10	10	40

Total Mark distribution

Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

<u>End Semester Examination [ESE]: Pattern</u>

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Overview of machine learning (7 Hrs)

Machine learning paradigms-supervised, semi-supervised, unsupervised, reinforcement learning. Basics of parameter estimation - maximum likelihood estimation(MLE) and maximum a posteriori estimation(MAP). Introduction to Bayesian formulation.

MODULE II: Supervised Learning (9 Hrs)

Regression - Linear regression with one variable, Linear regression with multiple variables, solution using gradient descent algorithm and matrix method, basic idea of overfitting in regression. Linear Methods for Classification- Logistic regression, Perceptron, Naive Bayes, Decision tree algorithm ID3.

MODULE III: Neural Networks (NN) and Support Vector Machines (SVM) (11 Hrs)

NN - Multilayer feed forward network, Activation functions (Sigmoid, ReLU, Tanh), Backpropagation algorithm. SVM - Introduction, Maximum Margin Classification, Mathematics behind Maximum Margin Classification, Maximum Margin linear separators, soft margin SVM classifier, non-linear SVM, Kernels for learning non-linear functions, polynomial kernel, Radial Basis Function(RBF).

MODULE IV: Unsupervised Learning (10 Hrs)

Clustering - Similarity measures, Hierarchical Agglomerative Clustering, K-means partitional clustering, Expectation maximization (EM) for soft clustering. Dimensionality reduction – Principal Component Analysis, factor Analysis, Multidimensional scaling, Linear Discriminant Analysis.

MODULE V: Classification Assessment (8 Hrs)

Classification Performance measures - Precision, Recall, Accuracy, F-Measure, Receiver Operating Characteristic Curve(ROC), Area Under Curve(AUC. Bootstrapping, Cross Validation, Ensemble methods, Bias-Variance decomposition. Case Study: Develop a classifier for face detection.

Text books

1. Ethem Alpaydin, Introduction to Machine Learning, 2nd edition, MIT Press 2010.
2. Mohammed J. Zaki and Wagner Meira, Data Mining and Analysis: Fundamental Concepts and Algorithms, Cambridge University Press, First South Asia edition, 2016.

Reference books

1. Christopher Bishop. Neural Networks for Pattern Recognition, Oxford University Press, 1995.
2. Kevin P. Murphy. Machine Learning: A Probabilistic Perspective, MIT Press 2012.
3. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements Of Statistical Learning, Second edition Springer 2007.
4. P. Langley, Elements of Machine Learning, Morgan Kaufmann, 1995.
5. Davy Cielen, Arno DB Meysman and Mohamed Ali. Introducing Data Science: Big Data, Machine Learning, and More, Using Python Tools, Dreamtech Press 2016.

Suggested MOOC Courses 1. NPTEL Course: Introduction To Machine Learning by Prof. Sudeshna Sarkar, IIT Kharagpur. 2. NPTEL Course: Introduction To Machine Learning by Prof. Balaraman Ravindran, IIT Madras.		
COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
MODULE 1		
1.1	Supervised, semi-supervised, unsupervised learning, reinforcement learning	1
1.2	Maximum likelihood estimation(MLE)	1
1.3	Maximum likelihood estimation (MLE)- example	1
1.4	Maximum a posteriori estimation(MAP)	1
1.5	Maximum a posteriori estimation(MAP)-example	1
1.6	Bayesian formulation	1
1.7	Bayesian formulation -example	1
MODULE II		
2.1	Linear regression with one variable	1
2.2	Multiple variables, Solution using gradient descent algorithm	1
2.3	Solution using matrix method (No derivation required)	1
2.4	Overfitting in regression, Lasso and Ridge regularization	1
2.5	Logistic regression	1
2.6	Perceptron	1
2.7	Naive Bayes	1
2.8	Decision trees	1
2.9	Decision trees- ID3 algorithm	1
MODULE III		
3.1	Multilayer Feed forward Network, Activation Functions (Sigmoid, ReLU, Tanh)	1
3.2	Back Propagation Algorithm	1
3.3	Illustrative Example for Back Propagation	1
3.4	Introduction, Maximum Margin Hyperplane,	1
3.5	Mathematics behind Maximum Margin Classification	1
3.6	Formulation of maximum margin hyperplane and solution	1

3.7	Soft margin SVM	1
3.8	Solution of Soft margin SVM	1
3.9	Non-linear SVM	1
3.10	Kernels for learning non-linear functions and properties of kernel functions.	1
3.11	Example Kernels functions- Linear, RBF, Polynomial.	1
	MODULE IV	
4.1	Similarity measures- Minkowski distance measures(Manhattan, Euclidean), Cosine Similarity	1
4.2	Clustering - Hierarchical Clustering	1
4.3	K-means partitional clustering	1
4.4	Expectation maximization (EM) for soft clustering - Lecture I	1
4.5	Expectation maximization (EM) for soft clustering - Lecture II	1
4.6	Dimensionality reduction – Principal Component Analysis - Lecture I	1
4.7	Dimensionality reduction – Principal Component Analysis - Lecture II	1
4.8	Factor Analysis	1
4.9	Multidimensional scaling	1
4.10	Linear Discriminant Analysis	1
	MODULE V	
5.1	Performance measures - Precision, Recall, Accuracy, F-Measure, ROC, AUC.	1
5.2	Boot strapping, Cross validation	1
5.3	Ensemble methods- bagging	1
5.4	Ensemble methods- boosting	1
5.5	Bias-Variance decomposition - Lecture I	1
5.6	Bias-Variance decomposition - Lecture II	1
5.7	Face detection - Lecture I	1
5.8	Face detection - Lecture II	1

CO Assessment Questions	
1	1. A coin is tossed 100 times and lands heads 62 times. What is the maximum likelihood estimate for θ, the probability of heads. 2. Suppose data x_1 ..., x_n are independent and identically distributed drawn from an exponential distribution $exp(\lambda)$. Find the maximum likelihood for λ. 3. Suppose x_1 ..., x_n are independent and identically distributed(iid) samples from a distribution with density. Find the maximum likelihood estimate(MLE) for θ. $$f(\theta) = \{\frac{\theta x^{\theta-1}}{3^{\theta}\, 0\,,\ otherwise},\ 0 \le x \le 3$$
2	1. Explain the difference between (batch) gradient descent and stochastic gradient descent. Give an example of when you might prefer one over the other. 2. Suppose that you are asked to perform linear regression to learn the function that outputs y, given the D-dimensional input x. You are given N independent data points, and that all the D attributes are linearly independent. Assuming that D is around 100, would you prefer the closed form solution or gradient descent to estimate the regressor? 3. Suppose you have a three class problem where class label $y \in 0, 1, 2$ and each training example X has 3 binary attributes $X1, X2, X3 \in 0, 1$. How many parameters (probability distribution) do you need to know to classify an example using the Naive Bayes classifier?
3	1. What are support vectors and list any three properties of the support vector classifier solution? 2. Why do you use kernels to model a projection from attributes into a feature space, instead of simply projecting the dataset directly? 3. Describe how Support Vector Machines can be extended to make use of kernels. Illustrate with reference to the Gaussian kernel $$K(x, y) = e^{-z}, where\ z = (x - y)^2.$$

4

1. Describe cluster analysis? Identify two applications where cluster analysis can be applied to multimedia data?
2. Given two objects represented by the tuples (22, 1, 42, 10) and (20, 0, 36, 8):
   a. Compute the Euclidean distance between the two objects.
   b. Compute the Manhattan distance between the two objects.
3. Use PCA to reduce the dimension from 2 to 1 for the design matrix X.
$$[6\ -4\ -3\quad 5\ -2\quad 6\,7\ -3\,]$$
4. What is Principal Component Analysis (PCA)? Which eigen value indicates the direction of largest variance?
5. Suppose that one runs a principal component analysis on a data set and tells that the percentage of variance explained by the first 3 components is 80%. How is this percentage of variance explained?

5

1. Suppose that you are contacted by a food processing company that wants you to develop a classifier that detects whether a rat is present in an image. You collect a large dataset of images by crawling the web, and have annotators determine which images contain rats. This set of images can then be used as the training set for your classifier.
   a) Suggest a machine learning method to use for this classification task and evaluate its performance.
   b) After you have delivered your solution to the company, they get back to you and complain that when they evaluate on a new test set, they get precision and recall values that are much lower than what you reported to them. Explain what might have gone wrong and propose remedial measures .
2. A real estate firm would like to build a system that predicts the sale prices of a house. They create a spreadsheet containing information about 1,500 house sales in the Kochi area. In addition to the price, there are 10 features describing the house, such as number of bedrooms, total indoor area, lot area, a swimming pool, location, etc. Explain how you would implement a machine learning model that would solve this prediction task. Give all steps you would carry out when developing it. Explain why the model you built is probably useless in the long run.
3. For a classifier, the confusion matrix is given by:

	+	-
+	9	9
-	1	5

What is the precision, recall and accuracy of that classifier?

24CSM510	Software Testing	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	0	4	2024

Preamble: This course enables students to adapt to the culture of an organization and foster behaviors conducive to the survival and effectiveness of the organization. This course covers social cognitive theory in terms of both environmental, contextual events and internal cognitive factors, as well as the dynamics and outcomes of the organizational behavior. It helps the learners to apply the principles of organizational behavior to increase the productivity and profitability of the organization to which they belong.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	List a range of different software testing techniques and be able to apply specific unit testing method to the projects using Junit. **(Cognitive Knowledge Level: Understand)**
CO2	Explain mutation testing method for a given piece of code to identify hidden defects that can't be detected using other testing methods. **(Cognitive Knowledge Level: Understand)**
CO3	Explain graph coverage criteria in terms of control flow graph and data flow graph for a given program**. (Understand level)**
CO4	Demonstrate the importance of black-box approaches in terms of domain and functional testing. **(Apply level)**
CO5	Illustrate the use of PEX tool with symbolic execution. **(Apply level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3			1						3
CO2	3	3	3	3	3	1				3		3
CO3	3	3	3			1				3		1
CO4	3	3	3	1		1						1
CO5	3	3	3	1	3	1				3		1

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
4-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULEI :<< :<<Introduction to Software Testing>>

Some Popular Errors – Ariane 5, Therac 25, Intel Pentium Bug. What is Software testing? Why should it be tested? Software Quality, Role of Testing. Testing Process -Level 0 thinking, Level 1 thinking, Level 2 thinking, Level 3 thinking, Level 4 thinking. Software Testing Terminologies - Verification, Validation and Testing, Faults, Error and Bug, Test cases, Coverage Criteria. Types of Testing- Unit testing, integration testing, System testing, Acceptance testing, Beta testing, Functional testing, Stress testing, Performance testing, Usability testing and Regression testing. Testing Methods - Black Box testing, White Box testing, Grey Box testing.

MODULEII :<< Unit Testing >>

Concept of Unit testing. Static Unit testing. Dynamic Unit testing - Control Flow testing, Data Flow testing, Domain testing, Functional Program testing. Mutation testing - Mutation and Mutants, Mutation operators, Mutation score. Junit - Framework for Unit testing. Case Study - Mutation testing using Junit and Muclipse.

MODULEIII :<< Unit Testing - White Box Approaches >>

Overview of Graph Coverage Criteria. Structural Graph Coverage Criteria - Node/vertex coverage, Edge coverage, Edge pair coverage, Path coverage, Complete path coverage, Prime path coverage, Complete round trip coverage, Simple round-trip coverage. Data Flow Criteria - du paths, du pairs. Subsumption Relationships among Graph Coverage Criteria. Graph Coverage for Source Code - Control flow graphs for code, CFG: If statement, CFG: If statement with return, CFG: Switch-case, CFG: Loops, CFG: Exceptions (try-catch). Example program – Statistics. Graph Coverage for Design Elements - Call graphs and classes, Class inheritance testing: Coverage criteria, Coverage criteria on inheritance graph, Data flow at the design level, Inter-procedural pairs, Coupling du-pairs example. Example - Quadratic Root. Case Study - Graph Based testing using JUnit Framework.

MODULEIV :<< Unit Testing - Black Box Approaches>>

Domain Testing / Input Space Partitioning - Partitions of a set. Input domain modelling - Interface-based approach, Functionality-based approach. Identifying values. Multiple partitions of the input domain - All Combinations Coverage (ACoC), Each Choice Coverage (ECC), Pair-wise Coverage, T-wise Coverage, Base Choice Coverage, Multiple Base Choices Coverage. TriTyp example. Functional Testing -Functional Testing Concepts of Howden. Functional testing - Important Steps. Types of Functional testing - Equivalence Class Partitioning, Boundary Value Analysis, Decision Tables, Random Testing. Case Study - Black Box testing approaches using JUnit.

MODULEV :<< (Grey Box Testing Approaches)>>

Introduction to Grey Box testing - Why Grey Box testing, Gray Box Methodology, Advantages and Disadvantages. Techniques of Grey Box Testing - Matrix Testing, Regression Testing, Orthogonal Array Testing or OAT, Pattern Testing. An Introduction to PEX - Parameterized Unit Testing, The Testing Problem. Symbolic Execution – Example, Symbolic execution tree. PEX application Case Study – PEX.

Text books

1. Paul Ammann and Jeff Offutt, Introduction to Software Testing.
2. KshirasagarNaik and Priyadarshi Tripathy, Software Testing and Quality Assurance: Theory and Practice

Reference books

1. King, James C, “Symbolic Execution and Program Testing”, Association for Computing Machinery, July 1976.

Suggested MOOC Courses

1. Software Testing, IIT Kharagpur-Prof. Rajib Mall

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
	MODULE 1	
1.1	Some Popular Errors– Ariane 5, Therac 25, Intel Pentium Bug.	1
1.2	What is Software testing? Why should it be tested? Software Quality, Role of Testing.	1
1.3	Testing Process - Level 0 thinking, Level 1 thinking, Level 2 thinking, Level 3 thinking, Level 4 thinking.	1
1.4	Software Testing Terminologies- Verification, Validation and Testing, Faults, Error and Bug, Test cases, Coverage Criteria.	1
1.5	Types of Testing- Unit testing, integration testing, System testing, Acceptance testing, Beta testing	1
1.6	Functional testing, Stress testing, Performance testing, Usability testing and Regression testing.	1
1.7	Testing Methods - Black Box testing, White Box testing, Grey Box testing.	1
	MODULE II	
2.1	Concept of Unit testing, Static Unit Testing	1
2.2	Dynamic Unit testing - Control Flow testing, Data Flow testing, Domain testing, Functional Program testing.	1
2.3	Mutation testing - Mutation and Mutants, Mutation operators, Mutation score.	1
2.4	Junit - Framework for Unit testing.	1
2.5	Case Study - Mutation testing using Junit	1
2.6	Case Study - Mutation testing using Muclipse	1
	MODULE III	
3.1	Structural Graph Coverage Criteria - Node/vertex coverage, Edge coverage, Edge pair coverage, Path coverage	1
3.2	Complete path coverage, Prime path coverage, Complete round trip coverage, Simple round-trip coverage.	1
3.3	Data Flow Criteria - du paths, du pairs	1

3.4	Subsumption Relationships among Graph Coverage Criteria	1
3.5	Graph Coverage for Source Code – Control Flow Graphs (CFG) for code, CFG: If statement, CFG: If statement with return, CFG: Switch-case, CFG: Loops, CFG: Exceptions (try-catch). Example program - Statistics	1
3.6	Graph Coverage for Design Elements – Structural graph coverage and data flow graph coverage for design elements.	1
3.7	Case Study - Graph Based testing using JUnit Framework. (Lecture 1)	1
3.8	Case Study - Graph Based testing using JUnit Framework. (Lecture 2)	
MODULE IV		
4.1	Domain Testing / Input Space Partitioning - Partitions of a set.	1
4.2	Input domain modelling - Interface-based approach, Functionality-based approach.	1
4.3	Multiple partitions of the input domain - All Combinations Coverage (ACoC), Each Choice Coverage (ECC), Pair-wise Coverage, T-wise Coverage, Base Choice Coverage, Multiple Base Choices Coverage.	1
4.4	Functional Testing - Functional Testing Concepts of Howden. Important Steps.	1
4.5	Types of Functional testing - Equivalence Class Partitioning, Boundary Value Analysis	1
4.6	Decision Tables, Random Testing.	1
4.7	Case Study - Black Box testing approaches using JUnit.	
MODULE V		
5.1	Introduction to Grey Box testing - Why Grey Box testing, Gray Box Methodology, Advantages and Disadvantages.	1
5.2	Techniques of Grey Box Testing - Matrix Testing, Regression Testing, Orthogonal Array Testing or OAT, Pattern Testing.	1
5.3	An Introduction to Pex - Parameterized Unit Testing, The Testing Problem.	1
5.4	Symbolic Execution – Example, Symbolic execution tree.	1
5.5	Case Study – PEX (Lecture 1)	1
5.6	Case Study – PEX (Lecture 2)	1
5.7	Case Study – PEX (Lecture 3)	1

<table>
<tr><th colspan="2">CO Assessment Questions</th></tr>
<tr><td>1</td><td>1. Apply Explain the following types of testing methods with examples.
(i) Black-box testing.
(ii) White-box testing.
(iii) Grey-box testing.</td></tr>
<tr><td>2</td><td>1. Define 12 mutants for the following method power() using effective mutation operators. Try to use each mutation operator at least once. Approximately, how many mutants do you think there would be, if all mutants for power() were created?
{
//*************************************
// Raises Left to the power of Right
// precondition : Right >= 0
// postcondition: Returns Left**Right
//*************************************
intrslt;
rslt = Left;
if (Right == 0)
{
rslt = 1;
}
else
{
for (int i = 2; i <= Right; i++)
rslt = rslt * Left;
}
return (rslt);
}</td></tr>
<tr><td>3</td><td>Draw the control flow graph and data flow graph of given piece of code.
public static double ReturnAverage(int value[],int AS, int MIN, int MAX){
/*
Function: ReturnAverageComputes the averageof all those numbers in the input array in
the positive range [MIN, MAX]. The maximum size of the array is AS. But, the
array size
could be smaller than AS in which case the end of input is represented by -999.
*/
int i, ti, tv, sum;</td></tr>
</table>

	double av;
	i = 0; ti = 0; tv = 0; sum = 0;
	while (ti< AS && value[i] != -999) {
	ti++;
	if (value[i] >= MIN && value[i] <= MAX) {
	tv++;
	sum = sum + value[i];
	}
	i++;
	if (tv> 0)
	av = (double)sum/tv;
	else
	av = (double) -999;
	return (av);

4	1. 1. Input domain modelling. 2. 2. All Combinations Coverage (ACoC) 3. 3. Each Choice Coverage (ECC) 4. 4. Pair-wise Coverage 5. 5. T-wise Coverage 6. 6. Base Choice Coverage 7. 7. Multiple Base Choices Coverage.

5	1. Draw the symbolic execution tree for the following program code and explain
	2. the symbolic execution of testme (α1, α2).
	3. int twice (int v) {
	4. return 2 ∗ v;
	5. }
	6. void testme (int x, int y) {
	7. z = twice (y);
	8. if (z == x){
	9. if (x > y + 10)
	10. ERROR;
	11. }
	12. }
	13. int main() {
	14. x = sym input();
	15. y = sym input();
	16. testme (x , y);
	17. return(0);

SIXTH SEMESTER													
Sl No	**Slot**	**Code**	**Category**	**Title**	**L**	**T**	**P**	**J**	**S**	**No. of Hours**	**No. of Credits**	**Total Marks**	
												CIA	**ESE**
1	A	24CST601	PCC	Theory of Computation	2	1	0	0	2	3	3	40	60
2	B	24CSP602	PCC	Introductory Cyber Security	2	0	2	0	4	4	3	60	40
3	C	24CSE6X4	PEC	Professional Elective I	3	0	0	0	3	3	3	40	60
4	D	24CSE6X5/ 24CSI6X5	PEC/ IEC	Professional Elective-2/ Industry Elective	3	0	0	0	3	3	3	40	60
5	F	24CSS606	SR	Seminar	0	0	4	0	4	4	2	100	
6	U	24SPJ607	MC	Socially Relevant Project	0	0	0	2	1	2	1	100	
7	I	24EST608	ESC	Digital Image Processing	2	0	0	0	2	2	2	100	
8	J	24HUT609	HSMC	Entrepreneurships and startups	2	0	0	0	2	2	2	100	
9	M/ H/R	24CSM6XX /24CSH6XX		MINOR/HONOURS/ REMEDIAL	4	0	0	0			4/ 4/ 0	40	60
TOTAL									**21**	**23**	**19**		

Professional Electives (PE)

Professional Elective 1

Slot	Course Code	Course Name
C	24CSE614	Advanced Machine Learning
	24CSE624	Wireless Sensor Networks
	24CSE634	Agile Methodologies*
	24CSE644	Advanced Algorithms
	24CSE654	Data Mining
	24CSE664	Distributed Computing
	24CSE674	Advanced Data Base System*
	24CSE684	Object Oriented System Design*
	24CSE694	Information Security
	24CSE6104	Mobile And Wireless Security
	24CSE6114	Advanced Computer Architecture
	24CSE6124	Data Storage Technologies And Networks
	24CSE6134	Medical Imaging
	24CSE6144	Information Retrieval
	24CSE6154	Fuzzy Logic And Its Application
	24CSE6164	Computer Graphics

Professional Elective 2/Industry Elective

Slot	Course Code	Course Name
D	24CSE615	Natural Language Processing
	24CSE625	Mobile Computing
	24CSE635	Parallel Algorithms
	24CSE645	Bioinformatics
	24CSE655	Principles of Programming Languages
	24CSE665	Secure Coding
	24CSE675	Social Networking And Security
	24CSE685	High Performance Computing
	24CSE695	IoT and Embedded Systems
	24CSE6105	Neural Networks And Deep Learning
	24CSE6115	Neural Networks And Fuzzy Logic
	24CSE6125	Internet of Things
	24CSE6135	Remote Sensing And Applications
	24CSE6145	Medical Imaging
	24CSI615	Software Testing*
	24CSI625	Blockchain Technology*

MINOR BUCKETS			
BUCKET 1		BUCKET 2	
Specialization - Machine Learning		Specialization - Software Engineering*	
Course Code	Course Name	Course Code	Course Name
S6	24CSM609	Concepts in Deep Learning	24CSM610

HONORS BUCKETS						
SEMESTER	BUCKET 1		BUCKET 2		BUCKET 3	
	Specialization - Data Structures and Algorithms		Specialization - Systems Engineering		Specialization - Data Science	
	Course Code	Course Name	Course Code	Course Name	Course Code	Course Name
S6	24CSH609	Parallel Algorithms	24CSH610	Advanced Database Management Systems	24CSH611	Social Network Analytics

24CST601	Theory of Computation	L	T	P	J	S	C	Year of Introduction
		2	1	0	0	2	3	2024

Preamble: In this course, students will gain a comprehensive understanding of formal languages, exploring the Chomsky classification, including in-depth discussions on grammar and automata applicable to regular, context-free, context-sensitive, and unrestricted languages. The curriculum extends to cover pivotal concepts such as decidability, Complexity classes and related problems. Practical applications of this course span various domains, including but not limited to compiler design, complexity theory, and software testing.

Prerequisite: Discrete Mathematics

Course Outcomes: After the completion of the course the student will be able to

CO1	Define and describe formal models of computation, such as finite automata, pushdown automata, and Turing machines and identify the languages according to Chomsky hierarchy. [**Cognitive knowledge level: Understand**]
CO2	Explain a formal representation of a given regular language as a finite state automaton, regular grammar, regular expression **[Cognitive knowledge level: Understand]**
CO3	Design a Pushdown Automaton and a Context-Free Grammar for a given context-free language. **[Cognitive knowledge level: Apply]**
CO4	Design Turing machines as language acceptors or transducers. [**Cognitive knowledge level: Apply]**
CO5	Explain the notion of decidability, reducibility, and complexity classes of real world problems**. [Cognitive knowledge level: Understand]**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2								2
CO2	2	3	3	1								1
CO3	2	3	3	1								1
CO4	2	3	3	3		2						2
CO5	3	3	3	3		3						3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test 1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate			✓	

Create			✓	

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
2-1-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Regular languages

Introduction to Regular Languages, Finite state automata - Types (DFA, NFA, Epsilon-NFA), properties, Extended Transition functions.
Designing DFA, NFA and Epsilon-NFA. Equivalence and conversions: DFA and NFA, NFA and Epsilon-NFA,
Myhill-Nerode Theorem and applications, Minimization of DFA states.

MODULE II : Regular Expressions
Regular Languages- Closure Properties of Regular Languages, Necessary conditions for regular languages-Pumping Lemma, Homomorphism. Regular Grammar (RG), Regular Expressions (REs), Equivalence and conversions: REs and Epsilon-NFA. Context-Free Languages (CFL)-Closure Properties of CFL. Necessary conditions for Context Free Languages-Pumping Lemma
MODULE III : Context free languages
Context-Free Grammar (CFG), Derivation trees, Ambiguity, Normal forms for CFGs: Chomsky Normal Form and Greibach normal forms (Definitions only). Nondeterministic Pushdown Automata (PDA), Deterministic Pushdown Automata (DPDA), Designing NPDAs and DPDAs. Turing Machine (TM) – Basics and formal definition, TMs as language acceptors, Encoding of Turing Machine
MODULE IV : Turing Machine and decidability
Recursively Enumerable Languages (REL), Recursive languages (RL), Properties of REL and RL. Church-Turing thesis, Notion of undecidable problems. Universal language and universal TM. Notion of reduction. Halting Problem and undecidable problems of TMs, Rice's theorem.
MODULE V : Complexity classes and related problems
Time and space measures of complexity, complexity classes P, NP, NP-complete problems. Cook-Levin theorem: NP-completeness of propositional satisfiability, other variants of satisfiability. NP-complete problems from graphs-vertex cover, Hamiltonian cycle Chomsky Hierarchy
Text books 1. Michael Sipser, Introduction to Theory of Computation, Cengage Publishers, 2013. 2. John E Hopcroft, Rajeev Motwani and Jeffrey D Ullman, Introduction to Automata 3. John C Martin, Introduction to Languages and the Theory of Computation, TMH, 2007 4. Theory, Languages, and Computation, 3/e, Pearson Education, 2007
Reference books 1. Dexter C. Kozen, Automata and Computability, Springer1999.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Introduction to Regular Languages Introduction to Finite state automata types-DFA, NFA, Epsilon- NFA	2

1.2	DFA properties, Transition functions and Design	1
1.3	NFA and Epsilon-NFA properties, Transition functions and Design	2
1.4	Equivalence/Conversion of DFA and NFA, NFA and Epsilon-NFA	2
1.5	Myhill-Nerode Theorem and applications and Minimization of DFA states	1
MODULE II		
2.1	Closure Properties of Regular Languages.	1
2.2	Necessary conditions for regular languages-Pumping Lemma	1
2.4	Introduction to Regular Grammar (RG)- Writing RG	1
2.5	Introduction to Regular Expressions (RE)	1
2.6	Equivalence of REs and Epsilon-NFA	1
2.7	Context-Free Languages (CFL)-Closure Properties of CFL	1
2.8	Necessary conditions for Context Free Languages-Pumping Lemma	1
MODULE III		
3.1	Context-Free Grammar (CFG)- Derivation trees, Designing	1
3.2	Ambiguity- Examples, Normal forms for CFGs: Chomsky Normal Form and Greibatch Normal forms-Definition	1
3.3	PDA - Nondeterministic Pushdown Automata (NPDA) and Deterministic Pushdown Automata (DPDA) Definition and designing	2
3.4	Turing Machine (TM) – Basics and formal definition	1
3.5	TMs as language acceptors- designs	1
3.6	Encoding of Turing Machine	1
MODULE IV		
4.1	Recursively Enumerable Languages (REL), Recursive languages (RL), Properties of REL and RL.	1
4.2	Church-Turing thesis, Notion of undecidable problems.	1
4.3	Universal language and universal TM.	1

4.4	Notion of reduction.	1
4.5	Halting Problem and undecidable problems of TMs.	2
4.6	Rice's theorem.	1
	MODULE V	
5.1	Time and space measures of complexity, complexity classes P, NP, NP-complete problems.	2
5.2	Cook-Levin theorem	1
5.3	NP-completeness of propositional satisfiability, other variants of satisfiability.	1
5.4	NP-complete problems from graphs-vertex cover, Hamiltonian cycle	2
5.5	Chomsky Hierarchy	1

	CO Assessment Questions
1	1. Identify the class of the following languages in Chomsky Hierarchy: $L1 = \{a^p \mid p \text{ is a prime number}\}$ $L2 = \{a^n \mid$ n $is\ a$ perfect square$\}$ $\{x \in \{0,1\}^* \mid x \text{ is the binary representation of a decimal number which is a multiple of } 5\}$ $L3 = \{ a^n b^n c^n \mid n \geq 0\}$ $L4 = \{ a^m b^n c^{m+n} \mid m > 0,\ n \geq 0\}$ $L5 = \{M\#x \mid M \text{halts on } x\}$. Here, M is a binary encoding of a Turing Machine and x is a binary input to the Turing Machine.
2	1. Design a DFA for the language $L = \{axb \mid x \in \{a, b\}^*\}$ 2. Write a Regular Expression for the language: $L = \{x \in \{a, b\}^* \mid \text{third last symbol in } x \text{ is } b\}$ 3. Write a Regular Grammar for the language:$L = \{x \in \{0,1\}^* \mid \text{there are no consecutive zeros in } x\}$
3	1. Design a PDA for the language$L = \{ww^R \mid w \in \{a, b\}^*\}$. Here, the notation w^R represents the reverse of the string w. 2. Write a Context-Free Grammar for the language $L = \{a^n b^{2n} \mid n \geq 0\}$.
4	1. Design a Turing Machine for the language $L = \{a^n b^n c^n \mid n \geq 0\}$ 2. Design a Turing Machine to compute the square of a natural number. Assume that the input is provided in unary representation
5	1 Argue that it is undecidable to check whether a Turing Machine M enters a given state during the computation of a given input x.

	2 How is propositional satisfiability related to NP-completeness according to the Cook-Levin theorem? 3 Explore other variants of satisfiability and their relevance to computational complexity. 4 Discuss NP-complete problems related to graphs, focusing on vertex cover and Hamiltonian cycle.

24CSP602	INTRODUCTORY CYBER SECURITY	L	T	P	J	S	C	Year of Introduction
		2	0	2	0	4	3	2024

Preamble: This course helps the learners to familiarize mathematical foundations for cyber security, explore various algorithms to offer different security services and different attacks in cyber security with their countermeasures. It covers classical encryption techniques, mathematical foundations, symmetric and public key crypto-system, key distribution techniques, authentication functions, program security, OS security and Database security. The concepts covered in this course enable the learners in effective use of cryptographic algorithms and appropriate countermeasures for securing real life applications.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Identify the security services provided against different types of security attacks. **(Understand Level)**
CO2	Illustrate classical encryption techniques for cyber security. **(Understand Level)**
CO3	Illustrate the fundamental mathematical properties and operations used in security algorithms. **(Apply Level)**
CO4	Illustrate symmetric/asymmetric key cryptosystems for secure communication. **(Apply Level)**
CO5	Explain message authentication and key management methods for a secure communication scenario. **(Understand Level)**
CO6	Identify the requirements and fundamentals of program and system security. (**Apply Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2										3
CO2	3	2	1									3
CO3	3	2	2		2							3
CO4	3	2	2		2							3
CO5	3	2	2		2							3
CO6	3	2	2		3							3

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓		✓	✓
Understand	✓		✓	✓
Apply	✓		✓	✓
Analyse			✓	
Evaluate				
Create				

Assessment Pattern for Lab component

Bloom's Category	Continuous Assessment Tools	
	Class work	Test1
Remember		
Understand	✓	✓
Apply	✓	✓
Analyse	✓	✓
Evaluate	✓	
Create		
Mark Distribution of CIA		

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Practical [P]		Total Marks
		Assignment	Test-1	Test-2	Class work	Lab Exam	
2-0-2-0	5	10	---	15	15	15	60

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	60	40	2.5 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 2		**2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions.** **Each question carries 8 marks.** **Marks: (5x 8 = 40 marks)** **Time: 2.5 hours**	**40**
	Total Marks: 0	**Total Marks: [5 x 8 = 40 marks]**	

SYLLABUS
MODULE I : Classical Cryptography (4 hours)
OSI security architecture – Security attacks, Services, Mechanisms. Cryptography vs Cryptanalysis. Classical encryption techniques – Symmetric cipher model. Substitution ciphers – Monoalphabetic vs Polyalphabetic ciphers, Caesar cipher, Affine cipher, Playfair cipher, Vigenere cipher, Hill cipher. Transposition ciphers – Keyless, Keyed, Double transposition.
MODULE II : Mathematical Foundations for Cyber Security (5 hours)
Integer arithmetic - Integer division, Divisibility, Greatest Common Divisor (GCD), Euclid's algorithm for GCD, Extended Euclid's algorithm. Modular arithmetic - Operations, Properties. Algebraic structures -Finite fields, GF(p), GF (2^n). Prime numbers - Fermat and Mersenne primes, Fermat's theorem, Euler's theorem, Euler's totient function. Primitive roots, Discrete logarithms, Elliptic curve arithmetic.
MODULE III : Symmetric and Asymmetric Cryptography (6 hours)
Symmetric key ciphers – Block vs Stream ciphers, Block cipher components, Product ciphers, Feistel and Non-Feistel ciphers. DES, AES, Modes of operations, RC4. Introduction to public key cryptosystems – Principles, Applications, Requirements, Conventional vs Public key cryptosystems.RSA, Diffie Hellman Key Exchange, Elliptic Curve Cryptography (ECC) – ElGamal ECC, Key exchange using ECC.
MODULE IV : Authentication and Key Management (5 hours)
Hash functions – Security requirements, Secure Hash Algorithm (SHA-512). Message Authentication Code (MAC) – Requirements, Uses, Hash-based MAC (HMAC), Cipher-based MAC (CMAC). Digital signatures – Attacks, Forgeries, Requirements, Direct vs Arbitrated digital signatures, RSA digital signature, Digital Signature Standard (DSS). Key management – Distribution of secret keys using symmetric and asymmetric encryption, Distribution of public keys.
MODULE V : Program and System Security (4 hours)
Introduction to computer security – Threats, Vulnerabilities, Controls. Browser attack types, Web attacks targeting users, and Email attack types. Introduction to programming security - Non-malicious programming oversights, Malware. Operating system security – security in the operating system, Security in the design of the operating system. Database security – Security requirements of databases, Reliability, and integrity, Database disclosure.
Text books 1. Behrouz A Forouzan, Cryptography and Network Security, 3/e, Tata McGraw-Hill, 2008. 2. William Stallings, Cryptography and Network Security Principles and Practice, 8/e, Pearson Ed, 2020. 3. Charles P Pfleeger, Shari Lawrence Pfleeger, Jonathan Margulies, Security in Computing, 5/e, Prentice Hall, 2015.

Reference books 1. G.A. Jones & J.M. Jones, Elementary Number Theory, Springer UTM, 2007		
NPTEL/SWAYAM Course https://nptel.ac.in/courses/106105162 (Cryptography And Network Security, IIT Kharagpur Prof. Sourav Mukhopadhyay)		
COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
MODULE 1		
1.1	OSI security architecture – Security attacks, Services, Mechanisms. Cryptography vs Cryptanalysis.	1
1.2	Classical encryption techniques – Symmetric cipher model. Substitution ciphers, Monoalphabetic vs Polyalphabetic ciphers.	1
1.3	Caesar cipher, Affine cipher, Playfair cipher, Vigenere cipher, Hill cipher	1
1.4	Transposition ciphers – Keyless, Keyed, Double transposition.	1
MODULE II		
2.1	Integer arithmetic - Integer division, Divisibility, Greatest Common Divisor (GCD), Euclid's algorithm for GCD, Extended Euclid's algorithm.	1
2.2	Modular arithmetic - Operations, Properties. Algebraic structures -Finite fields, GF(p), GF (2^n).	1
2.3	Prime numbers - Fermat and Mersenne primes, Fermat's theorem, Euler's theorem, Euler's totient function.	1
2.4	Primitive roots, Discrete logarithms,	1
2.5	Elliptic curve arithmetic.	1

MODULE III		
3.1	Symmetric key ciphers – Block vs Stream ciphers, Block cipher components, Product ciphers, Feistel and Non-Feistel ciphers.	1
3.2	DES, Modes of operations	1
3.3	AES	1
3.4	RC4. Introduction to public key cryptosystems – Principles, Applications, Requirements, Conventional vs Public key cryptosystems.	1
3.5	RSA, Diffie Hellman Key Exchange	1

3.6	Key exchange using ECC, Elliptic Curve Cryptography (ECC) – ElGamal ECC	1

MODULE IV		
4.1	Hash functions – Security requirements. Message Authentication Code (MAC) – Requirements, Uses	1
4.2	Secure Hash Algorithm (SHA-512)	1
4.3	Hash-based MAC (HMAC), Cipher-based MAC (CMAC), Digital signatures – Attacks, Forgeries, Requirements,	1
4.4	Direct vs Arbitrated digital signatures, RSA digital signature, Digital Signature Standard (DSS).	1
4.5	Key management – Distribution of secret keys using symmetric and asymmetric encryption, Distribution of public keys.	1

MODULE V		
5.1	Introduction to computer security – Threats, Vulnerabilities, Controls. Browser attack types, Web attacks targeting users, and Email attack types.	1
5.2	Introduction to programming security - Non-malicious programming oversights, Malware.	1
5.3	Operating system security – security in the operating system, Security in the design of the operating system.	1
5.4	Database security – Security requirements of databases, Reliability, and integrity, Database disclosure.	1

LESSON PLAN FOR LAB COMPONENT

(Use shoup.net for basic algorithms)

No.	Topic	No. of Hours	Experiment
1	Classical encryption techniques	1 1 1 1	1. Implementation of Affine and playfair cipher 2. Implementation of poly alphabetic ciphers 3. Implementation of Hill Cipher 4. Implementation of transposition techniques
2	Mathematical Foundations of cyber security	1 1 1	1. Implementation of Extended Euclid's Algorithm 2. Implementation of Discrete Logarithm. 3. Implementation of Elliptic Curve Arithmetic
3	Symmetric and Asymmetric algorithms	1 1 1 1 1 1 1	1. Implementation of the following algorithms 2.DES (Modes of operations) 3. AES (Modes of operations) 4. RSA with fast exponentiation (CRT has to be explained in the lab) 5. Diffie Hellman key exchange 6. Elliptic curve key exchange and cryptography 7. Elgamal Key exchange and encryption
4	Authentication Algorithms	1 1 1 1 1	Implement the following algorithms 1. MD5 and SHA-1 2. SHA – 512 3. HMAC 4. CMAC 5. DSS
5	Intrusion Detection and Malwares	1 1 1 1 1 1	1. Buffer overflow, integer overflow and format string vulnerability testing in vulnerable applications. 2. Install snort and monitor a network on their local network 3. Use static analysis tools to find how an executable can be analyzed.

CO Assessment Questions	
1	A. Define the type of security attack in the following case: A student breaks into office to obtain a copy of the next day's exam question paper. B. Which security mechanism is provided in the following case: A bank requires the customer's signature for a withdrawal.
2	A. Alice wishes to send the message "COME BACK EARLY" to Bob, using Playfair cipher. The key to be used is "SAFFRON". Show the process of encryption. B. Using Affine cipher, encrypt "HOT" and decrypt "JDG". Key is (7, 3). C. Implement the Vigenere cipher in a suitable programming language.
3	A.Find the n- bit word that is represented by the polynomial x^2+1 in $GF(2^5)$. B.Find an integer that has a remainder of 3 when divided by 7 and 13, but is divisible by 12. C. In the elliptic curve E(1,2) over the field GF(11), find the equation of the curve and all the points on the curve.
4	A.If the DES key with parity bit is 0123 ABCD 2562 1456, find the first round key. B. In RSA, given p=19, q=23, public key(e)=3, find n, $\phi(n)$ and private key(d). C. Implement any two symmetric/asymmetric encryption techniques in a suitable programming language. (Assignment)
5	A.Describe the steps involved in generating a Hash-based MAC. B.A company wishes to implement a secure authentication mechanism for communication. As a system security admin suggest any two ways of implementing such a mechanism. (Assignment)
6	A.How does fake email messages act as spam? B.Discuss the importance of auditability and access control in database security. C.Explain the various factors which can make data sensitive.

Professional Elective I

24CSE614	Advanced Machine Learning	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble:

This course introduces machine learning concepts and popular machine learning algorithms. It will cover the standard and most popular supervised learning algorithms including linear regression, logistic regression, decision trees, k-nearest neighbour, an introduction to Bayesian learning and the naive Bayes algorithm, support vector machines and kernels and basic clustering algorithms. Dimensionality reduction methods and some applications to real world problems will also be discussed. It helps the learners to develop application machine learning based solutions for real world applications.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Analyse the Machine Learning concepts, classifications of Machine Learning algorithms and basic parameter estimation methods. **(Cognitive Knowledge Level: Analyse)**
CO2	Illustrate the concepts of regression and classification techniques **(Cognitive Knowledge Level: Apply)**
CO3	Describe unsupervised learning concepts and dimensionality reduction techniques. **(Cognitive Knowledge Level: Apply)**
CO4	Explain Support Vector Machine concepts and graphical models. **(Cognitive Knowledge Level: Apply)**
CO5	Choose suitable model parameters for different machine learning techniques and to evaluate a model performance. **(Cognitive Knowledge Level: Apply)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2								3
CO2	3	3	2									3
CO3	3	3	2	2								3
CO4	3	3	2	2	2							3
CO5	3	3	2		2							3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test 1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	

Evaluate			✓	
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Parameter Estimation and Regression (7 hours)

Overview of machine learning: supervised, semi-supervised, unsupervised learning, reinforcement learning. Basics of parameter estimation: Maximum Likelihood Estimation(MLE), Maximum a Posteriori Estimation (MAP). Gradient Descent Algorithm, Batch Gradient Descent, Stochastic Gradient Descent. Regression algorithms: least squares linear regression, normal equations and closed form solution, Polynomial regression.

MODULE II :Regularization techniques and Classification algorithms (9 hours)

Overfitting, Regularization techniques - LASSO and RIDGE. Classification algorithms: linear and non-linear algorithms, Perceptrons, Logistic regression, Naive Bayes, Decision trees. Neural networks : Concept of Artificial neuron, Feed-Forward Neural Network, Back propagation algorithm.

MODULE III :Unsupervised learning (5 hours)

Unsupervised learning: clustering, k-means, Hierarchical clustering, Principal component analysis, Density-based spatial clustering of applications with noise (DBSCAN). Gaussian mixture models:
Expectation Maximization (EM) algorithm for Gaussian mixture model.

MODULE IV :Support Vector Machine and Graphical Models (6 hours)

Support vector machines and kernels : Max margin classification, Nonlinear SVM and the kernel trick, nonlinear decision boundaries, Kernel functions. Basics of graphical models - Bayesian networks, Hidden Markov model - Inference and estimation.

MODULE V : Evaluation Metrics and Sampling Methods (8 hours)

Classification Performance Evaluation Metrics: Accuracy, Precision, Precision, Recall, Specificity, False Positive Rate (FPR), F1 Score, Receiver Operator Characteristic (ROC) Curve, AUC. Regression Performance Evaluation Metrics: Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), R Squared/Coefficient of Determination. Clustering Performance Evaluation Metrics: Purity, Jaccard index, Normalized Mutual Information, Clustering Accuracy, Silhouette Coefficient, Dunn's Index. Boosting: AdaBoost, gradient boosting machines. Resampling methods: cross-validation, bootstrap. Ensemble methods: bagging, boosting, random forests Practical aspects in machine learning: data preprocessing, overfitting, accuracy estimation, parameter and model selection Bias-Variance tradeoff

Text books

1. Christopher Bishop. Neural Networks for Pattern Recognition, Oxford University Press, 1995.

Reference books

1. Kevin P. Murphy. Machine Learning: A Probabilistic Perspective, MIT Press 2012.
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements Of Statistical Learning, Second edition Springer 2007.
3. Ethem Alpaydin, Introduction to Machine Learning, 2nd edition, MIT Press 2010.
4. Tom Mitchell, Machine Learning, McGraw-Hill, 1997.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1 (Parameter Estimation and Regression)		
1.1	Overview of machine learning: supervised, semi-supervised, unsupervised learning, reinforcement learning.	1

1.2	Basics of parameter estimation: Maximum Likelihood Estimation(MLE)	1
1.3	Basics of parameter estimation: Maximum Likelihood Estimation(MLE) - Examples	1
1.4	Basics of parameter estimation: Maximum a Posteriori Estimation (MAP)	1
1.5	Gradient Descent Algorithm, Batch Gradient Descent, Stochastic Gradient Descent	1
1.6	Regression algorithms: least squares linear regression, normal equations and closed form solution	1
1.7	Polynomial regression	1
MODULE 2 (Regularization techniques and Classification algorithms)		
2.1	Overfitting, Regularization techniques - LASSO and RIDGE	1
2.2	Classification algorithms: linear and non-linear algorithms	1
2.3	Perceptrons	1
2.4	Logistic regression	1
2.5	Naive Bayes	1
2.6	Decision trees	1
2.7	Neural networks : Concept of Artificial neuron	1
2.8	Feed-Forward Neural Network	1
2.9	Back propagation algorithm	
MODULE 3 (Unsupervised learning))		
3.1	Unsupervised learning: clustering, k-means	1
3.2	Hierarchical clustering	1
3.3	Principal component analysis	1
3.4	Density-based spatial clustering of applications with noise (DBSCAN)	1
3.5	Gaussian mixture models: Expectation Maximization (EM) algorithm for Gaussian mixture model	1
MODULE 4 (Support Vector Machine and Graphical Models)		

4.1	Support vector machines and kernels : Max margin classification	1
4.2	Support vector machines: Max margin classification	1
4.3	Nonlinear SVM and the kernel trick, nonlinear decision boundaries	1
4.4	Kernel functions	1
4.5	Basics of graphical models - Bayesian networks	1
4.6	Hidden Markov model - Inference and estimation	1
	MODULE 5	
5.1	Classification Performance Evaluation Metrics: Accuracy, Precision, Precision, Recall, Specificity, False Positive Rate (FPR), F1 Score, Receiver Operator Characteristic (ROC) Curve, AUC	1
5.2	Regression Performance Evaluation Metrics: Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), R Squared/Coefficient of Determination	1
5.3	Clustering Performance Evaluation Metrics: Purity, Jaccard index, Normalized Mutual Information, Clustering Accuracy, Silhouette Coefficient, Dunn's Index	1
5.4	Boosting: AdaBoost, gradient boosting machines	1
5.5	Resampling methods: cross-validation, bootstrap	1
5.6	Ensemble methods: bagging, boosting, random forests	1
5.7	Practical aspects in machine learning: data preprocessing, overfitting, accuracy estimation, parameter and model selection	1
5.8	Bias-Variance tradeoff	

CO Assessment Questions	
1	a) Suppose that X is a discrete random variable with the following probability mass function: where $0 \leq \theta \leq 1$ is a parameter. The following 10 independent observations were taken from such a distribution: (3, 0, 2, 1, 3, 2, 1, 0, 2, 1). What is the maximum likelihood estimate of θ.

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<tr><td>X</td><td>0</td><td>1</td><td>2</td><td>3</td></tr>
<tr><td>$P(X)$</td><td>$2\theta/3$</td><td>$\theta/3$</td><td>$2(1-\theta)/3$</td><td>$(1-\theta)/3$</td></tr>
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b) What is the difference between Maximum Likelihood estimation (MLE) and Maximum a Posteriori (MAP) estimation?
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<td>2</td>
<td>
a) How can we interpret the output of a two-class logistic regression classifier as a probability?
b) Suppose you have a 3-dimensional input x = (x1, x2, x3) = (2, 2, 1) fully connected with weights (0.5, 0.3, 0.2) to one neuron which is in the hidden layer with sigmoid activation function. Calculate the output of the hidden layer neuron.
c) Consider the case of the XOR function in which the two points {(0, 0),(1, 1)} belong to one class, and the other two points {(1, 0),(0, 1)} belong to the other class. Design a multilayer perceptron for this binary classification problem.
d) Why does a single perceptron cannot simulate simple XOR function? Explain how this limitation is overcome?
e) Consider a naive Bayes classifier with 3 boolean input variables, X1, X2 and X3, and one boolean output, Y. How many parameters must be estimated to train such a naive Bayes classifier? How many parameters would have to be estimated to learn the above classifier if we do not make the naive Bayes conditional independence assumption?
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<td>3</td>
<td>
a) Describe the basic operation of k-means clustering.
b) A Poisson distribution is used to model data that consists of non-negative integers. Suppose you observe m integers in your training set. Your model assumption is that each integer is sampled from one of two different Gaussian distributions. You would like to learn this model using the EM algorithm. List all the parameters of the model. Derive the E-step and M-step for this model.
c) A uni-variate Gaussian distribution is used to model data that consists of non-negative integers. Suppose you observe m integers in your training set. Your model assumption is that each integer is sampled from one of two different Gaussian distributions. You would like to learn this model using the EM algorithm. List all the parameters of the model. Derive the E-step and M-step for the model.
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<td>4</td>
<td>
a) Describe how Support Vector Machines can be extended to make use of kernels. Illustrate with reference to the Gaussian kernel $K(x, y) = e^{-y}$, where $y = (x-y)^2$.
b) Suppose that you have a linear support vector machine(SVM) binary classifier. Consider a point that is currently classified correctly, and is far away from the decision boundary. If you remove the point from
</td>
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</table>

	the training set, and re-train the classifier, will the decision boundary change or stay the same? Justify your answer. c) What is the primary motivation for using the kernel trick in machine learning algorithms? d) Show that the Boolean function $(x1 \wedge x2) \vee (\neg x1 \wedge \neg x2)$ is not linearly separable (i.e. there is no linear classifier sign $(w1\ x1 + w2\ x2 + b)$ that classifies all 4 possible input points correctly). Assume that "true" is represented by 1 and "false" is represented by −1. Show that there is a linear separator for this Boolean function when we use the kernel $K(x, y) = (x \cdot y)^2$ (x.y denotes the ordinary inner product) . Give the weights and the value of b for one such separator.
5	a) With an example classification problem, explain the following terms: a) Hyper parameters b) Training set c) Validation sets d) Bias e) Variance. b) What is ensemble learning? Can ensemble learning using linear classifiers learn classification of linearly non-separable sets? c) Describe boosting. What is the relation between boosting and ensemble learning? d) Classifier A attains 100% accuracy on the training set and 70% accuracy on the test set. Classifier B attains 70% accuracy on the training set and 75% accuracy on the test set. Which one is a better classifier. Justify your answer. e) What are ROC space and ROC curve in machine learning? In ROC space, which points correspond to perfect prediction, always positive prediction and always negative prediction? Why? f) Suppose there are three classifiers A,B and C. The (FPR, TPR) measures of the three classifiers are as follows – A (0, 1), B (1, 1) , C (1,0.5). Which can be considered as a perfect classifier? Justify your answer. g) What does it mean for a classifier to have a high precision but low recall?

24CSE624	WIRELESS SENSOR NETWORKS	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: Wireless Sensor Networks (WSN) courses delve into the fundamental principles and advanced concepts of creating interconnected systems of sensors. Explore the architecture, protocols, and algorithms that govern the operation of WSNs.

Prerequisite: Basic Networking, Communication, and basic programming skill

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the fundamentals of wireless communication technology (**Understand level**)
CO 2	Distinguish functions of ad-hoc/ sensor networks (**Apply level**)
CO 3	Understand the issues in designing MAC protocols for ad hoc wireless networks (**Understand level**)
CO 4	Technically recognize the procedure for building WSN (**Apply level**)
CO 5	Analyze various critical parameters in deploying a WSN (**Apply level**)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	2			1				1		
CO 2	3	3	3							1		
CO 3	3	3	3		3				2			
CO 4	3	3	1			1						2
CO 5	**3**	3	3			1					2	

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA							
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Practical [P]		Total Marks
		Assignment	Test-1	Test-2	Class work	Lab Exam	
3-0-0-0	5	15	10	10			**40**

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Introduction (7 hours)

Introduction: Fundamentals of wireless communication technology, the electromagnetic spectrum radio propagation, characteristics of wireless channels, modulation techniques, multiple access techniques, wireless LANs, PANs, WANs, and MANs, Wireless Internet.

MODULE II: Introduction to ad-hoc/sensor networks (7 hours)

Introduction to ad-hoc/sensor networks: Key definitions of ad-hoc/ sensor networks, unique constraints and challenges, advantages of ad-hoc/sensor network, driving applications, issues in ad-hoc wireless networks, issues in the design of sensor network, sensor network architecture, data dissemination and gathering.

Module III: MAC Protocols (8 hours)

MAC Protocols: Issues in designing MAC protocols for ad hoc wireless networks, design goals, classification of MAC protocols, MAC protocols for sensor networks, location discovery, quality, other issues, S-MAC, IEEE 802.15.4.

MODULE IV: Routing Protocols (7 hours)

Routing Protocols: Issues in designing a routing protocol, classification of routing protocols, table-driven, on-demand, hybrid, flooding, hierarchical, and power-aware routing protocols

MODULE V: QoS and Energy Management (7 hours)

QoS and Energy Management: Issues and Challenges in providing QoS, classifications, MAC, network layer solutions, QoS frameworks, need for energy management, classification, battery, transmission power, and system power management schemes.

Textbooks

1. C. Siva Ram Murthy, and B. S. Manoj, "AdHoc Wireless networks ", Pearson Education - 2008.

Reference books

1. Feng Zhao and Leonides Guibas, "Wireless sensor networks ", Elsevier publication - 2004.
2. Jochen Schiller, "Mobile Communications", Pearson Education, 2nd Edition, 2003.
3. William Stallings, "Wireless Communications and Networks ", Pearson Education - 2004

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Introduction: Fundamentals of wireless communication technology, the electromagnetic spectrum radio propagation	2
1.2	Characteristics of wireless channels, modulation techniques	2
1.3	Multiple access techniques	1
1.4	Wireless LANs, PANs, WANs, and MANs, Wireless Internet	2
	MODULE II	
2.1	Introduction to ad-hoc/sensor networks: Key definitions of ad-hoc/ sensor networks, unique constraints and challenges	2
2.2	Advantages of ad-hoc/sensor network, driving applications, issues in ad-hoc wireless networks	2
2.3	Issues in the design of the sensor network	1
2.4	Sensor network architecture, data dissemination and gathering.	2
	MODULE III	
3.1	MAC Protocols: Issues in designing MAC protocols for ad hoc wireless networks, design goals	2
3.2	Classification of MAC protocols	2
3.3	MAC protocols for sensor networks, location discovery	2
3.4	S-MAC, IEEE 802.15.4	2
	MODULE IV	
4.1	Routing Protocols: Issues in designing a routing protocol	1
4.2	Classification of routing protocols, table-driven, on-demand	2
4.3	Routing Protocols: hybrid, flooding	2

4.4	Routing Protocols: hierarchical, and power-aware routing protocols	2
MODULE V		
5.1	QoS and Energy Management: Issues and Challenges in providing QoS, classifications	1
5.2	MAC, network layer solutions	2
5.3	QoS frameworks needed for energy management	2
5.4	transmission power, and system power management schemes.	2

CO Assessment Questions	
1	What are the fundamental multiple access techniques commonly used in wireless sensor networks? Explain
2	How can sensor networks overcome challenges posed by node failures?
3	How does a Medium Access Control (MAC) protocol contribute to establishing a basic network infrastructure for sensor nodes?
4	Why is it essential for protocols in wireless sensor networks to be round-free, as mentioned in the context of routing protocols?
5	How do the limited resources of sensor nodes, such as energy, bandwidth, and processing abilities, impact the design and implementation of QoS frameworks?

24CSE634	Agile Methodologies	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course aims to provide students with a theoretical as well as practical understanding of agile software development practices and how small teams can apply them to create high-quality software. This course covers the frameworks and practices used by agile teams. Innovative ways of gathering requirements, estimation, release planning, performance metrics, and scaling are covered with the Agile Manifesto in mind. The overall objective of this course is to provide students with practical experience in applying agile methodology to their work environment.

Prerequisite: Topics covered under the course Software Engineering (23CST502)

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand Agile Software Development, including principles, project management, team dynamics, ethical considerations and comparison with traditional models. **(Understand Level)**
CO 2	Demonstrate various Agile and Lean Software Development methodologies, enabling them to compare, contrast, and apply them effectively in real-world scenarios. **(Apply Level)**
CO 3	Understand challenges of Migrating to Agile Methodologies and employ the Story-Card Maturity Model (SMM) for efficient knowledge sharing. **(Apply Level)**
CO 4	Apply Agile processes in Requirements Engineering to manage unstable requirements and achieve concurrency in requirements generation. **(Apply Level)**
CO 5	Apply Agile approach to Quality Assurance, practice Test Driven Development, and demonstrate Agile approach in Global Software Development. **(Apply Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	2			1		1				3
CO 2	3	3	2	1		1						3
CO 3	3	3	2	1								3
CO 4	3	3	2	1								3
CO 5	3	3	2	1								3

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✔	✔	✔	✔
Understand	✔	✔	✔	✔
Apply	✔	✔	✔	✔
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Agile Methodology (7 hrs)

Theories for Agile Management – Agile Software Development – Traditional Model vs. Agile Model - Classification of Agile Methods – Agile Manifesto and Principles – Agile Project Management – Agile Team Interactions – Ethics in Agile Teams - Agility in Design, Testing – Agile Documentations – Agile Drivers, Capabilities and Values.

MODULE II: Agile Processes (7 hrs)

Lean Production - SCRUM, Crystal, Feature Driven Development- Adaptive Software Development - Extreme Programming: Method Overview – Lifecycle – Work Products, Roles and Practices.

MODULE III: Agility and Knowledge Management (8 hrs)

Agile Information Systems – Agile Decision Making - Earl_S Schools of KM – Institutional Knowledge Evolution Cycle – Development, Acquisition, Refinement, Distribution, Deployment , Leveraging – KM in Software Engineering – Managing Software Knowledge –

Challenges of Migrating to Agile Methodologies – Agile Knowledge Sharing – Role of Story-Cards – Story-Card Maturity Model (SMM).

MODULE IV: Agility and Requirements Engineering (8 hrs)

Impact of Agile Processes in RE–Current Agile Practices – Variance – Overview of RE Using Agile – Managing Unstable Requirements – Requirements Elicitation – Agile Requirements Abstraction Model – Requirements Management in Agile Environment, Agile Requirements Prioritization – Agile Requirements Modeling and Generation – Concurrency in Agile Requirements Generation.

MODULE V: Agility and Quality Assurance (6 hrs)

Agile Product Development – Agile Metrics – Feature Driven Development (FDD) – Financial and Production Metrics in FDD – Agile Approach to Quality Assurance - Test Driven Development – Agile Approach in Global Software Development.

Text books

1. David J. Anderson and Eli Schragenheim, Agile Management for Software Engineering: Applying the Theory of Constraints for Business Results, Prentice Hall, 2003.
2. Hazza and Dubinsky, Agile Software Engineering, Series: Undergraduate Topics in Computer Science, Springer, 2009.

Reference books

1. Craig Larman, Agile and Iterative Development: A Manager's Guide, Addison-Wesley, 2004.
2. Kevin C. Desouza, Agile Information Systems: Conceptualization, Construction, and Management, Butterworth-Heinemann, 2007.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Theories for Agile Management, Agile Software Development.	1
1.2	Traditional Model vs. Agile Model, Classification of Agile Methods.	1
1.3	Agile Manifesto and Principles.	1
1.4	Agile Project Management.	1
1.5	Agile Team Interactions – Ethics in Agile Teams.	1
1.6	Agility in Design, Testing.	1
1.7	Agile Documentations – Agile Drivers, Capabilities and Values.	1
	MODULE II	
2.1	Lean Production Lifecycle – Work Products, Roles and Practices.	1
2.2	SCRUM, Crystal.	1
2.3	Feature Driven Development.	1
2.4	Adaptive Software Development.	1
2.5	Extreme Programming: Method Overview.	1
2.6	Lifecycle, Work Products.	1
2.7	Roles and Practices.	1
	MODULE III	
3.1	Agile Information Systems.	1

3.2	Agile Decision Making.	1
3.3	Earl_S Schools of KM - Institutional Knowledge Evolution Cycle.	1
3.4	Development, Acquisition, Refinement, Distribution, Deployment , Leveraging.	1
3.5	KM in Software Engineering – Managing Software Knowledge.	1
3.6	Challenges of Migrating to Agile Methodologies.	1
3.7	Agile Knowledge Sharing – Role of Story-Cards.	1
3.8	Story-Card Maturity Model (SMM).	1
	MODULE IV	
4.1	Impact of Agile Processes in RE.	1
4.2	Current Agile Practices, Variance.	1
4.3	Overview of RE Using Agile, Managing Unstable Requirements.	1
4.4	Requirements Elicitation – Agile Requirements Abstraction Model.	1
4.5	Requirements Management in Agile Environment.	1
4.6	Agile Requirements Prioritization.	1
4.7	Agile Requirements Modeling and Generation.	1
4.8	Concurrency in Agile Requirements Generation.	1
	MODULE V	
5.1	Agile Product Development.	1
5.2	Agile Metrics – Feature Driven Development (FDD).	1
5.3	Financial and Production Metrics in FDD.	1
5.4	Agile Approach to Quality Assurance.	1
5.5	Test Driven Development.	1
5.6	Agile Approach in Global Software Development.	1

CO Assessment Questions	
CO1	1. Illustrate how the process differs in agile software development and traditional software development with a socially relevant case study.
CO2	1. In a software development team practicing Lean, discuss how you would apply specific metrics to measure the effectiveness of Lean principles. 2. In a cross-functional development team, explain how SCRUM practices contribute to collaboration, transparency, and the delivery of high-quality software. 3. Apply the key principles of Adaptive Software Development to a specific project scenario, demonstrating how they guide decision-making in response to change. 4. Illustrate how XP roles and responsibilities contribute to collaborative development, ensuring effective communication and shared responsibility among team members.

CO3	1. Discuss effective strategies for knowledge sharing within Agile teams and their impact on project success. 2. Apply the Story-Card Maturity Model (SMM) to evaluate the effectiveness of story cards in a specific Agile project. Discuss the evolution of story card usage over time. 3. Describe a critical situation in a software development project where Agile decision-making played a pivotal role. How did Agile principles guide decision-making under pressure?
CO4	1. Discuss how Agile methodologies strike a balance between flexibility and stability in requirements 2. Discuss how concurrency is achieved in the generation of requirements within Agile processes. 3. In an Agile project, explain how the use of user stories contributes to effective requirements communication and understanding. Share examples of successful user story implementations.
CO5	1. Illustrate the Agile approach to Quality Assurance and its importance in the product development life cycle. 2. In a real-world scenario, explain how financial metrics are applied in Feature Driven Development. How do these metrics contribute to project planning and decision-making? 3. Discuss how Test Driven Development can be effectively applied when implementing new features.

24CSE644	Advanced Algorithms	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The Advanced Algorithms course is designed to provide students with a deep understanding of sophisticated algorithmic techniques, advanced data structures, and mathematical tools that are essential for addressing real-world challenges in computing. This course delves into the intricacies of algorithmic design paradigms, offering a comprehensive exploration of advanced topics such as amortized analysis, randomized algorithms, tree structures, number-theoretic algorithms, string matching algorithms, online algorithms, and parallel algorithms. Through theoretical foundations of practical implementations, students will acquire the skills needed to develop algorithms that operate at the cutting edge of computational efficiency.

Prerequisite: Data Structures, Design and Analysis of Algorithms

Course Outcomes: After the completion of the course the student will be able to

CO1	Understand amortized time complexity of algorithms. **(Understand Level)**
CO2	Apply the appropriate data structure for solving complex computational problems. **(Apply Level)**
CO3	Decide and use special advanced tree data structures for solving practical problems. **(Apply Level)**
CO4	Design and analyze efficient randomized algorithms. **(Analyze Level)**
CO5	Detect and apply algorithmic structures in many different fields of engineering. **(Analyze Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2									1
CO2	2	3	2									1
CO3	2	2	2									
CO4	3	2	2									
CO5	3	2	2				1					1
CO6	3	2										

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	✓
Evaluate			✓	
Create				

Mark Distribution of CIA						
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

Module I: Amortized Analysis and Heaps (7 hours)

Advanced Design and Analysis -Amortized Analysis- Aggregate analysis, Accounting method, Potential method. Binomial Heaps, Deaps, Leftist Heaps, Fibonacci Heaps - Operations – insert, delete, find min.

Module II: Advanced Tree Algorithms (10 hours)

Red-Black Trees, Splay Trees, Point trees, Quad trees, K-d trees, TV-trees, Segment trees- Operations.

Module III: Randomized Algorithms (8 hours)

Randomized Algorithms- Las Vegas and Monte Carlo algorithms, Essential mathematical tools for Randomized algorithms- Linearity of expectation, Markov inequality, Chebyshev's inequality, Chernoff bound, and Union bound with examples to Randomized algorithm design. Linear Programming- Formulation of

Problems as Linear Programs, Simplex algorithm, Duality.		
Module IV: String matching (7 hours)		
String matching algorithms - Rabin-Karp fingerprint algorithm, Boyer Moore algorithm, Knuth- Morris – Pratt (KMP) algorithm, Suffix Trees. Number-theoretic algorithms – FFT.		
Module V: Online Algorithms (4 hours)		
Online Algorithms: Overview, Online scheduling and online Steiner tree, Online Bipartite matching, Online learning and multiplicative weights algorithm.		

Text books

1. Thomas H. Cormen, Charles Leiserson, Ronald Rivest, and Clifford Stein. Introduction to Algorithms. 3rd ed. MIT Press, 2009.
2. Rajeev Motwani and Prabhakar Raghavan, Randomized Algorithms, 2nd Edition, Cambridge University press, Cambridge, MA, 1995.

Reference books

1. M. J. Quinn, Designing Efficient Algorithms for Parallel Computers, McGraw Hill Higher Education, 1987.
2. J. Kleinberg and E. Tardos, Algorithm Design, Pearson.
3. H. S. Wilf, Algorithms and complexity, Prentice hall.
4. Michael T. Goodrich and Roberto Tamassia, “Algorithm Design: Foundations, Analysis and Internet Examples”, Second Edition, Wiley-India, 2006

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. ofHours
	MODULE 1	
1.1	Amortized Analysis- Aggregate analysis	1
1.2	Accounting method	1
1.3	Potential method	1
1.4	Binomial Heaps	1
1.5	Deaps	1
1.6	Leftist Heaps	1
1.7	Fibonacci Heaps	1
	MODULE II	
2.1	Red-Black Trees	2

2.2	Splay Trees	2
2.3	Point trees	1
2.4	Quad trees	1
2.5	K-d trees	1
2.6	TV-trees	2
2.7	Segment trees	1
MODULE III		
3.1	Randomized Algorithms- Las Vegas and Monte Carlo algorithms	1
3.2	Linearity of expectation	1
3.3	Markov inequality	1
3.4	Chebyshev's inequality, Chernoff bound	1
3.5	Union bound with examples to Randomized algorithm design	1
3.6	Linear Programming- Formulation of Problems as Linear Programs	1
3.7	Simplex algorithm	1
3.8	Duality	1
MODULE IV		
4.1	Rabin-Karp fingerprint algorithm	1
4.2	Boyer Moore algorithm	1
4.3	Knuth- Morris – Pratt (KMP) algorithm	2
4.4	Suffix Trees	1
4.5	Number-theoretic algorithms – FFT	2
MODULE V		
5.1	Online Algorithms: Overview, Online scheduling	1

5.2	online Steiner tree.	1
5.2	Online Bipartite matching	1
5.3	Online learning and multiplicative weights algorithm	1

CO Assessment Questions	
CO1	Suppose we perform a sequence of n operations on a data structure in which the i^{th} operation costs i, if i is an exact power of 2, and 1 otherwise. Use aggregate analysis to determine the amortized cost per operation.
CO2	Suppose that a binomial heap H has a total of n nodes. Discuss the relationship between the binomial trees that H contains and the binary representation of n. Conclude that H consists of at most [lg n] +1 binomial trees.
CO3	Discuss any limitations or scenarios where K-d Trees might not be the most suitable data structure.
	Suppose that a node x is inserted into a red-black tree with RB-INSERT and then is immediately deleted with RB-DELETE. Is the resulting red-black tree the same as the initial red-black tree? Justify your answer.
CO4	Multithread the RANDOMIZED-QUICKSORT algorithm by using nested parallelism. Give the pseudocode for your P-RANDOMIZED - QUICKSORT algorithm.
CO5	Give pseudocode for an efficient multithreaded algorithm that multiplies a p X q matrix by a q X r matrix. Your algorithm should be highly parallel even if any of p, q, and r are 1. Analyze your algorithm.

24CSE654	Data Mining	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course helps the learner to understand the concepts of data mining and data warehousing. It covers the key processes of data mining, data preprocessing techniques, fundamentals and advanced concepts of classification, clustering, association rule mining, web mining and text mining. It enables the learners to develop new data mining algorithms and apply the existing algorithms in real-world scenarios.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Employ the key process of data mining and data warehousing concepts in application domains. (**Cognitive Knowledge Level: Understand**)
CO2	Make use of appropriate preprocessing techniques to convert raw data into suitable format for practical data mining tasks (**Cognitive Knowledge Level**: **Apply**)
CO3	Illustrate the use of classification and clustering algorithms in various application domains (**Cognitive Knowledge Level: Apply**)
CO4	Comprehend the use of association rule mining techniques. (**Cognitive Knowledge Level: Apply)**
CO5	Explain advanced data mining concepts and their applications in emerging domains (**Cognitive Knowledge Level: Understand**)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										3
CO2	3	3	3	2	2							3
CO3	3	3	3	2	2							3
CO4	3	3	3	2	2							3
CO5	3	3										3
CO6	3	3										3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test 1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓

Analyse			✓	
Evaluate			✓	
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Introduction to Data Mining and Data Warehousing (6 hours)

Data warehouse-Differences between Operational Database Systems and Data Warehouses, Multidimensional data model- Warehouse schema, OLAP Operations, Data Warehouse Architecture, Data Warehousing to Data Mining, Data Mining Concepts and Applications, Knowledge Discovery in Database Vs Data mining, Architecture of typical data mining system, Data Mining Functionalities, Data Mining Issues.

MODULE II : Data Preprocessing (6 hours)

Data Preprocessing-Need of data preprocessing, Data Cleaning- Missing values, Noisy data, Data Integration and Transformation, Data Reduction-Data cube aggregation, Attribute subset selection, Dimensionality reduction, Numerosity reduction, Discretization and concept hierarchy generation.

MODULE III : Advanced classification and Cluster analysis (9 hours)

Classification- Introduction, Decision tree construction principle, Splitting indices - Information Gain, Gini indexDecision tree construction algorithms-ID3, Decision tree construction with presorting-SLIQ, Classification Accuracy-Precision, Recall. Introduction to clustering-Clustering Paradigms, Partitioning Algorithm- PAM, Hierarchical Clustering-DBSCAN, Categorical Clustering-ROCK

MODULE IV : Association Rule Analysis (8 hours)

Association Rules-Introduction, Methods to discover Association rules, Apriori(Level-wise algorithm), Partition Algorithm, Pincer Search Algorithm, Dynamic Itemset Counting Algorithm, FP-tree Growth Algorithm.

MODULE V : Advanced Data Mining Techniques (7 hours)

Web Mining - Web Content Mining, Web Structure Mining- Page Rank, Clever, Web Usage Mining- Preprocessing, Data structures, Pattern Discovery, Pattern Analysis. Text Mining-Text Data Analysis and information Retrieval, Basic measures for Text retrieval, Text Retrieval methods, Text Indexing Techniques, Query Processing Techniques.

Text books

1. Dunham M H, "Data Mining: Introductory and Advanced Topics", Pearson Education, New Delhi, 2003.
2. Arun K Pujari, "Data Mining Techniques", Universities Press Private Limited,2008.
3. Jaiwei Han and Micheline Kamber, "Data Mining Concepts and Techniques", Elsevier, 2006

Reference books

1. M Sudeep Elayidom, "Data Mining and Warehousing", 1st Edition, 2015, Cengage Learning India Pvt. Ltd.
2. MehmedKantardzic, "Data Mining Concepts, Methods and Algorithms", John Wiley and Sons, USA, 2003.
3. Pang-Ning Tan and Michael Steinbach, "Introduction to Data Mining", Addison Wesley, 2006.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Data warehouse-Differences between Operational Database Systems and Data Warehouses, Multidimensional data model- Warehouse schema	1

1.2	OLAP Operations	1
1.3	DataWarehouse Architecture, Data Warehousing to Data Mining	1
1.4	Datamining Concepts and Applications, Knowledge Discovery in Database Vs Data mining	1
1.5	Architecture of typical data mining system,Data Mining Functionalities	1
1.6	Data Mining Functionalities, Data Mining Issues	1
MODULE 2		
2.1	Data Preprocessing: Need of Data Preprocessing, Data Cleaning-Missing values, Noisy data.	1
2.2	Data integration	1
2.3	Data transformation	1
2.4	Data Reduction-Data cube aggregation, Attribute subset selection	1
2.5	Data Reduction-Dimensionality reduction	1
2.6	Numerosity reduction, Discretization and concept hierarchy generation	1
MODULE 3		
3.1	Classification- Introduction, Decision tree construction principle, Splitting indices-Information Gain, Gini index	1
3.2	Decision Tree- ID3	1
3.3	Decision Tree- ID3	1
3.4	Decision tree construction with presorting- SLIQ	1
3.5	Accuracy and error measures, evaluation	1
3.6	Introduction to clustering, Clustering Paradigms	1
3.7	Partitioning Algorithm- PAM	1
3.8	Hierarchical Clustering-DBSCAN	1
3.9	Categorical Clustering-ROCK	1
MODULE 4		

4.1	Association Rules: Introduction, Methods to discover association rules	1
4.2	A priori algorithm (Level-wise algorithm)	1
4.3	A priori algorithm (Level-wise algorithm)	1
4.4	Partition Algorithm	1
4.5	Pincer Search Algorithm	1
4.6	Pincer Search Algorithm	1
4.7	Dynamic Itemset Counting Algorithm	1
4.8	FP-tree Growth Algorithm	
MODULE 5		
5.1	Web Mining - Web Content Mining	1
5.2	Web Structure Mining- Page Rank	1
5.3	Web Structure Mining –Clever algorithm	1
5.4	Web Usage Mining- Preprocessing, Data structures	1
5.5	Web Usage Mining -Pattern Discovery, Pattern Analysis	1
5.6	Text Mining-Text Data Analysis and information Retrieval, Basic measures for Text retrieval	1
5.7	Text Retrieval methods, Text Indexing Techniques Query Processing Techniques	1

CO Assessment Questions	
1	1. (a) Explain the OLAP operations in a multidimensional model. (b) Compare the techniques used in ROLAP, MOLAP and HOLAP 2. Explain the various data mining issues with respect to mining methodology, user interaction and diversity of data types.

3. Suppose that a data warehouse consists of the three dimensions time, doctor, and patient, and the two measures count and charge, where charge is the fee that a doctor charges a patient for a visit.
    a) Draw star and snowflake schema diagrams for the data warehouse.
    b) Starting with the base cuboid [day; doctor; patient], what specific OLAP operations should be performed in order to list the total fee collected by each doctor in 2004?

2

1. Use the methods below to normalize the following group of data:100, 200, 300, 400,550, 600, 680, 850, 1000
    a. min-max normalization by setting min = 0 and max = 1
    b. z-score normalization
    c. Normalization by decimal scaling

   Comment on which method you would prefer to use for the given data, givingreasons as to why.
2. Identify a suitable dataset from any available resources and apply different preprocessing steps that you have learned. Observe and analyze the output obtained.

3

1. Illustrate the working of ID3 algorithm with the following example

MOTOR	WHEEELS	DOORS	SIZE	TYPE	CLASS
NO	2	0	small	cycle	bicycle
NO	3	0	small	cycle	tricycle
YES	2	0	small	cycle	motorcycle
YES	4	2	small	automobile	Sports car
YES	4	3	medium	automobile	minivan
YES	4	4	medium	automobile	sedan
YES	4	4	large	automobile	sumo

2. Illustrate the working of K medoid algorithm for the given dataset. A1=(3,9), A2=(2,5), A3=(8,4), A4=(5,8), A5=(7,5), A6=(6,4), A7=(1,2), A8=(4,9).

3. Take a suitable dataset from available resources and apply all the classification and clustering algorithms that you have studied on original and preprocessed datasets. Analyze the performance variation in terms of different quality metrics. Give a detailed report based on the analysis. (Assignment)

4

1. A database has five transactions. Let min sup = 60% and min con f = 80%.

TID	*items_bought*
T100	{M, O, N, K, E, Y}
T200	{D, O, N, K, E, Y }
T300	{M, A, K, E}
T400	{M, U, C, K, Y}
T500	{C, O, O, K, I ,E}

Find all frequent item sets using Apriori and FP-growth, respectively. Compare the efficiency of the two mining processes.

2. Identify and list some scenarios in which association rule mining can be used, and then use at least two appropriate association rule mining techniques in one of the two scenarios. (Assignment)

5

1. Consider an e-mail database that stores a large number of electronic mail (e-mail) messages. It can be viewed as a semi structured database consisting mainly of text data. Discuss the following.

   a) How can such an e-mail database be structured so as to facilitate multidimensional search, such as by sender, by receiver, by subject, and by time?
   b) What can be mined from such an e-mail database?
   c) Suppose you have roughly classified a set of your previous e-mail messages as junk, unimportant, normal, or important. Describe how a data mining system may take this as the training set to automatically classify new e-mail messages or unclassified ones.
2. Precision and recall are two essential quality measures of an information retrieval system.
   a) Explain why it is the usual practice to trade one measure for the other.
   b) Explain why the F-score is a good measure for this purpose.
   c) Illustrate the methods that may effectively improve the F-score in an information retrieval system.
3. Explain HITS algorithm with an example.

24CSE664	Distributed Computing	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The purpose of this course is to understand the system models, algorithms and protocols that allow computers to communicate and coordinate their actions to solve a problem. This course helps the learner to understand the distributed computation model and various concepts like global state, termination detection, mutual exclusion, deadlock detection, shared memory, failure recovery, consensus, file system. It helps the learners to develop solutions to problems in distributed computing environment.

Prerequisite: Basic knowledge in data structures and operating systems.

Course Outcomes: After the completion of the course the student will be able to

CO1	Summarize various aspects of distributed computation model and logical time. **(Cognitive Knowledge Level: Understand)**
CO2	Illustrate election algorithm, global snapshot algorithm and termination detection algorithm. **(Cognitive Knowledge Level: Apply)**
CO3	Compare token based, non-token based and quorum based mutual exclusion algorithms. **(Cognitive Knowledge Level: Understand)**
CO4	Recognize the significance of deadlock detection and shared memory in distributed systems. **(Cognitive Knowledge Level: Understand)**
CO5	Explain the concepts of failure recovery and consensus. **(Cognitive Knowledge Level: Understand)**
CO6	Explain distributed authentication mechanism. **(Cognitive Knowledge Level: Understand)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2									3
CO2	3	3	2	3								3
CO3	3	3	2									3
CO4	3	3	2									3
CO5	3	3	2									3
CO6	3	3	2									3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test 1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate			✓	

Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Distributed systems basics and Computation model (7 hours)

Distributed System – Definition, Relation to computer system components, Motivation, Primitives for distributed communication, Design issues, Challenges and applications. A model of distributed computations – Distributed program, Model of distributed executions, Models of communication networks, Global state of a distributed system, Cuts of a distributed computation, Past and future cones of an event, Models of process communications.

MODULE II : Logical Clock, Global state and Termination detection (8 hours)

Logical time – A framework for a system of logical clocks, Scalar time, Vector time. Leader election algorithm – Bully algorithm, Ring algorithm. Global state and snapshot recording algorithms – System model and definitions, Snapshot algorithm for FIFO channels – Chandy Lamport algorithm. Termination detection – System model of a distributed computation, Termination detection using distributed snapshots, Termination detection by weight throwing,Spanning-tree-based algorithm.

MODULE III : Mutual exclusion and Deadlock detection (6 hours)

Distributed mutual exclusion algorithms – System model, Requirements of mutual exclusion algorithm. Lamport's algorithm, Ricart–Agrawala algorithm, Quorum-based mutual exclusion algorithms – Maekawa's algorithm. Token-based algorithm – Suzuki–Kasami's broadcast algorithm. Deadlock detection in distributed systems – System model, Deadlock handling strategies, Issues in deadlock detection, Models of deadlocks.

MODULE IV : Distributed shared memory and Failure recovery (7 hours)

Distributed shared memory – Abstraction and advantages. Shared memory mutual exclusion – Lamport's bakery algorithm. Check pointing and rollback recovery – System model, consistent and inconsistent states, different types of messages, Issues in failure recovery, checkpoint based recovery, log based roll back recovery.

MODULE V : Consensus and authentication (7 hours)

Consensus and agreement algorithms – Assumptions, The Byzantine agreement and other problems, Agreement in (message-passing) synchronous systems with failures – Consensus algorithm for crash

Basis of authentication-Design principles for cryptographic protocols. Protocol based on symmetric cryptosystems-A protocol based on an authentication server, One-time password scheme, Kerberos authentication service

(Note: Proof of correctness and performance analysis are not expected for any of the algorithms in the syllabus).

Text books

1. Ajay D. Kshemkalyani and Mukesh Singhal, Distributed Computing: Principles, Algorithms, and Systems, Cambridge University Press, 2011.

Reference books

1. George Coulouris, Jean Dollimore, Tim Kindberg and Gordon Blair. Distributed Systems: Concepts and Design, Addison Wesley, Fifth edition.
2. Kai Hwang, Geoffrey C Fox, Jack J Dongarra, Distributed and Cloud Computing – From Parallel Processing to the Internet of Things, Morgan Kaufmann Publishers, 2012.
3. Sukumar Ghosh, Distributed Systems: An Algorithmic Approach, CRC Press, Second edition, 2015.
4. Maarten Van Steen, Andrew S. Tanenbaum, Distributed Systems, Prentice Hall of India,Third edition, 2017.

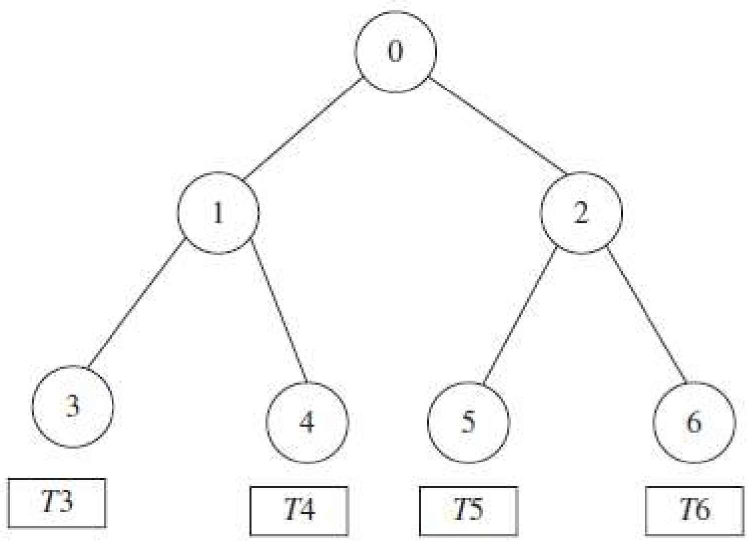
5. Randy Chow and Theodore Johnson, Distributed Operating Systems and Algorithm Analysis, Pearson Education India, First edition, 2009.
6. Valmir C. Barbosa, An Introduction to Distributed Algorithms, MIT Press, 2003.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Distributed System – Definition, Relation to computer system components	1
1.2	Primitives for distributed communication.	1
1.3	Design issues, challenges and applications.	1
1.4	Design issues, challenges and applications.	1
1.5	A model of distributed computations – Distributed program, Model of distributed executions	1
1.6	Models of communication networks, Global state of a distributed system, Cuts of a distributed computation	1
1.7	Cuts of a distributed computation, Past and future cones of an event, Models of process communications.	1
	MODULE 2	
2.1	Logical time – A framework for a system of logical clocks, Scalar time	1
2.2	Vector time.	1
2.3	Leader election algorithm – Bully Algorithm, Ring Algorithm	1
2.4	Global state and snapshot recording algorithms – System model and definitions	1
2.5	Snapshot algorithm for FIFO channels – Chandy Lamport algorithm.	1
2.6	Termination detection – System model of a distributed computation	1
2.7	Termination detection using distributed snapshots	1
2.8	Termination detection by weight throwing, Spanning tree-based algorithm	1
	MODULE 3	

3.1	Distributed mutual exclusion algorithms – System model, Lamport's algorithm	1
3.2	Ricart–Agrawala algorithm	1
3.3	Quorum-based mutual exclusion algorithms – Maekawa's algorithm	1
3.4	Token-based algorithm – Suzuki–Kasami's broadcast algorithm	1
3.5	Deadlock detection in distributed systems – System model, Deadlock handling strategies, Issues in deadlock detection	1
3.6	Models of deadlocks	1
	MODULE 4	
4.1	Distributed shared memory – Abstraction and advantages.	1
4.2	Shared memory mutual exclusion – Lamport's bakery algorithm.	1
4.3	Checkpointing and rollback recovery – System model, consistent and inconsistent states	1
4.4	different types of messages, Issues in failure recovery	1
4.5	checkpoint based recovery	1
4.6	log based roll back recovery.	1
4.7	log based roll back recovery.	
	MODULE 5	
5.1	Consensus and agreement algorithms – Assumptions, The Byzantine agreement and other problems	1
5.2	Agreement in (message-passing) synchronous systems with failures – Consensus algorithm for crash failures	1
5.3	Agreement in (message-passing) synchronous systems with failures – Consensus algorithm for crash failures	1
5.4	Basis of authentication-Design principles for cryptographic protocols	1
5.5	Protocol based on symmetric cryptosystems - A protocol based on an authentication server	1

5.6	One-time password scheme	1
5.7	Kerberos authentication service	1

CO Assessment Questions	
1	1. Define logical clock and explain the implementation of the logical clock. 2. Explain different forms of load balancing
2	1. Apply ring-based leader election algorithm with 10 processes in the worst-performing case. Count the number of messages needed. 2. Apply spanning tree-based termination detection algorithm in the following scenario. The nodes are processes 0 to 6. Leaf nodes 3, 4, 5, and 6 are each given tokens T3, T4, T5 and T6 respectively. Leaf nodes 3, 4, 5 and 6 terminate in the order, but before terminating node 5,it sends a message to node 1. 
3	1. What are the requirements of mutual exclusion algorithms? 2. Illustrate Suzuki- Kasami's broadcast algorithm.
4	1. Compare different models of deadlocks. 2. Illustrate the detailed abstraction of distributed shared memory and interaction with application processes.

5	1. Explain how consensus problem differs from the Byzantine agreement problem. 2. Classify different log based roll back recovery techniques.
6	1. Explain Kerberos authentication service 2. Discuss the design principles for cryptographic protocols

24CSE674	Advanced Database System	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course provides a clear understanding of distributed databases, query processing and optimization, database security, and multimedia databases. Students will be able to acquire an inquisitive attitude towards research topics in emerging databases in Cloud and Big Data.

Prerequisite: Topics covered under the course Introduction to Data Base Systems, Exposure to a High-Level Language like C/python.

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the fundamental concepts of distributed databases. **(Understand Level)**
CO2	Identify various measures of query processing and optimization. **(Apply Level)**
CO3	Outline the different security issues and threats to a database system. **(Understand Level)**
CO4	Explain the concepts of multimedia database and mobile data management. **(Understand Level)**
CO5	Discuss the recent technological trends in databases. **(Understand Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										3
CO2	3	3										3
CO3	3	3										3
CO4	3	3										3
CO5	3	3										3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure	Attendance	Theory [L- T]	Total

[L-T-P-J]		Assignment	Test-1	Test-2	Marks
3-0-0-0	5	15	10	10	40

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Distributed Databases (5hrs)

Distributed Database concepts, Distributed Databases vs. Conventional Databases, Types of Distributed Database systems, Distributed Database Architectures, Data Fragmentation, Replication and Allocation techniques for distributed database design, Distributed Catalog Management.

MODULE II: Query Processing and Optimization (7hrs)

Complex SQL Queries, Query Processing Algorithms – Query Optimization Techniques, Transaction Management- Transaction Processing Concepts, Concurrency Control, Deadlocks, Recovery Techniques.

MODULE III: Database Security (7hrs)

Introduction to Database Security Issues-Types of Security, Control Measures, Database Security and the DBA, Access Control, User Accounts, and Database Audits, Discretionary Access Control, Mandatory Access control (Role based only), SQL Injection, Challenges of database security.

MODULE IV: Multimedia Databases (6hrs)

Multimedia Databases- Data Formats, Continuous Media Data, Similarity Based Retrieval, Mobile Data Management- Mobile Computing Architecture, Data Management Issues, Location Based Services, Peer to Peer Systems and Applications, Application Platforms.

MODULE V: Emerging trends in Database management (8hrs)

Big Data – Motivation, Sources and Uses of Big Data, Querying Big Data, Big Data Storage Systems- Distributed File Systems, Sharding, Key Value Storage Systems, Blockchain Databases-Overview, Blockchain Properties, Simple Blockchain Transactions, Data Management in a Blockchain, Emerging Applications.

Textbooks

1. R. Elmasri, S.B. Navathe, "Fundamentals of Database Systems", 5/e, Pearson Education/Addison Wesley, 2011
2. Patrick O'Neil , Elizabeth O'Neil , "Database: Principles, Programming and Performance",2/e, Morgan Kaufmann, 2011
3. Thomas Cannolly and Carolyn Begg, "Database Systems, A Practical Approach to Design, Implementation and Management", 3/e, Pearson Education, 2010.
4. Henry F Korth, Abraham Silberschatz, S. Sudharshan, "Database System Concepts", 5/e, Tata McGraw Hill, 2006

Reference books

1 C.J. Date, A.Kannan and S. Swamynathan,"An Introduction to Database Systems", 8/e, Pearson Education India, 2006.

2. Joe Fawcett, Danny Ayers , Liam R. E. Quin, Beginning XML, 5/e, John Wiley & Sons, 2012

3. Grigoris Antoniou. Frank van Harmelen, "A Semantic Web Primer", The MIT Press,Cambridge, Massachusetts, 2003

4. Jules J. Berman, "Principles of Big Data: Preparing, Sharing and Analyzing Complex Information", Morgan Kufmann, 2013.

5. Pete Warden, "Big Data Glossary", O'Reilly Media Inc, 2011

Suggested MOOC Courses

1.Data Base Management System, IIT Kharagpur - Prof. Partha Pratim Das, Prof. Samiran Chattopadhyay, Prof. Kausik Datta

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1		

1.1	Distributed database concepts, Distributed Databases vs. conventional Databases	1
1.2	Types of Distributed Database Systems	1
1.3	Distributed Database Architectures	1
1.4	Data fragmentation, replication and allocation techniques for distributed database design	1
1.5	Distributed catalogue management.	1
	MODULE II	
2.1	Complex SQL Queries (Lecture 1)	1
2.2	Complex SQL Queries (Lecture 2)	1
2.3	Query Processing Algorithms, Query Optimization Techniques (Lecture 1)	1
2.4	Query Processing Algorithms, Query Optimization Techniques (Lecture 2)	1
2.5	Transaction Management: Transaction Processing Concepts, Concurrency Control (Lecture 1)	1
2.6	Transaction Management: Transaction Processing Concepts, Concurrency Control (Lecture 2)	1
2.7	Deadlocks, Recovery Techniques.	1
	MODULE III	
3.1	Introduction to Database Security Issues- Types of Security control measures	1
3.2	Database Security and the DBA	1
3.3	Access Control, User Accounts, and Database Audits	1
3.4	Discretionary Access Control	1
3.5	Mandatory Access control (Role based only)	1
3.6	SQL Injection	1
3.7	Challenges of database security	1
	MODULE IV	

4.1	Multimedia Databases: data formats, continuous media data, similarity-based retrieval (Lecture 1)	1
4.2	Multimedia Databases: data formats, continuous media data, similarity-based retrieval (Lecture 2)	1
4.3	Mobile data management: Mobile computing architecture	1
4.4	Data management issues	1
4.5	Location-based services	1
4.6	Peer-to-peer systems and applications – application platforms.	1
	MODULE V	
5.1	Big Data – Motivation, Sources and Uses of Big Data	1
5.2	Querying Big Data (Lecture 1)	1
5.3	Querying Big Data (Lecture 2)	1
5.4	Big Data Storage Systems- Distributed File Systems	1
5.5	Sharding, Key-Value Storage Systems	1
5.6	Blockchain Databases- Overview, Blockchain Properties	1
5.7	Simple Blockchain Transactions	1
5.8	Data Management in a Blockchain, Emerging Applications	1

CO Assessment Questions	
1	1. Explain the architecture of a DDBMS. Within the context of a centralized DBMS, briefly explain new components introduced by the distribution of data. 2. Using your own simple examples and/or time-line diagrams, describe how data may be damaged, lost or misread in a multi-user database if concurrency control techniques are not fully implemented. 3. Explain the naming problem in distributed databases.

2	1. Consider the following database that contains information about directors and the films they have directed: Film (filmNbr, title, year) Director (directID, name) Directs (directID*, filmNbr*) Consider the following query: SELECT Film.title FROM Film, Director, Directs WHERE Film.filmNbr = Directs.filmNbr AND Director.directID = Directs.directID AND Director.name = 'Lucas'; Suppose this query is run by executing the following sequence of steps: 1. R1 = Join of Director and Directs 2. R2 = Join of Film and R1 3. R3 = Selection (name = 'Lucas') from R2 4. R4 = Projection (title) from R3 (i) Draw the query tree for the above query. (ii) What is the problem caused if the query is executed based on the sequence above. (iii) Suggest a new sequence that will make the query more efficient. 2. Describe the typical steps involved when processing a high level query.
3	1. List the main types of threats that could affect a database system and describe the controls that you would use to counteract them. 2. A password profile is a tool used to enforce database security. For example, it can be used to check the complexity of a password. List three other mechanisms that can be achieved through this tool. 3. Describe two mechanisms for guarding against SQL injection.
4	1. Give a brief outline of mobile computing architecture. 2. Describe the transaction model used by mobile databases. 3. Explain the most important issues related to location-based services.

5	1. Suppose you need to store a very large number of small files, each of size say 2 kilobytes. If your choice is between a distributed file system and a distributed key-value store, which would you prefer, and explain why. 2. Explain the benefits and potential risks of sharding. 3. Explain the concept of a blockchain fork. List the two types of fork and explain their differences. 4. Since blockchains are immutable, how is a transaction abort implemented so as not to violate immutability?

<table>
<tr><td rowspan="2">24CSE684</td><td rowspan="2">Object Oriented System Design</td><td>L</td><td>T</td><td>P</td><td>J</td><td>S</td><td>C</td><td>Year of Introduction</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>3</td><td>3</td><td>2024</td></tr>
</table>

Preamble: This course enables students to understand the fundamental principles, methodologies, and practical aspects of object-oriented analysis and design and apply them for creating high-quality software systems. This course covers the basics of Object-Oriented Systems Development phases, UML Diagram, Object oriented analysis process, Object oriented design process including the designing of classes, Access layer and View layer.

Prerequisite: Advanced Programming

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the phases and methodologies in object-oriented software development. **(Understand Level)**
CO2	Design UML diagrams for real world application (**Analyze Level)**
CO3	Make use the concepts of Usecase-driven object-oriented analysis with Unified approach. **(Analyze Level)**
CO4	Select suitable pattern for the given scenario. **(Analyze Level)**
CO5	Apply the principles of object-oriented design to solve a given problem (**Understand Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										3
CO2	3	3										3
CO3	3	3										3
CO4	3	3										3
CO5	3	3										3
CO6	3	3										3

Assessment Pattern

<table>
<tr><th rowspan="2">Bloom’s Category</th><th colspan="3">Continuous Assessment Tools</th><th rowspan="2">End Semester Examination</th></tr>
<tr><th>Test 1</th><th>Test 2</th><th>Other tools</th></tr>
<tr><td>Remember</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Understand</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Apply</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Analyse</td><td></td><td></td><td>✓</td><td></td></tr>
<tr><td>Evaluate</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Create</td><td></td><td></td><td></td><td></td></tr>
</table>

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I :Introduction to Object-Oriented Systems Development (7 hrs)

Overview of Object basics. The software development process, building high quality software, Object oriented system development life cycle: a use case driven approach- Object oriented Analysis, Object-oriented Design, Prototyping, Implementation: Component based development and Rapid application development, Incremental Testing. Reusability. Object oriented Methodologies- Rumbaugh et al.'s object modelling technique, The Booch methodology, The Jacobson et al. methodology. The unifies approach to software development.

MODULE II : UML Diagrams (7 hrs)

Overview of class and Use case diagram. Behavior diagram-Interaction diagram-sequence diagram, collaboration diagram, state chart diagram, Activity diagram.

Implementation diagram-Component diagram, Deployment diagram.

MODULE III : Object oriented analysis process (7 hrs)

Use case driven object-oriented analysis: the unified approach. Use case model. Developing effective documentation. The concept of classification. Approaches for identifying classes-Noun phrase approach, common class patterns approach, use case driven approach, Classes, Responsibilities and Collaborators (CRC) approach. Analyzing relationship among classes, Class responsibilities- Identifying and defining attributes and methods.

MODULE IV :Object oriented design process (7 hrs)

The object-oriented design processes. Design Axioms. Corollaries. Design Pattern Basics, Creational Patterns-Singleton Pattern, Factory Pattern, Factory Method Pattern; Structural Patterns-Adapter Pattern, Composite Pattern; Decorator Patterns, Proxy Pattern, Behavioral Patterns: Iterator Pattern, Strategy Pattern, Visitor Pattern Command Pattern, Chain of Responsibility.

MODULE V : Designing of classes, Access layer and View layer (8 hrs)

The process of designing classes, Class Visibility-Designing well defined public, private and protected protocols. Refining attributes. Designing methods and protocols. Designing access layer classes. Macro level UI design process. Micro level UI design activities.

Text books

1. Ali Bahrami, Object Oriented Systems Development, Tata Mcgraw-Hill Edition, 2017.
2. G Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides, and Grady Booch. Design Patterns: Elements of Reusable Object-Oriented Software.,1994
3. Cay Horstmann, John Wiley & Sons, Object Oriented Design & Patterns, 2004
4. Grady Booch, Robert A. Maksimchuk, Michael W. Engle, Bobbi J. Young, Jim Conallen, Kelli A, Houston. Object-Oriented Analysis and Design with Applications, 2007.

Reference books

1. Cay Horstmann, John Wiley & Sons, Object-Oriented Analysis & Design: Understanding System Development with UML 2.0, 2004
2. Steve Mcrobb Simon Bennett, Ray Farmer, Object - Oriented Systems Analysis and Design Using UML, 2010
3. Michael R Blaha, James R Rumbaugh, Object Oriented Modeling and Design with UML, 2e, 2011

Suggested MOOC Courses

4. Object Oriented Analysis and Design by Prof. Partha Pratim Das, Prof. Samiran Chattopadhyay, Prof. Kausik Datta, IIT Kharagpur.
5. Object Oriented System Development Using UML, Java And Patterns by By Prof. Rajib Mall, IIT Kharagpur.

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours (36 hrs)
MODULE 1		
1.1	Overview of Object basics.	1
1.2	The software development process, building high quality software	1
1.3	Object oriented system development life cycle: a use case driven approach- Object oriented Analysis, Object-oriented Design	1
1.4	Prototyping, Implementation: Component based development and Rapid application development, Incremental Testing. Reusability	1
1.5	Object oriented Methodologies- Rumbaugh et al.'s object modelling technique	1
1.6	The Booch methodology	1
1.7	The Jacobson et al. methodology. The unifies approach to software development	1
MODULE II		
2.1	Overview of class and Use case diagram	1
2.2	Behavior diagram-Interaction diagram-	1
2.3	Sequence diagram, collaboration diagram	
2.4	State chart diagram	1
2.5	Activity diagram	1
2.6	Implementation diagram-Component diagram	1
2.7	Deployment diagram	1
MODULE III		
3.1	Use case driven object-oriented analysis: the unified approach.	1
3.2	Use case model	1
3.3	Developing effective documentation.	1
3.4	The concept of classification. Approaches for identifying classes-Noun phrase approach	1
3.5	Common class patterns approach, use case driven approach	1
3.6	Classes, Responsibilities and Collaborators (CRC) approach	1
3.7	Analyzing relationship among classes, Class responsibilities- Identifying and defining attributes and methods	1
MODULE IV		
4.1	The object-oriented design processes. Design Axioms.	1
4.2	Corollaries.	1
4.3	Design Pattern Basics, Creational Patterns-Singleton Pattern, Factory Pattern, Factory Method Pattern	1

4.4	Structural Patterns-Adapter Pattern, Composite Pattern	1
4.5	Decorator Patterns, Proxy Pattern	1
4.6	Behavioral Patterns: Iterator Pattern, Strategy Pattern, Visitor Pattern	1
4.7	Command Pattern, Chain of Responsibility	1
	MODULE V	
5.1	The process of designing classes, Class Visibility-Designing well defined public, private and protected protocols	1
5.2	Refining attributes. Designing methods and protocols	1
5.3	Designing access layer classes	1
5.4	Designing access layer classes	1
5.5	Macro level UI design process-Lecture 1	1
5.6	Macro level UI design process-Lecture 2	1
5.7	Micro level UI design activities-Lecture 1	1
5.8	Micro level UI design activities-Lecture 2	1

CO Assessment Questions	
1	a) Explain different phases of Object modeling technique. b) With an example, Explain the applicability of Booch & Jacobson methodology. c) Explain the different phases of the object-oriented software development process, emphasizing the role of each phase in building high-quality software.
2	a) Design a state chart diagram for a traffic signal system, identifying various states and transitions. b) Design a deployment diagram for a distributed online banking system, considering server locations and communication paths. c) Explore the process of online shopping. Analyze the steps involved in a typical online shopping transaction and create an activity diagram to represent the workflow. d) Imagine a real-time messaging application. Analyze a specific scenario where users exchange messages and create a sequence diagram to depict the interaction between different components. e) The Book Store sells textbooks but also many other items, ranging from Rhode Island College (RIC) sweatshirts to computers. The text purchasing department has unique characteristics, including advance notice from faculty members and issues dealing with unsold copies. Purchasing the other items is as for any retail store. An extension of both areas is the checkout (or sales) process. This process should include the cash registers, scanners, and sales slips. In fact, this process often is unduly slow. Design an activity diagram to show the business process of the book store.

3	You have been assigned to analyze and document the requirements for a new online shopping platform. Apply the principles of Use Case-Driven Object-Oriented Analysis using the Unified Approach to identify key actors, use cases, and their relationships. a) Analyze the various stakeholders involved in the online shopping platform. Identify and categorize actors based on their roles and interactions within the system b) Develop a comprehensive list of use cases that represent the functionalities and interactions within the online shopping system. c) Design appropriate UML diagrams to visually represent the system's structure and the flow of interactions.
4	Describe the suitable pattern best meets each of these situations below? Explain how two design *principles* apply to this design. a) The model stores a collection of blocks. Blocks can be medal or wood; can be painted, sanded, or chrome plated; and can sometimes be radioactive or magnetized. What design pattern would allow the system to easily add new types of blocks without changing existing code? b) The model for a game stores robot. The robot navigates a maze that has obstacles. While playing the game, the robot can be upgraded with new parts that change its abilities like speed, weapons, and shields. Which design principle allows the robot object to change its behaviour at runtime in flexible ways. c) The model stores a phone number, and the UI (a keypad) allows the user to enter digits one at a time. A different part of the UI wants to respond to each key being entered; however, a) the two parts of the UI should be decoupled, and b) the model should be decoupled from the UI (model knows nothing about the UI). Which pattern would allow this? d) A library supports recursively searching a directory for files. It allows the client code to provide it an object to filter the results. For each file which the library finds, it will ask the filter object if that file should be accepted or rejected.
5	a) A touch screen is one way to interact with the ViaNet kiosk. What are some other ways to interact with ViaNet kiosk? Use your imagination to design an interface. Also, design it for people with disability challenges. b) Imagine you are tasked with designing a system for an online library management platform. Apply the principles of object-oriented design to address the following aspects: i. Enumerate the potential objects and classes relevant to the library management system. ii. For each identified class, define the attributes and methods that encapsulate their behavior. iii. Identify opportunities for inheritance among the classes.

	Illustrate these relationships using class diagrams. iv. How encapsulation principles can be applied to protect the internal state of objects. v. how method overloading or overriding could be implemented in the context of the library management platform. vi. Propose and justify the application of one or more design patterns suitable for the library management system

24CSE694	Information Security	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The purpose of this course is to make learners to have thorough knowledge on Information security. This course covers different information security problems and Technologies. The concepts covered in this course enable the learners an understanding of need of Information Security and carryout development activities in the area of Information Security.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain different threats posed to Information Security in an organization (**Understand Level**)
CO2	Explain the importance of information security privacy principles, policies and issues (**Understand Level**)
CO3	Demonstrate different Access Controls and Authentication Methodologies. (**Apply Level)**
CO4	Explain different tools and methods to perform cyber crimes.(**Understand Level**)
CO5	Experiment different security tools used in Information Security Domain. (**Apply Level**)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3				2						3
CO2	3	3				2						3
CO3	3	3										3
CO4	3	3			3							3
CO5	3	3			3							3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

Module I: Introduction to Information Security (8 hours)

What Is Security? Key concepts in information security, Critical Characteristics of Information, Components of an Information System, Approaches to Information Security Implementation, Security in the Systems Development Life Cycle. The Need for Security: Introduction, Threats and Attacks, Compromises to Intellectual Property, Deviations to Quality of Services, Espionage or Trespass, Forces of Nature, Human Error or Failure, Information Extortion, Sabotage or Vandalism, Software Attacks, Technical Hardware and Software Failures or Errors, Technological Obsolescence, Theft, Defense In Depth.

Module II: Privacy Concepts (6 hours)		
Aspects of Information Privacy, Computer Privacy Problems – Threats to Personal Data Privacy-People Based Privacy Concerns- Privacy Principles and Policies-Individual Actions to Protect Privacy- Governments and Privacy-Identify theft-Privacy issues on the Web Data-Application of Cryptographic Techniques for Privacy Preservation.		
Module III: Identification, Authentication and Access Controls (6 hours)		
Identification, Authentication, Common Identification and Authentication Methods, Passwords, Biometrics, Hardware Tokens, What Are Access Controls? , Implementing Access Controls, Access Control Models, Physical Access Controls		
Module IV: Cyber Crimes And Cyber Security (8 hours)		
Cyber Crime and Information Security – classifications of Cyber Crimes – Tools and Methods – Password Cracking, Keyloggers, Spywares, SQL Injection – Network Access Control – Cloud Security – Web Security – Wireless Security		
Module V: Security Technology (8 hours)		
Intrusion Detection and Prevention Systems: Why use an IDPS? Types of IDPS, IDPS Detection Methods, Strengths and Limitations of IDPS, Deployment and Implementation of an IDPS , Security Information and Event Management (SIEM):Data Aggregation, Analysis, Operational Interface, Scanning and Analysis Tools: Port Scanners, Firewall Analysis Tools, Operating System Detection Tools, Vulnerability Scanners, Biometric Access Controls, Protecting Remote Connections , Scanning and Analysis Tools: Packet Sniffers, Wireless Security Tools, Firewalls, Protecting Remote Connections: Remote Access, VPNs		
Text books 1. Michael E. Whitman, Herbert J. Mattord, "Principles of Information Security", 6th edition, Cengage Learning India Private Limited, 2018. 2. Mark Stamp, Information Security: Principles and Practice, 2021, 3rd Edition, Wiley. 3. Joanna Lyn Grama, Legal and Privacy Issues in Information Security, 2020, 3rd Edition, Jones and Bartlett Publishers, Inc. 4. Nina Godbole, Sunit Belapure, "Cyber Security: Understanding Cyber crimes, Computer Forensics and Legal Perspectives", First Edition, Wiley India, 2011.		
Reference books 1. Jason Andress ,Fundamentals of Information Security A straight forward Introduction,2019.		
NPTEL online course :		
COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
MODULE 1		
1.1	What Is Security? Key concepts in information security, Critical Characteristics of Information.	1

1.2	Components of an Information System, Approaches to Information Security Implementation	1
1.3	Security in the Systems Development Life Cycle	1
1.4	The Need for Security: Introduction, Threats and Attacks, Compromises to Intellectual Property, Deviations to Quality of Services.	1
1.5	Espionage or Trespass, Forces of Nature,	1
1.6	Human Error or Failure, Information Extortion, Sabotage or Vandalism	1
1.7	Software Attacks, Technical Hardware and Software Failures or Errors	1
1.8	Technological Obsolescence, Theft, Defense In Depth.	1
MODULE II		
2.1	Aspects of Information Privacy, Computer Privacy Problems – Threats to Personal Data Privacy	1
2.2	People Based Privacy Concerns- Privacy Principles and Policies-	1
2.3	Individual Actions to Protect Privacy	1
2.4	Governments and Privacy-Identify theft	1
2.5	Privacy issues on the Web Data	1
2.6	Application of Cryptographic Techniques for Privacy Preservation.	1
MODULE III		
3.1	Identification, Authentication, Common Identification and Authentication Methods	1
3.2	Passwords	1
3.3	Biometrics	1
3.4	Hardware Tokens	1
3.5	What Are Access Controls? , Implementing Access Controls	1
3.6	Access Control Models, Physical Access Controls	1

MODULE IV		
4.1	Cyber Crime and Information Security	1
4.2	Classifications of Cyber Crimes	1
4.3	Tools and Methods – Password Cracking, Keyloggers, Spywares	1
4.4	SQL Injection	1
4.5	Network Access Control	1
4.6	Cloud Security	1
4.7	Web Security	1
4.8	Wireless Security	1
MODULE V		
5.1	Intrusion Detection and Prevention Systems: Why use an IDPS? Types of IDPS	1
5.2	IDPS Detection Methods, Strengths and Limitations of IDPS, Deployment and Implementation of an IDPS	1
5.3	Security Information and Event Management (SIEM):Data Aggregation, Analysis, Operational Interface	1
5.4	Scanning and Analysis Tools: Port Scanners	1
5.5	Firewall Analysis Tools, Operating System Detection Tools	1
5.6	Vulnerability Scanners, Biometric Access Controls, Protecting Remote Connections	1
5.7	Scanning and Analysis Tools: Packet Sniffers, Wireless Security Tools	1
5.8	Firewalls, Protecting Remote Connections: Remote Access, VPNs	1

CO Assessment Questions	
1	Different Types of Attack may occur to Systems. Judge the different attacks/Threats and classify which type of breach occurred. In the context of vulnerabilities and Threats, justify the need of Information Security in an organization.
2	Discuss about individual actions to protect the privacy of information

3	Identify suitable security measure using different Access Controls and Authentication methods to secure systems.
4	Illustrate how password cracking is performed in an information system.
5	Use any security methodologies/tools to experiment Security measures for specific area. Using Packet sniffers, Explain how troubleshooting for any network issue can be done.

24CSE6104	MOBILE AND WIRELESS SECURITY	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The course on Mobile and Wireless Security is a cutting-edge program designed to provide comprehensive knowledge and skills in securing mobile and wireless technologies. In an era where mobile devices and wireless networks play a pivotal role in our interconnected world, this course aims to equip participants with the expertise needed to address the unique security challenges associated with these technologies.

Prerequisite: Wireless Networking, Information Systems Security, Operating Systems

Course Outcomes: After the completion of the course the student will be able to

CO 1	Familiarize with the issues and technologies involved in designing a wireless and mobile system that is robust against various attacks. (**Understand level**)
CO 2	Gain knowledge and understanding of the various ways wireless networks can be attacked and tradeoffs in protecting networks. (**Understand level**)
CO 3	Acquire broad knowledge of the state-of-the-art and open problems in wireless and mobile security, thus enhancing their potential to research or pursue a career in this rapidly developing area. (**Apply level**)
CO 4	Recognize various security issues in cloud computing. (**Apply level**)
CO 5	Learn strong foundation in game theory and its practical applications in wireless networks (**Apply level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	2			1				1		
CO 2	3	3	3							1		
CO 3	3	3	3		3				2			
CO 4	3	3	1			1						2
CO 5	3	3	3			1					2	

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA							
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Practical [P]		Total Marks
		Assignment	Test-1	Test-2	Class work	Lab Exam	
3-0-0-0	5	15	10	10			40

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub-divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Security Issues in Wireless and Mobile Communications (7 hrs)

Security Requirements in Wireless and Mobile Communications, Security for Mobile Applications, Wireless Standards Security: Vulnerabilities in existing Wireless networks, Bluetooth Low Energy (BLE) Security, 3G Security, 4G Security, 5G Security, Wifi Security. Trends and Upcoming Wireless Networks: Upcoming Wireless Networks, Trends and Security challenges in wireless networks

MODULE II: Trust Assumptions and Adversary models (7 hours)

Trust, Trust in Ubiquitous computing. Physical Layer Security: Jamming, Wiretapping, Physical Layer defenses. MAC Layer Security: Operating principles of IEEE 802.11, Detecting selfish behavior in hotspots, Selfish behavior in pure ad hoc networks, MAC layer defenses.

Module III: Network Layer Security (8 hours)

Securing ad hoc network routing protocols, Secure routing in sensor networks, Network layer defenses. Privacy in Wireless Networks: Privacy in RFID Systems, Location Privacy in vehicular networks, Privacy-preserving routing in ad hoc networks

MODULE IV: Data Center Operations (7 hours)

Security challenge, implement "Five Principal Characteristics of Cloud Computing, Datacenter Security Recommendations Encryption for Confidentiality and Integrity, Encrypting data at rest, Key Management Lifecycle, Cloud Encryption Standards.

MODULE V: Game Theory (7 hours)

Normal Form Games, Strict Dominance, Weak Dominance, Iterated Dominance, Pure and Mixed Strategy Nash Equilibrium, Extensive Form Games, Backward Induction, Subgame Perfect Nash Equilibrium, Game Theory in Wireless Networks, Forwarder's dilemma, Joint Packet Forwarding game, Multiple Access Game and Jamming Game. Applications: RFID Security, Security for Wireless Sensor Networks, Security for Vehicular Networks.

Textbooks

1. Pallapa Venkataram, Satish Babu: "Wireless and Mobile Network Security", 1st Edition, Tata McGraw Hill,2010.
2. Levente Buttyán and Jean-Pierre Hubaux, Security and Cooperation in Wireless Networks, 2008
3. Frank Adelstein, K.S.Gupta : "Fundamentals of Mobile and Pervasive Computing", 1st Edition, Tata McGraw Hill 2005.

Reference books

1. Randall k. Nichols, Panos C. Lekkas : "Wireless Security Models, Threats and Solutions", 1st Edition, Tata McGraw Hill, 2006.
2. Bruce Potter and Bob Fleck : "802.11 Security" , 1st Edition, SPD O'REILLY 2005.
3. James Kempf: "Guide to Wireless Network Security, Springer. Wireless Internet Security – Architecture and Protocols", 1st Edition, Cambridge University Press, 2008. Edition, O'Reilly Media, 2011.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1		
1.1	Security Issues in Wireless and Mobile Communications,	1
1.2	Security Requirements in Wireless and Mobile Communications, Security for Mobile Applications	2
1.3	Wireless Standards Security: Vulnerabilities in existing Wireless networks, Bluetooth Low Energy (BLE) Security, 3G Security, 4G Security, 5G Security,	2
1.4	Wifi Security. Trends and Upcoming Wireless Networks: Upcoming Wireless Networks, Trends and Security challenges in wireless networks	2
MODULE II		
2.1	Trust Assumptions and Adversary models: Trust, Trust in Ubiquitous computing.	1

2.2	Physical Layer Security: Jamming, Wiretapping, Physical Layer defenses.	2
2.3	MAC Layer Security: Operating principles of IEEE 802.11,	2
2.4	Detecting selfish behavior in hotspots, Selfish behavior in pure ad hoc networks, MAC layer defenses.	2
	MODULE III	
3.1	Securing ad hoc network routing protocols,	1
3.2	Secure routing in sensor networks, Network layer defenses.	2
3.3	Privacy in Wireless Networks: Privacy in RFID Systems,	2
3.4	Location Privacy in vehicular networks, Privacy-preserving routing in ad hoc networks	3
	MODULE IV	
4.1	Data Center Operations - Security challenge	1
4.2	Implementation of principal characteristics of cloud computing,	2
4.3	Datacenter Security Recommendations, Encryption for Confidentiality and Integrity	2
4.4	Encrypting data at rest, Key Management Lifecycle, Cloud Encryption Standards.	3
	MODULE V	
5.1	Game Theory: Normal Form Games, Strict Dominance, Weak Dominance, Iterated Dominance	2
5.2	Pure and Mixed Strategy Nash Equilibrium, Extensive Form Games, Backward Induction, Subgame Perfect Nash Equilibrium,	2
5.3	Game Theory in Wireless Networks, Forwarder's dilemma, Joint Packet Forwarding game, Multiple Access Game and Jamming Game.	2
5.4	Applications: RFID Security, Security for Wireless Sensor Networks, Security for Vehicular Networks	1

CO Assessment Questions	
1	How does encrypting data, both at the source code and during transmission, contribute to mobile app security
2	Explain the trade-offs between security and throughput in opportunistic encryption-based wireless security, and how does it impact the overall network performance

3	What are the security and privacy challenges associated with the mass deployment of RFID technology in wireless networks, and how can these challenges be addressed
4	What strategies can be employed to secure interfaces and APIs in cloud environments?
5	How does game theory contribute to modeling and analyzing routing problems in wireless networks?

24CSE6114	ADVANCED COMPUTER ARCHITECTURE	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course aims to provide students with an in-depth knowledge to a range of advanced topics in computer architecture by addressing key issues such as instruction set design, micro-architecture of superscalar processors, its interaction with other hardware components, and constraints to be addressed when going from single-core to multi-core systems. This course covers the basics of computer design and analysis, memory hierarchy, different levels of parallelism and some design trade-offs. This course helps the learner to develop software/hardware applications based on architectural framework.

Prerequisite: Computer Organization and Architecture

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand different processor architectures, system-level design processes and design challenges. **(Understand Level)**
CO 2	Analyze and interpret the performance of a processor based on various metrices. **(Analyze Level)**
CO 3	Understand the components and operation of a memory hierarchy and analyze the range of performance issues influencing its design. **(Analyze Level)**
CO 4	Identify the challenges of realizing different kinds of parallelism and leverage them for performance advancement. **(Apply Level)**
CO 5	Explore emerging computing trends, computing platforms, and design trade-offs and familiarize recent research themes and challenges. **(Understand Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	3	3								3
CO 2	3	2	2	2						2		3
CO 3	3	2	1	2						1		3
CO 4	3	2	2	2						1		3
CO 5	3	2	2							2		3

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate			✓	
Create			✓	

Assessment Pattern for Lab component

Bloom's Category	Continuous Assessment Tools	
	Class work	Test1

Remember		
Understand	✓	✓
Apply	✓	✓
Analyse	✓	✓
Evaluate	✓	
Create	✓	

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Marks distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	
	Total Marks: 0	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Fundamentals of Quantitative Design and Analysis (5 hours)

Classes of Computers- Classes of parallelism and Parallel Architectures. Trends in Technology, Power and Cost. Measuring, Reporting and Summarizing Performance. Quantitative Principles of Computer Design. The Processor Performance.

MODULE II: Instruction Level Parallelism (7 hours)

Instruction Level Parallelism- Concepts and Challenges. Basic Compiler Techniques for Exposing ILP, Advanced Branch Prediction, Overcoming Data Hazards with Dynamic Scheduling- Tomasulo’s Approach. Hardware-Based Speculation.

Module III: Data and Thread Level Parallelism (8 hours)
Data Level Parallelism- Vector Architecture, Graphics Processing Units. Thread Level Parallelism- Multithreading: Exploiting Thread-Level Parallelism, Centralized Shared Memory, Distributed Shared Memory.
MODULE IV: Warehouse-Scale Computers (7 hours)
Warehouse-Scale Computers- Programming Models and Workloads for WSC, Computer Architecture of Warehouse-Scale Computers, Efficiency and Cost. Cloud Computing. Domain-Specific Architectures -Google's Tensor Processing Unit.
MODULE V: Modern Parallel Computing Paradigms (9 hours)
Overview Superscalar and VLIW architectures- EPIC, The Intel IA-64 Architecture. Multi-core architectures- Data marshaling for multi-core architectures, Heterogeneous core design, Core Fusion. On-chip interconnects (Network-on-Chip). Polymorphic architecture. Processing-in-Memory (PIM).
Text books 1. David. A. Patterson, John L. Hennessy, "Computer Architecture: A Quantitative approach", Morgan Kaufmann, 6th Edition 2019
Reference books 1. K.Hwang, Naresh Jotwani, "Advanced Computer Architecture, Parallelism, Scalability, Programmability", Tata McGraw Hill, 2nd Edition 2010 2. An Introduction to Parallel Programming, Peter S. Pacheco, 2011, 1st Edition, Morgan Kaufmann Publishers

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1		
1.1	Classes of Computers- Classes of parallelism and Parallel Architectures.	1
1.2	Trends in Technology, Power and Cost.	1
1.3	Measuring, Reporting and Summarizing Performance.	1
1.4	Quantitative Principles of Computer Design.	2
MODULE II		
2.1	Instruction Level Parallelism- Concepts and Challenges.	1
2.2	Basic Compiler Techniques for Exposing ILP	1
2.3	Advanced Branch Prediction	1
2.4	Dynamic Scheduling	1
2.5	Tomasulo's Algorithm, Illustration with example	2
2.6	Hardware-Based Speculation	1
MODULE III		
3.1	Vector Architecture	2
3.2	Graphics Processing Units- Architecture	2
3.3	Multithreading: Exploiting Thread-Level Parallelism	1
3.4	Centralized Shared Memory architecture.	2

3.5	Distributed Shared Memory.	1
MODULE IV		
4.1	Programming Models and Workloads for WSC.	1
4.2	Computer Architecture of Warehouse-Scale Computers	2
4.3	Efficiency and Cost of WSC.	1
4.4	Cloud Computing.	1
4.5	Domain-Specific Architectures- Guidelines	1
4.6	Google's Tensor Processing Unit.	1
MODULE V		
5.1	VLIW architectures.	1
5.2	EPIC, The Intel IA-64 Architecture.	1
5.3	Data marshaling for multi-core architectures	1
5.4	Heterogeneous core design, Core Fusion.	1
5.5	On-chip interconnects	1
5.6	Polymorphic architecture	2
5.7	Processing-in-Memory (PIM).	2

CO Assessment Questions	
1	Describe the importance of ISA in the design process. How does the choice of ISA impact the overall system design? Provide examples of ISAs and their applications.
2	Suppose we made the following measurements: Frequency of FP operations = 25%, Average CPI of FP operations = 4.0, Average CPI of other instructions = 1.33, Frequency of FSQRT = 2%, CPI of FSQRT = 20 Assume that the two design alternatives are to decrease the CPI of FSQRT to 2 or to decrease the average CPI of all FP operations to 2.5. Compare these two design alternatives using the processor performance equation
3	Determine whether a 32 KB four-way set associative L1 cache has a faster memory access time than a 32 KB two-way set associative L1 cache. Assume the miss penalty to L2 is 15 times the access time for the faster L1 cache. Ignore misses beyond L2. Which has the faster average memory access time? (Miss rate for two-way set associative cache is 0.038 and four-way set associative cache is 0.037)
4	Suppose we have a deeply pipelined processor, for which we implement a branch-target buffer for the conditional branches only. Assume that the misprediction penalty is always four cycles and the buffer miss penalty is always three cycles. Assume a 90% hit rate, 90% accuracy, and 15% branch frequency.

	How much faster is the processor with the branch-target buffer versus a processor that has a fixed two-cycle branch penalty? Assume a base clock cycle per instruction (CPI)) without branch stalls of one.
5	Explore the challenges associated with data movement in traditional architectures and how Processing-in-Memory aims to address these challenges. What impact does this have on energy efficiency?

24CSE6124	Data Storage Technologies And Networks	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course aims to equip learners with a foundational comprehension of enterprise data storage and management technologies. Students will acquire knowledge of diverse storage systems, storage networking technologies, storage virtualization, business continuity, and storage recovery methodologies. This comprehensive curriculum lays the groundwork for a subtle understanding of these critical concepts, enabling students to delve deeper into each topic in subsequent explorations.

Prerequisite: Proficient knowledge in computer networks

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the design of a data center and storage requirements. **(Understand Level)**
CO2	Identify the components of RAID and Intelligent Storage System. **(Apply Level)**
CO3	Summarize Direct Attached Storage and Storage Area Networks. **(Understand Level)**
CO4	Compare various types of storage and their properties. **(Understand Level)**
CO5	Outline the different forms of virtualization and their benefits. (**Understand Level)**
CO6	Explain backup and archiving in the context of recovery and business continuity. **(Understand Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										3
CO2	3	3										3
CO3	3	3										3
CO4	3	3										3
CO5	3	3										3
CO6	3	3										3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Information Storage System (7hrs)

Introduction to Information Storage and Management- Information Storage, Evolution of Storage Technology and Architecture, Data Center Infrastructure, Key Challenges in Managing Information, Information Lifecycle, Storage System Environment-Components of a Storage System Environment, Disk Drive Components, Disk Drive Performance, Fundamental Laws Governing Disk Performance, Logical Components of the Host, Application Requirements and Disk Performance

MODULE II: Data Protection and Intelligent Storage System (5hrs)

Data Protection: RAID - Implementation of RAID, RAID Array Components, RAID Levels, RAID Comparison, RAID Impact on Disk Performance, Hot Spares. Intelligent Storage System -Components of an Intelligent Storage System, Intelligent

Storage Array, Concepts in Practice: EMC CLARiiON and Symmetrix.

MODULE III: Direct Attached Storage and Storage Area Networks (6hrs)

Direct-Attached Storage- Types of DAS, DAS Benefits and Limitations, Disk Drive Interfaces, Introduction to SCSI, Introduction to Parallel SCSI, SCSI Command Model, Storage Area Networks-Fibre Channel, SAN and Its Evolution, Components of SAN, FC Connectivity, Fibre Channel Ports, Fibre Channel Architecture, Zoning, Fibre Channel Login Types. Concepts in Practice: EMC Connectrix.

MODULE IV: Network Attached Storage,IP SAN and CAS (9hrs)

Network attached storage-General purpose servers vs NAS Devices, Benefits of NAS, NAS file I/O, Components of NAS, NAS Implementations, NAS file sharing protocols, NAS I/O operations, Concepts in practice: EMC Celerra.IP SAN- iSCSI, FCIP, Content Addressed Storage: Fixed content and Archives, Types of Archives, Features and Benefits of CAS, CAS Architecture, Object Storage and Retrieval in CAS, Concepts in practice: EMC Centera.

MODULE V: Storage Virtualization, BC, Backup and Recovery (9hrs)

Storage Virtualization- Forms of Virtualization, SNIA Storage Virtualization taxonomy, Storage Virtualization Configurations, Storage Virtualization challenges, Types of storage virtualization, Concepts in practice: EMC Invista. Introduction to business continuity-Information Availability, BC terminology, BC Planning Life Cycle, Failure Analysis, Concepts in Practice: EMC Power path. Backup and Recovery- Backup Purpose, Backup Considerations, Backup granularity, Recovery considerations, Backup methods, Backup process, Backup and Restore operations, Backup Topologies, Backup in NAS environments, Concepts in practice: EMC Networker.

Text books

1. G. Somasundaram, A. Shrivastava, EMC Corporation : Information Storage and Management, Wiley publishing, 2018.
2. Robert Spalding, Storage Networks: The Complete Reference, Tata McGraw Hill,MH, 2017

Reference books

1. Marc Farley: Building Storage Networks, 2nd Edition, Tata McGraw Hill, Osborne, 2001.Andrew S. Tanenbaum, Computer Networks, PHI, 3/e, 2003
2. Meeta Gupta: Storage Area Network Fundamentals, 2nd Edition, Pearson Education Limited,2002.
3. Data Storage Networking: Real-World Skills for The Comptia Storage+ Certification and Beyond (SYBEX),2015

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1 (7hrs)		
1.1	Information Storage, Evolution of Storage Technology and Architecture	1

1.2	Data Center Infrastructure, Key Challenges in Managing Information	1
1.3	Information Lifecycle	1
1.4	Components of a Storage System Environment	1
1.5	Disk Drive Components, Disk Drive Performance	1
1.6	Fundamental Laws Governing Disk Performance, Logical Components of the Host	1
1.7	Application Requirements and Disk Performance.	1
	MODULE II (5hrs)	
2.1	Implementation of RAID, RAID Array Components	1
2.2	RAID Levels	1
2.3	RAID Comparison, RAID Impact on Disk Performance, Hot Spares	1
2.4	Components of an Intelligent Storage System, Intelligent Storage Array	1
2.5	EMC CLARiiON and Symmetrix.	1
	MODULE III (6hrs)	
3.1	Types of DAS, DAS Benefits and Limitations, Disk Drive Interfaces	1
3.2	Introduction to Parallel SCSI, SCSI Command Model,	1
3.3	Fibre Channel, SAN and Its Evolution, Components of SAN	1
3.4	FC Connectivity	1
3.5	Fibre Channel Ports, Fibre Channel Architecture,Zoning	1
3.6	Fibre Channel Login Types, EMC Connectrix.	1
	MODULE IV (9hrs)	
4.1	General purpose servers vs NAS Devices, Benefits of NAS, NAS file I/O, Components of NAS	1
4.2	NAS Implementations	1

4.3	NAS file sharing protocols, NAS I/O operations	1
4.4	EMC Celerra	1
4.5	iSCSI	1
4.6	FCIP	1
4.7	Fixed content and Archives, Types of Archives, Features and Benefits of CAS	1
4.8	CAS Architecture, Object Storage and Retrieval in CAS	1
4.9	EMC Centera	1
	MODULE V (9hrs)	
5.1	Storage Virtualization- Forms of Virtualization, SNIA Storage Virtualization taxonomy, Storage Virtualization Configurations	1
5.2	Storage Virtualization challenges, Types of storage virtualization	1
5.3	EMC Invista	1
5.4	Information Availability	1
5.5	BC terminology, BC Planning Life Cycle, Failure Analysis	1
5.6	EMC Power path	1
5.7	Backup Purpose, Backup Considerations, Backup granularity, Recovery considerations, Backup methods, Backup process	1
5.8	Backup and Restore operations ,Backup Topologies, Backup in NAS environments,	1
5.9	Concepts in practice: EMC Networker	1

CO Assessment Questions	
1	1. A hospital uses an application that stores patient X-ray data in the form of large binary objects in an Oracle database. The application is hosted on a UNIX server, and the hospital staff accesses the X-ray records through a Gigabit Ethernet backbone. Storage array provides storage to the UNIX server, which has 6 terabytes of usable capacity. ■ Explain the core elements of the data center. What are the typical challenges the storage management team may face in meeting the service-level demands of the hospital staff? ■ Describe how the value of this patient data might change over time
2	1. An application has 1,000 heavy users at a peak of 2 IOPS each and 2,000 typical users at a peak of 1 IOPS each, with a read/write ratio of 2:1. It is estimated that the application also experiences an overhead of 20 percent for other workloads. Calculate the IOPS requirement for RAID 1, RAID 3, RAID 5, and RAID 6. 2. Consider a scenario in which an I/O request from track 1 is followed by an I/O request from track 2 on a sector that is 180 degrees away from the first request. A third request is from a sector on track 3, which is adjacent to the sector on which the first request is made. Discuss the advantages and disadvantages of using the command queuing algorithm in this scenario.
3	1. If three hard disk drives are connected in a daisy chain and communicate over SCSI, explain how the CPU will perform I/O operations with a particular device. 2. Describe the process of assigning FC address to a node when logging in to the network for the first time.
4	1. SAN is configured for a backup to disk environment, and the storage configuration has additional capacity available. Can you have a NAS gateway configuration use this SAN? Discuss the implications of sharing the backup-to-disk SAN environment with NAS 2. A company is considering implementing storage. They do not have a current storage infrastructure to use, but they have a network that gives them good performance. Discuss whether native or bridged iSCSI should be used and explain your recommendation. 3. To access data in a SAN, a host uses a physical address known as a logical block address (LBA). A host using a CAS device does not use (or need) a physical address. Why?
5	1. Frequently, storage arrays in a data center are replaced with newer arrays to take advantage of technology advancements and cost benefits and to allow business growth. Migrating data from old arrays

	to a new array has now become a routinely performed activity in data centers. Do a survey of host-based, storage array–based, and virtualization appliance–based migration methods. Detail the advantages and disadvantages. Consider a migration scenario in which you are migrating from a DAS to a SAN environment. 2. How can a block-level virtualization implementation be used as a data migration tool? Explain how data migration will be accomplished and discuss the advantages of using this method for storage. Compare this method to traditional migration methods.
6	1 The IT department of a bank promises customer access to the currency conversion rate table between 9:00 am and 4:00 pm from Monday to Friday. It updates the table every day at 8:00 am with a feed from the mainframe system. The update process takes 35 minutes to complete. On Thursday, due to a database corruption, the rate table could not be updated. At 9:05 am, it was established that the table had errors. A rerun of the update was done and the table was recreated at 9:45 am Verification was run for 15 minutes and the rate table became available to the bank branches. What was the availability of the rate table for the week in which this incident took place, assuming there were no other issues. 2 There are limited backup devices in a file sharing NAS environment. Suggest a suitable backup implementation that will minimize the network traffic, avoid any congestion, and at the same time not impact the production operations. Justify your answer.

24CSE6134	Medical Imaging	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course enables the learners to understand the fundamental principles of different medical imaging techniques used for disease diagnosis. This course covers the imaging techniques such as X-Ray Computed Tomography, Ultrasound, Magnetic Resonance Imaging, Infrared imaging and hybrid imaging. It will help the students to gain insights into different imaging modalities and their real-world benefits and potential drawbacks.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Describe the principles and physics underlying ultrasound imaging, including the generation and propagation of ultrasound waves. **(Understand Level)**
CO2	Explain the operating principle, instrumentation and imaging techniques of X-Ray Computed Tomography, PET and SPECT. **(Apply Level)**
CO3	Describe the principles and image formation mechanism used in Magnetic Resonance Imaging. **(Apply Level)**
CO4	Describe the working of hybrid imaging modalities in medicine. **(Understand Level)**
CO5	Explain the concept of Infrared imaging and thermal detectors. **(Understand Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										3
CO2	3	3										3
CO3	3	3										3
CO4	3	3										3
CO5	3	3										3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA						
Course Structure [L-T-P-J]	Attendance	Theory [L- T]				Total Marks
		Assignment	Test-1	Test-2		
3-0-0-0	5	15	10	10		**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	**3 hrs**

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Ultrasound Imaging (6 hrs)

Basic physics of ultrasound – characteristic impedance, wavelength, frequency and velocity of propagation, Absorption, beam width, resolution. Ultra Sound in Medicine – Transducers and its types, Block diagram of an ultrasound machine. Principles of image formation, captureand display - A-mode, B-mode and M-mode displays, Applications, Doppler Ultrasound and Colour flow mapping

MODULE II : X-Ray computed tomography (7 hrs)

Principles of sectional imaging, Generations, data acquisition system, components, image formation principles, conversion of x-ray data into scan image. Image reconstruction from projections CT reconstruction - Radon transform, inverse radon transform, back projection, operator-convolution back projection, parallel beam geometry, Fan beam geometry. 2D image reconstruction techniques - Iteration and Fourier methods, Types of CT scanners – spiral CT, multi slice CT.

MODULE III : Magnetic Resonance Imaging (9 hrs)

Basic principles of magnetic resonance – magnetic moment, FID, excitation and emission, principles of image formation. Basic MRI technique - T1 weighted imaging, T2 weighted imaging, spin density weighted imaging, Gradient echo imaging. Pulse sequences - spin echo, gradient echo imaging sequence. MRI instrumentation – magnets, gradient system, RF coils, receiver system. Image acquisition and reconstruction techniques – MRI Fourier reconstruction. Functional MRI, BOLD signal, Clinical applications.

MODULE IV : Radiation and Hybrid Imaging (8 hrs)

Emission Computed Tomography, Radio isotope imaging, Radio nuclides for imaging, Rectilinear & Linear scanners, PET & SPECT – principle, Gamma Camera. Hybrid Imaging instrumentation, MR- PET Instrumentation, Mutual interference between MR and PET, MR Compatible PET detector technology, MR-PET system architecture. PET-CT, SPECT-CT.

MODULE V : Infrared Imaging (6 hrs)

Physics of thermography, IR Detectors - photon & thermal detectors, thermal uncooled IR detectors, resistive micro bolometers, pyroelectric and ferroelectric detectors, thermoelectric detectors. Pyroelectric vidicon camera, camera characterization, thermographic image processing.

Text books

1. Webb, The Physics of Medical Imaging, IOP Publishing Ltd., 1988.
2. Peter Fish, The Physics of Diagnostic Ultrasound, John Wiley & sons, England, 1990.

Reference books

1. Douglas A Christensen: Ultrasonic Bioinstrumentation, John Wiley, New York, 1988.
2. M N Rehani: Physics of Medical Imaging, Macmillian India Ltd., 1991.
3. D L Hykes, W R Hedrick & D E Starchman: Ultrasound Physics & Instrumentation,Churchill Livingstone, Melbourne, 1985.
4. Atam Dhavan, Medical Image Analysis,Wiley IEEE Press, 2003.

Suggested MOOC Courses

1. Introduction to Biomedical Imaging Systems, Prof. Arun K. Thittai | IIT Madras

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Basic physics of ultrasound – characteristic impedance, wavelength, frequency and velocity of propagation, Absorption, beam width, resolution.	1

1.2	Ultra Sound in Medicine – Transducers and its types.	1
1.3	Block diagram of an ultrasound machine.	1
1.4	Principles of image formation, capture.	1
1.5	Ultra Sound display - A-mode, B-mode and M-mode displays, Applications Organizational context – Foundations	1
1.6	Doppler Ultrasound and Colour flow mapping	1
	MODULE II	
2.1	Principles of sectional imaging, Generations, data acquisition system	1
2.2	Components, image formation principles, conversion of x-ray data into scan image	1
2.3	Image reconstruction from projections CT reconstruction - Radon transform, inverse radon transform	1
2.4	Back projection, operator-convolution back projection	1
2.5	Parallel beam geometry, Fan beam geometry	1
2.6	2D image reconstruction techniques - Iteration and Fourier methods	1
2.7	Types of CT scanners – spiral CT, multi slice CT	1
	MODULE III	
3.1	Basic principles of magnetic resonance – magnetic moment, FID, excitation and emission, principles of image formation	1
3.2	Basic MRI technique - T1 weighted imaging, T2 weighted imaging	1
3.3	Spin density weighted imaging, Gradient echo imaging	1
3.4	Pulse sequences - spin echo, gradient echo imaging sequence – Lecture 1	1
3.5	Pulse sequences - spin echo, gradient echo imaging sequence – Lecture 2	1
3.6	MRI instrumentation – magnets, gradient system, RF coils, receiver system	1
3.7	Image acquisition and reconstruction techniques – MRI Fourier reconstruction	1
3.8	Functional MRI, BOLD signal	1

3.9	Clinical applications	1
	MODULE IV	
4.1	Emission Computed Tomography	1
4.2	Radio isotope imaging, Radio nuclides for imaging	1
4.3	Rectilinear & Linear scanners	1
4.4	PET & SPECT – principle, Gamma Camera	1
4.5	Hybrid Imaging instrumentation, MR- PET Instrumentation	1
4.6	Mutual interference between MR and PET, MR Compatible PET detector technology	1
4.7	MR-PET system architecture	1
4.8	PET-CT, SPECT-CT	1
	MODULE V	
5.1	Physics of thermography	1
5.2	IR Detectors - photon & thermal detectors, thermal uncooled IR detectors	1
5.3	Resistive micro bolometers, pyroelectric and ferroelectric detectors	1
5.4	Thermoelectric detectors	1
5.5	Pyroelectric vidicon camera, camera characterization	1
5.6	Thermographic image processing	1

CO Assessment Questions	
1	1. Explain the significance of acoustic impedance in ultrasound imaging. What is the difference between acoustic impedance and acoustic absorption? 2. Justify the suitability of ultrasound in gynaecology. Identify the procedure for PNDT approval and its relevance in Indian scenario.
2	1. Referring appropriate literature, prepare a write up about the parameters to be checked in the quality assurance of Computed Tomography equipment for ensuring compliance with respective

	standards and specifications. Also, describe the test procedures and significance of such tests. 2. Compare iterative reconstruction techniques and filtered back projection in CT image reconstruction.
3	1. Consider an emergency situation where a patient is sandwiched between the main superconducting magnet of an MRI and a metal wheelchair with “missile effect”. Identify the emergency rescue system arranged in an MRI room for such a situation and illustrate the working of the same. Also estimate the approximate financial loss for the imaging centre to operate the rescue system with proper justification. 2. Illustrate the components of a clinical MRI system and explain functions of individual components.
4	1. Identify relevant standards and prepare a rough sketch and a project report for a room to install PET-CT Machine based on AERB regulations in India. 2. Explain the advantages of PET and SPECT imaging. List some radiotracers used in PET imaging and their applications.
5	1. Differentiate the thermal and photon detectors in infrared imaging. 2. Prepare a report on the clinical applications of thermography in rheumatology.

24CSE6144	Information Retrieval	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course aims to equip learners with a foundational comprehension of Information Retrieval. Students will acquire knowledge of Dictionaries and Tolerant Retrieval, Index and Dictionary Compression, Vector Space Models, Information retrieval system evaluation, Language Models, Web Search, and Link Analysis. This comprehensive curriculum lays the groundwork for a subtle understanding of these critical concepts, enabling students to delve deeper into each topic in subsequent explorations.

Prerequisite: Proficient knowledge in Data Structure

Course Outcomes: After the completion of the course the student will be able to

CO1	Summarize the various Information Retrieval models. **(Understand Level)**
CO2	Identify the various methods for index construction and compression. **(Apply Level)**
CO3	Utilize the concepts of scoring, term weighting, and vector space models. **(Apply Level)**
CO4	Outline the measures to evaluate the effectiveness of an IR system. (**Understand Level)**
CO5	Explain the fundamental features of the web and its ranking mechanisms. **(Understand Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										3
CO2	3	3										3
CO3	3	3	1									3
CO4	3	3										3
CO5	3	3										3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Dictionaries and Tolerant Retrieval (7hrs)

Boolean Retrieval-An example information retrieval problem, Inverted index, Processing Boolean queries, The extended Boolean model versus ranked retrieval, Search structures for dictionaries, Wildcard queries-General wildcard queries, k-gram indexes for wildcard queries, Spelling correction-Implementing spelling correction, Forms of spelling correction, Edit distance, k-gram indexes for spelling correction, Context sensitive spelling correction

MODULE II: Index Compression and Dictionary Compression (7hrs)

Index construction-Hardware basics, Blocked sort-based indexing, Single-pass in-memory indexing, Distributed indexing, Dynamic indexing, Index Compression-Heaps' law, Statistical properties of terms- Zipf's law, Dictionary compression- Dictionary as a string, Blocked storage,

MODULE III: Scoring, Term Weighting, and Vector Space Models (7hrs)

Parametric and zone indexes -Weighted zone scoring, Learning weights, optimal weight g, Term frequency, and weighting- Inverse document frequency Tf-idf weighting, Vector space model for scoring-Dot products, Queries as vectors, Computing vector scores. Variant tf-idf functions-Sublinear tf scaling, Maximum tf normalization, Document and query weighting schemes, Pivoted normalized document length.

MODULE IV: Evaluation and Language Models (7hrs)

Information retrieval system evaluation, Standard test collections, Evaluation of unranked retrieval sets, Evaluation of ranked retrieval results, Assessing relevance. Language models- Finite automata and language models, Types of language models, Multinomial distributions over words

MODULE V: Web Search and Link Analysis (8hrs)

Web characteristics-Web graph, Spam, Crawling-Features of a Crawler, Crawler architecture, DNS resolution, URL frontier, Link Analysis-Web Graph, PageRank – Markov chains, Page Rank computation, Topic-specific Page Rank.

Textbooks

1. C. Manning, P. Raghavan, and H. Schütze, "Introduction to Information Retrieval", Cambridge University Press, 2009.
2. C.J. Van Rijsbergen , Information Retrieval:, http://www.dcs.gla.ac.uk/Keith/Preface.html
3. Ricardo Baexa-Yates and Berthier Ribeiro-Neto, "Modern Information Retrieval", Addison Wesley Longman

Reference books

1. Bruce Croft, Donald Metzler and Trevor Strohman, "Search Engines: Information Retrieval in Practice", 1st Edition Addison Wesley, 2009.
2. Manu Konchady, "Building Search Applications: Lucene, Ling Pipe", First Edition, Gate Mustru Publishing, 2008.
3. Mark Levene, "An Introduction to Search Engines and Web Navigation", 2nd Edition Wiley, 2010.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Boolean Retrieval-An example information retrieval problem, Inverted index	1
1.2	Processing Boolean queries	1
1.3	The extended Boolean model versus ranked retrieval	1

1.4	Search structures for dictionaries, Wildcard queries-General wildcard queries, k-gram indexes for wildcard queries	1
1.5	Spelling correction-Implementing spelling correction, Forms of spelling correction	1
1.6	Edit distance	1
1.7	k-gram indexes for spelling correction, Context sensitive spelling correction	
	MODULE II	
2.1	Index construction-Hardware basics, Blocked sort-based indexing	1
2.2	Single-pass in-memory indexing , Distributed indexing	1
2.3	Dynamic indexing	1
2.4	Statistical properties of terms in information retrieval.	1
2.5	Heaps' law	1
2.6	Zipf's law	1
2.7	Dictionary as a string, Blocked storage,	1
	MODULE III	
3.1	Parametric and zone indexes -Weighted zone scoring	1
3.2	Learning weights	1
3.3	optimal weight g	1
3.4	Vector space model for scoring-Dot products, Queries as vectors.	1
3.5	Computing vector scores	1
3.6	Variant tf-idf functions-Sublinear tf scaling, Maximum tf normalization	1
3.7	Document and query weighting schemes, Pivoted normalized document length	1
	MODULE IV	
4.1	Information retrieval system evaluation, Standard test collections	1
4.2	Evaluation of unranked retrieval sets	1

4.3	Evaluation of ranked retrieval results	1
4.4	Assessing relevance.	1
4.5	Language models- Finite automata and language models	1
4.6	Types of language models	1
4.7	Multinomial distributions over words	1
	MODULE V	
5.1	Web graph, Spam	1
5.2	Features of a Crawler	1
5.3	Crawler architecture	1
5.4	DNS resolution, URL frontier	1
5.5	Web graph	1
5.6	Markov chains	1
5.7	Page Rank computation	1
5.8	Topic-specific Page Rank	1

CO Assessment Questions	
1	1. Describe Consider these documents: **Doc 1** breakthrough drug for schizophrenia **Doc 2** new schizophrenia drug **Doc 3** new approach for treatment of schizophrenia **Doc 4** new hopes for schizophrenia patients Draw the term-document incidence matrix and index representation for this document collection.(1.1) 2. If $\|S\|$ denotes the length of string S, show that the edit distance between s1 and s2 is never more than max$\{\|s1\|, \|s2\|\}$.
2	1. For n = 2 and 1 ≤ T ≤ 30, perform a step-by-step simulation of the Logarithmic merging algorithm. Create a table that shows, for each point in time at which T = 2 ∗ k tokens have been processed (1 ≤ k ≤ 15), which of the three indexes I0, . . . , I3 are in use. The first three

<table>
<tr>
<td></td>
<td>
lines of the table are given below.
<table>
<tr><th></th><th>I3</th><th>I2</th><th>I1</th><th>I0</th></tr>
<tr><td>2</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>4</td><td>0</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>6</td><td>0</td><td>0</td><td>1</td><td>0</td></tr>
</table>
2. Estimate the space usage of the Reuters dictionary with blocks of size k = 8 and k = 16 in blocked dictionary storage.
</td>
</tr>
<tr>
<td>3</td>
<td>
1. If we were to stem jealous and jealousy to a common stem before setting up the vector space, detail how the definitions of tf and idf should be modified.
2. One measure of the similarity of two vectors is the Euclidean distance (or L2 distance) between them:
$$|\vec{x} - \vec{y}| = \sqrt{\sum_{i=1}^{M}(x_i - y_i)^2}$$
Given a query q and documents d1, d2, . . ., we may rank the documents di in order of increasing Euclidean distance from q. Show that if q and the di are all normalized to unit vectors, then the rank ordering produced by Euclidean distance is identical to that produced by cosine similarities
</td>
</tr>
<tr>
<td>4</td>
<td>
1. Consider an information need for which there are 4 relevant documents in the collection. Contrast two systems run on this collection. Their top 10 results are judged for relevance as follows (the leftmost item is the top-ranked search result):
System 1 R N R N N N N N R R
System 2 N R N N R R R N N N
a. What is the MAP of each system? Which has a higher MAP?
b. Does this result intuitively make sense? What does it say about what is important in getting a good MAP score?
c. What is the R-precision of each system? (Does it rank the systems the same as MAP?)
</td>
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<tr>
<td>5</td>
<td>
1 If the number of pages with in-degree i is proportional to $1/i^{2.1}$, what is the probability that a randomly chosen web page has in-degree 1?
2 A user of a browser can in addition to clicking a hyperlink on the page x he is currently browsing, use the back button to go back to the page from which he arrived at x. Can such a user of back buttons be modeled as a Markov chain? How would we model repeated invocations of the back button?
</td>
</tr>
</table>

24CSE6164	Computer Graphics	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course creates an awareness about various graphics input and display devices and also to understand the various concepts in computer graphics. This course helps the learner to understand three-dimensional environment representation in a computer, transformation of 2D/3D objects and basic mathematical techniques and algorithms used to build useful applications. The study of computer graphics develops the ability to build algorithms for emerging display technologies.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Compare various graphics devices. **(Understand level)**
CO2	Illustrate algorithms for line drawing, circle drawing and polygon filling.**(Apply level)**
CO3	Apply geometrical transformation on 2D and 3D objects.**(Apply level)**
CO4	Implement algorithms for clipping.**(Apply level)**
CO5	Apply various projection techniques on 3D objects.**(Apply level)**
CO6	Summarize types of projections and visible surface detection methods. **(Understand level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											3
CO2	3	3	3	1								3
CO3	3	3	3	1								3
CO4	3	3	3	1								3
CO5	3	3	3	1								3
CO6	3		3									3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Introduction (9 hrs)

Basic concepts in Computer Graphics and its applications– Video Display devices- Refresh Cathode Ray Tubes, Random Scan Displays and systems, Raster scan displays and systems, Color CRT displays, Flat panel display and its categories.

MODULE II : Line and Circle Drawing and Polygon Filling Algorithms (6 hrs)

Line Drawing Algorithm- DDA, Bresenham's algorithm – Circle Generation Algorithms –Mid point circle algorithm, Bresenham's algorithm- Scan Conversion-frame buffers – solid area scan conversion – polygon filling algorithms

MODULE III : 2D transformations and Windowing concepts (8 hrs)

Two dimensional transformations. Homogeneous coordinate systems – matrix formulation and concatenation of transformations.

Windowing concepts –Window to Viewport Transformation- Two dimensional clipping-Line clipping – Cohen Sutherland, Midpoint Subdivision algorithm.

MODULE IV : Polygon Clipping (6 hrs)

Polygon clipping-Sutherland Hodgeman algorithm, Weiler-Atherton algorithm, Three dimensional object representation-Polygon surfaces, Quadric surfaces – Basic 3D transformations.

MODULE V : Projections and Visible surface detection methods (7 hrs)

Projections – Parallel and perspective projections – vanishing points.
Visible surface detection methods– Back face removal- Z-Buffer algorithm, A-buffer algorithm, Depth-sorting method, Scan line algorithm.

Text books

1. D. Hearn and M.P. Baker, Computer Graphics, C Version, Pearson Education, 2002.
2. James D. Foley, A. Van Dam, S.K. Feiner, and J.F. Hughes, Computer Graphics: Principles and Practice, 2nd ed. in C, Addison-Wesley Publishing Company, 1996.

Reference books

1. D. Hearn and M.P. Baker, Computer Graphics with OpenGL Version, 3 rd ed., Pearson Education, 2004.
2. Rogers B., Mathematical Elements of Computer Graphics, Tata McGraw Hill, 2002

Suggested MOOC Courses

1. Computer Graphics-IIT Madras, Prof.Sukhendu Das

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Basic concepts in Computer Graphics and its applications	1
1.2	Video Display devices- Refresh Cathode Ray Tubes- Lecture 1	1
1.3	Video Display devices- Refresh Cathode Ray Tubes- Lecture 2	1
1.4	Raster Scan Displays	1
1.5	Raster Scan Systems	1
1.6	Random Scan Displays	1
1.7	Random Scan Systems	1
1.8	Color CRT displays	1

1.9	Flat panel display and its categories	1
	MODULE II	
2.1	Line Drawing Algorithm- DDA.	1
2.2	Bresenham's algorithm	1
2.3	Circle Generation Algorithms –Mid point circle algorithm.	1
2.4	Bresenham's algorithm	1
2.5	Scan Conversion-frame buffers – solid area scan conversion.	1
2.6	Polygon filling algorithms.	1
	MODULE III	
3.1	Two dimensional transformations-Lecture 1.	1
3.2	Two dimensional transformations-Lecture 2	1
3.3	Homogeneous coordinate systems – matrix formulation.	1
3.4	Concatenation of transformations.	1
3.5	Windowing concepts –Window to Viewport Transformation.	1
3.6	Two dimensional clipping-Line clipping.	1
3.7	Cohen Sutherland.	1
3.8	Midpoint Subdivision algorithm.	1
	MODULE IV	
4.1	Polygon clipping-Sutherland Hodgeman algorithm.	1
4.2	Weiler-Atherton algorithm.	1
4.3	Three dimensional object representation-Polygon surfaces.	1
4.4	Quadric surfaces.	1
4.5	Basic 3D transformations- Lecture 1	1

4.6	Basic 3D transformations- Lecture 2	1
	MODULE V	
5.1	Projections – Parallel projections.	1
5.2	Perspective projections – vanishing points.	1
5.3	Visible surface detection methods– Back face removal.	1
5.4	Z-Buffer algorithm	1
5.5	A-buffer algorithm.	1
5.6	Depth-sorting method.	1
5.7	Scan line algorithm.	1

CO Assessment Questions	
1	1. Compare the working principle of raster scan systems and random scan systems. 2. How much time is spent scanning across each row of pixels during screen refresh on a raster system with resolution of 1280*1024 and a refresh rate of 60 frames per second?
2	1. Rasterize the line with end points(2,3) and (5,8) using Bresenham's line drawing algorithm. 2. Explain how the 4-connected area filling approach differs from 8- connected area filling in boundary filling algorithm
3	1. Rotate a triangle ABC 45 degree counter clockwise about the pivot point (10,3), where the position vector of the coordinate ABC is given as A(4,1), B(5,2) and C(4,3). 2. A triangle ABC with coordinates with A(0,0) B(6,5) C(6,0) is scaled with scaling factors Sx=2 and Sy=3 about the vertex C(6,0). Find the transformed coordinate points.
4	1. Given a clipping window A(20,20), B(60,20), C(60,40) and D(20,40). Using Cohen Sutherland algorithm, find the visible portion of the line segment joining the points P(40,80) and Q(120,30).
5	Prove that the multiplication of 3D transformation matrices for each of the following sequence of operations is commutative. a) Any two successive translations. b) Any two successive scaling operations.

	c) Any two successive rotations abot any one of the co-ordinate axes.
6	1. Explain scan line algorithm for detecting visible surfaces in an object. 2. Point out the differences between Z-Buffer method and A-Buffer method for determining visible surfaces.

		L	T	P	J	S	C	Year of Introduction
24CSE6154	**Fuzzy Logic and Its Application**	**3**	**0**	**0**	**0**	**3**	**3**	**2024**

Preamble: This course enables the students to understand the fundamental concepts of fuzzy logic and its diverse applications. The syllabus covers the topics like fuzzy sets and relations, Properties and development of membership functions, fuzzification and defuzzification processes, fuzzy logic & fuzzy systems, Fuzzy arithmetic and extension principle, and the practical application of fuzzy logic in control systems, pattern recognition and Image processing. It helps the learners to apply the principles of fuzzy logic to solve real-world problems and suggesting solutions for the research problems with uncertain or imprecise information.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Illustrate the need and operations of fuzzy set theory in capturing and representing imprecise information (**Apply Level)**
CO2	Demonstrate the need and techniques of fuzzification and defuzzification for a given scenario. **(Apply Level)**
CO3	Make use of the concept of inferences and reasoning to solve real world problems **(Apply Level)**
CO4	Explain the techniques in Fuzzy Arithmetic. **(Understand Level)**
CO5	Design fuzzy logic systems for solving real world problems. **(Apply Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**3**										**3**
CO2	**3**	**3**										**3**
CO3	**3**	**3**										**3**
CO4	**3**	**3**										**3**
CO5	**3**	**3**	**2**									**3**

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test 1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate			✓	
Create			✓	

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Introduction to Fuzzy sets and Fuzzy Relation (10 hrs)

Overview of crisp sets, Fuzzy Sets and Uncertainty: Uncertainty and information, fuzzy sets and membership functions, chance verses fuzziness, properties of fuzzy sets, fuzzy set operations. Fuzzy Relations: Cardinality, operations, properties, fuzzy cartesian product and composition, fuzzy tolerance and equivalence relations, forms of composition operation.

MODULE II : Membership Functions (6 hrs)

Features and Various forms of membership functions, fuzzification, defuzzification to crisp sets and scalars. Development of membership functions-Membership value assignments: intuition, inference, rank ordering, neural networks, inductive reasoning.

MODULE III :Fuzzy Logic and Fuzzy Systems (7 hrs)

Classic and fuzzy logic, approximate reasoning, other forms of implication operations, Natural language, linguistic hedges, fuzzy rule-based systems, graphical technique of inference.

MODULE IV : Fuzzy Arithmetic and Extension Principle (8 hrs)

Functions of fuzzy sets-extension principle, fuzzy mapping, fuzzy arithmetic, interval analysis in arithmetic, Approximate methods of extension- vertex method and DSW algorithm.

MODULE V : Applications of fuzzy logic system (5 hrs)

Fuzzy Logic Control System-General Block diagram, Different approaches to fuzzy logic controller design, Case Study-Aircraft landing control Problem. Fuzzy logic in Pattern Recognition-Fuzzy c-Means algorithm, Image processing.

Text books

1. Ross, T. J., "Fuzzy Logic with Engineering Applications", Wiley India Pvt. Ltd., 3rd Ed.2011
2. Klir, G. and Yuan, B., "Fuzzy Set and Fuzzy Logic: Theory and Applications", Prentice Hall of India Pvt. Ltd.2015
3. Yen, J., & Langar, R., "Fuzzy Logic: Intelligence, Control, and Information", Pearson Education India. .1999

Reference books

4. Zimmerman, H. J., "Fuzzy Set theory and its application", Springer India Pvt. Ltd., 4th Ed.2011
5. Klir, G. and Folger, T., "Fuzzy Sets, Uncertainty and Information", Prentice Hall of India Pvt. Ltd, 1995

Suggested NPTEL/MOOC Courses

1. Fuzzy Sets, Logic and Systems & Applications by Prof. Nishchal Kumar Verma IIT Kanpur.
2. Introduction to Fuzzy Set Theory, Arithmetic and Logic by Prof. Niladri Chatterjee, IIT Delhi
3. Approximate Reasoning Using Fuzzy Set Theory by Prof. Balasubramaniam Jayaram, IIT Hyderabad
4. Fuzzy Logic and Neural Networks by Prof. Dilip Kumar Pratihar, IIT Kharagpur

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36 hrs)
	MODULE 1	
1.1	Overview of crisp sets	1
1.2	Fuzzy Sets and Uncertainty: Uncertainty and information, fuzzy sets and membership functions	1
1.3	Chance verses fuzziness	1
1.4	Properties of fuzzy sets, fuzzy set operations	1
1.5	Properties of fuzzy sets, fuzzy set operations-Exercise Problems	1

1.6	Fuzzy Relations: Cardinality	1
1.7	Fuzzy Relations: Cardinality, operations, properties	1
1.8	fuzzy cartesian product and composition	1
1.9	fuzzy tolerance and equivalence relations	1
1.10	forms of composition operation.	
MODULE II		
2.1	Features and Various forms of membership functions	1
2.2	Fuzzification	1
2.3	defuzzification to crisp sets and scalars.	1
2.4	defuzzification to crisp sets and scalars.	1
2.5	Development of membership functions- Membership value assignments: intuition, inference, rank ordering, neural networks,	1
2.6	Membership value assignments- inductive reasoning	1
MODULE III		
3.1	Classic and fuzzy logic	1
3.2	approximate reasoning	1
3.3	other forms of implication operations	1
3.4	Natural language, linguistic hedges	1
3.5	fuzzy rule-based systems	1
3.6	graphical technique of inference	1
3.7	graphical technique of inference	1
MODULE IV		
4.1	Functions of fuzzy sets-extension principle	1
4.2	fuzzy mapping	1
4.3	fuzzy arithmetic	1
4.4	interval analysis in arithmetic	1
4.5	Approximate methods of extension- vertex method	1
4.6	Approximate methods of extension- vertex method (Exercise problems)	1
4.7	Approximate methods of extension- DSW method	
4.8	Approximate methods of extension- DSW method (Exercise problems)	
MODULE V		
5.1	Fuzzy Logic Control System-General Block diagram	1
5.2	Different approaches to fuzzy logic controller design.	1
5.3	Case Study-Aircraft landing control Problem	1
5.4	Fuzzy logic in Pattern Recognition-Fuzzy c-Means algorithm	1

5.5	Fuzzy image processing	

CO Assessment Questions	
1	a. Consider the universe of a speed moving object..The speed may be related as fast and slow defined on a universe of km/hr for a vehicle. Fast= $\left\{\frac{1}{100}+\frac{0.8}{80}+\frac{0.6}{60}+\frac{0.4}{40}+\frac{0.2}{20}\right\}$ slow= $\left\{\frac{0.2}{100}+\frac{0.4}{80}+\frac{0.6}{60}+\frac{0.8}{40}+\frac{10}{20}\right\}$ Find the membership functions for the following natural phrases. i)Slightly fast or very very fast ii) Not slightly fast and very slow b. Given that "x is Sweet" with T(x) = 0.8 and "y is Sweet" with T(y) = 0.6. What is the Fuzzy truth value of "If x is Sweet then y is Sweet" . c. Using your own intuition and your own definitions of the universe of discourse, plot fuzzy membership functions for the following variables: (a) age of people (i) very young (ii) young (iii) middle-aged (iv) old (v) very old d. For steel design, the cross-sectional area to column-height ratio largely determines the susceptibility of the columns to buckling under axial loads. The normalized ratios are on the universe, X = {0, 1, 2, 3}. These ratios are characterized as "small" to "large" as follows $$\text{"Small"} = \left\{\frac{1}{0}+\frac{0.9}{1}+\frac{0.8}{2}+\frac{0.7}{3}\right\}.$$ $$\text{"Large"} = \left\{\frac{0}{0}+\frac{0.1}{1}+\frac{0.2}{2}+\frac{0.3}{3}\right\}.$$ Find the membership functions for the following linguistic expressions (a) very very small (b) slightly large (c) not very large and small
2	a. (i) In the context of a customer feedback system, can the processes of fuzzification and defuzzification be applied? (ii) Demonstrate how the utilization of fuzzy defuzzification can be implemented to transform subjective linguistic feedback (e.g., "very satisfied," "somewhat dissatisfied") from customers into

actionable and measurable quantitative information.

b. In a smart traffic control system, demonstrate how fuzzy fuzzification can be used to interpret and process data from various sensors to determine traffic flow and congestion levels.

3

a. Let X be the universe of excess water-height to levee-height ratios (percentage), X = {0.5, 0.75, 1.0, 1.75} and let Y be a universe of damage indices (million dollars), Y = {0, 0.5, 1.0, 7.0}. Suppose we have fuzzy sets for a given water-height ratio (WH~) and a given damage in millions (D ~), as follows:

$$\mu_{\underset{\sim}{\mathrm{WH}}}(x)=\left\{\frac{1.0}{0.5}+\frac{1.0}{0.75}+\frac{0.6}{1.0}+\frac{0.1}{1.75}\right\},\ \text{moderate water-height ratio (percentage).}$$

$$\mu_{\underset{\sim}{\mathrm{D}}}(y)=\left\{\frac{0.2}{0}+\frac{0.3}{0.5}+\frac{0.8}{1.0}+\frac{1.0}{7}\right\},\ \text{relatively large damage (million dollars).}$$

(i) Use Zadeh's max-min to find the relation IF moderate water-height ratio, THEN relatively large damage.(use mamdani implication)

(ii) Suppose we are given a new water-height ratio (WH~) as follows:

$$\mu_{\underset{\sim}{\mathrm{WH}'}}(x)=\left\{\frac{0.0}{0.5}+\frac{1.0}{0.75}+\frac{0.7}{1.0}+\frac{0.4}{1.75}\right\}.$$

Using max–min composition, find the damage associated with this new water-height ratio.

b. In a smart city, the traffic management system utilizes a Mamdani inference system to optimize traffic signal timings. The inputs include traffic density and time of day, and the output is the duration of green signal for each direction.

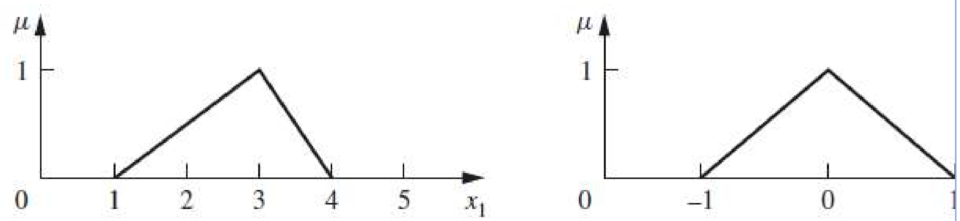
(i) How does the Mamdani inference system handle linguistic variables like "Low," "Medium," and "High" for traffic density and "Morning," "Afternoon," and "Evening" for time of day?

(ii) Define the rule base for the traffic signal control system. How are the rules determined based on the linguistic variables and their relationships?

(iii) Given a specific set of input values (e.g., medium traffic density in the morning), calculate the corresponding output (green signal duration) using the Mamdani inference system.

c. A restaurant uses a Sugeno inference system to assess customer satisfaction based on the quality of food, service speed, and cleanliness. The goal is to determine an appropriate discount for loyal customers.

(i) Explain how Sugeno inference handles input variables that have crisp numerical values (e.g., food quality rated on a scale of 1 to 10).

	(ii) Define the rule base for the restaurant's customer satisfaction system, specifying the relationship between input variables and the discount rate. (iii) Given a specific set of input values (e.g., food quality = 8, service speed = 9, cleanliness = 7), calculate the discount rate using the Sugeno inference system.
4	a. For the function $y = x_1^2 + x_2^2 - 4x_1 + 4$ and the membership functions for fuzzy variables x_1 and x_2 shown in the following Figure  find and plot the membership function for the fuzzy output variable, y, using (i) a discretized form of the extension principle; (ii) the vertex method; (iii) the DSW algorithm. b. The voltage drop across an element in a series circuit is equal to the series current multiplied by the element’s impedance. The current, I~, impedance, R~, and voltage, V~ are presumed to be fuzzy variables. Membership functions for the current and impedance are as follows: $\underset{\sim}{I} = \left\{ \frac{0}{0} + \frac{0.7}{0.5} + \frac{1}{1} + \frac{0.7}{1.5} + \frac{0}{2} \right\},$ $\underset{\sim}{R} = \left\{ \frac{0.5}{500} + \frac{0.8}{750} + \frac{1}{1000} + \frac{0.8}{1250} + \frac{0.5}{1500} \right\}.$ Find the arithmetic product for V~=I~·R~using the extension principle.
5	a. Design a fuzzy logic controller using Mamdani fuzzy model for a train approaching or leaving a station. The inputs are the distance from the station and speed of the train. The output is the amount of break power used. Use four descriptors for each variable. b. A dam employs a fuzzy logic controller for water level regulation, considering factors like rainfall, outflow, and reservoir capacity. (i) Specify the linguistic variables and fuzzy sets relevant to water level control, such as "Rainfall," "Outflow Rate," and "Reservoir

		Level."
	(ii)	Construct a set of fuzzy rules governing how the controller should adjust the outflow based on the linguistic variables. Consider the relationships between rainfall, outflow rate, and reservoir level.
	(iii)	Given a particular scenario (e.g., heavy rainfall, moderate outflow rate, high reservoir level), determine the appropriate outflow adjustment using the fuzzy logic controller.

Professional Elective2/ Industry Elective

24CSE615	Natural Language Processing	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course enables the learners to understand the fundamental concepts of Natural Language Processing. This course starts with the building blocks of language, the basic pre-processing steps, and language models. The course also focuses on the analysis of various NLP tasks such as information and relation extraction, Information Retrieval, Question Answer Systems, Machine Translation models and methods for evaluating their performance.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the basic concepts of natural language processing and its approaches. **(Understand level)**
CO2	Examine the various preprocessing methods on textual data. **(Apply level)**
CO3	Illustrate the different text representation techniques in NLP. **(Apply level)**
CO4	Make use text classification methods for sentiment analysis and evaluate their performance **(Apply level)**
CO5	Outline the NLP tasks such as Information Retrieval and Extraction, Relation Detection, QA Systems and Machine Translation **(Understand Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											3
CO2	3	3	3		2							3
CO3	3	2	3		2							3
CO4	3	3	3									3
CO5	3											3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS
MODULE I: Introduction to NLP (7 hrs)
NLP Tasks and Applications, Language-Building Blocks, Challenges of NLP, Machine Learning for NLP – Naïve Bayes Classifier, Logistic Regression, Support Vector Machines, Approaches to NLP-Heuristics-Based NLP, Machine Learning-based NLP.
MODULE II: Pre-processing and Text Representation (6 hrs)
NLP System Pipeline Steps-Data Acquisition, Text Extraction and Clean-up, Pre-processing, Feature Engineering, Modelling, Evaluation, Post-Modelling Phases Text Representation-Vector Space Models, Basic Vectorization Approaches-One-Hot Encoding, Bag of Words, Bag of N-Grams, TF-IDF; Distributed Representations-Word Embeddings, Doc2Vec.

MODULE III: Classification and Information Extraction (8 hrs)
Text Classification-Text classification applications, Pipeline for building text classification systems, Naïve Bayes for Sentiment Classification – Naïve Bayes Classifier Training, Optimizing for Sentiment Analysis, Evaluation: Precision, Recall, F-measure; Logistic Regression- Classification: the sigmoid, Learning in Logistic Regression. Information Extraction (IE)-IE Applications, The General Pipeline for IE, Named Entity Recognition (NER) - Ambiguity in Named Entity Recognition, NER as Sequence Labeling, Evaluation of NER.
MODULE IV: Relation Extraction and Information Retrieval (5 hrs)
Relation Extraction-Using Patterns to Extract Relations, Relation Extraction via Supervised Learning, Semisupervised Relation Extraction via Bootstrapping, Distant Supervision for Relation Extraction, Evaluation of Relation Extraction system. Information Retrieval – Term weighting and document scoring, Inverted Index, Evaluation of Information Retrieval Systems.
MODULE V: Question Answering Systems and Machine Translation (10 hrs)
Question-Answering Systems, Factoid Question Answering – Question Processing, Passage Retrieval, Answer Processing; Evaluation of Factoid Answers. Machine Translation – Why Machine Translation is Hard, Classical Machine Translation and the Vauquois Triangle– Direct Translation, Transfer; Statistical Machine Translation, The Phrase based Translation model, Alignment in MT, Training Alignment Models, Decoding for Phrase-based Statistical MT.
Text books 1. Daniel Jurafsky, James H. Martin, “Speech and Language Processing” (2nd and 3rd editions), Pearson Prentice Hall 2. Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta, Harshit Surana,” Practical Natural Language Processing: A Comprehensive Guide to Building Real-World NLP Systems “June 2020 Publisher(s): O'Reilly Media, Inc. ISBN: 9781492054054.
Reference books 1. James Allen, “Natural Language Understanding”, Second Edn, Pearson. 2. Christopher Manning and Hinrich Schutze, Statistical Natural Language Processing, MIT Press. **Suggested MOOC Courses** 1. Applied Natural Language Processing by by Prof. Ramaseshan R, IIT Madras. 2. Natural Language Processing by by Prof. Pawan Goyal, IIT Kharagpur.

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
	MODULE 1	
1.1	Introduction to NLP – Tasks and Applications	1

1.2	Language – Building Blocks, Challenges of NLP	1
1.3	Approaches to NLP - Heuristics-Based NLP, Machine Learning for NLP	1
1.4	Machine Learning for NLP – Naïve Bayes Classifier	1
1.5	Logistic Regression	1
1.6	Support Vector Machines – Linearly Separable Data	1
1.7	Support Vector Machines – Linearly Inseparable Data	1
	MODULE II	
2.1	NLP System Pipeline Steps-Data Acquisition, Text Extraction and Clean-up	1
2.2	NLP System Pipeline – Preprocessing - Sentence segmentation, Word tokenization, Stemming and lemmatization	1
2.3	Feature Engineering, Model Building, Evaluation – Metrices, Post modeling phase	1
2.4	Text Representation – Vector Space Model, Vectorization Approaches – One hot encoding, Bag of words	1
2.5	Bag of n-grams, TF-IDF	1
2.6	Word Embeddings – Word2Vec- CBOW, SkipGram models	1
	MODULE III	
3.1	Text Classification-Text classification applications – Pipeline for building text classification systems	1
3.2	Naïve Bayes for Sentiment Classification – Naïve Bayes Classifier Training, Optimizing for Sentiment Analysis (Lecture 1)	1
3.3	Naïve Bayes for Sentiment Classification – Naïve Bayes Classifier Training, Optimizing for Sentiment Analysis (Lecture 2)	1
3.4	Evaluation: Precision, Recall, F-measure	1
3.5	Logistic Regression- Classification: the sigmoid, Learning in Logistic Regression	1
3.6	Information Extraction(IE)-IE Applications, The General Pipeline for IE	1
3.7	Named Entity Recognition(NER)- Ambiguity in Named Entity Recognition	1
3.8	NER as Sequence Labeling, Evaluation of NER.	1

MODULE IV		
4.1	Relation Extraction-Using Patterns to Extract Relations	1
4.2	Relation Extraction via Supervised Learning, Semisupervised Relation Extraction via Bootstrapping	1
4.3	Distant Supervision for Relation Extraction, Evaluation of Relation Extraction system	1
4.4	Information Retrieval – Term weighting and document scoring	1
4.5	Inverted Index, Evaluation of Information Retrieval Systems.	1
MODULE V		
5.1	Question-Answering Systems, Factoid Question Answering – Question Processing, Passage Retrieval, Answer Processing; Evaluation of Factoid Answers. (Lecture 1)	1
5.2	Question-Answering Systems, Factoid Question Answering – Question Processing, Passage Retrieval, Answer Processing; Evaluation of Factoid Answers. (Lecture 2)	1
5.3	Machine Translation – Why Machine Translation is Hard	1
5.4	Classical Machine Translation and the Vauquois Triangle– Direct Translation, Transfer	1
5.5	Statistical Machine Translation, The Phrase based Translation model (Lecture 1)	1
5.6	Statistical Machine Translation, The Phrase based Translation model (Lecture 2)	1
5.7	Alignment in MT- IBM Model -1	1
5.8	Training Alignment Models - EM for Training Alignment Models (Lecture 1)	1
5.9	Training Alignment Models - EM for Training Alignment Models (Lecture 2)	1
5.10	Decoding for Phrase-based Statistical MT.	1

CO Assessment Questions	
1	1. Describe the major building blocks of language with suitable examples. 2. Explain the different approaches to solve an NLP project. 3. Explain the challenges involved in an NLP project. 4. Given the following data, use Naïve Bayes classifier to classify the new instance(Colour=Black, legs=2, Height = Tall, and smelly = No)

<table>
<tr>
<td></td>
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<table>
<tr><th>No</th><th>Colour</th><th>Legs</th><th>Height</th><th>Smelly</th><th>Species</th></tr>
<tr><td>1</td><td>White</td><td>3</td><td>Short</td><td>Yes</td><td>M</td></tr>
<tr><td>2</td><td>Black</td><td>2</td><td>Tall</td><td>No</td><td>M</td></tr>
<tr><td>3</td><td>Black</td><td>3</td><td>Short</td><td>Yes</td><td>M</td></tr>
<tr><td>4</td><td>White</td><td>3</td><td>Short</td><td>Yes</td><td>M</td></tr>
<tr><td>5</td><td>Black</td><td>2</td><td>Short</td><td>No</td><td>H</td></tr>
<tr><td>6</td><td>White</td><td>2</td><td>Tall</td><td>No</td><td>H</td></tr>
<tr><td>7</td><td>White</td><td>2</td><td>Tall</td><td>No</td><td>H</td></tr>
<tr><td>8</td><td>White</td><td>2</td><td>Short</td><td>Yes</td><td>H</td></tr>
</table>
</td>
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<tr>
<td>2</td>
<td>
1. Explain the main components of an NLP pipeline.
2. Illustrate POS-Tagging using Python Library.
3. Given a dataset of tweets, prepare the data for sentiment analysis by doing the following operations: conversion to lower casing, removal of punctuations, removal of stop-words, stemming, lemmatization, removal of emojis and removal of URLs. (Assignment Question)
</td>
</tr>
<tr>
<td>3</td>
<td>
1. Illustrate how one hot-encoding model is used to represent text using suitable examples and python code.
2. Compare CBOW and Skip-Gram models.
3. Use the toy corpus given below and represent the all the documents using tf-idf model.
<table>
<tr><td>Doc 1</td><td>Sky gets blue</td></tr>
<tr><td>Doc 2</td><td>Sun gets bright</td></tr>
<tr><td>Doc 3</td><td>Sun shines</td></tr>
<tr><td>Doc 4</td><td>Sun shines bright</td></tr>
</table>
</td>
</tr>
<tr>
<td>4</td>
<td>
1. Describe the pipeline for building text classification systems and explain each stage.
2. Given the following data about restaurant review and its classification, classify “Very good food” to one of the classes using Naïve Bayes classification.
<table>
<tr><td>Doc 1</td><td>Positive</td><td>Simply loved</td></tr>
<tr><td>Doc 2</td><td>Positive</td><td>This place has best food</td></tr>
<tr><td>Doc 3</td><td>Positive</td><td>Very good restaurant</td></tr>
<tr><td>Doc 4</td><td>Negative</td><td>Most disgusting food</td></tr>
<tr><td>Doc 5</td><td>Negative</td><td>Stay away, very disgusting food</td></tr>
</table>
</td>
</tr>
</table>

3. Perform binary sentiment classification on a movie review with the following features:

Var	**Definition**	**Value**
x_1	count(positive lexicon words Є doc)	3
x_2	count(negative lexicon words Є doc)	2
x_3	1 if “no” Є doc	1
	0 otherwise	
x_4	count(1st and 2nd pronouns Є doc)	3
x_5	1 if “!” Є doc	0
	0 otherwise	
x_6	log(word count of doc)	ln(66)

Assume that the weights corresponding to the features are[2.5,-5.0,-1.2, 0.5, 2.0, 0.7] and bias = 0.1.

5

1. Explain supervised approach to relation extraction and state its advantages.
2. Apply tf-idf document scoring method for the following data to retrieve the document for the query “good love”.

Doc 1	good good child! Love
Doc 2	Good laugh
Doc 3	How good is love?
Doc 4	Child!

3. Explain the phases of a factoid question answering system.
4. Explain statistical machine translation model.
5. Explain the challenges involved in a machine translation task.

24CSE625	Mobile Computing	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The course is designed to equip engineering students with the knowledge and skills necessary to comprehend communication protocols, diverse architectures, and security mechanisms employed in the realm of mobile computing. The curriculum encompasses fundamental mobile computing principles, the intricacies of wireless transmission system architectures, and next-generation networks. Furthermore, this course empowers learners to attain a deeper understanding of advanced concepts pertaining to wireless communication systems and mobile ad-hoc networks.

Prerequisite: Proficient knowledge in computer networks

Course Outcomes: After the completion of the course the student will be able to

CO1	Compare the various mobile computing applications, services, design considerations and architectures **(Understand Level)**
CO2	Identify the various technology trends for next generation cellular wireless networks and use the spreading concept on data transmission. **(Apply Level)**
CO3	Explain the architecture of various wireless LAN technologies. **(Understand Level)**
CO4	Outline the roles and tasks carried out by the mobile network layer and transport layer. **(Understand Level)**
CO5	Summarize the characteristics of Wireless Application Protocol. **(Understand Level)**
CO6	Explain the security concerns and challenges in the realm of mobile computing and upcoming next-generation technologies. **(Understand Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										3
CO2	3	3	3	1								3
CO3	3	3	3									3
CO4	3	3	3		1							3
CO5	3	3	3									3
CO6	3	3	3									3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				

Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Basics of Mobile Computing (7hrs)

Introduction to mobile computing — Functions, Networks, Middleware and Gateways, Applications and services. Mobile computing architecture — Internet: The Ubiquitous network, Three-tier architecture for Mobile Computing, Design considerations for mobile computing, Mobile Computing through the Internet.

MODULE II: Wireless Transmission and Telecommunications Systems (8hrs)

Signal Propagation-Path loss of radio signals, Additional Signal Propagation effects, Multi-path propagation, Spread spectrum — Direct sequence, Frequency hopping.

Medium Access Control — Space Division Multiple Access (SDMA), Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), and Code Division Multiple Access (CDMA). Telecommunication Systems - Global System for Mobile Communication (GSM), Satellite Systems — Geostationary Earth Orbit (GEO), Low Earth Orbit (LEO), Medium Earth Orbit (MEO), Routing, Localization, Handover.

MODULE III: Wireless LANs(7hrs)

Wireless LAN – Infrared vs radio transmission, Infrastructure and Ad-hoc mode, IEEE 802.11 System Architecture, Protocol Architecture, Physical layer, Medium Access Control layer, HIPERLAN-1, Bluetooth.

MODULE IV: Mobile Network and Transport Layer(8hrs)

Network layer — Mobile Internet Protocol (IP)- Dynamic Host Configuration Protocol (DHCP), Mobile ad-hoc networks — Routing, Dynamic Source Routing (DSR), Destination Sequence Distance Vector (DSDV), Ad-hoc routing protocols. Mobile transport layer — Traditional Transmission Control Protocol (TCP), Improvements in Classical TCP. Wireless Application Protocol (WAP) - Architecture, Wireless Datagram Protocol (WDP), Wireless Transport Layer Security (WTLS), Wireless Transaction Protocol (WTP), Wireless Session Protocol (WSP).

MODULE V: Mobile Security and Next-Generation Networks(6hrs)

Security issues in mobile computing - Information security, Security techniques, and algorithms, Security models. Next generation networks - Orthogonal Frequency Division Multiplexing (OFDM), Wireless Asynchronous Transfer Mode (WATM), Multi-Protocol Label Switching (MPLS), 10 pillars of 5G, Security for SG communication.

Textbooks

1. Asoke K. Talukder, Hasan Ahmad, Roopa R Yavagal, Mobile Computing Technology-Application and Service Creation, 2/e, McGraw Hill Education.
2. Jochen Schiller, Mobile Communications, Pearson Education Asia, 2008.
3. Jonathan Rodriguez, Fundamentals of 5G Mobile Networks, Wiley Publishers,2015.

Reference books

1. Raj Kamal, Mobile Computing, 2/c, Oxford University Press.
2. Andrew S. Tanenbaum, Computer Networks, PHI, 3/e, 2003
3. Theodore S. Rappaport, Wireless Communications Principles and Practice, 2/e, PHI, New Delhi, 2004.
4. Curt M. White, Fundamentals of Networking and Communication 7/c, Cengage learning.

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
MODULE 1		
1.1	Introduction to mobile computing – Functions ,Networks	1
1.2	Middleware and Gateways	1
1.3	Application and services	1
1.4	Internet: The Ubiquitous network	1
1.5	Three-tier architecture for Mobile Computing	1
1.6	Design considerations for mobile computing	1
1.7	Mobile Computing through Internet.	1
MODULE II		
2.1	Direct sequence spread spectrum, Frequency hopping spread spectrum	1
2.2	Space Division Multiple Access (SDMA), Frequency Division Multiple Access (FDMA)	1
2.3	Time Division Multiple Access (TDMA)	1
2.4	Code Division Multiple Access (CDMA)	1
2.5	Global System for Mobile Communication (GSM) services, Architecture	1
2.6	Satellite Systems Basics, Applications, Geostationary Earth Orbit (GEO), Low Earth Orbit (LEO), Medium Earth Orbit (MEO)	1
2.7	Routing, Localization, Handover	1
2.8	Handover, Security	1
MODULE III		
3.1	Wireless LAN - Wireless LAN – Infra red vs radio transmission, Infrastructure and Ad-hoc mode	1
3.2	IEEE 802.11 System Architecture	1

3.3	Protocol Architecture	1
3.4	Physical layer	1
3.5	Medium Access Control layer	1
3.6	HIPERLAN-1	1
3.7	Bluetooth	1
	MODULE IV	
4.1	Mobile Internet Protocol (IP), Dynamic Host Configuration Protocol (DHCP)	1
4.2	Mobile ad-hoc networks – Routing, Dynamic Source Routing (DSR)	1
4.3	Destination Sequence Distance Vector (DSDV)	1
4.4	Ad-hoc routing protocols	1
4.5	Traditional Transmission Control Protocol (TCP), Improvements in Classical TCP	1
4.6	Wireless Application Protocol (WAP) – Architecture, Wireless Datagram Protocol (WDP)	1
4.7	Wireless Transport Layer Security (WTLS)	1
4.8	Wireless Transaction Protocol (WTP), Wireless Session Protocol (WSP)	1
	MODULE V	
5.1	Information security, Security techniques	1
5.2	Security algorithms, Security models	1
5.3	Introduction to Next generation networks, Orthogonal Frequency Division Multiplexing (OFDM)	1
5.4	Wireless Asynchronous Transfer Mode (WATM)	1
5.5	Multi Protocol Label Switching (MPLS)	1
5.6	10 pillars of 5G, Security for 5G communication	1

CO Assessment Questions	
1	1. Describe the design considerations of three tier architecture of mobile computing. 2. Explain any four functions and applications of mobile computing
2	1. Demonstrate the encoding, decoding, and channel sharing procedures in a CDMA (Code Division Multiple Access) scenario involving four stations transmitting data, where station 3 intercepts data from station 1, with the data values being 1, 1, 1, and 0, respectively. 2. Compare the influence of near/far effect and its countermeasures in TDMA and CDMA systems.
3	1. Describe the protocol architecture of IEEE 802.11 2. Explain the phases in Elimination-yield non-preemptive priority multiple access of HIPERPLAN-1
4	1. With the help of an example, show the routing table creation using Destination Sequence Distance Vector Routing protocol in mobile ad-hoc networks 2. List the entities of a mobile IP. With the help of an example, explain how packet delivery is done to and from a fixed node..
5	1 How does WAP push operation differ from pull operation? 2 With the help of a neat sketch explain the secure session establishment using WTLS.
6	1. Elaborate on the security framework established by the 3rd Generation Partnership Project (3GPP) for enhancing mobile security. 2. Describe the features of the policy-based security model.

24CSE635	Parallel Algorithms	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course helps the learners to understand basic and advanced concepts of parallel algorithms. It covers Principles of Parallel Algorithm Design, Communication operations, Programming Using the Message Passing Paradigm, Programming Shared Address Space Platforms Thread Basics, and GPU Programming. This course enables a learner to design solutions to complex real world problems using parallel computing paradigms including thread parallelism, shared memory program, message passing interfaces, and vector processing.

Prerequisite: Knowledge in Computer Organization and Architecture.

Course Outcomes: After the completion of the course the student will be able to

CO1	Summarize the key parallel computational models **(Cognitive Knowledge Level : Understand)**
CO2	Appreciate and apply parallel and distributed algorithms in problem Solving **(Cognitive Knowledge Level :Apply)**
CO3	Appreciate the communication models for parallel algorithm development (**Cognitive Knowledge Level : Understand**)
CO4	Develop parallel algorithms using message passing paradigm **(Cognitive Knowledge Level : Apply)**
CO5	Formulate parallel algorithms for shared memory architectures. **(Cognitive Knowledge Level : Apply)**
CO6	Demonstrate the fundamental skills of heterogeneous computing with GPUs**(Cognitive Knowledge Level : Apply)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										3
CO2	3	3	3									3
CO3	3	3										3
CO4	3	3	3	3	2							3
CO5	3	3	3	3	2							3
CO6	3	3	3	3	2							3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test 1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate			✓	

Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Principles of Parallel Algorithm Design (7 hours)

Basic Introduction to Parallel Processing platforms. Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads, Parallel Algorithm Models.

MODULE II : Communication Operations (7 hours)

Basic Communication Operations **-** One-to-All Broadcast and All-to-One Reduction, All-to-All Broadcast and Reduction, All-Reduce and Prefix-Sum Operations, Scatter and Gather, All-to-All Personalized Communication, Circular Shift, Improving the Speed of Some Communication Operation

MODULE III : Programming Using the Message Passing Paradigm (7 hours)

Principles of Message-Passing Programming, The Building Blocks: Send and Receive

Operations, MPI: The Message Passing Interface, Overlapping Communication with Computation, Collective Communication and Computation Operations, Groups and Communicators.
MODULE IV : Programming Shared Address Space Platforms Thread Basics (7 hours)
Thread Basics, Why Threads? The POSIX Thread Application Programme Interface, Synchronization Primitives in POSIX, Controlling Thread and Synchronization Attributes, Thread Cancellation, Composite Synchronization Constructs, OpenMP: a Standard for Directive Based Parallel Programming, Specifying Concurrent Tasks in OpenMP, Synchronization Constructs in OpenMP, Data Handling in OpenMP, OpenMP Library Functions, OpenMP Applications: Parallel algorithm development for Matrix multiplication
MODULE V : GPU Programming (7 hours)
Heterogeneous Parallel Computing, Architecture of a Modern GPU, Speeding up Real Applications, Data parallel computing, CUDA C Program Structure, A Vector Addition Kernel, Device Global Memory and Data Transfer, Kernel Functions and Threading, Kernel Launch, CUDA Thread Organization, Mapping Threads to Multidimensional Data, Synchronization and Transparent Scalability, Resource Assignment, Querying Device Properties, Thread Scheduling and Latency Tolerance, Importance of Memory Access Efficiency, Cuda Memory Types, Tiling for Reduced Memory Traffic, Tiled Matrix Multiplication Kernel, Boundary Checks

Text books

1. Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, Introduction to Parallel Computing, 2nd Ed, Addison-Wesley, 2003
2. David B. Kirk, Wen-mei W. Hwu, Programming Massively Parallel Processors: A Hands-on Approach, 3rd Ed., Morgan Kaufman, 2016.

Reference books

1. Steven Brawer, Introduction to Parallel Computing, Academic Press, (1989)
2. Barbara Chapman, Gabriele Jost, Ruud van der Pas, Using OpenMP: Portable Shared Memory Paralwlel Programming , MIT Press, 2008.
3. William Gropp, Ewing Lusk, Anthony Skjellum Using MPI: Portable Parallel Programming with the Message-Passing Interface, 3rd Ed, MIT Press, 2014.
4. Thomas Rauber, Gudula Rünger, Parallel Programming for Multicore and Cluster Systems, Springer, 2010

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1		

1.1	Basic Introduction to Parallel Processing platforms. Preliminaries	1
1.2	Decomposition Techniques – Recursive, Data	1
1.3	Decomposition Techniques – Exploratory, Speculative, Hybrid	1
1.4	Characteristics of Tasks and Interactions	1
1.5	Mapping Techniques for Load Balancing -Static	1
1.6	Mapping Techniques for Load Balancing - Dynamic	1
1.7	Methods for Containing Interaction Overheads, Parallel Algorithm Models.	1
MODULE 2		
2.1	One-to-All Broadcast and All-to-One Reduction	1
2.2	All-to-All Broadcast and Reduction	1
2.3	All-Reduce and Prefix-Sum Operations, Scallter Gather	1
2.4	All-to-All Personalized Communication	1
2.5	Circular Shift	1
2.6	Improving the Speed of Some Communication Operation	1
MODULE 3		
3.1	Principles of Message-Passing Programming, The Building Blocks: Send and Receive Operations	1
3.2	MPI: The Message Passing Interface	1
3.3	MPI: The Message Passing Interface : Illustration	1
3.4	Overlapping Communication with Computation	1
3.5	Overlapping Communication with Computation : Illustration	1
3.6	Collective Communication and Computation Operations	1
3.7	Collective Communication and Computation Operations : Illustration	1
MODULE 4		

4.1	Thread Basics, Why Threads? The POSIX Thread API	1
4.2	Synchronization Primitives in POSIX	1
4.3	Controlling Thread and Synchronization Attributes	1
4.4	Thread Cancellation, Composite Synchronization Constructs	1
4.5	OpenMP: a Standard for Directive Based Parallel Programming	1
4.6	Specifying Concurrent Tasks in OpenMP, Synchronization Constructs in OpenMP	1
4.7	Data Handling in OpenMP, OpenMP Library Functions	1
4.8	OpenMP Applications: Parallel algorithm development for Matrix multiplication	1
MODULE 5		
5.1	Heterogeneous Parallel Computing, Architecture of a Modern GPU, Speeding up Real Applications	1
5.2	Data parallel computing – CUDA C Program Structure	1
5.3	Vector Addition Kernel, Device Global Memory and Data Transfer	1
5.4	Kernel Functions and Threading, Kernel Launch	1
5.5	CUDA Thread Organization, Mapping Threads to Multidimensional Data	1
5.6	Synchronization and Transparent Scalability, Resource Assignment, Querying Device Properties, Thread Scheduling and Latency Tolerance	1
5.7	Importance of Memory Access Efficiency, Cuda Memory Types	1
5.8	Tiling for Reduced Memory Traffic	1
5.9	Tiled Matrix Multiplication Kernel, Boundary Checks	1

CO Assessment Questions	
1	i. Differentiate between static and dynamic task mapping ii. Explain partitioning of data with an example

2	i. Explain the handshaking sequence of Blocking Non-Buffered Send/Receive operation with a neat diagram.
	ii. In the algorithm, assume a decomposition such that each execution of Line 7 is a task. Draw a task-dependency graph and a task-interaction graph.
	a) procedure FFT_like_pattern(A, n)
	b) begin
	c) m := log2 n;
	d) for j := 0 to m - 1 do
	e) k := 2j;
	f) for i := 0 to n - 1 do
	g) A[i] := A[i] + A[i XOR 2j];
	h) end // for
	i) end // FFT_like_pattern

3	i. Write a procedure for performing all-to-all reduction on a mesh . ii. Give a hypercube algorithm to compute prefix sums of n numbers if *p* is the number of nodes and n/p is an integer greater than 1. Assuming that it takes time *tadd* to add two numbers and time ts to send a message of unit length between two directly-connected nodes, give an exact expression for the total time taken by the algorithm.
4	i. Show how the two-dimensional matrix-vector multiplication program needs to be changed so that it will work correctly for a matrix of size *n x m* on a *q x r* process grid. ii. One of the advantages of non-blocking communication operations is that they allow the transmission of the data to be done concurrently with computations. Discuss the type of restructuring that needs to be performed on a program to allow for the maximal overlap of computation with communication. Is the sending process in a better position to benefit from this overlap than the receiving process
5	i. Implement a multi-access threaded queue with multiple threads inserting and multiple threads extracting from the queue. Use mutex-locks to synchronize access to the queue. Document the time for 1000 insertions and 1000 extractions each by 64 insertion threads (producers) and 64 extraction threads (consumers).

	ii. Implement a producer-consumer framework in OpenMP using sections to create a single producer task and a single consumer task. Ensure appropriate synchronization using locks.
6	i. Consider a hypothetical block with 8 threads executing a section of code before reaching a barrier. The threads require the following amount of time (in microseconds) to execute the sections: 2.0, 2.3, 3.0, 2.8, 2.4, 1.9, 2.6, and 2.9 and to spend the rest of their time waiting for the barrier. What percentage of the total execution time of the thread is spent waiting for the barrier? ii. Write and explain the CUDA program for vector addition.

24CSE645	Bioinformatics	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The primary objective of this course is to equip students with a comprehensive understanding of the principles, methodologies, and tools essential for the analysis, interpretation, and utilization of biological data. By integrating concepts from biology and computational science, the course aims to cultivate proficiency in navigating biological databases, performing sequence analysis, mastering molecular phylogenetics, and understanding the intricacies of genomics and proteomics. Through theoretical learning and practical applications, students will develop the skills needed to apply bioinformatics techniques to real-world scenarios, fostering a bridge between computational and biological sciences and preparing them for careers at the forefront of advancements in life sciences, healthcare, and biotechnology.

Prerequisite: A basic understanding of molecular biology and bio-chemistry, and the basics of algorithm design.

Course Outcomes: After the completion of the course the student will be able to

CO1	Understand the basic concepts of Bioinformatics with an emphasis on structure, function and synthesis of biomolecules. **(Understand Level)**
CO2	Acquire knowledge in biological data formats and databases, retrieve bio-sequences, and align bio sequences to identify similarity. **(Understand Level)**
CO3	Familiarize and apply similarity searching tools and algorithms to align sequences to highlight the similarity and describe the structure of genes. **(Apply Level)**
CO4	Delve into the algorithms that drive bioinformatics analyses, including sequence alignment, motif discovery, and phylogenetic tree construction. **(Analyze Level)**
CO5	Explore the technology of Genomics and Proteomics to understand and analyze the gene and protein structure and expressions. **(Apply Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2									1
CO2	2	3	2									1
CO3	2	2	2									
CO4	3	2	2									
CO5	3	2	2				1					1
CO6	3	2										

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓

Analyse			✓	✓
Evaluate			✓	
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

Module I: Introduction to bioinformatics (8 hours)

Introduction to bioinformatics - Nature and Scope, DNA, RNA, and Protein. The Central Dogma of Molecular Biology, Messenger RNA, tRNA, rRNA, Genetic code. Introduction to Biological Databases, NCBI, Genbank, Bio sequence formats-FASTA. Introduction to Bio-programming Languages.

Module II: Bio sequences and analysis (8 hours)

Sequence alignment- Global Alignment and Local Alignment, Dot Matrix Method, Dynamic Programming Method, Needleman and Wunsch and Smith–Waterman Algorithms, Gap Penalties, Amino Acid Scoring Matrices - PAM and BLOSUM. Multiple Alignment.

Module III: Molecular Phylogenetics (7 hours)
Motif finding, Gene Prediction, Molecular Phylogenetics, Phylogenetic trees, Algorithms for Phylogenetic Tree construction – UPGMA, Neighbour Joining. Small Parsimony Problem, Large Parsimony Problem.
Module IV: Combinatorial Pattern Matching (6 hours)
Combinatorial Pattern Matching, Repeat finding, Keyword Trees, Suffix Trees, Heuristic similarity search algorithms, Approximate Pattern Matching.
Module V: Genomics and Proteomics (7 hours)
Protein structure basics- visualization, comparison, and classification. Functional Genomics- Gene expression, Analyzing Gene Expression Data- EST, SAGE- Microarrays. Proteomics- Technology of Protein Expression Analysis.

Text books

1. N. C. Jones and P. A. Pevzner, An Introduction to Bioinformatics Algorithms, MIT Press, 2004
2. Jin Xion, Essential bioinformatics. Cambridge University Press, 2006.

Reference books

1. D. E. Krane and M. L. Raymer, Fundamental Concepts of Bioinformatics, Pearson Education, 2003.
2. T. K. Attwood and D. J. Parry-Smith, Introduction to Bioinformatics, Pearson Education, 2003.
3. Zvelebil, Marketa J., and Jeremy O. Baum. Understanding bioinformatics. Garland Science, 2007.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. ofHours
MODULE 1		
1.1	Introduction to bioinformatics - Nature and Scope, DNA, RNA, and Protein.	2
1.2	The Central Dogma of Molecular Biology, Messenger RNA, tRNA, rRNA, Genetic code	2
1.3	Introduction to Biological Databases- NCBI, Genbank	2
1.4	Bio sequence formats- FASTA	1
1.5	Introduction to Bio-programming Languages.	1
MODULE II		
2.1	Sequence alignment- Introduction, Dot Matrix Method	1
2.2	Edit Distance and Alignments	1

2.3	Longest Common Subsequences	1
2.4	Global Sequence Alignment	1
2.5	Local Sequence Alignment	1
2.6	Alignment with Gap Penalties	1
2.7	Multiple Alignment	1
2.8	Amino Acid Scoring Matrices - PAM and BLOSUM	1
MODULE III		
3.1	Motif finding	1
3.2	Gene Prediction	1
3.3	Molecular Phylogenetics, Phylogenetic trees, Algorithms	1
3.4	UPGMA	1
3.5	Neighbour Joining	1
3.6	Small Parsimony Problem	1
3.7	Large Parsimony Problem.	1
MODULE IV		
4.1	Combinatorial Pattern Matching, Repeat finding	1
4.2	Keyword Trees	1
4.3	Suffix Trees	1
4.4	Heuristic similarity search algorithms	1
4.5	Approximate Pattern Matching	2
MODULE V		
5.1	Protein structure basics- and classification.	1
5.2	Protein structure visualization, comparison, visualization, comparison,	2

5.3	Functional Genomics- Gene expression	1
5.4	Analyzing Gene Expression Data- EST, SAGE	1
5.5	Microarrays	1
5.6	Proteomics- Technology of Protein Expression Analysis.	1

CO Assessment Questions	
CO1	1. State and explain The Central Dogma of Molecular Biology. 2. Download DNA sequence of human insulin form NCBI. 3. Construct a dot plot and find the sequence alignment between the following two sequences: Sequence1: GATTCTATCTAACTA, Sequence2: GTTCTATTCTAAC
CO2	1. Identify the following qualifiers for GenBank and give their definitions: [ACCN], [ALL], [AUTH], [ECNO], [FKEY], [GENE], [JOUR], [KYWD] 2. Using the Smith-Waterman method, construct the dynamic programming alignment grid for a local alignment of the following two sequences: v = AACCTATAGCT and w = GCGATATA. Use the following scoring parameters: match score is +3 and the mismatch and indel penalties are −1. Find the optimal local alignment.
CO3	1. Construct a BLAST procedure for sequence alignment(HSP) if a sequence and its corresponding database sequence are given. Assume the necessary data and demonstrate the procedure. 2. What is a suffix tree? Construct a suffix tree for the nucleotide sequence TACCATACCAG and find the occurrence of the pattern CCA through threading.
CO4	Use UPGMA to reconstruct a phylogenetic tree using the following distance matrix:

Species	A	B	C	D
B	3	-	-	-
C	6	5	-	-
D	9	9	10	-
E	12	11	13	9

CO5	1. Explain the process of gene expression analysis using microarray spotting. Compare the process with Affymetrix microarray preparation. 2. Differentiate between primary and secondary protein structures. 3. Make use of an example and demonstrate the steps in protein comparison. Show how root mean square deviationis calculated while comparing two proteins.

24CSE655	Principles of Programming Languages	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The course provides the learners a clear understanding of the main constructs of contemporary programming languages and the various systems of ideas that have been used to guide the design of programming languages. This course covers the concepts of Names, Bindings & Scope, Statement-Level Control Structures, Sub Programs, Support for Object Oriented Programming, Exception Handling, Concurrency Control, Functional Programming and Logic Programming. This course helps the learners to equip with the knowledge necessary for the critical evaluation of existing and upcoming programming languages and also enables the learner to choose the most appropriate language for a given programming task.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the criteria for evaluating programming languages and compare Imperative, Functional and Logic programming languages . **(Understand level)**
CO2	Illustrate the characteristics of data types and variables.**(Apply level)**
CO3	Comprehend how control flow structures and subprograms help in developing the structure of a program to solve a computational problem **.(Apply level)**
CO4	Explain the characteristics of Object-Oriented Programming Languages. **(Understand level)**
CO5	Compare concurrency constructs in different programming languages. **(Understand level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									1
CO2	3	3										1
CO3	3	3	3	1								3
CO4	3	3										1
CO5	3	3										1

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Introduction (7 hrs)

Introduction – Role of Programming Languages, Programming Domains, Language Evaluation Criteria, Influence on Language Design, Language Design Trade-offs, Implementation Methods. Names, Bindings & Scope – Names, Variables, Concept of Binding, Scope and Lifetime, Referencing Environments.

MODULE II : Data Types and Exppressions (7 hrs)

Data Types – Primitive Data Types, Character String Types, User-Defined Ordinal Types, Array Types, Record Types, List Types, Pointer & Reference Types, Type Checking, Strong Typing, Type Equivalence. Expressions – Arithmetic Expressions, Overloaded Operators, Type Conversions, Relational and Boolean Expressions, Short-Circuit Evaluation. Assignment - Assignment Statements, Mixed-mode Assignment.

MODULE III : Control Structures,Subprograms (7 hrs)
Statement-Level Control Structures – Selection Statements, Iterative Statements, Unconditional Branching, Guarded Commands. Subprograms – Design Issues of Subprograms, Local Referencing Environments, Parameter Passing Methods, Subprograms as Parameters, Overloaded Subprograms, Closures, Co-routines.
MODULE IV : Object Oriented Programming Concepts (7 hrs)
Support for Object Oriented Programming – Inheritance, Dynamic Binding, Design Issues for Object Oriented Languages, Support for Object Oriented Programming in C++, Implementation of Object-oriented Constructs. Exception Handling – Basic Concepts, Design Issues.
MODULE V : Concurrency,Functional and Logical Programming (7 hrs)
Concurrency – Subprogram Level Concurrency, Semaphores, Monitors, Message Passing.Functional Programming Languages – Introduction to LISP and Scheme, Comparison of Functional and Imperative Languages. Logic Programming Languages – Basic Elements of Prolog, Applications of Logic Programming.

Text books

1. Robert W Sebesta, Concepts of Programming Languages, 10th Edition, Pearson,2012.
2. Scott M L, Programming Language Pragmatics, 3rd Edition, Morgan Kauffman Publishers,2009.

Reference books

1. Kenneth C. Louden, Programming Languages: Principles and Practice, 2nd Edition, Cengage Learning,2011.
2. Tucker A. B. and R. E. Noonan, Programming Languages: Principles and Paradigms, 2nd Edition. –TMH,2001.
3. Ravi Sethi, Programming Languages: Concepts & Constructs, 2nd Edition., Pearson Education,2006.
4. David A. Watt, Programming Language Design Concepts, Wiley Dreamtech,2004.

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
	MODULE 1	
1.1	Introduction: Reasons for studying Concepts of programming languages, Programming Domains.	1
1.2	Language Evaluation Criteria.	1
1.3	Influence on Language Design, Language Design Trade-offs.	1
1.4	Implementation Methods	1
1.5	Names, Variables.	1

1.6	Concept of Binding	1
1.7	Scope and Lifetime, Referencing Environments.	1
	MODULE II	
2.1	Scope and Lifetime, Referencing Environments	1
2.2	User-Defined Ordinal Types, Array Types	1
2.3	Record Types, List Types, Pointer and Reference Types	1
2.4	Implementation of pointer and reference types, Type Checking, Strong Typing, Type Equivalence.	1
2.5	Expressions and Assignment Statements, Arithmetic Expressions	1
2.6	Overloaded Operators, Type Conversions	1
2.7	Relational and Boolean Expressions, Short-Circuit Evaluation, Assignment Statements, Mixed-mode Assignment	1
	MODULE III	
3.1	Selection Statements, Iterative Statements	1
3.2	Unconditional Branching	1
3.3	Guarded Commands	1
3.4	Subprograms: Design Issues of Subprograms	1
3.5	Local Referencing Environments	1
3.6	Parameter Passing Methods	1
3.7	Subprograms as Parameters, Overloaded Subprograms	1
3.8	Closures, Co-routines	1
	MODULE IV	
4.1	Inheritance	1
4.2	Dynamic Binding	1
4.3	Design Issues for Object Oriented Languages	1

4.4	Support for Object Oriented Programming in C++	1
4.5	Implementation of Object-Oriented Constructs	1
4.6	Exception Handling – Basic Concepts.	1
4.7	Exception Handling - Design Issues	1
	MODULE V	
5.1	Subprogram Level Concurrency.	1
5.2	Semaphores, Monitors.	1
5.3	Message Passing.	1
5.4	Introduction to LISP and Scheme.	1
5.5	Comparison of Functional and Imperative Languages.	1
5.6	Basic Elements of Prolog.	1
5.7	Applications of Logic Programming .	1

CO Assessment Questions	
1	1. Compare any three programming languages based on the language evaluation criteria. Prepare a list of characteristics that affect the language evaluation criteria. 2. Identify the advantages and disadvantages of imperative, functional and logic programming languages.
2	1. Two most important design issues that are specific to character string types are (1) whether a string is simply a special kind of character array or a primitive type. (2) whether strings have static or dynamic length. Identify the implementations options for the above two cases. 2. Consider the following records of a particular language. Let the size of each char variable be 1 byte, int be 4 bytes and and Boolean be 1 bit. Struct Student { int id; char name[2]; int age;

	boolean scholarship; } Draw and comment on the possible memory layouts for the record for a 32-bit aligned machine.
3	1. What will be the output of the given program segment if it uses the following parameter passing mechanisms: a) call by reference b) call by value x : integer – – global procedure foo(y : integer) y := 3 print x . . . x := 2 foo(x) print x
4	1. Describe the role of a virtual method table in implementing dynamic method binding. 2. Identify the merits and demerits of inheritance.
5	1. Evaluate the use of semaphores and monitors for providing competition synchronization and cooperation synchronization.

24CSE665	Secure Coding	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course enables the learners to grasp fundamental principles and methods for secure coding, allowing them to effectively develop secure software. This course covers the basic security vulnerabilities, threats and mitigation strategies when working with concepts such as strings, integers, dynamic memory management, formatted outputs and multithreading. It will help the students to apply to apply Secure Development Life Cycle principles effectively in real-world applications.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Identify security weaknesses and vulnerabilities in programs that utilize string manipulation and employ suitable strategies to enhance the program security.**(Apply Level)**
CO2	Implement security measures to mitigate the security concerns related to the use of integer data types. **(Apply Level)**
CO3	Describe the security flaws and mitigation techniques in programs that make use of dynamic memory management. **(Apply level)**
CO4	Demonstrate the correct and incorrect use of formatted output functions and multithreading. **(Apply Level)**
CO5	Explain various phases of Security Development Lifecycle. **(Understand Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									3
CO2	3	3	3					3				3
CO3	3	3	3									3
CO4	3	3	3									3
CO5	3	3	3									3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Introduction and String Security (8 hrs)

Introduction & Motivation: Hacker vs. Cracker, Historical Background, Mode of Ethical Hacking, Hacker Motive. Software Security, Security Concepts, Security Policy, Security Flaws, Vulnerabilities, Exploits, Mitigations. Strings - Character Strings, Common string manipulation errors, String Vulnerabilities and Exploits, Mitigation strategies, Runtime protection strategies.

MODULE II : Integer Security (7 hrs)

Introduction to integer types, Integer Data Types, Integer Conversions, Integer operations, Integer Vulnerabilities, Mitigation strategies.

MODULE III : Dynamic Memory Management (8 hrs)

C Memory management functions, Common C Memory Management Errors - Initialization Errors, Failing to Check Return Values, Dereferencing Null or Invalid

Pointers, Referencing Freed Memory, Freeing Memory Multiple Times, Memory Leaks, ZeroLength Allocations, Mitigation Strategies.

MODULE IV : Formatted Output and Concurrency (8 hrs)

Security Development Lifecycle, Security Training, Requirements, Design, Implementation, Verification.

MODULE V : Security Development Life Cycle (5 hrs)

Security Development Lifecycle, Security Training, Requirements, Design, Implementation,Verification

Text books

1. Robert C. Seacord, Secure Coding in C and C++, 2nd Edition, Addison-Wesley, 2013.

Reference books

1. Wenliang Du, Computer Security – A hands-on Approach, Second Edition, Create space Independent Pub, 2019.
2. CERT C Coding Standard. Available online: https://wiki.sei.cmu.edu/confluence/display/c/SEI+CERT+C+Coding+Standard

Suggested MOOC Courses

1. Information Security - 5 - Secure Systems Engineering, Prof. Chester Rebeiro | IIT Madras.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Introduction & Motivation: Hacker vs. Cracker, Historical Background, Mode of Ethical Hacking, Hacker Motive.	1
1.2	Software Security, Security Concepts, Security Policy, Security Flaws, Vulnerabilities, Exploits, Mitigations.	1
1.3	Strings - Character Strings	1
1.4	Common string manipulation errors	1
1.5	String Vulnerabilities and Exploits – Lecture 1	1
1.6	String Vulnerabilities and Exploits – Lecture 2	1
1.7	Mitigation strategies	1
1.8	Runtime protection strategies	1
	MODULE II	

2.1	Introduction to integer types, Integer Data Types	1
2.2	Integer Conversions– Lecture 1	1
2.3	Integer Conversions– Lecture 2	1
2.4	Integer operations– Lecture 1	1
2.5	Integer operations – Lecture 2	1
2.6	Integer Vulnerabilities	1
2.7	Mitigation strategies	1
MODULE III		
3.1	C Memory management functions, Common C Memory Management Errors - Initialization Errors	1
3.2	Failing to Check Return Values, Dereferencing Null or Invalid Pointers	1
3.3	Referencing Freed Memory	1
3.4	Freeing Memory Multiple Times	1
3.5	Memory Leaks	1
3.6	Zero Length Allocations	1
3.7	Mitigation Strategies – Lecture 1	1
3.8	Mitigation Strategies – Lecture 2	1
MODULE IV		
4.1	Variadic Functions– Lecture 1	1
4.2	Variadic Functions– Lecture 2	1
4.3	Formatted Output Functions	1
4.4	Vulnerabilities	1
4.5	Mitigation Strategies	1

4.6	Concurrency – Multithreading, Parallelism	1
4.7	Common Errors	1
4.8	Mitigation strategies	1
MODULE V		
5.1	Security Development Lifecycle, Security Training	1
5.2	SDLC – Requirements	1
5.3	SDLC – Design	1
5.4	SDLC – Implementation	1
5.5	SDLC - Verification	1

CO Assessment Questions	
1	1. The code snippet below shows a simple example of a program that checks a user password and grants or denies access. Is there any form of string vulnerabilities present in the code? Explain. *bool IsPasswordOkay(void) {* *char Password[12];* *gets(Password);* *if (!strcmp(Password, "goodpass"))* *return(true);* *else return(false);* *}* *void main(void) {* *bool PwStatus;* *puts("Enter password:");* *PwStatus = IsPasswordOkay();* *if (PwStatus == false) {* *puts("Access denied");* *exit(-1);* *}* *else puts("Access granted");* *}* 2. Explain any four string manipulation errors in C that may led to security attacks with proper examples.

<table>
<tr><td></td><td>3. Identify any one notable vulnerability resulting from incorrect string handling and submit a report on the type of vulnerability, its consequence and the protection mechanisms adopted for mitigating the attacks. (Example: Morris worm and the W32.Blaster.Worm)</td></tr>
<tr><td>2</td><td>1. Illustrate various exceptional conditions occur while performing integer addition and subtraction.
2. Explain various mitigation strategies that can be adopted for exceptions caused by integer operations
3. Identify the security flaw occurs in the following code.
int *table = NULL;
int insert_in_table(int pos, int value)
{
    if(!table) {
        table = (int*) malloc(sizeof(int)*100);
    }
    if(pos>99) {
        return -1;
    }
table[pos]=value;
return 0;
}</td></tr>
<tr><td>3</td><td>1. Explain any four memory management errors in C with proper examples.
2. Identify the memory allocator used in GNU C library and explain the working of the memory allocator.
3. Several double free vulnerabilities exist in the MIT implementation of Kerberos 5 protocol. Identify the nature of vulnerabilities present in the protocol.</td></tr>
<tr><td>4</td><td>1. Explain the significance of Variadic functions and implement a variadic function to find the average of n numbers.
2. Illustrate the concept of stack randomization in the context of formatted output functions.
3. Identify a situation where concurrency and multithreading can be applied (For eg: Banking). Implement the scenario and analyze the presence of any security vulnerabilities present in the code.</td></tr>
<tr><td>5</td><td>1. Identify the vulnerabilities occurred in Microsoft Office and Open Office for the last 20 years. Does Security Development Lifecycle improve the security of the application? Justify.
2. Illustrate the Security Development Life Cycle and explain various phases involved in the life cycle.
3. Explain the need of incorporating security in software development and write the principles of Secure Software Development.</td></tr>
</table>

24CSE675	Social Networking and Security	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course is helps the students to understand the online social media privacy and security issues by addressing the complexities inherent in the security of social networking. The students will be able to identify and recognize various privacy and security problems on online social media platforms. Furthermore, the course emphasizes the active use of online social networks as a means to express a diverse range of problems, fostering a practical understanding of the challenges users encounter in these digital spaces.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Understand various social media privacy and security risks (spam, phishing, fraud nodes, identity theft). **(Cognitive Level : Understand)**
CO2	Apply analytical skills through data analytics, data mining, and cloud computing for dynamic malware detection and prevention. **(Cognitive Level : Understand)**
CO3	Analyse fraudulent entities in online social networks. **(Cognitive Level : Understand)**
CO4	Evaluate algorithm for handling various concerns comprehensively on online Social Media. **(Cognitive Level : Understand)**
CO5	Design the system addressing various privacy issues of frameworks to relate them to techniques and applications. **(Cognitive Level : Understand)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	1		1		1				1
CO2	1	3	1	3	2	1						
CO3	1	1	1	1		1						1
CO4	2	3	2	2	2	1						
CO5	2	2	1	1	1	1		1				1

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test 1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate			✓	
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Introduction to Social Networks Security (6 hours)

Types and Classification of Social Media, Problems and Opportunities of Social Media-Risks of Social Media, Public Embarrassment, False Information, Information Leakage, Retention and Archiving Content, Backing Up Social Media, Loss of Data/Equipment, Dark Side of Social Media, Cybercrime, Social Engineering, Hacked Accounts; Sharing Information on Social Media.

MODULE II : Attacks on Social Media And Data Analytics Solutions (9 hours)

Malware and Attacks, Types of Malware, Threats to Cyber Security, Attacks on Social Media, Data Analytics Solutions, Data Mining for Cyber Security, Malware Detection as a Data Stream Classification Problem, Cloud-Based Malware Detection for Evolving

Data Streams, Cloud Computing for Malware Detection, Design and Implementation of the System Ensemble Construction and Updating, Malicious Code Detection.

MODULE III : Confidentiality, Access Control, Privacy and Trust In Social Media (7 hours)

CPT Framework and Process, Inference Engines, Confidentiality Management, Privacy for Social Networks, Trust for Social Networks, Security Policies for Social Networks, Access Control System for Social Networks

MODULE IV : Inference Control & Secure Query Processing for Social Media (6 hours)

Architecture and Design of an Inference Controller, Inference Control through Query Modification - Query Modification, Query Modification With Relational Data, Sparql Query Modification, Query Modification for Enforcing Constraints, Applications, Use Cases of Inference Controller

Secure Cloud Query Processing with Relational Data for Social Media, Secure Cloud Query Processing for Semantic Web-Based Social Media - Access Control and System Architecture.

MODULE V : Social Network Integration and Analysis with Privacy Preservation (7 hours)

Social Network Analysis, Limitations of Current Approaches for Privacy-Preserving Social Networks - Privacy Preservation of Relational Data, K-Anonymity and L-Diversity, Privacy Preservation of Social Network Data, Framework of Information Sharing and Privacy Preservation For Integrating Social Networks - Sharing Insensitive Information, Generalization, Probabilistic Model of Generalized Information, Integrating Generalized Social Network For Social Network Analysis Task.

Text books

1. Thuraisingham B., Abrol Raymond Heatherly S., Kantarcioglu M., Khadilkar V., Khan L, “Analyzing and Securing Social Networks”, Taylor & Francis Group, 2016.

Reference books

1. Michael Cross, “Social Media Security”, Elsevier, 2013
2. Altshuler Y., Elovici Y., Cremers A.B., AharonyN., Pentland, “Security and Privacy in Social Networks”, Springer, 2013.
3. Gavin Bell, “Building Social Web Applications”,O’Reilly, 2009.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Types and Classification of Social Media, Problems and Opportunities of Social Media- Risks of Social Media,	1
1.2	Public Embarrassment, False Information, Information Leakage,.	1

1.3	Retention and Archiving Content, Backing Up Social Media,	1
1.4	Loss of Data/Equipment, Dark Side of Social Media, Cybercrime,	1
1.5	Social Engineering, Hacked Accounts;	1
1.6	Sharing Information on Social Media	1
MODULE 2		
2.1	Malware and Attacks, Types of Malware, Threats to Cyber Security,	1
2.2	Attacks on Social Media,	1
2.3	Data Analytics Solutions	1
2.4	Data Mining for Cyber Security	1
2.5	Malware Detection as a Data Stream Classification Problem	1
2.6	Cloud-Based Malware Detection for Evolving Data Streams	1
2.7	Cloud Computing for Malware Detection	1
2.8	Design and Implementation of the System Ensemble Construction and Updating	1
2.9	Malicious Code Detection	1
MODULE 3		
3.1	CPT Framework and Process	1
3.2	Inference Engines	1
3.3	Confidentiality Management	1
3.4	Privacy for Social Networks,	1
3.5	Trust for Social Networks	1
3.6	Security Policies for Social Networks	1
3.7	Access Control System for Social Networks	1
MODULE 4		

4.1	Architecture and Design of an Inference Controller, Inference Control through Query Modification - Query Modification, Applications, ,	1
4.2	Query Modification With Relational Data, Sparql Query Modification,	1
4.3	Query Modification for Enforcing Constraints,	1
4.4	Use Cases of Inference Controller	1
4.5	Secure Cloud Query Processing with Relational Data for Social Media	1
4.6	Secure Cloud Query Processing for Semantic Web-Based Social Media - Access Control and System Architecture.	1
MODULE 5		
5.1	Social Network Analysis, Limitations of Current Approaches for Privacy-Preserving Social Networks	1
5.2	Privacy Preservation of Relational Data, K-Anonymity and L-Diversity,	1
5.3	Privacy Preservation of Social Network Data	1
5.4	Framework of Information Sharing and Privacy Preservation For Integrating Social Networks	1
5.5	Sharing Insensitive Information	1
5.6	Generalization, Probabilistic Model of Generalized Information,	1
5.7	Integrating Generalized Social Network For Social Network Analysis Task.	1

CO Assessment Questions	
1	a) How can individuals distinguish between accurate and false information on social media, and what role do platforms play in addressing misinformation? b) What measures can users take to prevent information leakage on social media, and what responsibilities do platforms have in this regard? c) How do you foresee the landscape of information sharing on social media evolving in the next decade, considering privacy, security, and user expectations? d) Develop a strategic plan for the business, addressing the risks, opportunities, and providing practical steps to ensure a secure and effective presence on social media.

2	a) Classify and describe different types of malware, ranging from traditional viruses to more sophisticated forms like ransomware and advanced persistent threats. Discuss the specific characteristics and attack vectors associated with each type, highlighting their potential impact on information systems. b) Identify and analyze the various threats that pose risks to cybersecurity. How do factors such as social engineering, insider threats, and nation-state cyber activities contribute to the overall threat landscape? Discuss strategies and best practices for mitigating these threats.
3	a) Elaborate on the key components of effective security policies for social networks. How do these policies address issues such as data breaches, unauthorized access, and malicious activities? Provide examples of successful security policy implementations in social networking platforms. b) Examine the significance of access control systems in securing social networks. Discuss the challenges associated with balancing user accessibility and security. How do access control systems contribute to preventing unauthorized access and protecting user data in social networks?
4	a) Investigate the application of query modification techniques specifically in the context of SPARQL queries for Semantic Web data. How does query modification address security concerns in Semantic Web environments? Provide examples of SPARQL query modification and its impact on data confidentiality. b) Describe in detail the architecture and design considerations for an Inference Controller in a cybersecurity context. Discuss the key components, functionalities, and how it integrates with existing systems. How does the architecture of an Inference Controller contribute to enhancing security in information systems?
5	a) Explore the application of probabilistic models to represent generalized information in privacy-preserving social networks. How can probabilistic models enhance the accuracy of privacy-preserving mechanisms? Discuss the challenges and benefits of using probabilistic models in this context. b) Explain the concepts of K-Anonymity and L-Diversity in the context of privacy preservation. How do these techniques contribute to safeguarding individual privacy in social networks? Discuss their strengths, limitations, and real-world applications.

24CSE685	High Performance Computing	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course is designed to provide students with a comprehensive understanding of the fundamental concepts, methodologies, and challenges associated with high-performance computing systems. It involves the use of parallel processing techniques and supercomputers to solve complex computational problems efficiently. The course outlines the various aspects that define the landscape of HPC through the perplexities of modern processors, parallel computing architectures, distributed and shared-memory programming paradigms, and advanced topics that define the cutting edge of high-performance computing (HPC).

Prerequisite: Strong Foundation in Computer Organization, Architecture and Programming.

Course Outcomes: After the completion of the course the student will be able to

CO1	Appraise modern parallel architectures such as superscalar, multi-core, and multi-threaded systems in server and cloud environments. **(Understand Level)**
CO2	Assess the significance of High-Performance Computing in addressing contemporary computational challenges. **(Understand Level)**
CO3	Apply parallel execution models and methodologies for parallel programming and parallel applications development. **(Apply Level)**
CO4	Gain insights into the emerging trends and advanced topics in High Performance Computing. **(Analyze Level)**
CO5	Understand the practical applications of high-performance technical computing in industry, finance and research. **(Understand Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2									3
CO2	3	3	2									3
CO3	3	3	2									3
CO4	3	3	2									3
CO5	3	3	2									3
CO6	3	3										3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	✓
Evaluate			✓	

Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

Module I: Modern Processors (8 hours)

Stored-program computer architecture, Need for Parallelism, Data parallelism, Functional parallelism. Parallel Computers- SIMD systems, MIMD systems. Parallel architectures- superscalar architectures, multi-core, multi-threaded, server and cloud.

Module II: Navigating the High-Performance Computing Landscape (7hours)

Importance of HPC in current times, Fundamental design issues in HPC- Load balancing, Scheduling, Synchronization and Resource management. Operating systems for scalable HPC. Fundamental limitations in HPC- bandwidth, latency and latency hiding techniques. Benchmarking HPC

Module III: Shared-memory parallel programming with OpenMP (7hours)

Parallel execution, Data scoping, OpenMP work-sharing for loops, Synchronization, Reductions, Loop scheduling, Tasking, Cache Coherence, and False Sharing- Thread Safety. Case study: OpenMP-parallel Jacobi algorithm.

Module IV: Distributed-memory parallel programming with MPI (6hours)

Message passing, Messages and point-to-point communication, The Trapezoidal Rule in MPI, Collective communication, Nonblocking point-to-point, Virtual topologies, A Parallel Sorting Algorithm- Odd even Transposition Sort.

Module V: Advanced Topics (8hours)

Accelerated HPC- architecture, programming and typical accelerated system with GPU, FPGA and Xeon Phi. Handling big data- Introduction to HDF5. Visualization tools- VisIt and Paraview. Peta scale computing, optics in HPC, quantum computers.

Text books

1. Georg Hager and Gerhard Wellein. Introduction to High Performance Computing for Scientists and Engineers. CRC Press, Chapman & Hall/CRC Computational Science, India, 2010.
2. Peter S. Pacheco, An Introduction to Parallel Programming, 2011. 1st Edition, Morgan Kaufmann Publishers.

Reference books

1. Vipin Kumar, Ananth Grama, Anshul Gupta, George Karypis. Introduction to Parallel Computing. Pearson India . 2003.
2. David B. Kirk and Wen-mei W. Hwu. Programming Massively Parallel Processors: A Hands-On Approach (1st ed.). Elsevier India Pvt. Ltd. 2010.
3. Michael T. Heath. Scientific Computing: An Introductory Survey (2nd ed.). McGraw Hill Education (India) Private Limited, 2011

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. ofHours
	MODULE 1	
1.1	Stored-program computer architecture, Need for Parallelism	1
1.2	Data parallelism	1
1.3	Functional parallelism	1
1.4	SIMD systems	1
1.5	MIMD systems	1

1.6	Superscalar architectures	1
1.7	Multi-core and multi-threaded architectures.	1
1.8	Server and cloud	1
	MODULE II	
2.1	Importance of HPC in current times, Fundamental design issues in HPC- Overview	1
2.2	Load balancing, Scheduling	1
2.3	Synchronization and Resource management	1
2.4	Operating systems for scalable HPC	1
2.5	Fundamental limitations in HPC- bandwidth and latency	1
2.6	Latency hiding techniques	1
2.7	Benchmarking HPC	1
	MODULE III	
3.1	Open MP Introduction, Parallel execution, Data scoping	1
3.2	OpenMP work-sharing for loops	1
3.3	Synchronization, Reductions	1
3.4	Loop scheduling and Tasking	1
3.5	Cache Coherence, and False Sharing	1
3.6	Thread Safety	1
3.7	Case study: OpenMP-parallel Jacobi algorithm.	1
	MODULE IV	
4.1	Message passing, Messages and point-to-point communication.	1
4.2	The Trapezoidal Rule in MPI	1
4.3	Collective communication	1

4.4	Nonblocking point-to-point, Virtual topologies	1
4.5	A Parallel Sorting Algorithm- Odd even Transposition Sort.	2
MODULE V		
5.1	Accelerated HPC- architecture, programming and typical accelerated system- GPU.	1
5.2	FPGA	1
5.3	Xeon Phi	1
5.4	Handling big data- Introduction to HDF5	1
5.5	Visualization tools- Visit and Paraview	1
5.6	Peta scale computing	1
5.7	Optics in HPC	1
5.8	Quantum computers	1

CO Assessment Questions	
CO1	Explain why the performance of a hardware multithreaded processing core might degrade if it had large caches and it ran many threads.
	Suppose that a vector processor has a memory system in which it takes 10 cycles to load a single 64-bit word from memory. How many memory banks are needed so that a stream of loads can, on average, require only one cycle per load?
CO2	Define task scheduling in HPC. What factors should be considered when designing a task scheduling algorithm for a parallel computing environment?
	Explain the challenges associated with scheduling in heterogeneous computing environments. How can these challenges be addressed?
CO3	Write an OpenMP program that determines the default scheduling of parallel for loops. Its input should be the number of iterations, and its output should be which iterations of a parallelized for loop are executed by which thread. For example, if there are two threads and four iterations, the output might be: Thread 0: Iterations 0−−1 Thread 1: Iterations 2--3

CO4	Discuss the supported data formats in VisIt and how it handles complex, multidimensional datasets. How does VisIt address challenges associated with data exploration and analysis?
	Explain the concept of parallel visualization in ParaView. How does ParaView leverage parallel processing to enhance the visualization of large-scale datasets?
CO5	Discuss the impact of PetaScale computing on advancing research in fields such as climate modeling, astrophysics, and molecular dynamics.
	Explore the role of optics in improving the energy efficiency of HPC systems. How can optical interconnects and components contribute to reducing power consumption in large-scale computing clusters?

24CSE695	IoT AND EMBEDDED SYSTEMS	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The course on IoT and Embedded Systems is a comprehensive program designed to equip participants with the knowledge and skills necessary to excel in the dynamic field of the Internet of Things (IoT) and Embedded Systems. This course delves into the intricacies of both IoT and Embedded Systems, focusing on key aspects such as the architecture, programming of embedded processors, and the development of embedded solutions.

Prerequisite: Introduction to Embedded Systems, C++ Programming

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the basics of Embedded Systems and 1oT (**Understand level**)
CO 2	Correlate the architecture and programming of ARM Microcontroller (**Understand level)**
CO 3	Work with Raspberry Pi using Python Programming. (**Apply level**)
CO 4	Summarize IOT standards, communication technologies and protocols (**Understand level**)
CO 5	Implement real-time projects using the tools and techniques of the IoT Platform. (**Apply level**)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3		2			1				1		
CO 2	2	3								1		
CO 3	1		3		3				2			
CO 4	3		1			1						2
CO 5			3			1					2	

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate				
Create				

Mark Distribution of CIA							
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Practical [P]		Total Marks
		Assignment	Test-1	Test-2	Class work	Lab Exam	
3-0-0-0	5	15	10	10			40

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub-divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Introduction (7 hours)

Introduction to Embedded Systems and Internet of Things (IOT): Architecture of Embedded Systems, Embedded Systems Development process, Architecture of Internet of Things, Applications of Embedded Systems and IOT, Design Methodology for IOT Products.

MODULE II: Introduction to ad-hoc/sensor networks (7 hours)

ARM Microcontrollers Architecture and Programming: Architecture, Instruction set, Programming ports, Timer/Counter, Serial communication, interrupts, Introduction ARM mBed platform.

Module III: MAC Protocols (8 hours)

Fundamentals of Python Programming & Raspberry Pi: Introduction to Python Programming, Working with functions, classes, and REST full. Web Services, Client Libraries, Introduction and programming Raspberry Pi3, Integrating Input Output devices with Raspberry Pi3.

MODULE IV: Routing Protocols (7 hours)

IoT Technologies, Standards and Tools: Fundamental Characteristics and high-level requirements of 1oT, IoT Reference models; Introduction to Communication Technologies & Protocols of IoT: BLE, Wi-Fi, LORA, 3G/4G Technologies and HTTP, MQTT, COAP protocols.

MODULE V: QoS and Energy Management (7 hours)

Cloud Computing Platforms for IoT Development: 1oT Platform Architecture (IBM Internet of Things & Watson Platforms); API Endpoints for Platform Services; Devices Creation and Data Transmission; Introduction to NODE-RED and Application Deployment.
Textbooks 1. ArsheepBahga, Vijay Madisctti, “Internet of Things: A Hands-On Approach”, 1st Edition, VPT, 2014. 2. K.V.K.K Prasad, “Embedded Real Time Systems: Concepts, Design and Programming”, 1st Edition, Dreamtech Publication, 2014. 3. Adrian McEwen, Hakim Cassimally, “Designing the Internet of Things”, Wiley Publications,2013
Reference books 1. Jonathan W Valvano, “Embedded Microcomputer Systems: Real-Time Interfacing”, , Thomson Engineering, 2012. 2. Olivier Hersent, David Boswarthick, Omar Elloumi, “The Internet of Things: Key applications and Protocols”, 2™ Edition, Wiley Publications, 2012.

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. ofHours
	MODULE 1	
1.1	Introduction to Embedded Systems and the Internet of Things (IoT)	1
1.2	Architecture of Embedded Systems,	1
1.3	Embedded Systems Development process	1
1.4	Architecture of Internet of Things	1
1.5	Architecture of Internet of Things	1
1.6	Applications of Embedded Systems and IOT	1
1.7	Design Methodology for IOT Products	1
	MODULE II	
2.1	ARM Microcontrollers Architecture and Programming: Introduction	1
2.2	ARM Microcontrollers Architecture and Programming Architecture,	2
2.3	Instruction set	2
2.4	Programming ports, Timer/Counter, Serial communication, Interrupts	1
2.5	Introduction ARM mBed platform.	1
	MODULE III	
3.1	Introduction to Python Programming	1
3.2	Working with functions, classes, REST full.	2
3.3	Web Services, Client Libraries	2
3.4	Introduction & programming Raspberry Pi3	1
3.5	Integrating Input Output devices with Raspberry Pi3.	2
	MODULE IV	
4.1	IoT Technologies Standards and Tools	1
4.2	Fundamental characteristics and high-level requirements	1

	of IoT	
4.3	IoT Reference models;	2
4.4	Introduction to Communication Technologies & Protocols of IoT: BLE, Wi-Fi, LORA, 3G/4G Technologies	2
4.5	Introduction to Communication Technologies & Protocols of IoT: HTTP, MQTT, COAP protocols.	1
	MODULE V	
5.1	Cloud Computing Platforms for IoT Development: 1oT Platform Architecture (IBM Internet of Things & Watson Platforms);	2
5.2	API Endpoints for Platform Services; Devices Creation and Data Transmission	2
5.3	API Endpoints for Platform Services; Devices Creation and Data Transmission.	1
5.4	Introduction to NODE-RED and Application Deployment	2

CO Assessment Questions	
1	In the context of IoT, what are smart devices, and how are they integrated into IoT technology?
2	Draw and explain the block diagram and architecture of a specific ARM microcontroller LPC2148.
3	Explain how Python is used for programming Raspberry Pi.
4	How does M2M communication play a role in IoT?
5	How does the cloud platform handle scalability requirements for IoT applications, considering potential increases in data and device connections?

24CSE6105	Neural Networks and Deep Learning	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course typically aims to provide students with a deeper understanding of advanced concepts, techniques, and applications in the field of deep learning. It aims to familiarize various models and algorithms in Deep Learning and be able to select suitable models corresponding to different applications. To compare DL algorithm performance and apply the algorithms to a real-world problem, optimize the models learned and report on the expected performance.

Prerequisite: A Sound knowledge in Computational fundamentals of machine learning.

Course Outcomes: After the completion of the course the student will be able to

CO1	Illustrate the neural networks, identify its components and applications (**Apply Level**)
CO2	Explain the basic concepts of shared weights and use Convolutional neural network architecture. **(Understand)**
CO3	Explain the concepts of modern RNNs like LSTM, GRU, and attention Mechanism.(**Understand Level**)
CO4	Understand probabilistic models, generative models and encoder-based models. (**Understand Level)**
CO5	Demonstrate the practical issues in ML/DL model training and testing. **(Apply level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2		2	2	2							2
CO2	2		2	2	2							2
CO3	3		2	2	2	2						2
CO4	2		2	3	3	3						2
CO5	1		2	2	2							2

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Introduction to neural networks

Introduction to neural networks - McCulloch Pitts Neuron,-Single layer perceptrons, Multi Layer Perceptrons (MLPs), Linearly Separable Boolean functions, Representation Power of MLPs, Activation functions - Sigmoid, Tanh, ReLU, Softmax. Loss function, Training MLPs with backpropagation.

MODULE II : Convolutional Neural Networks

Convolutional Neural Networks – Convolution operation, Motivation, Pooling, CNN architecture, MLP versus CNN - Convolution and Pooling as an infinitely strong prior, Variants of convolution functions, Structured outputs, Data types, Efficient convolution algorithms.

Practical use cases for CNNs, Case study - Popular CNN architecture – LeNet, AlexNet, Building CNN model AlexNet with handwritten digit dataset MNIST.

MODULE III : Recurrent neural networks

Recurrent neural networks – Sequence learning problems, Backpropagation Through Time, The Problem of vanishing and exploding gradients, Computational graphs, RNN design, encoder – decoder sequence to sequence architectures, deep recurrent networks, recursive neural networks, modern RNNs LSTM and GRU, Introduction to attention Mechanism and Transformers.

MODULE IV : Bayesian Model and Deep Generative Models

Bayes' Rule and Naive Bayes Model, Maximum Likelihood estimation. Discrete Markov Processes, Hidden Markov Models.

Deep Generative Models: Variational Autoencoder, Generative Adversarial Network, Autoregressive Models.

MODULE V : Practical issues in Neural network training

Practical issues in neural network training - Overfitting, Underfitting, Vanishing and exploding gradient problems, Local and spurious Optima, Computational Challenges.

Effective training in Deep Net- early stopping, Dropout, Batch Normalization, Instance Normalization, Group Normalization. Glimpse of Ethical and Responsible AI

Text books

1. Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.
2. Neural Networks and Deep Learning, Aggarwal, Charu C., c Springer International Publishing AG, part of Springer Nature 2018
3. Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms (1st. ed.). Nikhil Buduma and Nicholas Locascio. 2017. O'Reilly Media, Inc.

Reference books

1. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.
2. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.
3. Michael Nielsen, Neural Networks and Deep Learning, 2018.
1. Coursera Course - Introduction to Deep Learning by Prof. Geena Kim, University of Colorado Boulder.

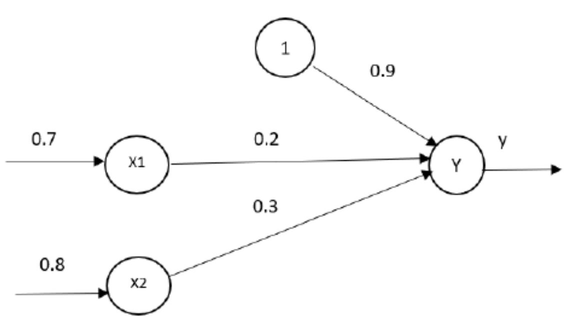
COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Introduction to neural networks - McCulloch Pitts Neuron	1
1.2	Single layer perceptrons, Multi Layer Perceptrons (MLPs)	1
1.3	Linearly Separable Boolean functions, Representation Power of MLPs	1

1.4	Activation functions - Sigmoid, Tanh, ReLU, Softmax. Loss function	1
1.5	Training MLPs with backpropagation.	1
1.6	Illustration of back propagation algorithm	1
MODULE II		
2.1	Convolutional Neural Networks – Motivation.	1
2.2	Convolution and Pooling operation	1
2.3	CNN architecture, MLP versus CNN	1
2.4	Convolution and Pooling as an infinitely strong prior	1
2.5	Variants of convolution functions, Structured outputs, Data types	1
2.6	Efficient convolution algorithms, Practical use cases for CNNs	1
2.7	Case study - Popular CNN architecture – LeNet, AlexNet	1
2.8	Building CNN model AlexNet with handwritten digit dataset MNIST	1
MODULE III		
3.1	Recurrent neural networks – Sequence learning problems	1
3.2	Backpropagation Through Time	1
3.3	The Problem of vanishing and exploding gradients	1
3.4	Computational graphs, RNN design	1
3.5	Encoder – decoder sequence to sequence architectures	1
3.6	Deep recurrent networks, Recursive neural networks	1
3.7	Modern RNNs – LSTM, GRU	1
3.8	Introduction to attention Mechanism and Transformers	1
MODULE IV		
4.1	Bayes' Rule and Naive Bayes Model	1

4.2	Maximum Likelihood estimation.	1
4.3	Discrete Markov Processes	1
4.4	Hidden Markov Models.	1
4.5	Deep Generative Models: Variational Autoencoder	1
4.6	Generative Adversarial Network	1
4.7	Autoregressive Models.	2
	MODULE V	
5.1	Practical issues in neural network training - Overfitting, Underfitting, Vanishing and exploding gradient problems	2
5.2	Local and spurious Optima, Computational Challenges.	1
5.3	Effective training in Deep Net- early stopping, Dropout	1
5.4	Batch Normalization, Instance Normalization, Group Normalization.	1
5.5	Glimpse of Ethical and Responsible AI	1

<table>
<tr><th colspan="2">CO Assessment Questions</th></tr>
<tr><td>1</td><td>
1. For the network shown below, calculate the output of the neuron Y when the activation function is:
a) Sigmoid
b) tanH
c) ReLu



2. Illustrate the limitation of a single layer perceptron with an example.
3. Design a Multilayer Perceptron for the XOR function.
</td></tr>
</table>

2	1. Draw and explain the architecture of convolutional neural networks. 2. Suppose that a CNN was trained to classify images into different categories. It performed well on a validation set that was taken from the same source as the training set but not on a testing set. What could be the problem with the training of such a CNN? How will you ascertain the problem? How can those problems be solved? 3. You would like to train a fully-connected neural network with 5 hidden layers, each with 10 hidden units. The input is 20-dimensional and the output is a scalar. What is the total number of trainable parameters in your network?
3	1. Explain the concept of 'Unrolling through time' in Recurrent Neural Networks. 2. Draw and explain the architecture of LSTM. 3. Illustrate the workings of the RNN with an example of a single sequence defined on a vocabulary of four words.
4	1. Discuss the key assumptions underlying the Naive Bayes Model. How does the independence assumption impact its performance in classification tasks? 2. Discuss the challenges associated with training and evaluating deep generative models. How do these models contribute to unsupervised learning and data generation tasks? Provide examples of applications where each model excels and discuss their potential societal implications.
5	1. Explain in detail any four practical issues in neural network training. 2. Discuss any the methods to prevent overfitting in a neural network. 3. A) Discuss the significance of dropout regularization in training a neural network. B) Initializing the weights of a neural network with very small or large random numbers are not advisable. Justify.

24CSE6115	Neural Networks And Fuzzy Logic	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course enables the students to understand the fundamentals of neural network and the concepts of fuzzy logic. This course introduces the leaners how the fuzzy system can be incorporated with neural networks to utilize the back propagation learning and rule-based decision making of fuzzy logic. The students will be able to use Fuzzy or Neural-fuzzy systems in many different applications especially in control systems, pattern recognition, robotics.

Prerequisite: Fundamentals of Machine Learning

Course Outcomes: After the completion of the course the student will be able to

CO1	Illustrate the neural networks, identify its components and applications (**Apply Level**)
CO2	Explain the need and operations of fuzzy set theory in capturing and representing imprecise information (**Understand Level**)
CO3	Demonstrate the need and techniques of fuzzification and defuzzification for a given scenario. (**Apply Level**)
CO4	Identify and apply neuro-fuzzy systems for various domains **(Apply Level)**
CO5	Use Fuzzy Arithmetic and Extension Principle apply fuzzy logic systems for solving real world problems. (**Create Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2		2	2	2							2
CO2	3											3
CO3	3	3	2	2	1							3
CO4	2	3	3	3	2	2						3
CO5	3	3	2	2		2						3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✔	✔	✔	✔
Understand	✔	✔	✔	✔
Apply	✔	✔	✔	✔
Analyse			✔	
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Introduction to neural networks

Introduction to neural networks -Motivation from Biological neuron, McCulloch Pitts Neuron, -Single layer perceptrons, Multi Layer Perceptrons (MLPs), Linearly Separable Boolean functions, Representation Power of MLPs, Activation functions - Sigmoid, Tanh, ReLU, Softmax. Loss functions, Training MLPs with backpropagation. Practical issues neural network training - The Problem of Overfitting, Vanishing and exploding gradient problems.

MODULE II : Introduction to Fuzzy sets and Fuzzy Relation

Overview of crisp sets, Fuzzy Sets and Uncertainty: Uncertainty and information, fuzzy sets and membership functions, chance verses fuzziness, properties of fuzzy sets, fuzzy set operations. Fuzzy Relations: Cardinality, operations, properties, fuzzy cartesian product and composition, fuzzy tolerance and equivalence relations, forms of composition operation.

MODULE III : Membership Functions

Features and Various forms of membership functions, fuzzification, defuzzification to crisp sets and scalars. Development of membership functions- Membership value assignments: intuition, inference, rank ordering, neural networks, inductive reasoning.

MODULE IV : Fuzzy inference system

Introduction, Mamdani Fuzzy models, Sugeno models, Tsukamatto fuzzy models Other considerations: input space partitioning - grid partition, Re partition, tree partition, Scatter partition. Fuzzy modeling.

MODULE V : Fuzzy Arithmetic and Extension Principle

Neuro- Fuzzy modelling:- Introduction, ANFIS Architecture, hybrid learning algorithm, learning methods with ANFIS and RBFN, ANFIS as a universal approximator.

Generalised ANFIS - Introduction, multi IO systems, architectural comparison, Neuron functions for adaptive networks, Analysis of adaptive learning capability.

Text books

1. Ross, T. J., “Fuzzy Logic with Engineering Applications”, Wiley India Pvt. Ltd., 3rd Ed.
2. Klir, G. and Yuan, B., “Fuzzy Set and Fuzzy Logic: Theory and Applications”,Prentice Hall of India Pvt. Ltd.
3. Yen, J., & Langar, R., “Fuzzy Logic: Intelligence, Control, and Information”, Pearson Education India.
4. Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence,'' by J.S.R. Jang, C.T. Sun, and E. Mizutani, Prentice Hall, 1996
5. Foundations on Neuro-Fuzzy Systems, D. Nauck, F. Klawonn, R. Kruse, Wiley, Chichester, 1997
6. Fuzzy Logic with Engineering Applications by T.J. Ross, McGraw-Hill Book Company, 1995.

Reference books

1. Zimmerman, H. J., “Fuzzy Set theory and its application”, Springer India Pvt.Ltd., 4th Ed.
2. Klir, G. and Folger, T., “Fuzzy Sets, Uncertainty and Information”, Prentice Hall of India Pvt. Ltd

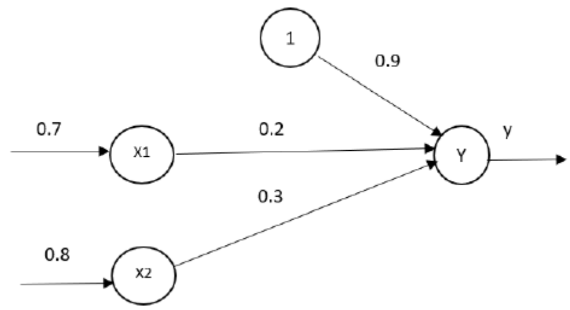
Suggested MOOC Courses

1. Fuzzy Sets, Logic and Systems & Applications by Prof. Nishchal Kumar Verma IIT Kanpur.
2. Introduction to Fuzzy Set Theory, Arithmetic and Logic by Prof. Niladri Chatterjee, IIT Delhi
3. Approximate Reasoning Using Fuzzy Set Theory by Prof. Balasubramaniam Jayaram, IIT Hyderabad
4. Fuzzy Logic and Neural Networks by Prof. Dilip Kumar Pratihar, IIT Kharagpur

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
MODULE 1		
1.1	Introduction to neural networks - McCulloch Pitts Neuron	1
1.2	Single layer perceptrons, Multi Layer Perceptrons (MLPs)	1
1.3	Linearly Separable Boolean functions, Representation Power of MLPs	1
1.4	Activation functions - Sigmoid, Tanh, ReLU, Softmax. Loss function	1
1.5	Training MLPs with backpropagation.	1
1.6	Illustration of back propagation algorithm	1
1.7	Practical issues in neural network training - The Problem of Overfitting, Vanishing and exploding gradient problems.	1
MODULE II		
2.1	Overview of crisp sets	1
2.2	Fuzzy Sets and Uncertainty: Uncertainty and information, fuzzy sets and membership functions	1
2.3	Chance verses fuzziness, properties of fuzzy sets, fuzzy set operations	1
2.4	Fuzzy Relations: Cardinality, operations, properties,	1
2.5	Fuzzy cartesian product and composition	1
2.6	Fuzzy tolerance and equivalence relations	1
2.7	Forms of composition operation.	1
MODULE III		
3.1	Features and Various forms of membership functions,	1
3.2	Fuzzification	1
3.3	defuzzification to crisp sets and scalars.	1
3.4	defuzzification to crisp sets and scalars.	1
3.5	Development of membership functions- Membership value assignments: intuition, inference, rank ordering, neural	1

	networks,	
3.6	Membership value assignments- inductive reasoning	1
MODULE IV		
4.1	Fuzzy inference system – Introduction	1
4.2	Mamdani Fuzzy models	1
4.3	Sugeno models	1
4.4	Tsukamatto fuzzy models	1
4.5	Other considerations: input space partitioning - grid partition, Re partition	1
4.6	Input space partitioning - tree partition, Scatter partition.	1
4.7	Fuzzy modelling.	1
MODULE V		
5.1	Neuro- Fuzzy modelling: - Introduction	1
5.2	ANFIS Architecture, hybrid learning algorithm	1
5.3	Learning methods with ANFIS and RBFN	1
5.4	ANFIS as a universal approximator.	1
5.5	Generalised ANFIS – Introduction	1
5.6	Multi IO systems, architectural comparison	1
5.7	Neuron functions for adaptive networks	1
5.8	Analysis of adaptive learning capability	1

CO Assessment Questions	
1	1. For the network shown below, calculate the output of the neuron Y when the activation function is: a) Sigmoid b) tanH c) ReLu

	 2. Illustrate the limitation of a single layer perceptron with an example. 3. Design a Multilayer Perceptron for the XOR function.
2	1. Define two fuzzy relations R and S on the set {1, 2, 3} such that R = {(1, 0.3), (2, 0.8), (3, 0.5)} and S = {(1, 0.6), (2, 0.2), (3, 0.7)}. Compute the composition R ◦ S. 2. Define a fuzzy equivalence relation on the set {red, green, blue} such that μ(x, x) = 1 for all x and μ(x, y) = 0.2 for x ≠ y. Verify the properties of reflexivity, symmetry, and transitivity.
3	1. Using your own intuition and your own definitions of the universe of discourse, plot fuzzy membership functions for the following variables: a. age of people (i) very young (ii) young (iii) middle-aged (iv) old (v) very old 2. For steel design, the cross-sectional area to column-height ratio largely determines the susceptibility of the columns to buckling under axial loads. The normalized ratios are on the universe, X = {0, 1, 2, 3}. These ratios are characterized as “small” to “large” as follows $\text{“Small”} = \left\{ \frac{1}{0} + \frac{0.9}{1} + \frac{0.8}{2} + \frac{0.7}{3} \right\}.$ $\text{“Large”} = \left\{ \frac{0}{0} + \frac{0.1}{1} + \frac{0.2}{2} + \frac{0.3}{3} \right\}.$ 3. Find the membership functions for the following linguistic expressions (a) Very very small (b) slightly large (c) not very large and small
4	1. (i) In the context of a customer feedback system, can the processes of fuzzification and defuzzification be applied? (ii) Demonstrate how the utilization of fuzzy defuzzification can be implemented to transform subjective linguistic feedback (e.g."very satisfied," "somewhat dissatisfied”) from customers into actionable and measurable quantitative information.

2. Let X be the universe of excess water-height to levee-height ratios (percentage), X = {0.5, 0.75, 1.0, 1.75} and let Y be a universe of damage indices (million dollars), Y = {0, 0.5, 1.0, 7.0}. Suppose we have fuzzy sets for a given water-height ratio (WH~) and a given damage in millions (D~), as follows:

$$\mu_{\underset{\sim}{\mathrm{WH}}}(x)=\left\{\frac{1.0}{0.5}+\frac{1.0}{0.75}+\frac{0.6}{1.0}+\frac{0.1}{1.75}\right\},\ \text{moderate water-height ratio (percentage).}$$

$$\mu_{\underset{\sim}{\mathrm{D}}}(y)=\left\{\frac{0.2}{0}+\frac{0.3}{0.5}+\frac{0.8}{1.0}+\frac{1.0}{7}\right\},\ \text{relatively large damage (million dollars).}$$

(i) Use Zadeh's max-min to find the relation IF moderate water-height ratio, THEN relatively large damage.(use mamdani implication)

(ii) Suppose we are given a new water-height ratio (WH~) as follows:

$$\mu_{\underset{\sim}{\mathrm{WH}'}}(x)=\left\{\frac{0.0}{0.5}+\frac{1.0}{0.75}+\frac{0.7}{1.0}+\frac{0.4}{1.75}\right\}.$$

Using max–min composition, find the damage associated with this new water-height ratio.

b. In a smart city, the traffic management system utilizes a Mamdani inference system to optimize traffic signal timings. The inputs include traffic density and time of day, and the output is the duration of green signal for each direction.

(i) How does the Mamdani inference system handle linguistic variables like "Low," "Medium," and "High" for traffic density and "Morning," "Afternoon," and "Evening" for time of day?

(ii) Define the rule base for the traffic signal control system. How are the rules determined based on the linguistic variables and their relationships?

(iii) Given a specific set of input values (e.g., medium traffic density in the morning), calculate the corresponding output (green signal duration) using the Mamdani inference system.

c) A restaurant uses a Sugeno inference system to assess customer satisfaction based on the quality of food, service speed, and cleanliness. The goal is to determine an appropriate discount for loyal customers.

(i) Explain how Sugeno inference handles input variables that have crisp numerical values (e.g., food quality rated on a scale of 1 to 10).

(ii) Define the rule base for the restaurant's customer satisfaction system, specifying the relationship between input variables and the discount rate.

(iii) Given a specific set of input values (e.g., food quality = 8, service speed = 9, cleanliness = 7), calculate the discount rate using the Sugeno inference system.

5

1. Consider an ANFIS architecture with two input variables x and y, each with three membership functions. If the rule base consists of nine

	rules, compute the total number of parameters (weights and biases) in the ANFIS architecture. 2. For a system with three input variables x, y, and z and two output variables u and v, formulate the mathematical expression for the output of a Generalized ANFIS. Discuss how this formulation handles multi-input, multi-output systems.

24CSE6125	INTERNET OF THINGS	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: Embark on a transformative journey into the realm of the Internet of Things (IoT) with our comprehensive course offerings

Prerequisite: Basic knowledge of systems, computing and programming

Course Outcomes: After the completion of the course the student will be able to

CO 1	Identify key components that constitute an IoT ecosystem. (**Understand level**)
CO 2	Understand various protocols for IoT. (**Understand level)**
CO 3	Design a PoC of an IoT system using Raspberry Pi/Arduino (**Apply level)**
CO 4	Apply data analytics and use cloud offerings related to IoT. (**Apply level)**
CO 5	Analyze applications of IoT in real-time scenario (**Apply level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	2			1				1	1	
CO 2	3	3	2							1	1	
CO 3	3	3	3		3				2			
CO 4	3	3	1			1						2
CO 5	3	3	3			1					1	

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure	Attendance	Theory [L- T]			Practical [P]		Total Marks
		Assignment	Test-1	Test-2	Class work	Lab Exam	
[3-0-0-0]	5	15	10	10			40

Total Marks distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern			
PATTERN	**PART A**	**PART B**	**ESE Marks**
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Fundamentals of IoT (7 hours)

Evolution of Internet of Things – Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT models – Simplified IoT Architecture and Core IoT Functional Stack -– Fog, Edge and Cloud in IoT – Functional blocks of an IoT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects

MODULE II: IoT Protocols (7 hours)

IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN – Network Layer: IP versions, Constrained Nodes and Constrained Networks – Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks – Application Transport Methods: Supervisory Control and Data Acquisition – Application Layer Protocols: CoAP and MQTT.

Module III: Design and Development (8 hours)

Design Methodology – Embedded computing logic – Microcontroller, System on Chips – IoT system building blocks – Arduino – Board details, IDE programming – Raspberry Pi – Interfaces and Raspberry Pi with Python Programming

MODULE IV: Data Analytics and Supporting Services (7 hours)

Structured Vs Unstructured Data and Data in Motion Vs Data in Rest – Role of Machine Learning – No SQL Databases – Hadoop Ecosystem – Apache Kafka, Apache Spark – Edge Streaming Analytics and Network Analytics – Xively Cloud for IoT, Python Web Application Framework – Django – AWS for IoT – System Management with NETCONF-YANG

MODULE V: Case Studies/Industrial Applications (7 hours)

Cisco IoT system – IBM Watson IoT platform – Manufacturing – Converged Plantwide Ethernet Model (CPwE) – Power Utility Industry – GridBlocks Reference Model – Smart and Connected Cities: Layered architecture, Smart Lighting, Smart Parking Architecture and Smart Traffic Control

Textbooks

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry,

—IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017

2. Arshdeep Bahga, Vijay Madisetti, —Internet of Things – A hands-on approach, Universities Press, 2015

Reference books

1. Olivier Hersent, David Boswarthick, Omar Elloumi , —The Internet of Things – Key applications and Protocols, Wiley, 2012
2. Jan Ho¨ ller, Vlasios Tsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things – Introduction to a New Age of Intelligence", Elsevier, 2014.
3. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), —Architecting the Internet of Things, Springer, 2011.
4. Michael Margolis, Arduino Cookbook, Recipes to Begin, Expand, and Enhance Your Projects, 2nd Edition, O'Reilly Media, 2011.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Evolution of Internet of Things – Enabling Technologies	1
1.2	IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT models –	2
1.3	Simplified IoT Architecture and Core IoT Functional Stack -– Fog, Edge and Cloud in IoT	2
1.4	Functional blocks of an IoT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects	2
	MODULE II	
2.1	IoT Access Technologies: Physical and MAC layers,	1
2.2	IoT Access Technologies topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN –	2
2.3	Network Layer: IP versions, Constrained Nodes and Constrained Networks	1
2.4	Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks.	2
2.5	Application Transport Methods: Supervisory Control and Data Acquisition – Application Layer Protocols: CoAP and MQTT	1
	MODULE III	
3.1	Design Methodology – Embedded computing logic – Microcontroller	2
3.2	System on Chips – IoT system building blocks – Arduino – Board details	2
3.3	IDE programming – Raspberry Pi	2
3.4	Interfaces and Raspberry Pi with Python Programming	2
	MODULE IV	

4.1	Structured Vs Unstructured Data and Data in Motion Vs Data in Rest	1
4.2	Role of Machine Learning – No SQL Databases – Hadoop Ecosystem – Apache Kafka, Apache Spark –	2
4.3	Edge Streaming Analytics and Network Analytics – Xively Cloud for IoT	2
4.4	Python Web Application Framework – Django – AWS for IoT – System Management with NETCONF-YANG	2
MODULE V		
5.1	Cisco IoT system – IBM Watson IoT platform	1
5.2	Manufacturing – Converged Plantwide Ethernet Model (CPwE)	2
5.3	Power Utility Industry – GridBlocks Reference Model	2
5.4	Smart and Connected Cities: Layered Architecture, Smart Lighting, Smart Parking Architecture and Smart Traffic Control	2

CO Assessment Questions	
1	Explain the key components that constitute an IoT ecosystem.
2	What is MQTT, and how does it facilitate communication in the Internet of Things? Provide key features and use cases.
3	Compare the roles of Raspberry Pi and Arduino in IoT PoC. How do they complement each other, and in what scenarios is one preferred over the other?
4	Explore the ways ML algorithms enhance IoT functionality
5	What is the primary purpose of the Converged Plantwide Ethernet Model (CPwE)? Describe the essential components involved in CPwE

24CSE6135	REMOTE SENSING AND APPLICATIONS	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The course on Remote Sensing and Applications offers a comprehensive exploration of the fundamental physical concepts involved in various phases of remote sensing. Gain insights into the principles and applications of remote sensing technology, learning how it contributes to diverse fields.

Prerequisite: Foundational understanding of geography, earth sciences, or related fields

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the fundamental principles of remote sensing and its applications in various fields. (**Understand level**)
CO 2	Attain foundation in photogrammetry and aerial photography, enabling them to contribute to fields like cartography, and geospatial analysis. (**Understand level)**
CO 3	Obtain skills to effectively acquire, process, and interpret remote sensing data. (**Apply level**)
CO 4	Acquire knowledge of Visual Imaging and Photography in Remote Sensing. (**Apply level)**
CO 5	Achieve practical skills required to utilize active remote sensing technologies for a wide range of applications. (**Apply level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	2			1				1		
CO 2	2	3								1		
CO 3	3	3	3		3				2			
CO 4	3	3	1			1						2
CO 5	3	3	3			1					2	

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA							
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Practical [P]		Total Marks
		Assignment	Test-1	Test-2	Class work	Lab Exam	
3-0-0-0	5	15	10	10			40

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub-divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Platforms and Sensors (7 hours)

Overview of Remote sensing: Definition of Remote sensing, Principles of Remote Sensing, Electromagnetic Radiation, Radiometric terms, and definitions, Radiation Laws, EM spectrum, Sources of EM, Interaction of, EM Radiation with atmosphere, and target.
Platforms- Types of platforms, ground, airborne, and space-born platforms, The orbit of satellites, Kepler's Law, satellite characteristics, satellites for Earth observations studies, and planetary missions (Chandrayana), Sensors- Types and classification of sensors, imaging modes, Characteristics of optical sensors, sensor resolution-spectral, radiometric and temporal, Characteristics of detectors.

MODULE II: Terrestrial and Aerial photographs (7 hours)

Terrestrial and Aerial photographs - vertical and oblique photographs - height determination contouring - photographic interpretations- stereoscopy – parallax bar-Flight Planning- Photo Interpretation, Applications of aerial Photos-Photo theodolite.

Module III: Data acquisition (8 hours)

Procedure, Reflectance and Digital numbers- Intensity-Reference data ,Ground truth, Analog to digital conversion, Detector mechanism-Spectro - radiometer-Ideal remote sensing system – Characters of real and successful remote sensing system- Platforms and sensors- orbit types– Resolution

MODULE IV: Visual imaging (7 hours)

Visual imaging (passive)- elements of photography, film types (black and white, color, color infrared), storage and manipulation of data, applications of photographic products - topographic and planimetric mapping, environmental monitoring, applications- Digital Elevation Models (limited utility), Digital Surface Models.

MODULE V: Active remote sensing (7 hours)

Active remote sensing: radar- satellite and aircraft borne, resolution, azimuth, range, terrestrial-borne systems- ground-penetrating radar- LiDAR -terrain analysis, pollution detection and monitoring, moisture assessment, target recognition, Global cloud-based analyses -Google Earth Engine (GEE)

Textbooks

1. Paul Jude Gibson, Introductory Remote Sensing: Principles and Concepts, Routledge, 11 New Fetter Lane, Landon, UK. 2000. ISBN: 0-415-17024-9
2. M. Anji Reddy, Textbook of Remote Sensing and Geographical Information systems, BS Publications, Hyderabad. 2011. ISBN: 81-7800-112-8
3. Remote Sensing and Image Interpretation by Lillesand, Kiefer, and Chipman,7th Edition, 2015. Wiley, and Sons. ISBN: 9781118343289.

Reference books

1. Remote Sensing: Principles, Interpretation, and Applications, by Sabins & Ellis. 4th edition, 2020
2. A.M. Chandra and S.K. Gosh. Remote Sensing and GIS, Narosa Publishing Home, NewDelhi2009.
3. Thomas M. Lillesand, Ralph W. Kiefer, Jonathan W. Chipman, Remote sensing and image interpretation John Wiley & Sons, 2008
4. George Joseph, Fundamentals of Remote Sensing Universities Press, Hyderabad 2005

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Definition of Remote sensing, Principles of Remote Sensing, Electromagnetic Radiation, Radiometric terms, and definitions,	1
1.2	Radiation Laws, EM spectrum, Sources of EM, Interaction of EM Radiation with atmosphere, and target.	1
1.3	Platforms- Types of platforms, ground, airborne, and space-born platforms,	1
1.4	The orbit of satellites, Kepler’s Law, satellite characteristics, satellites for Earth observations studies, and planetary missions (Chandrayana),	2
1.5	Sensors- Types and classification of sensors, imaging modes,	2

	Characteristics of optical sensors, sensor resolution-spectral, radiometric and temporal, Characteristics of detectors	
MODULE II		
2.1	Terrestrial and Aerial photographs - vertical and oblique photographs.	1
2.2	height determination contouring - photographic interpretations-stereoscopy – parallax bar- Flight Planning- Photo Interpretation, Applications of aerial Photos-Photo theodolite	1
2.3	Height determination contouring - photographic interpretations-stereoscopy – parallax bar.	1
2.4	Flight Planning- Photo Interpretation, Applications of aerial Photos-Photo theodolite	2
2.5	Flight Planning- Photo Interpretation, Applications of aerial Photos-Photo theodolite	2
MODULE III		
3.1	Data acquisition – Procedure, Reflectance and Digital numbers	2
3.2	Intensity-Reference data, Ground truth, Analog to digital conversion,	2
3.3	Detector mechanism-Spectro - radiometer-	2
3.4	Ideal remote sensing system – Characters of real and successful remote sensing system- Platforms and sensors- orbit types– Resolution	2
MODULE IV		
4.1	Visual imaging (passive)- elements of photography, film types (black and white, color, color infrared), storage and manipulation of data,	2
4.2	Applications of photographic products - topographic and planimetric mapping, environmental monitoring,	2
4.3	Applications of photographic products - environmental monitoring	1
4.3	Digital Elevation Models (limited utility), Digital Surface Models	2
MODULE V		
5.1	Active remote sensing: radar- satellite and aircraft borne,	2
5.2	resolution, azimuth, range, terrestrial-borne systems	2
5.3	ground-penetrating radar- LiDAR -terrain analysis, pollution detection and monitoring, moisture assessment, target recognition	2
5.4	Global cloud-based analyses -Google Earth Engine (GEE)	1

CO Assessment Questions	
1	How do the principles of remote sensing contribute to its applications?

2	Explain the direct method of contouring in surveying?
3	How does remote sensing technology obtain information about a target from a distance?
4	In the context of remote sensing, how is image interpretation utilized to extract qualitative and quantitative information from photographs or imagery?
5	How do active remote sensing technologies contribute to forest canopy inventory and terrain mapping?

24CSE6145	Medical Image analysis	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course enables the learners to understand the characteristics of medical image processing and different techniques needed to analyze the medical images. This course covers different medical imaging modalities, image enhancement techniques, image restoration techniques, morphological image processing, image segmentation methods, object recognition and classification, and three dimensional visualization of medical images. This course will help the learners to apply the state-of-the-art medical image processing and analysis algorithms in real world applications.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the basics of image processing and various modalities of Medical imaging. **(Understand level)**
CO2	Apply different image enhancement techniques in spatial domain and frequency domain. **(Apply level)**
CO3	Elucidate the mathematical modelling of image restoration. **(Apply level)**
CO4	Apply morphological image processing and segmentation methods in different medical images. **(Apply level)**
CO5	Explain feature recognition and classification methods and illustrate 3D visualization of medical images. **(Apply level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3					3						3
CO2	3	3			3	3						3
CO3	3	3			3	3						3
CO4	3	3			3	3						3
CO5	3	3			3	3						3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA						
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Introduction and Image Enhancement (8 hrs)

Basics of image processing – Digital image, Image resolution and Aspect ratio, Components of image processing. Computer Aided diagnosis system. Various modalities of biomedical imaging – Breast Cancer Imaging, mammographic imaging, Ultrasound imaging, MRI, functional imaging, Nuclear Imaging, CT Imaging, Positron imaging tomography, Ultrasonography. Image enhancement – Sources of Noise Spatial domain filters and Frequency domain filters.

MODULE II : Medical image restoration (8 hrs)

Image restoration, Degradation model, Estimation of degradation function, Blur model, Medical Image restoration – Inverse filter, Least square filter, Boundary value problem. Blur identification, Super resolution model, Applications.

MODULE III : Morphological Image processing (7 hrs)
Mathematical morphology, Morphological operators – Dilation and Erosion, Opening and Closing, Hit or miss transform, Thinning and Skeletonization, Convex Hull, Extension to grayscale images.
MODULE IV : Image Segmentation (8 hrs)
Point detection, Line detection, Edge detection, Histogram based segmentation, Split and Merge method, Region growing method, Watershed method, k-means clustering method, Fractal method.
MODULE V : Feature recognition and Classification (6 hrs)
Connected components labeling, Features, Object recognition and classification, Statistical classification, structural/syntactic classification. Three-dimensional visualization - Surface rendering, Volume rendering, Virtual reality.

Text books

1. Sinha G. R, Patel, B. C., "Medical Image Processing: Concepts And Applications", Prentice Hall, 2014.
2. Geoff Dougherty, "Digital Image Processing for Medical Applications", Cambridge University Press, 2009.
3. Gonzalez R C, Woods R E, "Digital Image Processing", Third Edition, Prentice Hall, 2007.

Reference books

1. Rangayyan R M, "Biomedical Image Analysis", Fifth Edition, CRC Press, 2005.
2. Kayvan Najarian, Robert Splinter, "Biomedical Signal and Image Processing", Second Edition, CRC Press, 2014.
3. Deserno T M, "Biomedical Image Processing", Springer, 2011.

Suggested MOOC Courses

NPTEL SWAYAM course on Medical Image Analysis, By Prof. Ganapathy krishnamurthi | IIT Madras.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Basics of image processing – Digital image, Image resolution and Aspect ratio	1
1.2	Components of image processing, Computer Aided diagnosis system	1
1.3	Various modalities of biomedical imaging - Breast Cancer Imaging, Mammographic imaging, Ultrasound imaging, MRI, Functional imaging	1
1.4	Nuclear Imaging, CT Imaging, Positron imaging tomography, Ultrasonography	1
1.5	Image enhancement – Sources of Noise	1

1.6	Spatial domain filters – Lecture 1	1
1.7	Spatial domain filters – Lecture 2	1
1.8	Frequency domain filters	1
MODULE II		
2.1	Image restoration, Degradation model	1
2.2	Estimation of degradation function	1
2.3	Blur model	1
2.4	Medical Image restoration – Inverse filter	1
2.5	Least square filter, Boundary value problem	1
2.6	Blur identification	1
2.7	Super resolution model	1
2.8	Applications	1
MODULE III		
3.1	Mathematical morphology	1
3.2	Morphological operators – Dilation and Erosion	1
3.3	Opening and Closing	1
3.4	Hit or miss transform	1
3.5	Thinning and Skeletonization	1
3.6	Convex Hull	1
3.7	Extension to grayscale images	1
MODULE IV		
4.1	Point detection	1
4.2	Line detection	1

4.3	Edge detection	1
4.4	Histogram based segmentation	1
4.5	Split and Merge method, Region growing method	1
4.6	Watershed method	1
4.7	k-means clustering method	1
4.8	Fractal method	1
	MODULE V	
5.1	Connected components labeling	1
5.2	Features	1
5.3	Object recognition and classification, Statistical classification	1
5.4	Structural/syntactic classification	1
5.5	Three-dimensional visualization - Surface rendering	1
5.6	Volume rendering , Virtual reality	1

CO Assessment Questions	
1	1. Explain the differences between spatial resolution and brightness (gray scale) resolution in a digitized image 2. To what class of image processing operations do the following examples belong: tomographic reconstruction, removing distortion, pattern recognition, edge enhancement, noise removal, brightness adjustment? 3. Distinguish between direct and indirect imaging systems, giving examples to illustrate each system. 4. Applying a 3 × 3 averaging mask twice does not produce the same result as applying a 5 × 5 averaging mask once. To what is it equivalent? 5. Can unsharp masking be used to reverse the effect of blurring? Choose an image and apply an unsharp mask after a 3 × 3 averaging mask. Describe the result 6. The array below represents a small grayscale image. Calculate the 4 ×

	4 image that would result if the middle 16 pixels were transformed using (i) a 3 × 3 averaging mask and (ii) a 3 × 3 median mask. 17 51 97 125 34 23 35 96 228 245 85 47 56 128 205 245 118 58 85 230 254 202 186 86 188 240 210 150 122 96 96 105 204 88 56 11
2	1. An amateur photographer chances upon a bank robbery. As the robbers' van speeds past him he takes a photograph of the side of the van. Unfortunately the photograph is blurred because he forgot to "pan" with the moving van, and the sign on the van cannot be read. Suggest a method for restoring the image. What blurring function should be used? Can it be estimated from the image itself? 2. You are working with a noisy video camera and digitizer, and observe that the standard deviation of the noise is about twelve gray levels. You have detail in the image which requires better than five gray levels of precision to be sure of resolving it. How many images would you need to average to see this detail? 3. Open image **salt-and-pepper1** in ImageJ, and use a 3 × 3 median mask (**Process/ Filter/ Median …** with a radius of 1 pixel) to reduce its salt-and-pepper noise. Now use an adaptive median mask (**Plugins/ Ch.8Plugins/ Adaptive_Median**, set k1, k2 and k3 all equal to zero, check on **Salt-and-PepperNoiseremoval**, and enter 1.0 as the multiple for standard deviation) on the original image. Compare the two results and see whether a different multiple might result in a superior result for the adaptive median mask. Repeat with image **salt-and-pepper 2.**
3	1. Sketch the structuring elements required for the hit-or-miss transform to locate (i) isolated points in an image, (ii) end points in a binary skeleton and (iii) junction points in a binary skeleton. Several structuring elements may be needed in some cases to locate all possible orientations. 2. Grayscale dilation and erosion are generalizations of binary dilation and erosion. Describe how they are implemented.
4	1. Under what situations might you choose to use the Canny operator rather than the Roberts cross-gradient or Sobel operators? In what situations would you not choose it 2. Explain the segmentation method particularly useful for segmenting images that contain a variable background? Explain the basis of the method and why it works. 3. Explain why the watershed lines of a binary image correspond to the

	"skiz" lines.
5	1. Consider the recognition of the character 'E' in different sizes, orientations and both handwritten and in various printed fonts. What features would you extract to achieve recognition invariance under these conditions? 2. Describe an application of structural classification in medical diagnosis. 3. Explain the invariance of shape features to translation, rotation, scaling, noise and illumination. Illustrate your answer with specific examples of features. 4. Open the sample stack of MRI images of the head (File/OpenSamples and choose MRI Stack) in ImageJ. Open the plugin VolumeJ, and accept all the default parameters except those in bold following: Rotate 100, 20, 0; Scale 1.0; Aspect 1, 1, 5; Classifier: Gradient no index (this makes the voxels more opaque the closer their intensity is to the threshold (128.0) and the higher their surface gradient (set by the deviation, 2.0)); Interpolation: trilinear; Light 1,1,10. Choose the "raytrace rendering algorithm," and click "Render" to view the rendered result.

24CSI615	Software Testing	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course in theoretical computer science introduces the concepts and methods in software testing. It covers various techniques for test case design used to test software artifacts, including requirements, design, and code, the different techniques for test case design based on graphs, programming language syntaxes and symbolic execution using PEX tool. It enables the learners to follow systematic software testing approaches while developing applications.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	List a range of different software testing techniques and be able to apply specific unit testing method to the projects using Junit.**(Understand level)**
CO2	Illustrate using appropriate tools the mutation testing method for a given piece of code to identify hidden defects that can't be detected using other testing methods.**(Apply level)**
CO3	Explain graph coverage criteria in terms of control flow graph and data flow graph for a given program.**(Understand level)**
CO4	Demonstrate the importance of black-box approaches in terms of domain and functional testing.**(Apply level)**
CO5	Illustrate the use of PEX tool with symbolic execution.**(Apply level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									3
CO2	3	3	3	3	3					3		3
CO3	3	3	3							3		1
CO4	3	3	3	1								1
CO5	3	3	3	1	3					3		1

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Introduction to Software Testing (7 hrs)

Some Popular Errors – Ariane 5, Therac 25, Intel Pentium Bug. What is Software testing? Why should it be tested? Software Quality, Role of Testing. Testing Process - Level 0 thinking, Level 1 thinking, Level 2 thinking, Level 3 thinking, Level 4 thinking. Software Testing Terminologies - Verification, Validation and Testing, Faults, Error and Bug, Test cases, Coverage Criteria. Types of Testing- Unit testing, integration testing, System testing, Acceptance testing, Beta testing, Functional testing, Stress testing, Performance testing, Usability testing and Regression testing. Testing Methods - Black Box testing, White Box testing, Grey Box testing.

MODULE II : Unit Testing (6 hrs)

Concept of Unit testing. Static Unit testing. Dynamic Unit testing - Control Flow testing, Data Flow testing, Domain testing, Functional Program testing. Mutation testing - Mutation and Mutants, Mutation operators, Mutation score. Junit - Framework for Unit testing. Case Study - Mutation testing using Junit and Muclipse.

MODULE III : Unit Testing - White Box Approaches (8 hrs)

Overview of Graph Coverage Criteria. Structural Graph Coverage Criteria - Node/vertex coverage, Edge coverage, Edge pair coverage, Path coverage, Complete path coverage, Prime path coverage, Complete round trip coverage, Simple round trip coverage. Data Flow Criteria - du paths, du pairs. Subsumption Relationships among Graph Coverage Criteria. Graph Coverage for Source Code - Control flow graphs for code, CFG: If statement, CFG: If statement with return, CFG: Switch-case, CFG: Loops, CFG: Exceptions (try-catch). Example program – Statistics. Graph Coverage for Design Elements - Call graphs and classes, Class inheritance testing: Coverage criteria, Coverage criteria on inheritance graph, Data flow at the design level, Inter-procedural DU pairs, Coupling du-pairs example. Example - Quadratic Root. Case Study - Graph Based testing using JUnit Framework.

MODULE IV : Unit Testing - Black Box Approaches (7 hrs)

Domain Testing / Input Space Partitioning - Partitions of a set. Input domain modelling - Interface-based approach, Functionality-based approach. Identifying values. Multiple partitions of the input domain - All Combinations Coverage (ACoC), Each Choice Coverage (ECC), Pair-wise Coverage, T-wise Coverage, Base Choice Coverage, Multiple Base Choices Coverage. TriTyp example. Functional Testing - Functional Testing Concepts of Howden. Functional testing - Important Steps. Types of Functional testing - Equivalence Class Partitioning, Boundary Value Analysis, Decision Tables, Random Testing. Case Study - Black Box testing approaches using JUnit.

MODULE V : Grey Box Testing Approaches (7 hrs)

Introduction to Grey Box testing - Why Grey Box testing, Gray Box Methodology, Advantages and Disadvantages. Techniques of Grey Box Testing - Matrix Testing, Regression Testing, Orthogonal Array Testing or OAT, Pattern Testing. An Introduction to PEX - Parameterized Unit Testing, The Testing Problem. Symbolic Execution – Example, Symbolic execution tree. PEX application Case Study – PEX.

Text books

1. Paul Ammann and JeffOffutt , Introduction to Software Testing, Cambridge University Press,2016
2. Kshirasagar Naik and Priyadarshi Tripathy, Software Testing And Quality Assurance: Theory And Practice, Wiley,2008.

Reference books

1. King, James C, “Symbolic Execution and Program Testing”, Association for Computing Machinery, July 1976.

Suggested MOOC Courses

1. Software Testing, IIT Kharagpur-Prof. Rajib Mall

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
MODULE 1		
1.1	Some Popular Errors– Ariane 5, Therac 25, Intel Pentium Bug.	1
1.2	What is Software testing? Why should it be tested? Software Quality, Role of Testing.	1
1.3	Testing Process - Level 0 thinking, Level 1 thinking, Level 2 thinking, Level 3 thinking, Level 4 thinking.	1
1.4	Software Testing Terminologies- Verification, Validation and Testing, Faults, Error and Bug, Test cases, Coverage Criteria.	1
1.5	Types of Testing- Unit testing, integration testing, System testing, Acceptance testing, Beta testing	1
1.6	Functional testing, Stress testing, Performance testing, Usability testing and Regression testing.	1
1.7	Testing Methods - Black Box testing, White Box testing, Grey Box testing.	1
MODULE II		
2.1	Concept of Unit testing, Static Unit Testing	1
2.2	Dynamic Unit testing - Control Flow testing, Data Flow testing, Domain testing, Functional Program testing.	1
2.3	Mutation testing - Mutation and Mutants, Mutation operators, Mutation score.	1
2.4	Junit - Framework for Unit testing.	1
2.5	Case Study - Mutation testing using Junit	1
2.6	Case Study - Mutation testing using Muclipse	1
MODULE III		
3.1	Structural Graph Coverage Criteria - Node/vertex coverage, Edge coverage, Edge pair coverage, Path coverage	1
3.2	Complete path coverage, Prime path coverage, Complete round trip coverage, Simple round trip coverage.	1
3.3	Data Flow Criteria - du paths, du pairs	1
3.4	Subsumption Relationships among Graph Coverage Criteria	1
3.5	Graph Coverage for Source Code – Control Flow Graphs (CFG) for code, CFG: If statement, CFG: If statement with return, CFG: Switch-case, CFG: Loops, CFG: Exceptions (try-catch). Example program -	1

	Statistics	
3.6	Graph Coverage for Design Elements – Structural graph coverage and data flow graph coverage for design elements.	1
3.7	Case Study - Graph Based testing using JUnit Framework. (Lecture 1)	1
3.8	Case Study - Graph Based testing using JUnit Framework. (Lecture 2)	1
	MODULE IV	
4.1	Domain Testing / Input Space Partitioning - Partitions of a set.	1
4.2	Input domain modelling - Interface-based approach, Functionality-based approach.	1
4.3	Multiple partitions of the input domain - All Combinations Coverage (ACoC), Each Choice Coverage (ECC), Pair-wise Coverage, T-wise Coverage, Base Choice Coverage, Multiple Base Choices Coverage.	1
4.4	Functional Testing - Functional Testing Concepts of Howden. Important Steps.	1
4.5	Types of Functional testing - Equivalence Class Partitioning, Boundary Value Analysis .	1
4.6	Decision Tables, Random Testing.	1
4.7	Case Study - Black Box testing approaches using JUnit.	1
	MODULE V	
5.1	Introduction to Grey Box testing - Why Grey Box testing, Gray Box Methodology, Advantages and Disadvantages.	1
5.2	Techniques of Grey Box Testing - Matrix Testing, Regression Testing, Orthogonal Array Testing or OAT, Pattern Testing.	1
5.3	An Introduction to Pex - Parameterized Unit Testing, The Testing Problem.	1
5.4	Symbolic Execution – Example, Symbolic execution tree.	1
5.5	Case Study – PEX (Lecture 1)	1
5.6	Case Study – PEX (Lecture 2)	1
5.7	Case Study – PEX (Lecture 3)	1

	CO Assessment Questions
1	1. Apply Explain the following types of testing methods with examples.

	(i) Balck-box testing. (ii) White-box testing. (iii) Grey-box testing.

2	1. Define 12 mutants for the following method *power*() using effective mutation operators. Try to use each mutation operator at least once. Approximately, how many mutants do you think there would be, if all mutants for *power*() were created?
	public static int power (int left, int right)
	{
	//************************************
	// Raises Left to the power of Right
	// precondition : Right >= 0
	// postcondition: Returns Left**Right
	//************************************
	intrslt;
	rslt = Left;
	if (Right == 0)
	{
	rslt = 1;
	}
	else
	{
	for (int i = 2; i <= Right; i++)
	rslt = rslt * Left;
	}
	return (rslt);
	}

3	Draw the control flow graph and data flow graph of given piece of code.
	public static double ReturnAverage(int value[],int AS, int MIN, int MAX){
	/*
	Function: ReturnAverageComputes the averageof all those numbers in the input array in
	the positive range [MIN, MAX]. The maximum size of the array is AS. But, the array size
	could be smaller than AS in which case the end of input is represented by -999.
	*/
	int i, ti, tv, sum;
	doubleav;
	i = 0; ti = 0; tv = 0; sum = 0;
	while (ti< AS && value[i] != -999) {
	ti++;
	if (value[i] >= MIN && value[i] <= MAX) {
	tv++;
	sum = sum + value[i];

<table>
<tr><td></td><td>}
i++;
}
if (tv> 0)
av = (double)sum/tv;
else
av = (double) -999;
return (av); }</td></tr>
<tr><td>4</td><td>1. Consider a situation where multiple constraints apply to a single input parameter. How would you determine and test the valid and invalid equivalence classes in this complex scenario?
2. Explain the following with examples.
1. Input domain modelling.
2. All Combinations Coverage (ACoC)
3. Each Choice Coverage (ECC)
4. Pair-wise Coverage
5. T-wise Coverage
6. Base Choice Coverage
7. Multiple Base Choices Coverage.</td></tr>
<tr><td>5</td><td>Draw the symbolic execution tree for the following program code and explain the symbolic execution of testme (α1, α2).
int twice (int v) {
return 2 ∗ v;
}
void testme (int x, int y) {
z = twice (y);
if (z == x){
if (x > y + 10)
ERROR;
}
}
int main() {
x = sym input();
y = sym input();
testme (x , y);
return(0);</td></tr>
</table>

24CSI625	Blockchain Technology	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course enables the learners to understand the fundamental principles of blockchain technology. This course covers the origin and introduction of blockchains, concepts of bitcoin and cryptocurrency, ethereum, hyperledger and solidity programming and applications of blockchains in different domains. It will help the students to gain insights into blockchain technologies and their real-world applications.

Prerequisite: Basic Knowledge of Cryptography

Course Outcomes: After the completion of the course the student will be able to

CO1	Understand and explore the fundamentals of Blockchain technology (**Understand Level**)
CO2	Explain the importance of blockchain technology in bitcoin and cryptocurrency (**Understand Level**)
CO3	Demonstrate the concepts of Ethereum and Smart Contracts. (**Apply Level**)
CO4	Demonstrate the working of Hyperledger. (**Understand Level**)
CO5	Explain the use of blockchain in domains like Internet of Things, Medical Record Management System, and Domain Name Service. (**Understand Level**)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										3
CO2	3	3										3
CO3	3	3			3							3
CO4	3	3			3							3
CO5	3	3			3							3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

<table>
<tr><th colspan="6">Mark Distribution of CIA</th></tr>
<tr><th rowspan="2">Course Structure [L-T-P-J]</th><th rowspan="2">Attendance</th><th colspan="3">Theory [L- T]</th><th rowspan="2">Total Marks</th></tr>
<tr><th>Assignment</th><th>Test-1</th><th>Test-2</th></tr>
<tr><td>3-0-0-0</td><td>5</td><td>15</td><td>10</td><td>10</td><td>40</td></tr>
</table>

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

Module I: Introduction Of Cryptography And Blockchain (6 hours)

What is Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins, Objective of Blockchain, Blockchain Challenges, Transactions and Blocks, P2P Systems, Keys as Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Blockchain.

Module II: Bitcoin And Cryptocurrency (7 hours)

What is Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Merkle Tree, Double- Spend Problem, Blockchain and Digital Currency, Transactional Blocks, Impact of Blockchain Technology on Cryptocurrency.

Module III: Introduction To Ethereum (7 hours)

What is Ethereum, Introduction to Ethereum, Ethereum Virtual Machine (EVM), Consensus Mechanisms, Metamask Setup, Ethereum Accounts, Transactions, Receiving Ethers, Smart Contracts.

Module IV: Introduction To Hyperledger And Solidity Programming (8 hours)

What is Hyperledger? Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer. Solidity - Language of Smart Contracts, Installing Solidity & Ethereum Wallet, Basics of Solidity, Layout of a Solidity Source File & Structure of Smart Contracts, General Value Types.

Module V: Blockchain Applications (8 hours)

Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins.

Text books

1. Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained", Second Edition, Packt Publishing, 2018.
2. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction" Princeton University Press, 2016
3. Antonopoulos and G. Wood, "Mastering Ethereum: Building Smart Contracts and Dapps", O'Reilly Publishing, 2018.
4. D. Drescher, Blockchain Basics. Apress, 2017.

Reference books

1. Antonopoulos, Mastering Bitcoin, O'Reilly Publishing, 2014.

NPTEL online course : https://nptel.ac.in/courses/106/104/106104220/#

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	What is Blockchain, Blockchain Technology Mechanisms & Networks	1
1.2	Blockchain Origins	1
1.3	Objective of Blockchain, Blockchain Challenges	1
1.4	Transactions and Blocks, P2P Systems, Keys as Identity	1
1.5	Digital Signatures, Hashing, and public key cryptosystems	1

1.6	Private vs. public Blockchain	1
	MODULE II	
2.1	What is Bitcoin, The Bitcoin Network	1
2.2	The Bitcoin Mining Process, Mining Developments	1
2.3	Bitcoin Wallets, Decentralization and Hard Forks	1
2.4	Merkle Tree	1
2.5	Double- Spend Problem	1
2.6	Blockchain and Digital Currency, Transactional Blocks	1
2.7	Impact of Blockchain Technology on Cryptocurrency	1
	MODULE III	
3.1	What is Ethereum, Introduction to Ethereum,	1
3.2	Ethereum Virtual Machine (EVM)	1
3.3	Consensus Mechanisms	1
3.4	Metamask Setup	1
3.5	Ethereum Accounts, Transactions	1
3.6	Receiving Ethers	1
3.7	Smart Contracts	1
	MODULE IV	
4.1	What is Hyperledger? Distributed Ledger Technology & its Challenges	1
4.2	Hyperledger & Distributed Ledger Technology	1
4.3	Hyperledger Fabric, Hyperledger Composer	1
4.4	Solidity - Language of Smart Contracts	1
4.5	Installing Solidity & Ethereum Wallet	1

4.6	Basics of Solidity	1
4.7	Layout of a Solidity Source File & Structure of Smart Contracts	1
4.8	General Value Types	1
	MODULE V	
5.1	Applications of blockchain in Internet of Things	1
5.2	Applications of blockchain in Internet of Things	1
5.3	Applications of blockchain in Medical Record Management System	1
5.4	Applications of blockchain in Medical Record Management System	1
5.5	Applications of blockchain in Domain Name	1
5.6	Applications of blockchain in Domain Name	1
5.7	Service Future of Blockchain	1
5.8	Alt Coins	1

CO Assessment Questions	
1	Explain the design principles necessary for a blockchain Create a Simple Blockchain in any suitable programming language.
2	How does Bitcoin handle Double Spending? Explain with diagram
3	1. Formulate the creation of smart contract using ethereum. 2. Consider an application like election system, how smart contracts can be done for it. Show and explain with use case diagram. 3. What is the need of Consensus Algorithms in Blockchain and explain Proof-of-Work (PoW) and Proof-of-Burn(PoB) algorithms in detail? 4. Use Geth to Implement Private Ethereum Block Chain.
4	1. What is a ledger? Is Blockchain an incorruptible ledger? Explain the components of Blockchain Ecosystem? 2. Build Hyperledger Fabric Client Application. 3. Build Hyperledger Fabric with Smart Contract.

5	1. Discuss about the privacy and security issues in medical record management system. How can it be addressed through blockchain technology? 2. Create Case study of Block Chain being used in illegal activities in real world. 3. Using Python Libraries to develop Block Chain Application.

24CSS606	SEMINAR	L	T	P	J	S	C	Year of Introduction
		0	0	4	0	4	2	2024

Preamble: The course 'Seminar' is intended to enable a B.Tech graduate to read, understand, present and prepare report about an academic document. The learner shall search in the literature including peer reviewed journals, conference, books, project reports etc., and identify an appropriate paper/thesis/report in her/his area of interest, in consultation with her/his seminar guide. This course can help the learner to experience how a presentation can be made about a selected academic document and also empower her/him to prepare a technical report.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Identify academic documents from the literature which are related to her/his areas of interest. **(Apply level)**
CO 2	Read and apprehend an academic document from the literature which is related to her/ his areas of interest. **(Analyze level)**
CO 3	Prepare a presentation about an academic document. **(Create level)**
CO 4	Give a presentation about an academic document. **(Apply level)**
CO 5	Prepare a technical report. **(Create level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	3	3	3	3	3					3
CO 2	3	3	3	3	3	3	3					3
CO 3	3	3			3			3		3		3
CO 4	3							3		3		3
CO 5	3	3	3	3	3	3		3		3		3

General Guidelines

- Choosing a seminar topic: The topic for a UG seminar should be current and broad based rather than a very specific research work. It's advisable to choose a topic for the Seminar to be closely linked to the final year project area. Every member of the project team could choose or be assigned Seminar topics that covers various aspects linked to the Project area.
- A topic/paper relevant to the discipline shall be selected by the student during the semester break.
- Topic/Paper shall be finalized in the first week of the semester and get it approved by the second week of the semester.
- Accurate references from genuine peer reviewed published material to be given in the report and to be verified.
- The report and the presentation shall be evaluated by a team of internal members comprising three senior faculty members based on the style of

presentation, technical content, adequacy of reference, depth of knowledge and overall quality of the report.

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	100	--	--

Mark Distribution

a. Attendance : 5%
b. Guide : 25%
c. Technical Content : 30%
d. Presentation : 40%

23SPJ607	SOCIALLY RELEVANT PROJECT	L	T	P	J	S	C	Year of Introduction
		0	0	0	2	1	1	2024

Preamble: The main purpose of Socially Relevant Projects is to link the institution with the society for mutual benefit. The community will benefit from the focused contribution of students towards local development. At the same time, the institution finds an opportunity to develop social sensibility and responsibility among students and emerge as a socially responsible institution.

Course Objectives

The objectives of Socially Relevant Projects are:

- To provide students with an opportunity to engage in meaningful community service and apply their learning to real-world situations.
- To promote civic responsibility and leadership skills among students, and to foster a deeper understanding of social issues.
- To facilitate the development of partnerships between colleges and local communities, and to contribute to local development.
- To encourage students to think critically and creatively about social issues, and to develop innovative solutions to address them.
- To promote interdisciplinary learning and collaboration, and to provide opportunities for students to apply their knowledge and skills across different fields

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Model and solve real world socially relevant problems by applying knowledge across domains. **(Apply level)**
CO 2	Develop products, processes or technologies for sustainable and socially relevant applications. **(Apply level)**
CO 3	Function effectively as an individual and as a leader in diverse teams and to comprehend and execute designated tasks. **(Apply level)**
CO 4	Plan and execute tasks utilizing available resources within timelines, following ethical and professional norms. **(Apply level)**
CO 5	Identify technology/research gaps and propose innovative/creative solutions to socially relevant problems. **(Analyze level)**
CO 6	Organize and communicate technical and scientific findings effectively in written and oral forms. **(Apply level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	3	2	3	3	3	3	3	3	2	3
CO 2	3	3	3	2	3	3	3	3	3	3		3
CO 3						3		3	3	3		3

CO 4						**3**		**3**	**3**	**3**	**2**	**3**
CO 5	**3**	**3**	**3**	**2**		**3**	**3**	**3**	**3**	**3**		**3**
CO 6					**3**	**3**		**3**	**3**	**3**		**3**

Activities for Socially Relevant Project

❖ Conducting surveys and research on social issues and concerns to gain a better understanding of the problem and identify potential solutions.

❖ Developing and implementing educational programs to promote awareness and understanding of social issues and concerns.

❖ Collaborating with local NGOs and community groups to organize events and activities that promote social welfare and community development.

❖ Developing and implementing social welfare programs that address the needs of marginalized and vulnerable communities, such as homeless individuals, refugees, and low-income families.

❖ Conducting community service activities, such as volunteering at local shelters, food banks, and community centers.

❖ Developing and implementing environmental conservation programs that promote sustainable practices and reduce the impact of human activities on the environment.

❖ Creating and distributing educational materials, such as pamphlets and brochures, to raise awareness about social issues and concerns.

❖ Organizing fundraising events to support social welfare programs and community development initiatives.

❖ Engaging in advocacy and lobbying efforts to influence public policy and promote social justice.

Procedure for doing Socially Relevant Project

Assign a group of students or a single student to a particular habitation, village, or municipal ward in the near vicinity of their place of stay.

- Conduct a survey of the habitation to gain a better understanding of the social issues and concerns that need to be addressed. A common survey format could be designed to ensure consistency.
- Develop a project work related to the student's domain or subject area that addresses the identified social issues and concerns. The project should be designed to be socially relevant and have a positive impact on the community.
- Implement the project work with the help of the local community and relevant authorities. This could include organizing awareness programs, developing and implementing educational programs, conducting community service activities, and engaging in advocacy and lobbying efforts.
- Monitor and evaluate the project work to ensure that it is having the desired impact on the community. This could include conducting surveys and research, gathering feedback from the local community, and tracking key

performance indicators.

- Document the project work and its impact on the community, and share the findings with relevant stakeholders, including the local community, government authorities, and academic institutions

Guidelines

Each student should complete a minimum of 60 hours of community service during their lower semesters (1-5).

a. Students shall be assigned a mentor to guide them through the process.
b. Students shall keep a log book of their activities, which must be signed off by their mentor or faculty member in charge.
c. The participation of students in NSS/NCC/Club activities will not be coming under the purview of socially relevant project.
d. Each team shall submit a report and make brief presentation based on the service rendered to the society, and an evaluation will be conducted by a committee constituted by the Head of the Department.

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	100	--	--

Mark Distribution:

a. Work assessed by the Mentor based on log book 25%
b. Final evaluation by the Internal Three-member Committee 50%
    a. Establishing the Social relevance of work (Objectives) 20%
    b. Illustrating the execution process for the attainment of outcome 50%
    c. Presentation 30%
c. Final Report 25%

24EST608	Digital Image Processing	CATEGORY	L	T	P	J	S	C	Year of Introduction
		ESC	2	0	0	0	2	2	2024

Preamble: This course enables the students to make awareness about theoretical foundations of digital image processing technique and its practical applications and making them capable of tackling image-related challenges in diverse fields, ranging from scientific research to industrial applications. This course covers the fundamental concepts in image processing, role of different image transforms, Image Enhancement, Morphological operations and Image Segmentation which helps the students to analyze and process digital images effectively, to create image processing frameworks for different domains.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO 1	Summarize the concepts of digital image representation, processing and demonstrate pixel relationships **(Understand Level)**
CO 2	Explain the role of image transforms in representing, highlighting, and modifying image features. **(Understand Level)**
CO 3	Explain different morphological operations to process digital images for various tasks (**Understand Level)**
CO 4	Solve image enhancement problem using spatial domain techniques **(Apply Level)**
CO 5	Make use of the concept of image segmentation techniques in real-world problems. **(Apply Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3										3
CO 2	3	3										3
CO 3	3	3										3
CO 4	3	3										3
CO 5	3	3										3

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			End Semester Examination
	Test1	Test 2	Other Tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate				
Create				

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
2-0-0-0	**5**	**35**	**30**	**30**	**100**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	100	-	-

SYLLABUS

MODULE I : Fundamental Concepts in Image Processing (4 hrs)

Image as 2D data. Image representation in gray scale, Binary and Color images. Fundamental steps in image processing, Sampling and quantization. Spatial and Gray Level Resolution, Basic relationship between pixels– neighborhood, adjacency, connectivity. Applications of digital image processing.

MODULE II : Image Transform (4 hrs)

Basic concept of spatial domain and frequency domain, 2D Discrete Fourier Transform (DFT). 2D Discrete Cosine Transform (2D DCT). 2D Discrete Wavelet Transform (DWT)- Approximation and Detail coefficients.

MODULE III : Image Enhancement (7 hrs)

Basic gray level transformation functions - Log transformations, Power-Law transformations, Contrast stretching, Grey-level slicing. Histogram equalization. Basics of spatial filtering – Convolution. Smoothing spatial filter- Linear and nonlinear filters, sharpening spatial filters-Gradient and Laplacian

MODULE IV: Morphological operations (4 hrs)

Structuring Element. Morphological operations-Dilation and Erosion, Opening and Closing. Morphological algorithms-Hit or Miss Transformation, Boundary detection.

MODULE V: Image Segmentation (5hrs)

Fundamentals of Image Segmentation. Thresholding - Basics of Intensity thresholding. Global and Adaptive thresholding. Region based Approach - Region Growing, Region Splitting and Merging. Edge Detection - Edge Operators- Sobel and Prewitt, Canny

Text books

1. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing (English) 3rd Edition, Pearson India, 2013
2. A K. Jain, Fundamentals of digital image processing, Prentice Hall of India, First

edition, 2015.

Reference books

1. Al Bovik, The Essential Guide to Image Processing, Academic Press, 2009.
2. Milan Sonka, Vaclav Hlavac and Roger Boyle, Image Processing, Analysis, and Machine Vision, Thomson Learning, 2008.
3. S Jayaraman, S Esakkirajan and T Veerakumar, Digital Image Processing, McGraw Hill, Education, 2009.

Suggested NPTEL/MOOC Courses

1. Digital Image Processing by Prof. Prabir Kumar Biswas, IIT Kharagpur
2. Computer Vision and Image Processing - Fundamentals and Applications by Prof. M. K. Bhuyan, IIT Guwahati

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (24 hrs)
	MODULE 1	
1.1	Image as 2D data- Image representation in gray scale, Binary and Colour images Use any programming language (MATLAB/ Scilab/Python) to • Read, display and write an image • Convert between data classes and Image Types	1
1.2	Fundamental steps in image processing	1
1.3	Sampling and quantization. Spatial and Gray Level Resolution Sample problems.	1
1.4	Basic relationship between pixels– neighbourhood, adjacency, connectivity. Sample Problems	1
	MODULE II	
2.1	Basic concept of spatial domain and frequency domain, Need of Transform, Concept of basis function/ Kernal	1
2.2	Basics of 2D Discrete Fourier Transform (DFT), Properties-Separable, Convolution, Shifting and Rotation.	1
2.3	Basics of 2D Discrete Cosine Transform (DCT)- Role of DCT in image compression, 2D Discrete Wavelet transform-Approximation and Detail coefficients, Multi resolution analysis	1
2.4	Use any programming language (MATLAB/ Scilab/Python) to • Compute and visualize the 2D DFT, 2D DCT and 2D DWT on an image • Demonstrate the convolution and Rotation property of 2D DFT on an image	1

	• Demonstrate the importance of phase component in an image.	
	MODULE III	
3.1	Basic gray level transformation functions - Log transformations, Power-Law transformations.	1
3.2	Contrast stretching, Grey-level slicing	1
3.3	Histogram equalization- purpose and steps to perform histogram equalization.	1
3.4	Basics of spatial filtering – Convolution. Smoothing spatial filter- Linear and nonlinear filters.	1
3.5	sharpening spatial filters-Gradient and Laplacian. (Mask only)	1
3.6	Use any programming language to a. Read an image and perform histogram equalization of the input image and analyze the result. b. Read an image and apply gray-level slicing with and without preserving background i. Implement a median filtering. size of filter should be a parameter. ii. Take an image corrupts them with a salt and paper noise. c. Apply median filtering to each of corrupted images. For comparison purpose, apply averaging too. Try 2 different mask sizes for each case (5X5),(3X3). d. Write a program that perform histogram equalization of the input gray scale image. Plot the histogram of original and histogram equalized. e. Write a function called powerlaw that accept uint8 bits intensity image and variable gamma and applies power law transformation to the input image. Output image should be a uint8 intensity image observe the output image by varying the value of gamma between 0.2 and 1.2 in the steps of 0.2 f. Apply high pass filtering of input image using the mask h(m,n)=[1 1 1;1 -8 1;1 1 1].	2
	MODULE IV	
4.1	Morphological Image Processing- Purpose. Structuring Element	1
4.2	Morphological operations- Dilation, Erosion, Opening and closing	1

4.3	Morphological algorithms- Hit or Miss Transformation, Boundary detection	1
4.4	Use any programming language to a. Perform dilation, erosion, opening and closing operations on binary images. Allow users to specify the structuring element's size and shape (e.g., square, circle) as input parameters. Analyze the result b. Implement boundary detection on an image using morphological operations c. Apply Hit or Miss Transformation on binary images. Allow users to define the Hit and Miss structuring elements and detect specific patterns in the input image.	1
	MODULE V	
5.1	Fundamentals of Image Segmentation- Edge and Region based approach	1
5.2	Thresholding- Basics, Global and Adaptive thresholding	1
5.3	Region based Approach - Region Growing, Region Splitting and Merging	1
5.4	Edge Operators- Roberts, Prewitt, Sobel (mask only), Canny- basics	1
5.5	Use any programming language to a. Read grayscale image as input and use a fixed threshold value to create a binary mask separating the objects from the background. b. Apply Otsu's thresholding to segment an input grayscale image. c. Compare the results of different thresholding methods (global, adaptive, Otsu's, etc.) on the same grayscale image. d. Read an input image and compute the edges in the image using different edge detectors like Robert, prewitt, sobel and canny and comment on the result e. Read an RGB image and the desired number of clusters as input, and segment the image based on color similarity.	1

	CO Assessment Questions
1	Consider the image segment shown. Let V= {1,2} and compute the length of the shortest 4- ,8- and m- path between p and q. If a particular path does not exist between these two points, explain why? 4 2 3 2 (q)

	3 3 1 3 2 3 2 2 (p) 2 1 2 3
2	a. Explain a suitable image transform that helps to analyze an image in multiple resolution. b. Discuss the role of DCT in JPEG image compression. How does it reduce the image size while preserving essential image information? c. With the help of advanced image editing softwares, digital images can be manipulated maliciously. Thus, it is essential to be able to detect unauthorized image manipulations. In image authentication, a specific watermark is inserted into image, so that all attempts to manipulate the content of the image will alter the watermark also. Determine the best transformation domain in which to devise robust watermark embedding methods given that the watermarked data undergo lossy compression prior to watermark detection or extraction and design the necessary steps.
3	a. A research team is studying cell cultures using microscopic images. They need to count the number of cells in each image accurately to monitor cell growth and proliferation. However, the images often contain overlapping cells, making manual counting challenging and time-consuming. Suggest a suitable approach to handle this problem. b. Explain how morphological processing can be used to detect the boundary of an object.
4	a. A skilled medical technician is charged with the job of inspecting a certain class of monochrome images generated by electronic microscope. To facilitate the inspection, the technician uses image processing aids. However, when he examines the images, he finds the following problems. i. Presence of bright isolated dots that are not of interest. ii. Lack of sharpness iii. Poor contrast b. Propose and explain sequence of preprocessing steps that the technician may use to overcome the above-mentioned problems. Suggest suitable implementation environment. (i) Let y(m) = {2,3,8,4,2}. Obtain the median filter output for the window W = [-1,0,1,2] and show how salt and pepper noise is reduced. c. A 5x5, 3 bits/pixel original image is given by

	$$\begin{bmatrix} 4 & 4 & 4 & 4 & 4 \\ 3 & 4 & 5 & 4 & 3 \\ 3 & 5 & 5 & 5 & 3 \\ 3 & 4 & 5 & 4 & 3 \\ 4 & 4 & 4 & 4 & 4 \end{bmatrix}$$ (i) Apply histogram equalization to the image by rounding the resulting image pixels to integers. (ii) Sketch the histogram of the original image and the histogram-equalized image. Write the inference on image segment before and after equalization
5	a. A hospital's radiology department wants to develop an automated system for tumor detection in brain MRI scans. The goal is to accurately segment tumor regions from the rest of the brain in the images. This will assist radiologists in diagnosing and monitoring brain tumors more efficiently. Suggest a sequence of steps that you may use to automate this process as an image processing student. b. A research institute is conducting studies on cell behavior using fluorescence microscopy. They need to segment individual cells from the microscopic images to analyze their properties, such as size, shape, and fluorescence intensity. Suggest and explain a suitable approach to handle this problem.

		L	T	P	J	S	C	Year of Introduction
24HUT609	**Entrepreneurships and startups**	**2**	**0**	**0**	**0**	**2**	**2**	**2024**

Preamble: This course enables the learners to understand the basic idea about the entrepreneurships, its regulatory bodies and funding sources to convert it into startups and incubations. This covers the basic concept of entrepreneurships, financing options, promotional agencies and project life cycle. It helps the learners to overcome the barriers and fears associated with establishing startups based on the innovative ideas and funds from national agencies.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the concepts of entrepreneurship and startups. **(Understand Level)**
CO2	Explain different statutory boards and promotional agencies available for entrepreneurship. **(Understand Level)**
CO3	Analyze different financial options available for entrepreneurship. **(Apply Level)**
CO4	Implement the phases of project life cycle in a real life application. **(Apply Level)**
CO5	Prepare project report for a live project. **(Apply Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						2		3				3
CO2						2		3	3	3		3
CO3						3		3			3	3
CO4						3		3	3	3	3	3
CO5					3	3		3	3	3	3	3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate				
Create				

Mark Distribution of CIA

Course Structure	te nd an	Theory [L- T]	al Mar

[L-T-P-J]		Assignment	Test-1	Test-2	
3-0-0-0	5	35	30	30	**100**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	100	---	---

SYLLABUS

MODULE I :<<Introduction to Entrepreneurship Development>>

Definition of Entrepreneurship, Concept of Entrepreneurship, Types of Entrepreneurs and Entrepreneurship, Barriers, ED cycle. EDP in India, Phases of Entrepreneurial programs, Government Policies, Administrative Frame work, Policy instruments.

MODULE II :<<Statutory Boards and Promotional agencies>>

Statutory Boards, Industrial Estates, Industrial clusters, Incentives and subsidies, Advantages, Needs & Problems. Promotional agencies – NMCC, SIDO, NSIC, NAYE, TCO, SISI's- Khadi & Village Commission, STEP, NIESBUD, KITCO, SIDCO, KINFRA, MSME & DICs, Business Incubators & Startups.

MODULE III :<<Financing options >>

Financing Options - Bridge capital, Seed capital assistance, Margin money scheme, Sickness, Causes, Remedies. Overview on the roles of institutions/schemes in entrepreneurial development, Commercial banking schemes - Any two schemes in INDIA, Other financing options. Venture capital, Crowd funding, Angel Investors.

MODULE IV :<<Project Life Cycle>>

Project in Entrepreneurship – Meaning, Features, Classification. Project Ideas, Project Life Cycle, Project identification, Project formulation elements, Feasibility Analysis, Network Analysis.

MODULE V :<<Project Financing and Report preparation >>

Financial Analysis, Project Financing, Project Appraisal & Evaluation, Project Report Preparation, Ideal project report, Project implementation.

Text books

1. Nandan H, Fundamentals of Entrepreneurship, 3/e, PHI New Delhi, 2013.

Reference books

1. Sangram Keshari Mohanty, Fundamentals of Entrepreneurship, PHI New Delhi
2. Vasant Desai, Entrepreneurial Development
3. P. Saravanavel, Entrepreneurial Development
4. E. Gordan& K. Natarajan, Entrepreneurial Development
5. Arora, Renu.,Sood S.K, Entrepreneurial Development and Management
6. Gupta C.B., Srinivasan N.P, Entrepreneurship Development in India.

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
MODULE 1		
1.1	Definition of Entrepreneurship, Concept of Entrepreneurship	1
1.2	Types of Entrepreneurs and Entrepreneurship	1
1.3	Barriers , ED cycle, EDP in India	1
1.4	Phases of Entrepreneurial programs – Government Policies	1
1.5	Administrative Frame work – Policy instruments	1
MODULE II		
2.1	Statutory Boards, Industrial Estates, —.- STEP – NIESBUD, KITCO –SIDCO- KINFRA- MSME & DICs,	1
2.2	Industrial clusters, Incentives and subsidies, Advantage, Needs & Problems	1
2.3	Promotional agencies – NMCC,SIDO, NSIC, NAYE, TCO, SISI's- Khadi & Village Commission	1
2.4	STEP, NIESBUD, KITCO, SIDCO, KINFRA, MSME & DICs	1
2.5	Business Incubators& Start-ups	1
MODULE III		
3.1	Financing Options - Bridge capital, Seed capital assistance	1
3.2	Margin money scheme, Sickness, Causes, Remedies	1
3.3	Overview on the roles of institutions/schemes in entrepreneurial development	1
3.4	Commercial banking schemes - Any two schemes in INDIA	1
3.5	Other financing options, Venture capital	1
3.6	Crowd funding, Angel Investors	1
MODULE IV		
4.1	Project in Entrepreneurship – Meaning, Features, Classification	1
4.2	Project Ideas, Project Life Cycle	1

4.3	Project identification, Project formulation elements	1
4.4	Feasibility Analysis, Network Analysis	1
	MODULE V	
5.1	Financial Analysis, Project Financing	1
5.2	Project Appraisal & Evaluation	1
5.3	Project Report Preparation, Ideal project report	1
5.4	Project implementation	1

CO Assessment Questions	
1	1. Sheila has a degree in robotics and she loves to design products. She started her career in 'Robotech' which uses high end technology in all their products. Her job profile included travelling a lot also. Whenever she travelled she noticed that disabled people have difficulty in maneuvering their wheelchair from one place to another because in some places ramp is not provided and there is no way they can walk up the stairs. She came up with an idea of a wheelchair which can be used on stairs easily. She decided to quit her job and start her own company. She realized that her idea was the first stage in the process of innovation. Identify the concept and explain the steps in its process. 2. Explain the scope of entrepreneurship in present scenario. Do you think there are some entrepreneurial barriers in India? Explain. 3. Enumerate the achievements of EDPs in India. 4. 'Entrepreneur and entrepreneurship are catalysts in the process of economic development of a country'. Explain. 5. Give an account of the Government policy measures taken over the period for developing rural entrepreneurship.
2	1. Give a presentation on the support provided by the promotional agencies like NMCC,SIDO, NSIC, NAYE, TCO, SISI's- Khadi & Village Commission, STEP, NIESBUD, KITCO, SIDCO, KINFRA, MSME & DICs to small scale industries in the country. **(Group Work, where each group can present any three of these agencies)**
3	1. Crowd funding platforms, such as Kick starter or Go Fund Me, allow start-ups to access many different investors who may be able to contribute only small amounts in return for relatively small rewards. In the case of the i-Back Pack, those providing funds

	through Kick starter were largely unaware of the company's post funding operations. a) How did the lack of oversight harm investors? b) How might this situation have been different if a single angel investor had been involved? 2. Sanjiv was developing a business plan for his organization. While working on the financial plan he realised that his financial requirements will be for fixed assets and their installations, preliminary expenses, working capital, expenses on research and development and investment in short-term assets viz. raw material, level of cash, etc. To decide on the sources of funds for the venture, he tried to ensure the selection of the best overall mix of financing for the enterprise. a. Identify the elements of financial plan discussed here. b. Why is it important for an entrepreneur to ensure the selection of the best overall mix of financing for the enterprise? 3. Bhushan and Vinay were pursuing Electrical Engineering from a prestigious engineering college. During their third year they developed a solar LED bulb which can be used indoors. The bulb had a small panel which had to be charged at a stretch for 10 hours in the sun and it would last for 200 hours of usage. The idea was risky as there was a possibility that the market might not accept such a product, but if they do so, then, there would be a revolution in the power industry as it would lead to saving of power in every household. The prototype was made but to manufacture and distribute the same, they required around 5 crores. Both Bhushan and Vinay approached some affluent individuals who were ready to invest in their business in exchange for a convertible debt. Identify the type of investors and state any two features of the same.
4	1. Illustrate the concepts of project life cycle and also perform feasibility analysis from the context of your own project idea. **(Group Activity)**
5	1. Kapish an unemployed graduate got training for automobile repairing and allied services under PMKVY (Pradhan Mantri Kaushal Vikas Yojana) for skill development. He is planning to start a digital workshop for which he needs 25 lacs. Though through MUDRA (Micro Units Development and Refinance Agency) he is able to get a loan of 10 lacs but still he is falling short of 15 lacs. He wants to pitch in his idea to potential investors through his business plan. Explain the different formats in which he can present his business plan for his start-up. 2. Describe the steps involved in the preparation of project report, based on the project proposed in CO4 question. **(Group Activity)**

Honors- S6

24CSH609	Parallel Algorithms	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	4	4	2024

Preamble: This course helps the learners to understand basic and advanced concepts of parallel algorithms. It covers Principles of Parallel Algorithm Design, Communication operations, Programming Using the Message Passing Paradigm, Programming Shared Address Space Platforms Thread Basics, and GPU Programming. This course enables a learner to design solutions to complex real world problems using parallel computing paradigms including thread parallelism, shared memory program, message passing interfaces, and vector processing.

Prerequisite: Knowledge in Computer Organization and Architecture.

Course Outcomes: After the completion of the course the student will be able to

CO1	Summarize the key parallel computational models **(Cognitive Knowledge Level: Understand)**
CO2	Appreciate and apply parallel and distributed algorithms in problem Solving **(Cognitive Knowledge Level :Apply)**
CO3	Appreciate the communication models for parallel algorithm development (**Cognitive Knowledge Level : Understand**)
CO4	Develop parallel algorithms using message passing paradigm **(Cognitive Knowledge Level : Apply)**
CO5	Formulate parallel algorithms for share memory architectures. **(Cognitive Knowledge Level : Apply)**
CO6	Demonstrate the fundamental skills of heterogeneous computing with GPUs **(Cognitive Knowledge Level : Apply)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										3
CO2	3	3	3									3
CO3	3	3										3
CO4	3	3	3	3	2							3
CO5	3	3	3	3	2							3
CO6	3	3	3	3	2							3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate			✓	

Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
4-0-0-0	**5**	**15**	**10**	**10**	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

<u>End Semester Examination [ESE]: Pattern</u>

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I :<< Principles of Parallel Algorithm Design >>

Basic Introduction to Parallel Processing platforms. Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads, Parallel Algorithm Models.

MODULE II :<< Communication Operations >>

Basic Communication Operations - One-to-All Broadcast and All-to-One Reduction, All-to-All Broadcast and Reduction, All-Reduce and Prefix-Sum Operations, Scatter and Gather, All-to-All Personalized Communication, Circular Shift, Improving the Speed of Some Communication Operation
MODULE III :<< Programming Using the Message Passing Paradigm >>
Principles of Message-Passing Programming, The Building Blocks: Send and Receive Operations, MPI: The Message Passing Interface, Overlapping Communication with Computation, Collective Communication and Computation Operations, Groups and Communicators
MODULE IV :<< Programming Shared Address Space Platforms Thread Basics>>
Thread Basics, Why Threads? The POSIX Thread Application Programme Interface, Synchronization Primitives in POSIX, Controlling Thread and Synchronization Attributes, Thread Cancellation, Composite Synchronization Constructs, OpenMP: a Standard for Directive Based Parallel Programming, Specifying Concurrent Tasks in OpenMP, Synchronization Constructs in OpenMP, Data Handling in OpenMP, OpenMP Library Functions, OpenMP Applications: Parallel algorithm development for Matrix multiplication
MODULE V :<< GPU Programming >>
Heterogeneous Parallel Computing, Architecture of a Modern GPU, Speeding up Real Applications, Data parallel computing, CUDA C Program Structure, A Vector Addition Kernel, Device Global Memory and Data Transfer, Kernel Functions and Threading, Kernel Launch, CUDA Thread Organization, Mapping Threads to Multidimensional Data, Synchronization and Transparent Scalability, Resource Assignment, Querying Device Properties, Thread Scheduling and Latency Tolerance, Importance of Memory Access Efficiency, Cuda Memory Types, Tiling for Reduced Memory Traffic, Tiled Matrix Multiplication Kernel, Boundary Checks.

Text books

1. Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, Introduction to Parallel Computing, 2nd Ed, Addison-Wesley, 2003
2. David B. Kirk, Wen-mei W. Hwu, Programming Massively Parallel Processors: AHands-on Approach, 3rd Ed., Morgan Kaufman, 2016.

Reference books

1. Steven Brawer, Introduction to Parallel Computing, Academic Press, (1989)
2. Barbara Chapman, Gabriele Jost, Ruud van der Pas, Using OpenMP: Portable Shared Memory Paralwlel Programming , MIT Press, 2008.
3. William Gropp, Ewing Lusk, Anthony Skjellum Using MPI: Portable Parallel Programming with the Message-Passing Interface, 3rd Ed, MIT Press, 2014.
4. Thomas Rauber, Gudula Rünger, Parallel Programming for Multicore and Cluster Systems, Springer, 2010

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Basic Introduction to Parallel Processing platforms. Preliminaries	1
1.2	Decomposition Techniques – Recursive, Data	1
1.3	Decomposition Techniques – Exploratory, Speculative, Hybrid	1
1.4	Characteristics of Tasks and Interactions	1
1.5	Mapping Techniques for Load Balancing -Static	1
1.6	Mapping Techniques for Load Balancing - Dynamic	1
1.7	Methods for Containing Interaction Overheads	1
1.8	Parallel Algorithm Models	1
	MODULE II	
2.1	One-to-All Broadcast and All-to-One Reduction	1
2.2	All-to-All Broadcast and Reduction	1
2.3	All-Reduce and Prefix-Sum Operations	1
2.4	Scallter Gather	1
2.5	All-to-All Personalized Communication	1
2.6	Circular Shift	1
2.7	Improving the Speed of Some Communication Operation	1

MODULE III		
3.1	Principles of Message-Passing Programming	1
3.2	The Building Blocks: Send and Receive Operations	1
3.3	MPI: The Message Passing Interface	1
3.4	MPI: The Message Passing Interface : Illustration	1
3.5	Overlapping Communication with Computation	1
3.6	Overlapping Communication with Computation : Illustration	1
3.7	Collective Communication and Computation Operations	1
3.8	Collective Communication and Computation Operations : Illustration	1
MODULE IV		
4.1	Thread Basics, Why Threads?	1
4.2	The POSIX Thread API	1
4.3	Synchronization Primitives in POSIX	1
4.4	Controlling Thread and Synchronization Attributes	1
4.5	Thread Cancellation	1
4.6	Composite Synchronization Constructs	1
4.7	OpenMP: a Standard for Directive Based Parallel Programming	1
4.8	Specifying Concurrent Tasks in OpenMP	1
4.9	Synchronization Constructs in OpenMP	1
4.10	Data Handling in OpenMP, OpenMP Library Functions	1
4.11	OpenMP Applications: Parallel algorithm development for Matrix multiplication	1
MODULE V		
5.1	Heterogeneous Parallel Computing	1
5.2	Architecture of a Modern GPU, Speeding up Real Applications	1
5.3	Data parallel computing – CUDA C Program Structure	1
5.4	Vector Addition Kernel, Device Global Memory and Data Transfer	1
5.5	Kernel Functions and Threading, Kernel Launch	1
5.6	CUDA Thread Organization, Mapping Threads to Multidimensional Data	1
5.7	Synchronization and Transparent Scalability, Resource Assignment	1

5.8	Querying Device Properties, Thread Scheduling and Latency Tolerance	1
5.9	Importance of Memory Access Efficiency, Cuda Memory Types	1
5.10	Tiling for Reduced Memory Traffic	1
5.11	Tiled Matrix Multiplication Kernel, Boundary Checks	1

CO Assessment Questions	
1	1. Differentiate between static and dynamic task mapping. 2. Explain partitioning of data with an example.

2	1. Explain the handshaking sequence of Blocking Non-Buffered Send/Receive operation with a neat diagram.
	2. In the algorithm, assume a decomposition such that each execution of Line 7 is a task. Draw a task-dependency graph and a task-interaction graph.
	i. procedure FFT_like_pattern(A, n)
	ii. begin
	iii. m := log2 n;
	iv. for j := 0 to m - 1 do
	v. k := 2j;
	vi. for i := 0 to n - 1 do
	vii. A[i] := A[i] + A[i XOR 2j];
	viii. end // for
	ix. end // FFT_like_pattern

3	1. Write a procedure for performing all-to-all reduction on a mesh . 2. Give a hypercube algorithm to compute prefix sums of n numbers if *p* is the number of nodes and n/p is an integer greater than 1. Assuming that it takes time *tadd* to add two numbers and time ts to send a message of unit length between two directly-connected nodes, give an exact expression for the total time taken by the algorithm.

4	1. Show how the two-dimensional matrix-vector multiplication program needs to be changed so that it will work correctly for a matrix of size $n x\ m$ on a $q\ x\ r$ process grid. 2. One of the advantages of non-blocking communication operations is that they allow the transmission of the data to be done concurrently with computations. Discuss the type of restructuring that needs to be performed on a program to allow for the maximal overlap of computation with communication. Is the sending process in a better position to benefit from this overlap than the receiving process
5	1. Implement a multi-access threaded queue with multiple threads inserting and multiple threads extracting from the queue. Use mutex-locks to synchronize access to the queue. Document the time for 1000 insertions and 1000 extractions each by 64 insertion threads (producers) and 64 extraction threads (consumers). 2. Implement a producer-consumer framework in OpenMP using sections to create a single producer task and a single consumer task. Ensure appropriate synchronization using locks
6	1. Consider a hypothetical block with 8 threads executing a section of code before reaching a barrier. The threads require the following amount of time (in microseconds) to execute the sections: 2.0, 2.3, 3.0, 2.8, 2.4, 1.9, 2.6, and 2.9 and to spend the rest of their time waiting for the barrier. What percentage of the total execution time of the thread is spent waiting for the barrier? 2. Write and explain the CUDA program for vector addition.

24CSH610	Advanced Database System	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	0	4	2024

Preamble: This course presents a clear understanding to advanced database concepts and its emerging trends. This course includes the basic principles of distributed and object-oriented databases. The course gives a fundamental idea on query processing and optimization techniques. An optimum insight of database security is also provided.

Prerequisite: Topics covered under the course 23CSJ404 Introduction to Database Systems, Exposure to a High-Level Language like C/python.

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the fundamental concepts of distributed databases. (**Understand Level**)
CO2	Identify various measures of query processing and optimization. **(Apply Level)**
CO3	Outline the different security issues and threats to a database system. (**Understand Level)**
CO4	Explain the basic concepts of object-oriented databases. (**Understand Level**)
CO5	Outline the recent technological trends in databases. (**Understand Level**)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										3
CO2	3	3	1									3
CO3	3	3	1									3
CO4	3	3	1									3
CO5	3	3	1									3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L - T]			Total Marks
		Assignment	Test-1	Test-2	
4-0-0-0	**5**	**15**	**10**	**10**	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Database System Architectures and Distributed Databases(7hrs)

Distributed Database concepts, Distributed Databases vs. Conventional Databases, Types of Distributed Database systems, Distributed Database Architectures, Data Fragmentation, Replication and Allocation techniques for distributed database design, Distributed RDB design & its Transparency, Distributed Catalog Management.

MODULE II: Query Processing and Optimization (8 hrs)

Complex SQL Queries, Query Processing Algorithms – Query Optimization Techniques, Transaction Management- Transaction Processing Concepts, Concurrency Control, Deadlocks, Recovery Techniques.

MODULE III: Database Security (8 hrs)
Introduction to Database Security Issues-Types of Security, Control Measures, Database Security and the DBA, Access Control, User Accounts, and Database Audits, Discretionary Access Control, Mandatory Access control (Role based only), SQL Injection, Challenges of database security.
MODULE IV: Object-oriented Databases (12 hrs)
Concepts for Object Databases: Introduction to Object-Oriented Concepts and Features, Object Identity, Object structure, Type Constructors, Encapsulation of Operations, Methods, Persistence, Type and Class, Hierarchies, Inheritance, Complex Objects, ODMG, ODL, OQL, basic OQL queries. Object Relational Systems – Case studies: Oracle and Informix.
MODULE V: Emerging trends in database management (9 hrs)
Big Data – Motivation, Sources and Uses of Big Data, Querying Big Data, Big Data Storage Systems- Distributed File Systems, Sharding, Key Value Storage Systems, Blockchain Databases-Overview, Blockchain Properties, Simple Blockchain Transactions, Data Management in a Blockchain, Emerging Applications.

Text books

1. R. Elmasri, S.B. Navathe, “Fundamentals of Database Systems”, 5/e, Pearson Education/Addison Wesley, 2011
2. Patrick O'Neil , Elizabeth O'Neil , “Database: Principles, Programming and Performance”,2/e, Morgan Kaufmann, 2011
3. Thomas Cannolly and Carolyn Begg, “Database Systems, A Practical Approach to Design, Implementation and Management”, 3/e, Pearson Education, 2010.
4. Henry F Korth, Abraham Silberschatz, S. Sudharshan, “Database System Concepts”, 5/e, Tata McGraw Hill, 2006

Reference books

1. C.J. Date, A.Kannan and S. Swamynathan,”An Introduction to Database Systems”, 8/e, Pearson Education India, 2006.
2. Joe Fawcett, Danny Ayers , Liam R. E. Quin, Beginning XML, 5/e, John Wiley & Sons, 2012
3. Grigoris Antoniou. Frank van Harmelen, “A Semantic Web Primer”, The MIT Press,Cambridge, Massachusetts, 2003
4. Jules J. Berman, “Principles of Big Data: Preparing, Sharing and Analyzing Complex Information”, Morgan Kufmann, 2013.

Suggested MOOC Courses

1. Data Base Management System, IIT Kharagpur - Prof. Partha Pratim Das, Prof. Samiran Chattopadhyay, Prof. Kausik Datta.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Distributed database concepts, Distributed Databases Vs Conventional Databases	1

1.2	Types of Distributed Database systems	1
1.3	Distributed Database Architectures	1
1.4	Data fragmentation, replication and allocation techniques for distributed database design	1
1.5	Distributed RDB design & its Transparency (Lecture 1)	1
1.6	Distributed RDB design & its Transparency (Lecture 2)	1
1.7	Distributed catalogue management.	1
MODULE II		
2.1	Complex SQL Queries (Lecture 1)	1
2.2	Complex SQL Queries (Lecture 2)	1
2.3	Query Processing Algorithms, Query Optimization Techniques (Lecture 1)	1
2.4	Query Processing Algorithms, Query Optimization Techniques (Lecture 2)	1
2.5	Transaction Management: Transaction Processing Concepts, Concurrency Control (Lecture 1)	1
2.6	Transaction Management: Transaction Processing Concepts, Concurrency Control (Lecture 2)	1
2.7	Deadlocks, Recovery Techniques (Lecture 1)	1
2.8	Deadlocks, Recovery Techniques (Lecture 2)	1
MODULE III		
3.1	Introduction to Database Security Issues- Types of Security control measures	1
3.2	Database Security and the DBA	1
3.3	Access Control, User Accounts, and Database Audits	1
3.4	Discretionary Access Control Based on Granting and Revoking Privileges (Lecture 1)	1
3.5	Discretionary Access Control Based on Granting and Revoking Privileges (Lecture 2)	1
3.6	Mandatory Access control (Role based only)	1

3.7	SQL Injection	1
3.8	Challenges of database security	1
MODULE IV		
4.1	Concepts for Object Databases: Introduction to Object-Oriented Concepts and Features	1
4.2	Object Identity, Object structure	1
4.3	Type Constructors, Encapsulation of Operations	1
4.4	Methods, Persistence	1
4.5	Type and Class Hierarchies, Inheritance, Complex Objects (Lecture 1)	1
4.6	Type and Class Hierarchies, Inheritance, Complex Objects (Lecture 2)	1
4.7	The ODMG Object Model and the Object Definition Language ODL (Lecture 1)	1
4.8	The ODMG Object Model and the Object Definition Language ODL (Lecture 2)	1
4.9	The Object Query Language OQL	1
4.10	Simple OQL Queries	1
4.11	Object Relational Systems – Case studies: Oracle	1
4.12	Object Relational Systems – Case studies: Informix.	1
MODULE V		
5.1	Big Data – Motivation, Sources and Uses of Big Data	1
5.2	Querying Big Data (Lecture 1)	1
5.3	Querying Big Data (Lecture 2)	1
5.4	Big Data Storage Systems- Distributed File Systems	1
5.5	Sharding, Key-Value Storage Systems	1
5.6	Parallel and Distributed Databases	1

5.7	Blockchain Databases- introduction, Blockchain Properties	1
5.8	Simple Blockchain Transactions	1
5.9	Data Management in a Blockchain, Emerging Applications	1

<table>
<tr><th colspan="2">CO Assessment Questions</th></tr>
<tr><td>1</td><td>1. Explain the architecture of a DDBMS. Within the context of a centralized DBMS, briefly explain new components introduced by the distribution of data.
2. Using your own simple examples and/or time-line diagrams, describe how data may be damaged, lost or misread in a multi-user database if concurrency control techniques are not fully implemented.
3. Explain the naming problem in distributed databases.</td></tr>
<tr><td>2</td><td>1. Consider the following database that contains information about directors and the films they have directed:
Film (filmNbr, title, year)
Director (directID, name)
Directs (directID*, filmNbr*)

Consider the following query:
SELECT Film.title
FROM Film, Director, Directs
WHERE Film.filmNbr = Directs.filmNbr
AND Director.directID = Directs.directID
AND Director.name = ‘Lucas’;
Suppose this query is run by executing the following sequence of steps:
1. R1 = Join of Director and Directs
2. R2 = Join of Film and R1
3. R3 = Selection (name = ‘Lucas’) from R2
4. R4 = Projection (title) from R3
(i) Draw the query tree for the above query.
(ii) What is the problem caused if the query is executed based on the sequence above.
(iii) Suggest a new sequence that will make the query more efficient.

2. Describe the typical steps involved when processing a high level query.</td></tr>
</table>

3	1. List the main types of threat that could affect a database system and describe the controls that you would use to counteract them. 2. A password profile is a tool used to enforce database security. For example, it can be used to check the complexity of a password. List three other mechanisms that can be achieved through this tool. 3. Describe two mechanisms for guarding against SQL injection.
4	1. Explain the concept of encapsulation and how it is used to create abstract data types. 2. Describe the various type constructors. How are they used to create complex object structures? 3. State the difference between regular inheritance, multiple inheritance, and selective inheritance.
5	1. Suppose you need to store a very large number of small files, each of size say 2 kilobytes. If your choice is between a distributed file system and a distributed key-value store, which would you prefer, and explain why. 2. Explain the benefits and potential risks of sharding. 3. Explain the concept of a blockchain fork. List the two types of fork and explain their differences. 4. Since blockchains are immutable, how is a transaction abort implemented so as not to violate immutability.

24CSH611	Social Network Analytics	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	4	4	2024

Preamble: This course enables the learners to investigate different quantitative measures for defining the structure of a network and identify the strength and pitfalls of each network model based on the requirements.This course covers the preliminaries for defining a network, architecture of different network models, link analysis and prediction as well as anomaly detection methods in social community networks. It helps the learners to choose appropriate network model for real world application scenarios.

Prerequisite:NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Identify the relationship between physical society and online social network, and quantitatively analyze the microscopic, mesoscopic and macroscopic structure of a network.**(Apply Level)**
CO2	Identify the shortcomings of the existing network models to replicate the evolution of new real-world network. **(Apply Level)**
CO3	Explain how the network links help in measuring the importance of nodes in a network. **(Apply Level)**
CO4	Choose an appropriate link prediction algorithm for an unknown task depending on the strengths and limitations of the existing link prediction methods.**(Apply Level)**
CO5	Compare and contrast various anomaly detection methods.**(Apply Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3		3							3
CO2	3	3	3		3							3
CO3	3	3	3		3							3
CO4	3	3	3									3
CO5	3	3	3									3

Assessment Pattern

Bloom'sCategory	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate				
Create				

Mark Distribution of CIA						
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
4-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Networks and Society (8 hrs)

Introduction, Applications of social Network Analysis, Preliminaries, Three levels of Social Network Analysis, Graph Visualization tools. Network Measures – Basics, Node Centrality, Assortativity, Transitivity, Reciprocity, Similarity, Degeneracy.

MODULE II : Network Growth Models (9 hrs)

Properties of Real-World Networks, Random Network Model, Ring lattice Network Model, Watts – Strogatz Model, Preferential Attachment Model, Price's Model, Network model with Accelerating Growth. Gephi graph visualization and exploration software – practice.

MODULE III : Link Analysis (10 hrs)

Signed networks – Balance theory, Status theory, Triad Balance and Status, Strong and Weak Ties- Strength, Triadic Closure, Dunbar Number, Local bridges, Link

Analysis algorithms, Page Rank, Personalized Page rank, Applications of Link Analysis. SNAP system for large networks analysis and manipulation.

MODULE IV : Link Prediction (8 hrs)

Temporal changes in Network, Evaluating link prediction methods – Train test split, Positive Negative Samples, Evaluation Metric, Heuristic Models – Local and Global, Probabilistic Models.

MODULE V : Anomaly detection in networks (10 hrs)

Outliers Vs Networks based anomalies, Challenges, Anomaly detection Static Networks – Plain Networks, Attributed Networks, Relational Learning, Anomaly detection in dynamic networks – Feature based approaches, Decomposition based, Community based, Window Based.Case studies – Modelling the spread of Covid-19, Collusion in Online Social Networks

Text books

1. Tanmoy Chakraborthy," Social Network Analysis", Wiley India, 1st edition, 2021.

Reference books

1. Ajith Abraham, Aboul Ella Hassanien, Vaclav Snasel , "Computational Social Network Analysis: Trends, Tools and Research Advances", Springer, 2012.
2. Borko Furht, "Handbook of Social Network Technologies and Applications", Springer, 1st edition,2011.
3. Charu C. Aggarwal, "Social Network Data Analytics", Springer, 2014.
4. Giles, Mark Smith, John Yen, "Advances in Social Network Mining and Analysis", Springer, 2010.
5. Guandong Xu, Yanchun Zhang and Lin Li, "Web Mining and Social Networking – Techniques and applications", Springer, 1st edition, 2012.

Suggested MOOC Courses

1. **NPTEL:**Social Network Analysis, Prof. Tanmoy Chakraborty | IIT Delhi.
2. **NPTEL:**Social Networks, Prof. Sudarshan Iyengar | IIT Ropar

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE I	
1.1	Introduction and Applications of Social Network Analysis	1
1.2	Preliminaries	1
1.3	Three levels of Social Network Analysis	1
1.4	Graph Visualization tools	1
1.5	Network Measures – Basics	1

1.6	Node Centrality, Assortativity	1
1.7	Transitivity, Reciprocity	1
1.8	Similarity, Degeneracy	1
MODULE II		
2.1	Properties of Real World Networks	1
2.2	Random Network Model	1
2.3	Ring lattice Network Model	1
2.4	Watts – Strogatz Model	1
2.5	Preferential Attachment Model	1
2.6	Price's Model	1
2.7	Network model with Accelerating Growth	1
2.8	Gephi graph visualization and exploration software – practice	1
2.9	Gephi graph visualization and exploration software – practice	1
MODULE III		
3.1	Signed networks – Balance theory, Status theory	1
3.2	Triad Balance and Status	1
3.3	Strong and Weak Ties- Strength, Triadic Closure	1
3.4	Dunbar Number, Local bridges	1
3.5	Link Analysis algorithms	1
3.6	Page Rank	1
3.7	Personalized Page rank	1
3.8	Applications of Link Analysis	1

3.9	SNAP system for large networks analysis and manipulation – Familiarization	1
3.10	SNAP system for large networks analysis and manipulation - Practice	1
MODULE IV		
4.1	Temporal changes in Network –Lecture 1	1
4.2	Temporal changes in Network –Lecture 2	1
4.3	Evaluating link prediction methods – Train test split	1
4.4	Positive Negative Samples	1
4.5	Evaluation Metric	1
4.6	Heuristic Models – Local and Global	1
4.7	Probabilistic Models – Lecture 1	1
4.8	Probabilistic Models – Lecture 2	1
MODULE V		
5.1	Outliers Vs Networks based anomalies and Challenges	1
5.2	Anomaly detection Static Networks – Plain Networks, Attributed Networks	1
5.3	Relational Learning	1
5.4	Anomaly detection in dynamic networks	1
5.5	Feature based approaches	1
5.6	Decomposition based approaches	1
5.7	Community based anomaly detection	1
5.8	Window Based anomaly detection	1
5.9	Case studies – Modelling the spread of Covid-19	1
5.10	Collusion in Online Social Network	1

<table>
<tr><th colspan="2">CO Assessment Questions</th></tr>
<tr><td>1</td><td>
1. Under Covid-19 pandemic situation, people are talking about social distancing. Illustrate with justification the structure of the social network using the SARS-CoV-2 virus causing the pandemic is spreading.
2. You are given a task to model an online discussion forum such as Reddit using a network. What would be your approach?
3. Choose a network from the UCI network repository and visualize it using Gephi.
4. Explain the concept of Katz centrality and how it varies with the change in the attenuation factor.
5. Suppose you are an Intelligence Officer in Research and Analysis Wing. For a very long time, your missions for intercepting the enemy are failing as every time you try to catch them, they leave a few minutes ago. You come to know that someone is tipping the enemy from inside your organization and you know which department to look for but do not know where to start. Explain in network terminology where to start.
</td></tr>
<tr><td>2</td><td>
1. List the two major drawbacks in the assumptions of the Watts-Strogatz model with respect to the real world network.
2. Draw a graph showing the evolution of a random network and explain the phases of transition.
3. List any two real world properties captured by the Barabasi-Albert model. What are the assumptions/open ended questions regarding the basic Barabasi-Albert.
</td></tr>
<tr><td>3</td><td>
1. Consider that you got an offer as a data analysis from a multinational company of food and drink suppliers. Being your first task, you have to provide a ranked list of the locations in your company’s network. What factors would you consider? Explain
2. Consider a restaurant review network containing objects of two types – restaurant® and user (U). there exists a review relationship between U and R. Consider the adjacency matrix as shown below, where each cell shows the number of reviews given by the user to a restaurant. Find the peer restaurant for Mint.
<table>
<tr><th></th><th>Michelle</th><th>Alice</th><th>Bob</th><th>Eve</th></tr>
<tr><td>Mint</td><td>2</td><td>4</td><td>0</td><td>0</td></tr>
<tr><td>Pavilion</td><td>4</td><td>0</td><td>2</td><td>1</td></tr>
<tr><td>Symposium</td><td>2</td><td>4</td><td>0</td><td>0</td></tr>
<tr><td>Sky Route</td><td>0</td><td>0</td><td>1</td><td>3</td></tr>
</table>
3. Explain the working of the Page Rank algorithm with proper examples.
</td></tr>
</table>

4	1. Link prediction can be used for predicting missing links in graphs at current state and for predicting future links. Provide mathematical formulation for both problems. 2. You are a freelancer network researcher. Recently, Japanese health ministry has contracted you to analyse their organization structure on various metrics that can be further used to understand and improve the organization. In order to complete the said task, they have provided a graph of the organization in which nodes are employees and an edge between two employees indicates that they communicate with each other for work. Due to some negligence, you accidentally deleted a few edges from the edge list file. You are afraid of asking for a newer copy since it can spoil you reputation to the high valued client. Therefore, you have decided to use a link prediction algorithm to approximate-deleted edges. Which link prediction algorithm will be suitable for this task and explain in detail. 3. Explain the reasoning behind the names of Hub promoted/Depresses Index.
5	1.Y ou have an anomaly detection system that gives 95%accuracy. Would you be satisfied with this performance? Why? 2.Y ou read a published paper that says that the number of edges connected to a node in a network is directly proportional to the age of the node. This study was published in 2005. Would you blindly follow this study in 2024? Justify your answer with reasons. 3.S tate and explain some practical data specific challenges that arise in anomaly detection problems.

Minor- S6

24CSM609	Concepts in Deep Learning	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	4	4	2024

Preamble: This course enables the learners to gain the knowledge needed to take a definitive step in the world of AI. Deep learning is a subfield of machine learning, a subfield of artificial intelligence. Basic concepts and application areas of machine learning, deep networks, convolutional neural network and recurrent neural network are covered here. The objective of the course is to help students to understand the capabilities, challenges, and consequences of deep learning and prepare them to participate in the development of leading-edge AI technology.

Prerequisite: Sound knowledge in Basics of linear algebra and probability theory

Course Outcomes: After the completion of the course the student will be able to

CO1	Demonstrate basic concepts in machine learning. (**Understand**)
CO2	Illustrate the validation process of machine learning models using hyper-parameters and validation sets. (**Understand**)
CO3	Demonstrate the concept of the feed forward neural network and its training process. (**Apply Level**)
CO4	Build CNN and Recurrent Neural Network (RNN) models for different use cases. (**Apply Level**)
CO5	Use different neural network/deep learning models for practical applications. (**Apply Level**)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3								3
CO2	3	3	3	3								3
CO3	3	3	3	1	3							3
CO4	3	3	3	1	3	1						3
CO5	3	3	3	1	3	1						3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✔	✔	✔	✔
Understand	✔	✔	✔	✔
Apply	✔	✔	✔	✔
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
4-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	**PART A**	**PART B**	**ESE Marks**
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : << Introduction >>

Key components - Data, models, objective functions, optimization algorithms, Learning algorithm.Supervised learning- regression, classification, tagging, web search, page ranking, recommender systems, sequence learning, Unsupervised learning, Reinforcement learning, Historical Trends in Deep Learning. Other Concepts - overfitting, underfitting, hyperparameters and validation sets, estimators, bias and variance.

MODULE II : << Optimization and Neural Networks >>

Neural Networks – Perceptron, Gradient Descent solution for Perceptron, Multilayer perceptron, activation functions, architecture design, chain rule, back propagation, gradient based learning. Introduction to optimization– Gradient based optimization, linear least squares. Stochastic gradient descent, Building ML algorithms and challenges.

MODULE III : << Convolutional Neural Network >>

Convolutional Neural Networks – convolution operation, motivation, pooling, Structure of CNN, Convolution and Pooling as an infinitely strong prior, variants of convolution functions, structured outputs, data types, efficient convolution algorithms. Practical challenges of common deep learning architectures- early stopping, parameter sharing, dropout. Case study: AlexNet, VGG, ResNet.

MODULE IV : << Recurrent Neural Network >>

Recurrent neural networks – Computational graphs, RNN design, encoder – decoder sequence to sequence architectures, deep recurrent networks, recursive neural networks, modern RNNs LSTM and GRU, Practical use cases for RNNs.

MODULE V : << Application Areas >>

Applications – computer vision, speech recognition, natural language processing, common word embedding: continuous Bag-of-Words, Word2Vec, global vectors for word representation (GloVe). Research Areas – autoencoders, representation learning, boltzmann machines, deep belief networks.

Text books

1. Ian Goodfellow, YoshuaBengio, Aaron Courville, Deep Learning, MIT Press 2015 ed.
2. Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, Dive into Deep Learning, August 2019.
3. Neural Networks and Deep Learning, Aggarwal, Charu C., c Springer International Publishing AG, part of Springer Nature 2018.

Reference books

1. Neural Smithing: Supervised Learning in Feedforward Artificial Neural Networks by Russell Reed, Robert J MarksII, A Bradford Book,2014.
2. Practical Convolutional Neural Networks by MohitSewak, Md. Rezaul Karim,
PradeepPujari,Packt Publishing 2018.
3. Hands-On Deep Learning Algorithms with Python by SudharsanRavichandran, Packt Publishing 2019.
4. Deep Learning with Python by Francois Chollet,Manning Publications Co.,2018.

Suggested MOOC Courses

1. NPTEL Course - Deep Learning by Prof. Prabir Kumar Biswas , IIT Kharagpur.
2. NPTEL Course - Deep Learning by Prof. Sudarshan Iyengar, Prof. Padmavati , IITRopar.
3. NPTEL Course - Deep Learning for Computer Vision by Prof. Vineeth N Balasubramanian, IIT Hyderabad.
4. Coursera Course - Introduction to Deep Learning by Prof. Geena Kim, University of Colorado Boulder.

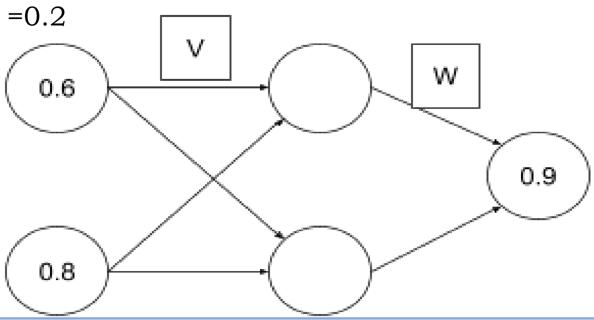
COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours

MODULE 1 (9)		
1.1	Key components - Data, models, objective functions, optimization algorithms.(TB2: Section 1.1-1.2)	1
1.2	Learning algorithm (TB1: Section 5.1), Supervised learning- regression, classification (TB2: Section 1.3.1)	1
1.3	Tagging, web search, page ranking (TB2: Section 1.3.1)	1
1.4	Recommender systems, Sequence learning, Unsupervised learning,Reinforcement learning(TB2: Section 1.3.2-1.3.4)	1
1.5	Historical Trends in Deep Learning (TB1: Section 1.2)	1
1.6	Concepts: over-fitting, under-fitting, hyperparameters and validation sets.(TB1: Section 5.2-5.3)	1
1.7	Concepts: Estimators, bias and variance. (TB1: Section 5.4)	1
1.8	Demonstrate the concepts of supervised learning algorithms using a suitable platform.	1
1.9	Demonstrate the concepts of unsupervised using a suitable platform.	1
MODULE II (9)		
2.1	Perceptron, Stochastic Gradient descent, Gradient descent solution for perceptron (TB3: Section 1.1 - 1.2.1)	1
2.2	Multilayer perceptron (TB3: Section 1.2.2), (TB1: Section 6.1,6.3)	1
2.3	Activation functions- Sigmoid, tanh, Softmax, ReLU, leaky ReLU (TB3: Section 1.2.1.3 - 1.2.1.5)	1
2.4	Architecture design (TB1: Section 6.4, TB3: Section 1.6)	1
2.5	Chain rule, back propagation (TB3: Section 1.3)	1
2.6	Gradient based learning (TB1: Section 6.2)	1
2.7	Gradient based optimization (TB1: Section 4.3)	1
2.8	Linear least squares using a suitable platform. (TB1: Section 4.5)	1
2.9	Building ML Algorithms and Challenges (TB3: 1.4, TB1: 5.10-5.11)	1
MODULE III (10)		

3.1	Convolution operation, Motivation, pooling (TB1:Section 9.1-9.3)	1
3.2	Structure of CNN (TB3: Section 8.2)	1
3.3	Convolution and Pooling as an infinitely strong prior (TB1: Section 9.4)	1
3.4	Variants of convolution functions – multilayer convolutional network, tensors, kernel flipping, downsampling, strides and zero padding. (TB1: Section 9.5	1
3.5	Variants of convolution functions - unshared convolutions, tiled convolution, training different networks. (TB1: Section 9.5)	1
3.6	Structured outputs, data types (TB1: Section 9.6-9.7)	1
3.7	Efficient convolution algorithms. (TB1: Section9.8,9.10)	1
3.8	Practical challenges of common deep learning architectures- early Stopping (TB3: 4.6)	1
3.9	Practical challenges of common deep learning architectures- parameter sharing, drop-out (TB3: Section 4.9, 4.5.4)	1
3.10	Case Study: AlexNet,VGG, ResNet. (TB3: Section 8.4.1-8.4.3,8.4.5)	1
MODULE IV (8)		
4.1	Computational graphs (TB1: Section 10.1)	1
4.2	RNN (TB1: Section 10.2-10.3)	1
4.3	Encoder – decoder sequence to sequence architectures. (TB1: Section 10.4)	1
4.4	Deep recurrent networks (TB1: Section 10.5)	1
4.5	Recursive neural networks , Modern RNNs, (TB1: Section 10.6, 10.10)	1
4.6	LSTM and GRU (TB1: Section 10.10, TB3: Section 7.5-7.6)	1
4.7	Practical use cases for RNNs. (TB1: Section 11.1-11.4)	1
4.8	Demonstrate the concepts of RNN using a suitable platform.	1
MODULE V (9)		
5.1	Computer vision. (TB1: Section 12.2)	1

5.2	Speech recognition. (TB1: Section 12.3)	1
5.3	Natural language processing. (TB1: Section 12.4)	1
5.4	Common Word Embedding -: Continuous Bag-of-Words, Word2Vec (TB3: Section 2.6)	1
5.5	Common Word Embedding -: Global Vectors for Word Representation(GloVe) (TB3: Section 2.9.1- Pennigton 2014)	1
5.6	Brief introduction on current research areas- Autoencoders, Representation learning. (TB3: Section 4.10)	1
5.7	Brief introduction on current research areas- representation learning. (TB3: Section 9.3)	1
5.8	Brief introduction on current research areas- Boltzmann Machines, Deep belief networks. (TB1: Section 20.1, TB3 Section 6.3)	1
5.9	Brief introduction on current research areas- Deep belief networks. (TB1: Section 20.3)	1

CO Assessment Questions	
1	1. Compare regression and classification 2.Define supervised learning? Distinguish between regression and classification. 3. Discuss the different learning approaches used in machine learning.
2	1. What are hyperparameters? Why are they needed? 2. What issues are to be considered while selecting a model for applying machine learning in a given problem?
3	1. Draw the architecture of a multi-layer perceptron. 2. Derive update rules for parameters in the multi-layer neural network through the gradient descent. 3. Update the parameters V 11 in the given MLP using back propagation with learning rate as 0.5 and activation function as sigmoid. Initial weights are given as V11 = 0.2, V12 =0.1, V21 =0.1, V22 =0.3, V11 =0.2, W 11 =0.5, W21 =0.2 

4	1. Give two benefits of using convolutional layers instead of fully connected ones for visual tasks. 2. Suppose that a CNN was trained to classify images into different categories. It performed well on a validation set that was taken from the same source as the training set but not on a testing set. What could be the problem with the training of such a CNN? How will you ascertain the problem? How can those problems be solved?
5	1. Explain how the cell state is updated in the LSTM model from Ct-1 to Ct 2. Show the steps involved in an LSTM to predict stock prices. 3. Illustrate the workings of the RNN with an example of a single sequence defined on a vocabulary of four words.

:

24CSM610	Software Project Management	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	0	0	2024

Preamble: This course provides fundamental knowledge in the Software Development Process. It covers Software Development, Quality Assurance, Project Management concepts and technology trends. This course enables the learners to apply state of the art industry practices in Software development.

Prerequisite: Familiarity with basics in software engineering and software testing.

Course Outcomes: After the completion of the course the student will be able to

CO1	Demonstrate Traditional and Agile Software Development approaches. **(Apply Level)**
CO2	Familiarize the different methods and techniques used for project management. **(Understand Level)**
CO3	Evaluate a project to develop the scope of work, provide accurate cost estimates and to plan the various activities. **(Analyze Level)**
CO4	Identify the resources required for a project and to produce a work plan and resource schedule. **(Apply level)**
CO5	Understand the basics and benefits of software quality engineering. **(Understand Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3			1							3
CO2	3	3	1						3			3
CO3	3	3	1									3
CO4	3	3			3				3			3
CO5	3	3	3	3					1			3
CO6	3	1			3							3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
4-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

<u>End Semester Examination [ESE]: Pattern</u>

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I :<<INTRODUCTION>>

Defining Software Development Process - Process - Tailoring the Process - Improving the process discipline - Need for implementing discipline. Software Production Process - Identify the Software Model - Software Process Models: Waterfall Model, Prototyping Model, RAD Model, Incremental Model, Spiral Model, Agile Software Development.

MODULE II :<<PLANNING>>

Project management fundamentals-Approaches- Challenges-Project management cycle- Management spectrum- Role of Project Manager-Planning Fundamentals – Major issues in software project planning – Planning activities - Risk Management - Configuration Management.

MODULE III :<<PROJECT ESTIMATION>>

Project estimation- techniques-Size estimation– Major issues in estimating software cost – Cost estimation methods – Experience based model – Parameter based model – COCOMO – Versions of COCOMO – Software size estimation – Function points – Staffing Level Estimation-Project Scheduling-organization and Team Structures.

MODULE IV :<<PROJECT SCHEDULING>>

Time management: importance of Project schedules, schedules and activities, sequencing and scheduling activities, Network Planning models, duration estimation and schedule development, Critical path analysis, PERT, Use of software (Microsoft project) to assist in project scheduling

MODULE V :<<SOFTWARE QUALITY>>

Software Quality - Quality Measures - FURPS - Software Quality Assurance, Software Reviews - Format Technical Review (FTR) Formal Approaches to SQA - Software Reliability - Introduction to SQA - The Software Quality Assurance Plan - Formal approaches to SQA - Cleanroom Methodology.

Text books

1. Software Engineering - Ian Sommerville, Pearson Education, Tenth edition, 2015.
2. Software Engineering: A practitioner's approach - Roger S. Pressman, McGraw Hill publication, Eighth edition, 2014
3. Fundamentals of Software Engineering - Rajib Mall, Eastern Economy Edition, Fifth edition, 2018.

Reference books

1. Software Project Management Subramanian Chandramouli Saikat Dutt, Pearson Education Publishing, 2015.
2. Engineering Software Products: An Introduction to Modern Software Engineering - Ian Sommerville, Pearson Education, First Edition, 2020.

Suggested MOOC Courses

1. Prof. Rajib Mall & Prof. Durga Prasad Mohapatra /IIT Kharagpur , https://onlinecourses.nptel.ac.in.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1		
1.1	Defining of Software Development Process	1
1.2	Process - Tailoring the Process - Improving the process discipline	1
1.3	Improving the process discipline	1

1.4	Need for implementing discipline. Software Production Process	1
1.5	Identify the Software Model - Software Process Models: Waterfall Model	1
1.6	Prototyping Model	1
1.7	RAD Model, Incremental Model	1
1.8	Spiral Model	1
1.9	Agile software development (Lecture I)	1
1.10	Agile software development (Lecture II)	1
	MODULE II	
2.1	Project management fundamentals-Approaches	1
2.2	Challenges- Role of Project Manager	1
2.3	Planning Fundamentals	1
2.4	Major issues in software project planning	1
2.5	Planning Activities	1
2.6	Project plan	1
2.8	Risk Management	1
2.9	Configuration Management	1
	MODULE III	
3.1	Project estimation- techniques-Size estimation	1
3.2	Major issues in estimating software cost	1
3.3	Cost estimation methods – Experience based model	1
3.4	Parameter based model	1
3.5	COCOMO Model (Lecture I)	1

3.6	COCOMO Model (Lecture II)	1
3.7	Versions of COCOMO	1
3.8	Software size estimation – Function points	1
3.9	Staffing Level Estimation	1
3.10	Project Scheduling	1
3.11	Project organization	1
3.12	Team Structures-Configuration Management	1
MODULE IV		
4.1	Time management: importance of Project schedules, schedules and activities	1
4.2	Sequencing and scheduling activities, Network Planning models	1
4.3	Duration estimation and schedule development	1
4.4	Critical path analysis	1
4.5	PERT	1
4.6	Use of software (Microsoft project) to assist in project scheduling	1
MODULE V		
5.1	Software Quality - Quality Measures	1
5.2	FURPS - Software Quality Assurance	1
5.3	Software Reviews - Format Technical Review (FTR) Formal Approaches to SQA	1
5.4	Software Reliability	1
5.5	Introduction to SQA	1
5.6	The Software Quality Assurance Plan	1
5.7	Formal approaches to SQA	1

5.8	Clean room Methodology	1

CO Assessment Questions	
1	1. Illustrate agile software development and traditional software development with a socially relevant case study. 2. Explain the criteria of process model selection.
2	1. Demonstrate the risk management process with the help of examples. 2. Write a case study to illustrate the importance of communications in a project team. Assume that some team members work remotely and it is impossible to get the whole team together at short notice.
3	1. A system has 12 external inputs, 24 external outputs, fields 30 different external queries, manages 4 internal logical files, and interfaces with 6 different legacy systems (6 EIFs). All of these data are of average complexity and the overall system is relatively simple. Compute FP for the system? 2. Suppose you are developing a software product of organic type. You have estimated the size of the product to be about 100000 LOC. Compute the nominal effort and development time.
4	1. How is Gantt chart useful in software project management? What problems might be encountered, if project monitoring and control is carried out using a Gantt chart? 2. The following table indicates the various tasks involved in completing a software project, the corresponding activities, and the estimated effort for each task in person-months. The precedence relation Ti ≤ {Tj, Tk} implies that the task Ti must complete before either task Tj or Tk can start. The following precedence relation is known to hold among different tasks: T1 ≤ T2 ≤ {T3, T4, T5, T6} ≤ T7. (a) Draw the Activity network representation of the tasks. (b) Determine ES, EF and LS, LF for every task. (c) Develop the Gantt chart representations for the project.

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<table>
<tr><th>Notation</th><th>Activity</th><th>Effort in person-months</th></tr>
<tr><td>T_1</td><td>Requirements specification</td><td>1</td></tr>
<tr><td>T_2</td><td>Design</td><td>2</td></tr>
<tr><td>T_3</td><td>Code actuator interface module</td><td>2</td></tr>
<tr><td>T_4</td><td>Code sensor interface module</td><td>5</td></tr>
<tr><td>T_5</td><td>Code user interface part</td><td>3</td></tr>
<tr><td>T_6</td><td>Code control processing part</td><td>1</td></tr>
<tr><td>T_7</td><td>Integrate and test</td><td>6</td></tr>
<tr><td>T_8</td><td>Write user manual</td><td>3</td></tr>
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<td>5</td>
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Assume that 10 errors have been introduced in the requirements model and that each error will be amplified by a factor of 2:1 into design and an additional 20 design errors are introduced and then amplified 1.5:1 into code where an additional 30 errors are introduced. Assume further that all unit testing will find 30 percent of all errors, integration will find 30 percent of the remaining errors, and validation tests will find 50 percent of the remaining errors. No reviews are conducted. How many errors will be released to the field.
Reconsider the situation described in Problem 1, but now assume that requirements, design, and code reviews are conducted and are 60 percent effective in uncovering all errors at that step. How many errors will be released to the field?
Reconsider the situation described in Problems 1 and 2. If each of the errors released to the field costs $4,800 to find and correct and each error found in review costs $240 to find and correct, how much money is saved by conducting reviews?

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TKM COLLEGE OF ENGINEERING

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COMPUTER SCIENCE AND ENGINEERING

B. Tech Curriculum 2024

Semester 7 and 8

SEVENTH SEMESTER														
Sl No	Slot	Code	Category	Title	L	T	P	J	S	No. of Hours	No. of Credits	Total Marks	
												CIA	ESE
1	A	24CSP701	PCC	Compiler Design	2	1	2	0	4	5	4	60	40
2	B	24CSP702	PCC	Cloud Computing	2	1	2	0	4	5	4	60	40
3	C	24CSE7X3	PEC	Professional Elective-3	3	0	0	0	3	3	3	40	60
4	D	24CSO7X4 /24CSI7X4	OEC /IEC	Open Elective 1/ Industry Elective	3	0	0	0	3	3	3	40	60
5	U	24CSD705	PR	Project/Internship	0	0	14	0	14	14	7	100	
6	M/ H/ R	24CSM709 / 24CSH7XX	PRM /HR / RL	PROJECT IN MINOR/HONORS/ REMEDIAL	0	0	0	4			4/ 4/ 0	100	
TOTAL									**28**	**30**	**21**		

Professional Elective 3

Slot	Course Code	Course Name
C	24CSE713	Speech Processing
	24CSE723	Wireless and Mobile Communications
	24CSE733	Software Reliability*
	24CSE743	Evolutionary algorithms
	24CSE753	Parallel and Distributed Algorithms
	24CSE763	Big Data Analytics*
	24CSE773	Web Mining
	24CSE783	Advanced Social, Text and Media Analytics
	24CSE793	Digital Currency Programming*
	24CSE7103	Android programming*
	24CSE7113	Networks and Systems Security

	24CSE7123	Ethical Hacking*
	24CSE7133	GPU Architecture and Programming
	24CSE7143	Software Defined networks
	24CSE7153	AWS Cloud Computing*
	24CSE7163	Soft Computing

Open Elective 1/ Industry Elective

Slot	Course Code	Course Name
D	24CSO714	Data Structures
	24CSO724	Introduction to Soft Computing
	24CSO734	Development of Mobile Apps
	24CSO744	E-Commerce
	24CSI714	Cyber Law & Ethics

MINOR BUCKETS				
SEMESTER	BUCKET 1		BUCKET 2	
	Specialization - Machine Learning		Specialization - Software Engineering*	
	Course Code	Course Name	Course Code	Course Name
S7	24CSM709	PROJECT IN MINOR	24CSM709	PROJECT IN MINOR

<table>
<tr><th colspan="7">HONORS BUCKETS</th></tr>
<tr><th rowspan="3">SEMESTER</th><th colspan="2">BUCKET 1</th><th colspan="2">BUCKET 2</th><th colspan="2">BUCKET 3</th></tr>
<tr><th colspan="2">Specialization - Data Structures and Algorithms</th><th colspan="2">Specialization - Systems Engineering</th><th colspan="2">Specialization - Data Science</th></tr>
<tr><th>Course Code</th><th>Course Name</th><th>Course Code</th><th>Course Name</th><th>Course Code</th><th>Course Name</th></tr>
<tr><td>S7</td><td>24CSH709</td><td>Evolutionary Algorithms</td><td>24CSM710</td><td>Advanced Computer Architecture</td><td>24CSM711</td><td>Time Series Analysis and Forecasting</td></tr>
</table>

24CSP701	Compiler Design	L	T	P	J	S	C	Year of Introduction
		2	1	2	0	4	4	2024

Preamble: The purpose of this course is to create awareness among students about the phases of a compiler and the techniques for designing a compiler and offer students hands-on experience on compiler design concepts. This course covers the fundamental concepts of different phases of compilation such as lexical analysis, syntax analysis, semantic analysis, intermediate code generation, code optimization and code generation. Students can apply this knowledge in design and development of compilers.

Prerequisite: Sound knowledge in Data Structures, Formal Languages & Automata Theory.

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the phases in compilation process and model a lexical analyzer. **(Apply Level)**
CO2	Compare different types of parsers(Bottom-up and Top-down) and construct parser for a given grammar. **(Apply Level)**
CO3	Build Syntax Directed Translation for a context free grammar, compare various storage allocation strategies and classify intermediate representations. **(Apply Level)**
CO4	Illustrate code optimization and code generation techniques in compilation. **(Apply Level)**
CO5	Design and implement various phases of the compiler and familiarize various compiler writing tools. **(Apply Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3									3
CO5	3	3	3	3	3		3	3				3

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Assessment Pattern for Lab component

Bloom's Category	Continuous Assessment Tools	
	Class work	Test1
Remember		

Understand	✓	✓
Apply	✓	✓
Analyse	✓	✓
Evaluate		
Create		

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Practical [P]		Total Marks
		Assignment	Test-1	Test-2	Class work	Lab Exam	
2-1-2-0	5	10	12.5	12.5	10	10	**60**

Total Marks distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	60	40	2.5 hrs

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 2		2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x 8 = 40 marks) Time: 2.5 hours	40
	Total Marks: 0	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Introduction to compilers and lexical analysis (7 hrs)

Analysis of the source program - Analysis and synthesis phases, Phases of a compiler. Compiler writing tools. Bootstrapping. Lexical Analysis - Role of Lexical Analyser, Input Buffering, Specification of Tokens - Regular Expressions (RE) to represent tokens, Recognition of Tokens.

MODULE II : Top Down parsing (7 hrs)

Role of the Syntax Analyser, Review of Context Free Grammars - Derivation and Parse Trees, Eliminating Ambiguity. Basic parsing approaches - Eliminating left recursion, left factoring. Top-Down Parsing - Recursive Descent parsing, Predictive Parsing, LL(1) Grammars.

MODULE III : Bottom Up Parsing (8 hrs)

Handle Pruning. Shift Reduce parsing. Operator precedence parsing (Concept only). LR parsing - Constructing SLR, LALR and canonical LR parsing tables.

MODULE IV : Syntax directed translation and Intermediate Code Generation (8 hrs)

Syntax directed translation - Syntax directed definitions, S-attributed definitions, L-attributed definitions, Bottom-up evaluation of S-attributed definitions. Run-Time Environments - Source Language issues, Storage organization, Storage-allocation strategies. Intermediate Code Generation - Intermediate languages, Graphical representations, Three-Address code, Quadruples, Triples.

MODULE V : Code optimization and Code Generation (6 hrs)

Code Optimization - Principal sources of optimization, Machine dependent and machine independent optimizations, Local and global optimizations. Code generation - Issues in the design of a code generator, Target Language, A simple code generator.

Text books

1. Aho A.V., Ravi Sethi and D. Ullman. Compilers – Principles Techniques and Tools, Addison Wesley, 2006.

Reference books

1. Andrew Appel and Jens Palsberg, Modern Compiler Implementation in Java. 2/e, Cambridge University Press, 2002.
2. D.M.Dhamdhere, System Programming and Operating Systems, Tata McGraw Hill & Company, 1996.
3. Kenneth C. Louden, Compiler Construction – Principles and Practice, Cengage Learning Indian Edition, 2006.

NPTEL/SWAYAM MOOC Courses

1. NPTEL Course on “Compiler Design”, Prof. Santanu Chattopadhyay, IIT Kharagpur.
2. NPTEL Course on “Principles of Compiler Design”, Prof. Y.N. Srikanth, IISc Bangalore.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Analysis of the source program - Analysis and synthesis phases	1
1.2	Phases of a compiler	1
1.3	Compiler writing tools. Bootstrapping	1

1.4	Lexical Analysis - Role of Lexical Analyser	1
1.5	Input Buffering	1
1.6	Specification of Tokens - Regular Expressions (RE) to represent tokens	1
1.7	Recognition of Tokens	1
MODULE II		
2.1	Role of the Syntax Analyser	1
2.2	Review of Context Free Grammars - Derivation and Parse Trees	1
2.3	Eliminating Ambiguity	1
2.4	Basic parsing approaches - Eliminating left recursion, left factoring	1
2.5	Top-Down Parsing - Recursive Descent parsing	1
2.6	Predictive Parsing	1
2.7	LL(1) Grammars	1
MODULE III		
3.1	Handle Pruning	1
3.2	Shift Reduce parsing	1
3.3	Operator precedence parsing (Concept only)	1
3.4	LR parsing - Constructing SLR parsing tables	1
3.5	LR parsing - Constructing SLR parsing tables	1
3.6	LR parsing – Constructing canonical LR parsing tables	1
3.7	LR parsing – Constructing LALR parsing tables	1
3.8	LR parsing algorithm	1
MODULE IV		

4.1	Syntax directed translation - Syntax directed definitions	1
4.2	S-attributed definitions – Lecture 1	1
4.3	S-attributed definitions – Lecture 2	1
4.4	L-attributed definitions	1
4.5	Bottom-up evaluation of S-attributed definitions	1
4.6	Run-Time Environments - Source Language issues, Storage organization, Storage-allocation strategies	1
4.7	Intermediate Code Generation - Intermediate languages, Graphical representations, Three-Address code	1
4.8	Quadruples, Triples	1
MODULE V		
5.1	Code Optimization - Principal sources of optimization	1
5.2	Machine dependent and machine independent optimizations	1
5.3	Local and global optimizations	1
5.4	Code generation - Issues in the design of a code generator	1
5.5	Target Language	1
5.6	A simple code generator	1

LESSON PLAN FOR LAB COMPONENT

No.	Topic	No. of Hours	Experiment
1	Introduction to Compilers	1	Viewing the intermediate representations and the final assembly code generated by GCC/LLVM, relating them to the input program.

2	Lexical Analysis	5	1. Design and implement a lexical analyzer using C language to recognize all valid tokens in the input program. The lexical analyzer should ignore redundant spaces, tabs and newlines. It should also ignore comments. 2. Generating a lexical analyzer using LEX/Flex 3. Write a lex program to display the number of lines, words and characters in an input text. 4. Write a LEX Program to convert the substring *abc* to *ABC* from the given input string. 5. Write a lex program to find out total number of vowels and consonants from the given input string.
3	Recognition and Specification of tokens	5	1. Write a program to find ε – closure of all states of any given NFA with ε transition. 2. Write a program to convert NFA with ε transition to NFA without ε transition. 3. Write a program to convert NFA to DFA. 4. Write a program to minimize any given DFA.
4	Syntax Analysis	6	1. Write a program to find First and Follow of any given grammar. 2. Design and implement a recursive descent parser for a given grammar. 3. Implement Predictive Parsing algorithm. 4. Construct a Shift Reduce Parser for a given language. 5. Design an Operator Precedence Parsing for a given Context Free Grammar.
5	Intermediate Code Generation	3	Implement Intermediate code generation for simple expressions using three address code and postfix notation.
6	Code Optimization	2	Write a program to perform constant propagation and constant folding.
7	Code Generation	2	Implement the back end of the compiler which takes the three address code and produces the 8086 assembly language instructions that can be assembled and run using an 8086 assembler. The target assembly instructions can be simple move, add, sub, jump etc.

CO Assessment Questions	
1	1. Draw the transition diagram for the regular definition, Relop→< | <= | = | <> | >= | > 2. Construct a regular expression to denote a language L over Σ= {0,1} accepting all strings of 0's and 1's that do not contain substring 011. 3. For a source language statement*a= b*c - 2*, where a, b and c are float variables, * and – represents multiplication and subtraction on same data types, show the input and output at each of the compiler phases.
2	1. Design a recursive descent parser for the grammar S→cAd A→ab/ b 2. Consider the following grammar E→E or T | T T→ T and F |F F→ not F | (E) | true | false (i) Remove left recursion from the grammar. (ii) Construct a predictive parsing table. (iii) Justify the statement "The grammar is LL (1)". 3. Derive LALR (1) parsing algorithm for following grammar S→AS/b A→SA/a
3	1. With an SDD for a desk calculator, give the appropriate code to be executed at each reduction in the LR parser designed for the calculator. Also give theannotated parse tree for the expression *(3*5) –2* 2. Construct the syntax tree and then draw the DAG for the statement e := (a*b) + (c-d) * (a*b) 3. Write the SDD for a simple type declaration and draw the annotated parse tree for the declaration *float a, b, c*.
4	1. Explain different code optimization techniques available in local and global optimizations. 2. Write the algorithm for partitioning a sequence of three-address instructions into basic blocks. 3. Write the Code Generation Algorithm and explain the getreg function. Generate a code sequence for the assignment d=(a-b)+(a-c)+(a-c)
5	Implement lexical analysis and Syntax analysis phase for a simple arithmetic expression.

24CSP702	Cloud Computing	L	T	P	J	S	C	Year of Introduction
		2	1	2	0	4	4	2024

Preamble: This course helps the learners to understand cloud computing concepts with some practical exposure. This course includes basic understanding of virtualization, fundamentals of cloud security, cloud computing based programming techniques and different industry popular cloud computing platforms. This course enables the student to do simple cloud based tasks and suggest cloud based solutions to real world problems.

Prerequisite: Fundamentals of operating systems and computer networks

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the various cloud computing models and services. **(Understand Level)**
CO2	Demonstrate the significance of implementing virtualization techniques.**(Apply Level)**
CO3	Explain different cloud enabling technologies and compare private cloud platforms.**(Understand Level).**
CO4	Apply appropriate cloud programming methods to solve big data problems.**(Apply Level)**
CO5	Compare the different popular cloud computing platforms.**(Understand Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										3
CO2	3	3	3									3
CO3	3	3										3
CO4	3	3	3		3							3
CO5	3	3			3							3

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✔	✔	✔	✔
Understand	✔	✔	✔	✔
Apply	✔	✔	✔	✔
Analyse			✔	
Evaluate				
Create				

Assessment Pattern for Lab component		
Bloom's Category	**Continuous Assessment Tools**	
	Class work	**Test1**
Remember		
Understand	✔	✔
Apply	✔	✔
Analyse	✔	✔
Evaluate	✔	
Create		

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Practical [P]		Total Marks
		Assignment	**Test-1**	**Test-2**	**Class work**	**Lab Exam**	
2-1-2-0	5	10	12.5	12.5	10	10	**60**

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	60	40	2.5 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 2		2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x 8 = 40 marks) Time: 2.5 hours	40
	Total Marks: 0	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Fundamental Cloud Computing (7 hours)

Traditional computing- Limitations. Overview of Computing Paradigms-Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing. NIST reference Model-Basic terminology and concepts. Cloud characteristics, benefits and challenges, Roles and Boundaries. Cloud delivery (service) models-Infrastructure-as-a-Service (IaaS), Platform-as-a-Service(PaaS),Software-as-a-Service (SaaS), XaaS (Anything-as-a-service)-Cloud deployment models- Public cloud, Community cloud, Private cloud, Hybrid cloud

MODULE II: Virtualization (8 hours)

Introduction to virtualization-Virtualizing physical computing resources, Virtual Machines (Machine virtualization), non-virtualized v/s virtualized machine environments. Types of VMsprocess VM v/s system VM, Emulation, interpretation and binary translation. Hardware-level virtualization- Hypervisors/VMM. Types of Hypervisors. Full Virtualization, ParaVirtualization, Hardware-assisted virtualization, OS level virtualization. Basics of Network Virtualization, Storage Virtualization and Desktop Virtualization, Pros and cons of virtualization. Case Study- Xen: Para-virtualization, VMware: full virtualization.

MODULE III: Cloud-Enabling Technologies, Private cloud platforms and programming (9 hours)

Broadband networks and internet architecture- Internet Service Providers (ISPs), Data center technology, Web technology, Multitenant technology, Service technology. Resource provisioning techniques-static and dynamic provisioning. Open-source software platforms for private cloud-OpenStack, CloudStack, Basics of Eucalyptus, Open Nebula, Nimbus. Cloud Programming- Parallel Computing and Programming Paradigms. Map Reduce – Hadoop Library from Apache, HDFS, Pig Latin High Level Languages, Apache Spark

MODULE IV : Amazon Web Services (6 hours)

Amazon Web Services(AWS):- AWS ecosystem- Computing services, Amazon machine images, Elastic Compute Cloud (EC2), Advanced compute services. Storage services-Simple Storage System (Amazon S3), Elastic Block Store (Amazon EBS), Database Services, Amazon CDN Services and Communication services.

MODULE V : Google Cloud Platform and Microsoft Azure (6 hours)

Google Cloud Platform:- IaaS Offerings: Compute Engine (GCE), Cloud Storage, PaaS Offerings: Google App Engine (GAE), Storage services, Application services, Compute services, Database Services, SaaS Offerings: Gmail, Docs, Google Drive.
Microsoft Azure: Azure Platform Architecture, Hyper-V, Azure Virtual Machine, Compute services, Storage services.

Text books

1. Thomas, E., Zaigham M., Ricardo P "Cloud Computing Concepts, Technology & Architecture.", (2013 Edition). Prentice Hall.
2. Buyya, R., Vecchiola, C., & Selvi, S. T. “Mastering cloud computing: foundations and applications programming”, (2017 Edition), Morgan Kaufmann.
3. Bhowmik, S., “Cloud computing”, (2017 Edition). Cambridge University Press.

Reference books

1. Marinescu, D. C., “Cloud computing: theory and practice.”, (2017 Edition). Morgan Kaufmann.
2. Buyya, R., Broberg, J., & Goscinski, A. M., “Cloud computing: Principles and paradigms” (2011 Edition). John Wiley & Sons.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Traditional computing: Limitations.	1
1.2	Overview of Computing Paradigms: Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing.	1
1.3	NIST reference Model, Basic terminology and concepts.	1
1.4	Cloud characteristics and benefits, challenges. Roles and Boundaries	1
1.5	Cloud delivery (service) models: Infrastructure-as-a-Service (IaaS), Platform-asa-Service (PaaS).	1
1.6	Cloud delivery (service) models: Software-as-a-Service (SaaS), XaaS (Anything-as-a-service).	1
1.7	Cloud deployment models: Public cloud, Community cloud, Private cloud, Hybrid cloud.	1
	MODULE II	
2.1	Introduction to virtualization, Virtualizing physical computing resources	1
2.2	Virtual Machines (Machine virtualization):- non-virtualized v/s virtualized machine environments.	1
2.3	Types of VMs: process VM v/s system VM, Emulation, interpretation and binary translation.	1
2.4	Hardware-level virtualization: Hypervisors/VMM, Types of Hypervisors.	
2.5	Full Virtualization, Para-Virtualization, Hardware-assisted virtualization, OS level virtualization.	1
2.6	Basics of Network Virtualization, Storage Virtualization and Desktop Virtualization, Pros and cons of virtualization	1
2.7	Case Study: Xen: Para-virtualization.	1
2.8	Case Study: VMware: full virtualization.	1
	MODULE III	
3.1	Broadband networks and internet architecture: Internet Service Providers (ISPs), Data center technology, Web technology, Multitenant technology, Service technology.	1
3.2	Resource provisioning techniques: static and dynamic provisioning.	1
3.3	Open-source software platforms for private cloud: OpenStack, CloudStack	1

3.4	Basics of Eucalyptus, Open-Nebula, Nimbus.	1
3.5	Cloud Programming: Parallel Computing and Programming Paradigms	1
3.6	Map Reduce.	1
3.7	Hadoop Library from Apache, HDFS.	1
3.8	Pig Latin High Level Languages	1
3.9	Apache Spark.	1
MODULE IV		
4.1	Amazon Web Services(AWS):- AWS ecosystem	1
4.2	Computing services: Amazon machine images, Elastic Compute Cloud (EC2).	1
4.3	Advanced computing services, Storage services: Simple Storage System (Amazon S3).	1
4.4	Elastic Block Store (Amazon EBS).	1
4.5	Database Services.	1
4.6	Amazon CDN Services and Communication services.	
MODULE V		
5.1	Google Cloud Platform:- IaaS Offerings: Compute Engine (GCE), Cloud Storage	1
5.2	PaaS Offerings: Google App Engine (GAE), Storage services, Application services, Compute services.	1
5.3	Database Services, SaaS Offerings: Gmail, Docs, Google Drive.	1
5.4	Microsoft Azure: Azure Platform Architecture, Hyper-V, Azure Virtual Machine	1
5.5	Microsoft Azure: Azure Virtual Machine	1
5.6	Azure Compute services, Storage services.	1

LESSON PLAN FOR LAB COMPONENT

No.	Topic	No. of Hours	Experiment
1	Virtual Machines	1 1 1 1 1 1	1. Install Virtualbox/VMware/ Equivalent open source cloud Workstation with different flavours of Linux or Windows OS on top of windows 8 and above. 2. Install a C compiler in the virtual machine created using a virtual box and execute Simple Programs
2	Map reduce, Hadoop	1 1 1 1 1 1 1 1	1. Creation and execution of Hadoop cluster and execute map reduce programs. 2. Execute HDFS commands and Unix commands in virtual machine. 3. Execute programs using Hadoop and demonstrate VM migration
3	Cloud Programming	1 1 1 1 1	1. Simulate a cloud scenario using CloudSim and run a scheduling algorithm that is not present in CloudSim. 2. Find a procedure to transfer the files from one virtual machine to another virtual machine.

4	Google Cloud Platform	1 1 1 1 1	1. Install Google App Engine. Create a hello world app and other simple web applications using python/java. 2. Use the GAE launcher to launch the web applications.

CO Assessment Questions	
1	a. "A hybrid cloud is a combination of two or more other cloud deployment models". Justify the statement with an example. b. What are the main characteristics of a Platform-as-a-Service solution? c. How does cloud computing help to reduce the time to market for applications and to cut down capital expenses? d. Differentiate public and private clouds in terms of flexibility
2	a. Define virtualization. What is the role of VMM in virtualization? b. Explain various implementation levels of Virtualization. c. State the differences between a traditional computer and a virtual machine.
3	a. Differentiate between on-premise and cloud-based internetworking. b. What are the benefits of Data Center Technologies? c. What are the characteristics of Multi-tenant technology? d.How can virtualization be implemented at the hardware level?
4	a. Write a Hadoop MapReduce program that counts the number of occurrences of each character in a file. b. Write a Hadoop MapReduce program to find the maximum temperature in the weather dataset.
5	a. Explain the cloud based databases. b. With a neat diagram, write about Google App Engine for PaaS applications. c. Differentiate between amazon SimpleDB and Amazon RDS. d. "Storage services in the cloud are offered in two different forms as IaaS and as SaaS". Explain.

24CSD705	**PROJECT** / INTERNSHIP	L	T	P	J	S	C	Year of Introduction
		0	0	14	0	14	7	2024

Preamble: This course focuses on strengthening the understanding of student's fundamental concepts through the application of theoretical concepts and to enhance their skills and widen the horizon of their thinking in research by implementing/working a recent research paper in the domain of study. The research-based project in the seventh semester shall be continued as the Project in the eighth semester.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Model and solve real world problems by applying knowledge across domains. **(Apply level)**
CO 2	Develop products, processes or technologies for sustainable applications. **(Apply level)**
CO 3	Function effectively as an individual and as a leader in diverse teams and to comprehend and execute designated tasks. **(Apply level)**
CO 4	Plan and execute tasks utilizing available resources within timelines, following ethical and professional norms. **(Apply level)**
CO 5	Identify technology/research gaps and propose innovative/creative solutions to real world problems. **(Analyze level)**
CO 6	Organize and communicate technical and scientific findings effectively in written and oral forms. **(Apply level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	3	2	3	3	3	3	3	3	2	3
CO 2	3	3	3	2	3	3	3	3	3	3		3
CO 3						3		3	3	3		3
CO 4						3		3	3	3	2	3
CO 5	3	3	3	2		3	3	3	3	3		3
CO 6					3	3		3	3	3		3

Project Guidelines

a. The Research based mini project shall be executed as a group activity where each group can have a maximum of four students
b. Identify a topic of interest in consultation with Mini Project Coordinator that shall lead to their dissertation/final year project.
c. The progress of the Research based Mini Project is evaluated based on three reviews, two interim reviews and a final review.
d. The progress of the mini project shall be evaluated based on three reviews: two interim reviews and a final review.
e. Students have to submit a report during the final review.
f. Credits can be assigned to a student for research based mini project if he/she earns a pass grade in the final review.

Total Marks distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration

100	100	--	--

Mark Distribution

a. Work assessed by the project guide – 25%
b. Three-member Continuous Internal Evaluation Committee – 25% (Guide shall be one member in the CIE committee)
c. Draft report – 5 %
d. Final Report - 10%
e. Final Evaluation by a three-member Committee comprising of the department project coordinator, guide and a member nominated by Head of the Department. - 35%

Professional Elective III

24CSE713	Speech Processing	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The course equips the learners to analyze, understand and synthesize human speech. This course covers the fundamental concepts of mathematics and signal processing required for processing speech, articulatory phonetics,LPC models, speech pattern techniques,HMMs, speech recognition and synthesis. This course helps the learners to have a comprehensive understanding of speech processing which is vital for tackling challenges in speech recognition, synthesis, and other related fields, contributing to advancements in human-computer interaction and communication technologies.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the fundamental concepts in mathematics and signal processing relevant to speech processing. **(Understand level)**
CO2	Perceive a knowledge of articulatory phonetics, filter banks, and linear predictive coding models, and the application of these concepts in the field of speech recognition. **(Understand level)**
CO3	Compare different speech pattern techniques and its application in speech processing. **(Understand level)**
CO4	Compare different types of HMMs and identify their applicability in real world speech processing challenges. **(Understand level)**
CO5	Illustrate the fundamental concepts of speech recognition and its significance and also describe the fundamentals of speech synthesis, including the principles and methodologies employed in generating artificial speech. **(Understand level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										3
CO2	3	3										3
CO3	3	3										3
CO4	3	3										3
CO5	3	3										3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Introduction,Mathematics for Speech Processing (7 hrs)

Introduction , Mathematics for Speech Processing-Preliminary Concepts,Signals and Linear Systems,Frequency Analysis,Discrete-Time Signals and Systems,Filters.

MODULE II : Articulatory and Acoustic Phonetics (7 hrs)

Articulatory Phonetics-Manner of Articulation,Structure of the Syllable,Voicing, Place of Articulation,Phonemes in Other Languages,Articulatory Models.The Bank of Filters Front End Processor-Types of Filter bank used for Speech Recognition , Implementation of Filter Banks,Summary of considerations for Speech Recognition Filter Banks,Linear Predictive Coding Model for Speech Recognition

MODULE III : Analysis of Speech (7 hrs)

Pattern Comparison Techniques-Speech Detection,Distortion Measures,Spectral Distortion Measures,Incorporation of Spectral Dynamic Features into the Distortion Measure,Time Alignment and Normalization.

MODULE IV : Modelling of Speech (7 hrs)

Theory and Implementation of HMMs-Discrete Time Markov Process,Extensions to HMMs,The three basic problems for HMMs,Types of HMMs,Continuous Observation Densities in HMMs,Autoregressive HMMs,Variants on HMM structures,Inclusion of explicit state duration density in HMMs,Optimization Criteria,Comparison of HMMs,Implementation issues for HMMs,HMM system for isolated word recognition.

MODULE V : Recognition and Speech Synthesis (7 hrs)

Speech Recognition based on Connected Word Models-Introdution, General Notation, Two Level DP Algorithm,The LB Algorithm, The One Pass Algorithm, Multiple Candidate strings

Speech Synthesis-Introduction,Principles fo Speech Synthesis,Synthesizer Methods-Articulatory Synthesis, Formant Synthesis,LPC Synthesis,Speech Synthesis for other Speakers, Speech Synthesis in Other Languages, Evaluation of TTS systems.

Text books

1. Douglas O’Shaugnessy, “Speech Communication,Human and Machine” ,IEEE Press, 2000.
2. Lawrence Rabiner and Biing-Hwang Juang, “Fundamentals of Speech Recognition”, Pearson Education, 1993.

Reference books

1. Daniel Jurafsky and James H Martin, “Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition”, Pearson Education,2013.
2. Steven W. Smith, “The Scientist and Engineer’s Guide to Digital Signal Processing”, California Technical Publishing,1999.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Introduction , Mathematics for Speech Processing-Preliminary Concepts.	1
1.2	Signals and Linear Systems	1
1.3	Frequency Analysis(Lecture 1)	1
1.4	Frequency Analysis(Lecture 2)	1
1.5	Discrete-Time Signals and Systems (Lecture 1)	1
1.6	Discrete-Time Signals and Systems (Lecture 2)	1

1.7	Filters	1
MODULE II		
2.1	Articulatory Phonetics-Manner of Articulation.	1
2.2	Structure of the Syllable,Voicing, Place of Articulation.	1
2.3	Phonemes in Other Languages,Articulatory Models.	1
2.4	The Bank of Filters Front End Processor-Types of Filter bank used for Speech Recognition.	1
2.5	Implementation of Filter Banks.	1
2.6	Summary of considerations for Speech Recognition Filter Banks.	1
2.7	Linear Predictive Coding Model for Speech Recognition.	1
MODULE III		
3.1	Pattern Comparison Techniques-Speech Detection	1
3.2	Distortion Measures	1
3.3	Spectral Distortion Measures	1
3.4	Incorporation of Spectral Dynamic Features into the Distortion Measure(Lecture 1)	1
3.5	Incorporation of Spectral Dynamic Features into the Distortion Measure(Lecture 2)	1
3.6	Time Alignment and Normalization(Lecture 1)	1
3.7	Time Alignment and Normalization(Lecture 2)	1
MODULE IV		
4.1	Theory and Implementation of HMMs-Discrete Time Markov Process	1
4.2	Extensions to HMMs,The three basic problems for HMMs	1
4.3	Types of HMMs,Continuous Observation Densities in HMMs	1
4.4	Autoregressive HMMs,Variants on HMM structures	1
4.5	Inclusion of explicit state duration density in HMMs	1

4.6	Optimization Criteria,Comparison of HMMs	1
4.7	Implementation issues for HMMs,HMM system for isolated word recognition	1
	MODULE V	
5.1	Speech Recognition based on Connected Word Models-Introdution, General Notation	1
5.2	Two Level DP Algorithm	1
5.3	The LB Algorithm, The One Pass Algorithm, Multiple Candidate strings	1
5.4	Speech Synthesis-Introduction,Principles fo Speech Synthesis	1
5.5	Synthesizer Methods-Articulatory Synthesis, Formant Synthesis	1
5.6	LPC Synthesis,Speech Synthesis for other Speakers	1
5.7	Speech Synthesis in Other Languages, Evaluation of TTS systems	1

CO Assessment Questions	
1	1. Explain the role of linear algebra in representing speech signals. Provide an example illustrating its application in speech processing. 2. Explain how digital signal processing (DSP) integrates mathematical concepts in the analysis of speech signals. Discuss the role of sampling in the digital representation of speech signals.
2	1. Explain the components of a syllable and their significance in phonetics. Provide examples to illustrate different syllable structures. 2. How do phonemes vary across different languages, and what role do cultural and linguistic factors play in shaping phoneme distinctions?
3	1. Discuss why normalization is necessary and its impact on the comparability of patterns. 2. Why is accurate time alignment essential for reliable pattern matching?
4	1. What are the three basic problems for Hidden Markov Models (HMMs), and why are they significant in the field of HMM-based modeling? 2. How are continuous observation densities, like Gaussian Mixture Models (GMMs), utilized in Hidden Markov Models (HMMs)? What are the advantages of employing continuous observation densities?
5	1. Explain the advantages and applications of LB algorithm in speech recognition. 2. How considering multiple candidate strings in connected word model find its applications in speech processing?

		L	T	P	J	S	C	Year of Introduction
24CSE723	**Wireless and Mobile Communications**	**3**	**0**	**0**	**0**	**3**	**3**	**2024**

Preamble: Sets the foundation for understanding the intricate world of communication in wireless and mobile networks.

Prerequisite: Basic knowledge of Data communication, Computer networks

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand Wireless Transmission and its fundamental concepts. (**Understand level**)
CO 2	Understand the fundamentals of Cellular Wireless Networks, including their architecture and management, through an in-depth exploration of key concepts and principles (**Understand level**)
CO 3	Recognize various wireless networking technologies, including 802.11 variants, and PAN (**Apply level**)
CO 4	Acquire a deep understanding of the concepts and operations of routing protocols, covering both static and dynamic approaches. (**Understand level**)
CO 5	Apply knowledge of the OSI model to analyze and comprehend the inner workings of Bluetooth cellular concepts. (**Apply level**)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	2									
CO 2	2	3	3									
CO 3	3	3	3		3				2			
CO 4	3	3	3									2
CO 5	3	3	3									

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA							
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Practical [P]		Total Marks
		Assignment	Test-1	Test-2	Class work	Lab Exam	
3-0-0-0	5	15	10	10			40

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Introduction (7 hours)

Wireless Transmission – signal propagation – Free space and two ray models – spread spectrum- Satellite Networks – Capacity Allocation – FDMA – TDMA- SDMA – DAMA

MODULE II: Mobile Networks (7 hours)

Cellular Wireless Networks – GSM – Architecture – Protocols – Connection Establishment – Frequency Allocation – Handover – Security – GPRA. Modern wireless communication systems: 2G networks, 3G networks, Bluetooth and personal area networks.

Module III: Wireless Networks (8 hours)

LAN Technologies: Evolution of Wireless LAN, IEEE802.11, Physical, Layer, MAC Sub-layer. Adhoc networks: Characteristics – Performance issues. Overview to Wireless ATM, HYPERLAN, IEEE802.15 Wireless PAN, and Home RF.

MODULE IV: Routing (7 hours)

Mobile IP- SIP – DHCP – AdHoc Networks – Proactive and Reactive Routing Protocols – Multicast Routing - WSN routing – LEACH- SPIN- PEGASIS

MODULE V: Bluetooth Cellular concepts and Transport layers (7 hours)

Bluetooth Cellular concepts: Frequency reuse, channel assignment strategies, hand off strategies, interference and system capacity, improving coverage and capacity in cellular systems, routing in mobile hosts. Mobile IP – DHCP – Mobile transport layer – Indirect TCP – Snooping TCP – Transmission/time-out freezing – Selective retransmission –Transaction oriented TCP.

Textbooks

1.Rappaport T. S., “Wireless Communication: Principles and Practice”, Second Edition, Pearson Education, 2009

Reference books

1. Pahlavan K. and Krishnamurthy P., “Principles of Wireless Networks”, Prentice–Hall, 2006.
2. Stallings W., “Wireless communications and networks”, Pearson Education Limited, 2002.
3. Jochen S., “Mobile communications”, Pearson Education Limited, 2000.
4. Lee W. C. Y., “Wireless and Cellular Communications”, Third Edition, Tata McGraw Hill Publishing Company Limited, 2006.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Wireless Transmission – signal propagation – Free space and two-ray models	2
1.2	spread spectrum-	2
1.3	Satellite Networks	1
1.4	Capacity Allocation – FDMA – TDMA- SDMA – DAMA	2
	MODULE II	
2.1	Cellular Wireless Networks	1
2.2	GSM – Architecture – Protocols – Connection Establishment	2
2.3	Frequency Allocation – Handover – Security – GPRA.	1
2.4	Modern wireless communication systems: 2G networks, 3G networks,	2
2.5	Bluetooth and personal area networks.	1
	MODULE III	
3.1	LAN Technologies: Evolution of Wireless LAN	2
3.2	IEEE802.11, Physical, Layer, MAC Sub-layer,	2
3.3	Adhoc networks: Characteristics – Performance issues. Overview to Wireless ATM, HYPERLAN	2
3.4	IEEE802.15 Wireless PAN, and Home RF	2
	MODULE IV	
4.1	Mobile IP	1
4.2	SIP – DHCP	2
4.3	AdHoc Networks – Proactive and Reactive Routing Protocols	2
4.4	MulticastRouting - WSN routing – LEACH- SPIN- PEGASIS	2

MODULE V		
5.1	Bluetooth Cellular concepts: Frequency reuse, channel assignment strategies,	1
5.2	hand off strategies, interference and system capacity, improving coverage and capacity in cellular systems,	2
5.3	routing in mobile hosts. Mobile IP – DHCP	2
5.4	Mobile transport layer – Indirect TCP – Snooping TCP – Transmission / time-out freezing – Selective retransmission – Transaction oriented TCP	2

CO Assessment Questions	
1	How does the Two-Ray Ground-Reflection Model contribute to understanding wireless signal propagation in real-world environments? Provide examples of situations where this model is particularly relevant.
2	Explain the concept of mobility in mobile networks and discuss its two different kinds. Illustrate the need for mobility support in wireless communication
3	Explain the IEEE 802.11 standard for wireless LANs. Elaborate on the key features and functionalities that distinguish it from other LAN technologies. Provide examples of scenarios where 802.11 is commonly used
4	Highlight the features of Mobile Ad-Hoc Network (MANET) routing protocols. Discuss how these features contribute to the efficient and reliable routing of data in mobile environments
5	Describe the traditional TCP (Transmission Control Protocol) and highlight its key features in the mobile computing environment. Discuss any improvements made to classical TCP for better performance in mobile networks

24CSE733	Software Reliability	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course provides a basic understanding of software reliability and its importance in the nascent phases of the software lifecycle.This course includes an in-depth discussion of software testing fundamentals, elucidating the strategic use of operational profiles for reliability estimation, the application of time/structure-based models, and the strategic integration of Software Reliability Engineering (SRE) approaches throughout the diverse phases of software development. This course helps the learners to have a comprehensive understanding of software reliability and its contribution in developing software systems that stand the test of time.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the relationship between software and hardware reliability and also the concept of operational profiles to analyze and improve software reliability. **(Understand level)**
CO2	Identify different kinds of failure for software products,implement effective reliability strategies and also to predict basic failure intensity using models. **(Understand level)**
CO3	Explain software reliability by encompassing historical perspectives and using various failure time models and the application of reliability prediction and growth modeling in software lifecycle. **(Understand level)**
CO4	Recognize software complexity, encompassing both static and dynamic aspects, and the use of sophisticated reliability models, in getting softwares with enhanced quality and reliability. **(Understand level)**
CO5	Describe the fundamentals of software testing and the benefits and approaches of SRE in different phases of the software development .**(Understand level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										3
CO2	3	3										3
CO3	3	3										3
CO4	3	3										3
CO5	3	3										3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓

Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Introduction and Operational Profile (7 hrs)

The Need for Reliable Software, Software Reliability Engineering Concepts, Basic definitions, Software practitioners biggest problem, software reliability engineering approach, software reliability engineering process, defining the product, Reliability concepts, software reliability and hardware reliability, developing operational profiles, applying operational profiles, learning operations and run concepts.

MODULE II : Software Reliability Concepts (6 hrs)
Defining failure for the product, common measure for all associated systems, setting system failure intensity objectives, determining develop software failure intensity objectives, software reliability strategies, failures, faults and errors, availability, system and component reliabilities and failure intensities, predicting basic failure intensity.
MODULE III : Software Reliability Modeling Survey (7 hrs)
Introduction, Historical Perspective and Implementation, Exponential Failure Time Class of Models, Weibull and Gamma Failure Time Class of Models, Infinite Failure Category Models, Bayesian Models, Model Relationship, Software Reliability Prediction in Early Phases of the LifeCycle, software reliability growth modeling.
MODULE IV : Software Metrics for Reliability Assessment (6 hrs)
Introduction, Static Program Complexity, Dynamic Program Complexity, Software Complexity and Software Quality, Software Reliability Modeling.
MODULE V : Software Testing and Reliability (8 hrs)
Introduction, Overview of Software Testing, Operational profiles, Time/Structure Based Software Reliability Estimation, Benefits and approaches of SRE, SRE during requirements phase, SRE during implementation phase, SRE during Maintenance phase.

Text books

1. Handbook of Software Reliability Engineering Edited by Michael R. Lyu, published by IEEE Computer Society Press and McGraw-Hill Book Company,1996.
2. Software Reliability Engineering John D. Musa, second edition Tata McGraw-Hill,2004.

Reference books

1. Practical Reliability Engineering, Patric D. T. O connor, 4th Edition, John Wesley & Sons,2003.
2. Software Reliability, H. Pham, Springer Verlag, New York , 2000
3. Software Reliability Methods, D. Reled, Springer Verlag, New York , 2001.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	The Need for Reliable Software	1
1.2	Software Reliability Engineering Concepts, Basic definitions.	1
1.3	Software practitioners biggest problem, software reliability engineering approach.	1
1.4	Software reliability engineering process, defining the product.	1

1.5	Reliability concepts, software reliability and hardware reliability.	1
1.6	Developing operational profiles, applying operational profiles.	1
1.7	Learning operations and run concepts.	1
MODULE II		
2.1	Defining failure for the product, common measure for all associated systems.	1
2.2	Setting system failure intensity objectives.	1
2.3	Determining develop software failure intensity objectives.	1
2.4	Software reliability strategies, failures, faults and errors.	1
2.5	Availability, system and component reliabilities and failure intensities.	1
2.6	Predicting basic failure intensity.	1
MODULE III		
3.1	Introduction, Historical Perspective and Implementation.	1
3.2	Exponential Failure Time Class of Models.	1
3.3	Weibull and Gamma Failure Time Class of Models.	1
3.4	Infinite Failure Category Models.	1
3.5	Bayesian Models.	1
3.6	Model Relationship, Software Reliability Prediction in Early Phases of the LifeCycle.	1
3.7	Software reliability growth modeling.	1
MODULE IV		
4.1	Introduction.	1
4.2	Static Program Complexity.	1
4.3	Dynamic Program Complexity.	1
4.4	Software Complexity and Software Quality- Lecture1.	1

4.5	Software Complexity and Software Quality Lecture2.	1
4.6	Software Reliability Modeling.	1
	MODULE V	
5.1	Introduction, Overview of Software Testing.	1
5.2	Operational profiles.	1
5.3	Time/Structure Based Software Reliability Estimation-Lecture1.	1
5.4	Time/Structure Based Software Reliability Estimation-Lecture2.	1
5.5	Benefits and approaches of SRE.	1
5.6	SRE during requirements phase.	1
5.7	SRE during implementation phase.	1
5.8	SRE during Maintenance phase.	1

CO Assessment Questions	
1	1. Explain why reliable software is crucial for various industries. Provide examples of the impact of unreliable software on businesses and users. 2. Analyze the common challenges faced by software practitioners. How can these challenges be addressed through a software reliability engineering approach?
2	1. Propose a software reliability strategy for a large-scale software application with a focus on fault tolerance. Explain how this strategy addresses potential failures and contributes to system robustness. 2. Explain the process of setting system failure intensity objectives. What factors should be considered when establishing these objectives?
3	1. Explain the fundamental concepts behind exponential failure time models. How do these models contribute to understanding and predicting software reliability? 2. Compare and contrast Weibull and Gamma failure time models. In what scenarios would one model be more appropriate than the other for software reliability analysis?
4	1. Define static program complexity and discuss how it contributes to software reliability. Provide examples of static complexity measures and their impact on code quality.

	2. Define software reliability modeling and its purpose. How can reliability models be used to assess and predict the reliability of software systems?
5	1. Explain the fundamental concepts of software testing. How does effective testing contribute to software reliability, and what are the key considerations in designing a reliable testing strategy? 2. Explore the application of SRE principles during the implementation phase. How can SRE contribute to the development of reliable software during coding and implementation?

24CSE743	Evolutionary Algorithms	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course enables the learners to understand the need of evolutionary computing strategies and identify different types of evolutionary algorithms. This course covers the preliminaries of evolutionary computing, Genetic Algorithms, Evolution strategies, Parameter Control, multimodal optimization, multi-objective optimization and special forms of evolution. This will help the learners to formulate a given problem as an optimization problem and apply evolutionary algorithms to solve the problems

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the concepts and the terminology needed for evolutionary computing strategies. **(Understand Level)**
CO2	Formulate a problem as an evolutionary computation search/optimization by specifying representations, selection and recombination and mutation operators. **(Apply level)**
CO3	Apply appropriate evolution strategies and parameter tuning mechanisms for an application. **(Apply level)**
CO4	Apply evolutionary optimization techniques to real world problems. **(Apply level)**
CO5	Examine the relevance of Co-evolution and Interactive Evolution in computational problems. **(Apply level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3									3
CO5	3	3	3									3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test 1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate				
Create				

Mark Distribution of CIA						
Course Structure [L-T-P-J]	Attendance	Theory [L- T]				Total Marks
		Assignment	Test-1	Test-2		
3-0-0-0	5	15	10	10		**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Evolutionary Computing Preliminaries (8 hrs)

Introduction, Components of Evolutionary Algorithms – Representation, Evaluation Function (Fitness Function), Population, Parent Selection Mechanism, Variation Operators, Survivor Selection, Mechanism (Replacement), Initialization, Termination Condition. Example Applications - The 8-Queens Problem, The Knapsack Problem. Working of an Evolutionary Algorithm (EA), Evolutionary Computing and Global Optimization.

MODULE II : Genetic Algorithms (7 hrs)

Representation of Individuals, Mutation and Recombination – Binary, Integer, Real-valued or Floating-Point, Permutation Representations, Multiparent recombination. Population Models, Parent Selection - Fitness Proportional Selection, Ranking Selection, Implementing Selection Probabilities, Tournament Selection. Survivor

Selection - Age-Based Replacement, Fitness Based Replacement. Example Application: Solving a Job Shop Scheduling Problem.

MODULE III : Evolution strategies and Parameter control (6 hrs)

Evolution Strategy operators – Selection, Crossover, Mutation. A generic Evolution strategy Algorithm. Examples of Changing Parameters - Changing the Mutation Step Size. Changing the Penalty Coefficients. Classification of Control Techniques, Examples of Varying EA Parameter, Varying Several Parameters Simultaneously.

MODULE IV : Evolutionary methods for Multimodal and multiobjective optimization (7 hrs)

Multi-Modal Problems – Introduction. Genetic Drift, Biological Motivations and Algorithmic Approaches. Algorithmic vs. Genetic vs. Solution Space. Multi-Objective Evolutionary Algorithms – Example. Dominance and Pareto optimality. EA Approaches to Multi-Objective Optimization. Example Application: Distributed Co-Evolution of Job-shop Schedules.

MODULE V : Special form of Evolutions (7 hrs)

Co-evolution - Cooperative co-evolution. Competitive co-evolution, Example Application: Co-evolutionary Constraint Satisfaction. Interactive Evolution – Optimization. Design, Exploration. Interactive Evolutionary Design and Art, Example Application - The Mondriaan Evolver. Non-Stationary Function Optimization - Algorithmic Approaches, Selection and Replacement Policies. Example Application - The Time Varying Knapsack Problem.

Text books

1. A.E. Eiben and J.E. Smith, Introduction to Evolutionary Computing, Springer, Natural Computing Series 1st edition, 2003.
2. Bäck, T, Evolutionary Computation 1: Basic Algorithms and Operators. Institute of Physics Publishing, Bristol, 2000.

Reference books

1. S. Rajasekharan, G.A. Vijayalakshmi Pai, Neural Networks, Fuzzy Systems and Evolutionary Algorithms – Synthesis and Applications, PHI Learning, 2/e, 2017.
2. Alex A.Freitas, Data Mining and Knowledge Discovery with Evolutionary Algorithms, Springer, 1/e, 2008.
3. Melanie Mitchell, An Introduction to Genetic Algorithms, MIT Press, 1996.
4. John Koza, Genetic Programming, MIT Press, 1992.
5. Genetic Programming: An Introduction, Wolfgang Banzhaf, Peter Nordin, Robert E. Keller, and Frank D. Francone, Morgan Kaufmann Publishers, 1998.

Suggested MOOC Courses

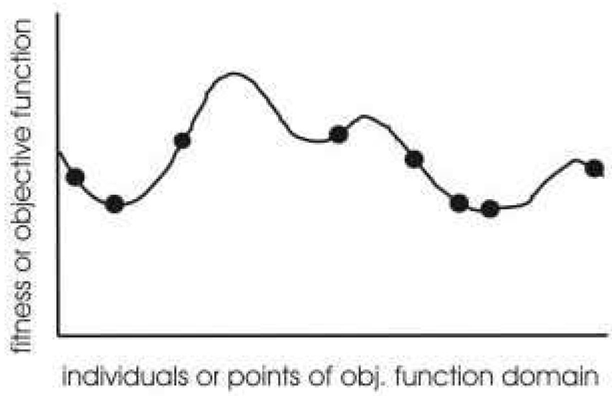
1. NPTEL: Evolutionary Computation for Single and Multi-Objective Optimization, Prof. Deepak Sharma, IIT Guwahati

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1		
1.1	Introduction, Components of Evolutionary Algorithms – Representation	1
1.2	Evaluation Function (Fitness Function), Population, Parent Selection Mechanism	1
1.3	Variation Operators, Survivor Selection – Lecture 1	1
1.4	Variation Operators, Survivor Selection – Lecture 2	1
1.5	Variation Operators, Survivor Selection – Lecture 3	1
1.6	Mechanism (Replacement), Initialization, Termination Condition	1
1.7	Example Applications - The 8-Queens Problem, The Knapsack Problem	1
1.8	Working of an Evolutionary Algorithm, Evolutionary Computing and Global Optimization	1
MODULE II		
2.1	Representation of Individuals, Mutation	1
2.2	Recombination	1
2.3	Binary, Integer, Real-valued or Floating-Point, Permutation Representations, Multiparent recombination. Population Models	1
2.4	Parent Selection - Fitness Proportional Selection, Ranking Selection	1
2.5	Implementing Selection Probabilities, Tournament Selection	1
2.6	Survivor Selection- Age-Based Replacement Fitness Based Replacement	1
2.7	Example Application: Solving a Job Shop Scheduling Problem	1
MODULE III		
3.1	Evolution Strategy operators – Selection, Crossover, Mutation	1
3.2	A generic Evolution strategy Algorithm	1
3.3	Examples of Changing Parameters - Changing the Mutation Step Size	1
3.4	Changing the Penalty Coefficients	1

3.5	Classification of Control Techniques, Examples of Varying EA Parameter	1
3.6	Varying Several Parameters Simultaneously	1
	MODULE IV	
4.1	Multi-Modal Problems – Introduction	1
4.2	Genetic Drift, Biological Motivations and Algorithmic Approaches	1
4.3	Algorithmic vs. Genetic vs. Solution Space	1
4.4	Multi-Objective Evolutionary Algorithms – Examples	1
4.5	Dominance and Pareto optimality	1
4.6	EA Approaches to Multi-Objective Optimization	1
4.7	Example Application: Distributed Co-Evolution of Job-shop Schedules.	1
	MODULE V	
5.1	Co-evolution - Cooperative co-evolution	1
5.2	Competitive co-evolution, Example Application: Co-evolutionary Constraint Satisfaction	1
5.3	Interactive Evolution – Optimization	1
5.4	Design, Exploration	1
5.5	Interactive Evolutionary Design and Art, Example Application: The Mondriaan Evolver	1
5.6	Non-Stationary Function Optimization - Algorithmic Approaches, Selection and Replacement Policies	1
5.7	Example Application: The Time Varying Knapsack Problem	1

<table>
<tr><th colspan="2">CO Assessment Questions</th></tr>
<tr><td>1</td><td>
1. Find a problem where EAs would certainly perform very poorly compared to alternative approaches. Explain why you expect this to be the case.

2. Consider the beginning phase of an evolutionary search process as depicted in the figure below. Is exploration or exploitation the dominant force in this stage? What about the end phase?


3. There is much current research in producing autonomous vehicles that can be used on real roads. For each of the following capabilities that such a system should exhibit, state whether they are an optimization, modelling, or simulation problem.
a. Learning to recognize traffic signs.
b. Recognizing a traffic sign in a video feed as the vehicle drives along.
c. Planning shortest, or quickest, route between two places.
d. Avoiding a child that runs into the road.
e. Steering in the middle of the road.
</td></tr>
<tr><td>2</td><td>
1. In a 0-1 knapsack problem, how could you implement a repair mutation to transform infeasible solutions into feasible ones (i.e. make the sum of costs of the selected items go below the budget)?

2. A mountain bike designer is trying to create a frame with certain desirable characteristics under simulation. To do this they must specify a set of n tube lengths and m angles between them. What representation do you think would be most suitable for this problem?

3. You are given the fitness function $f(x) = x^2 + 10$ and a population of three individuals $\{a,b,c\}$. When decoded their genes when decoded give the values 1, 2 and 3 respectively. When you pick a single parent
</td></tr>
</table>

	using Fitness Proportionate Selection, what is the probability that it is *b*? 4. A generational EA has a population size of 100, uses fitness proportionate selection without elitism, and after t generations has a mean population fitness of 76.0. There is one copy of the current best member, which has fitness 157.0. What is the expectation for the number of copies of the best individual present in the mating pool? What is the probability that there will be no copies of that individual in the mating pool, if selection is implemented using the roulette wheel algorithm?
3	1. Take a numerical optimization problem and a GA that is suited to solve it, i.e., uses the appropriate representation. (You can write your own code, or download it from the Web.) Select 3 different values for each of the parameters population size μ, mutation rate p_m, and crossover rate p_c. Execute 30 runs with each of the 27 different GA instances and for each run save the best fitness at termination, the number of fitness evaluations and the CPU time needed to complete the run. Perform a simple statistical analysis on the spread of the outcomes, e.g., calculate the minimum, the maximum, the average, the standard deviation, etc. Use all 27 setups as the basis of your statistics first, then fix one parameter at one of its values and do the same analysis for the 9 corresponding runs. How does this change your results? Summarise your observations in a short report. 2. Give arguments why mutation strength (e.g., p_m or σ) should be increased during a run. Give arguments why it should be decreased. 3. Explain the General Evolution Strategy algorithm with suitable examples.
4	1. Describe the main components necessary to add to a "standard" EA in order to tackle a multiobjective problem. 2. A simple multiobjective problem has two objective functions, $f_1(x) = x_1$ and $f_2(x) = x_2$ and is subject to the constraints $x_1^2 + x_2^2 \leq 10$. What will the Pareto front for this problem look like? 3. Identify an application where multimodal and multiobjective optimization is needed and design the algorithm based on the concept of evolutionary computing.
5	1. Implement a two-population cooperative GA where the solutions in each population code for half of a 50-bit OneMax problem, and the

	populations take it in turns to evolve for a generation. Use 100 in each population, binary tournament selection, 1-point crossover with probability 0.7 and bit-wise mutation with probability 0.01. Investigate the effect of random versus best pairing strategies. 2. Now repeat this experiment, but this time use a competitive model. Let the fitness that one population gets be the OneMax score and the fitness that the other gets be (50 – OneMax) i.e., ZeroMax. What happens to the two populations? 3. Compare and contrast Cooperative co-evolution and Competitive co-evolution.

24CSE753	Parallel and Distributed Algorithms	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course helps the learners to understand multi-core processors and many-core accelerators to large-scale distributed memory clusters.. It covers survey of common parallel architectures and types of parallelism, and then follows with an overview of formal approaches to assess scalability and efficiency of parallel algorithms. This course also covers the most common and current parallel programming techniques and APIs, including for shared address space, many-core accelerators, distributed memory clusters and big data analytics platforms.

Prerequisite: Knowledge in Computer Organization and Architecture.

Course Outcomes: After the completion of the course the student will be able to

CO1	Understand the importance of parallel processing, distinguish between types of parallelism, understand Flynn's taxonomy, and summarize key features of various parallel architectures. **(Cognitive Knowledge Level : Understand)**
CO2	Understand foundational concepts in parallel processing, including the formal definition of parallelism and essential metrics like work, speedup, efficiency, overhead, and scaling laws. **(Cognitive Knowledge Level :Understand)**
CO3	Apply multi-core programming skills by implementing shared memory and shared address space concepts, data and task parallelism, and using APIs such as OpenMP and TBB. (**Cognitive Knowledge Level : Apply**)
CO4	Analyze distributed memory programming concepts using MPI, the latency + bandwidth model, and their applications like distributed hashing, sample sort, parallel BFS, and basic linear algebra operations **(Cognitive Knowledge Level : Analyze)**
CO5	Evaluate higher-level programming models, including stateless programming in Map/Reduce and Apache Spark, and apply these models practically in tasks such as triangle counting, connected components, and single-source shortest path using Spark. **(Cognitive Knowledge Level : Evaluate)**
CO6	Apply their knowledge in many-core programming, utilizing SIMD parallelism and GPGPU accelerators. **(Cognitive Knowledge Level : Apply)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										3
CO2	3	3	3									3
CO3	3	3										3
CO4	3	3	3	3	2							3
CO5	3	3	3	3	2							3
CO6	3	3	3	3	2							3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools	End Semester Examination

	Test 1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate			✓	
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Overview of parallel processing landscape (7 hours)

why and how, types of parallelism, Flynn's taxonomy and brief overview of parallel architectures. Basic concepts in parallel processing: formal definition of parallelism, concepts of work, speedup, efficiency, overhead, strong and weak scaling (Amdahl's law, Gustafson’s law), practical considerations using parallel reduction and parallel prefix

MODULE II : Multi-core programming (6 hours)

Shared memory and shared address space, data and task parallelism, summary of available APIs (OpenMP, TBB). OpenMP and parallel
merge sort, pointer jumping, parallel BFS and basic linear algebra.

MODULE III : Distributed memory programming (7 hours)

Message Passing Interface, latency + bandwidth model, distributed hashing, sample sort, parallel BFS, and basic linear algebra (matrix-vector, maxtrixmatrix products) with relation to graph algorithms.

MODULE IV : Higher-level programming models (7 hours)

Stateless programming in Map/Reduce, Apache Spark and fault-tolerance via Resilient Distributed Datasets. Triangle counting, connected components, single source shortest path using Spark.

MODULE V : Many-core programming (8 hours)

SIMD parallelism and massively parallel GPGPU accelerators. Brief overview of available APIs (OpenACC, oneAPI, OpenCL, SYCL). Programing GPUs in NVIDIA CUDA: data movement and organization, 1D/2D stencils, parallel prefix, matrix-matrix product.

Text books

1. M. McCool, J. Reinders, A. Robison, “Structured Parallel Programming: Patterns for Efficient Computation,” Morgan Kaufmann, 2012, ISBN-13: 9780124159938.
2. A. Grama, G. Karypis, V. Kumar, A. Gupta, “Introduction to Parallel Computing (2nd Ed.),” Pearson, 2003, ISBN-13: 9780201648652.

Reference books

1. H. Karau, A. Konwinski, P. Wendell, M. Zaharia, “Learning Spark: Lightning-Fast Big Data Analysis (2nd Ed.),” O’Reilly Media, 2020, ISBN-13: 9781492050049.
2. D.B. Kirk, W.W. Hwu, “Programming Massively Parallel Processors: A Hands-on Approach (3rd Ed.),” Morgan Kaufmann, 2010, ISBN-13: 978-0128119860.

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
MODULE 1		
1.1	why and how	1
1.2	types of parallelism	1

1.3	Flynn’s taxonomy and brief overview of parallel architectures	1
1.4	Basic concepts in parallel processing: formal definition of parallelism	1
1.5	concepts of work	1
1.6	speedup, efficiency, overhead, strong and weak scaling (Amdahl’s law, Gustafson’s law)	1
1.7	Practical considerations using parallel reduction and parallel prefix.	1
MODULE 2		
2.1	Shared memory and shared address space	1
2.2	Data and task parallelism	1
2.3	Summary of available APIs (OpenMP, TBB).	1
2.4	OpenMP	1
2.5	Parallel merge sort, pointer jumping	1
2.6	Parallel BFS and basic linear algebra.	1
MODULE 3		
3.1	Message Passing Interface	1
3.2	latency + bandwidth model	1
3.3	distributed hashing	1
3.4	sample sort	1
3.5	parallel BFS, and basic linear algebra (matrix-vector, maxtrixmatrix products) with relation to graph algorithms.	1
3.6	parallel BFS, and basic linear algebra (matrix-vector, maxtrixmatrix products) with relation to graph algorithms.	1
3.7	parallel BFS, and basic linear algebra (matrix-vector, maxtrixmatrix products) with relation to graph algorithms.	1
MODULE 4		
4.1	Stateless programming in Map/Reduce	1
4.2	Stateless programming in Map/Reduce	1

4.3	Apache Spark and fault-tolerance via Resilient Distributed Datasets	1
4.4	Apache Spark and fault-tolerance via Resilient Distributed Datasets	1
4.5	Triangle counting	1
4.6	connected components	1
4.7	single source shortest path using Spark	1
	MODULE 5	
5.1	SIMD parallelism and massively parallel GPGPU accelerators	1
5.2	SIMD parallelism and massively parallel GPGPU accelerators	1
5.3	Brief overview of available APIs (OpenACC, oneAPI, OpenCL, SYCL).	1
5.4	Brief overview of available APIs (OpenACC, oneAPI, OpenCL, SYCL).	1
5.5	Programing GPUs in NVIDIA CUDA: data movement and organization	1
5.6	Programing GPUs in NVIDIA CUDA: data movement and organization	1
5.7	1D/2D stencils, parallel prefix, matrix-matrix product	1
5.8	1D/2D stencils, parallel prefix, matrix-matrix product	1

CO Assessment Questions	
1	1. What distinguishes distributed memory parallel architectures from shared memory architectures? 2. Explain the characteristics of a many-core architecture in the context of parallel processing. 3. Provide real-world examples illustrating different types of parallelism.
2	1. Analyze a parallel program and identify potential sources of overhead. How might you mitigate these sources? 2. How do scaling laws influence the design decisions when developing parallel algorithms for different computational tasks? 3. In what situations might scaling laws, such as Amdahl's law and Gustafson's law, be particularly important to consider?

3	1. Design a simple program that demonstrates the concept of shared memory in a multi-core environment. What challenges might arise when multiple cores access shared memory concurrently, and how can they be addressed? 2. Compare and contrast the features and advantages of OpenMP and Intel Threading Building Blocks (TBB) in the context of multi-core programming. Provide a practical example illustrating the use of TBB for a parallel task. 3. Explain the difference between data parallelism and task parallelism. Provide a real-world scenario where task parallelism might be more suitable than data parallelism and vice versa.
4	1. Develop a stateless programming approach using Apache Spark to calculate the single source shortest path in a graph. How does the fault-tolerance mechanism contribute to the reliability of the computation? 2. Illustrate how connected components can be computed using a stateless programming approach in a Map/Reduce paradigm. What advantages does stateless programming offer in this scenario? 3. Design an Apache Spark program for counting triangles in a graph. Describe the role of stateless programming principles in this implementation.
5	1. In what scenarios would stateless programming be more suitable than stateful programming in the context of distributed computing? Provide examples. 2. Develop a step-by-step explanation of how a stateless programming model in Apache Spark can be practically applied to count triangles in a graph. Include details on the transformation and action stages in Spark. 3. Evaluate the performance of stateless programming models in Apache Spark for tasks like connected components and single-source shortest path. Discuss factors that may influence the effectiveness of these models in real-world scenarios.
6	1. Choose a computational problem suitable for parallelization and implement a solution using GPGPU accelerators, such as NVIDIA CUDA. Discuss the data movement, organization, and parallelism considerations in your implementation. 2. Analyze the trade-offs between different APIs for many-core programming. Under what circumstances might one API be more

	suitable than another, considering factors like ease of use and performance? 3. Evaluate the performance gains achieved by employing GPGPU accelerators in your solution. What challenges did you encounter during the implementation, and how were they addressed?

24CSE763	Big Data Analytics	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Prerequisite: Computational Fundamentals for Machine Learning

Preamble: This course delves into the foundations of big data, analytics best practices, real-world use cases, and the tools and techniques that empower data-driven decision-making. It explores the dynamic and transformative field of harnessing big data for insightful decision-making and innovation. This course is designed to equip the student with the knowledge in big data related file system, data storage, management and no-sql databases.

Course Outcomes: After the completion of the course the student will be able to

CO1	Identify significance, characteristics, and practices of Bigdata. **(Cognitive Knowledge Level: Understand)**
CO2	Demonstrate proficiency in Hadoop Distributed File System (HDFS) and the management of resources and applications using Hadoop YARN. **(Cognitive Knowledge Level: Understand)**
CO3	Apply the principles of MapReduce programming, including the functions of Mapper, Reducer, Combiner, and Partitioner. **(Cognitive Knowledge Level: Apply)**
CO4	Develop skills in implementing data-related tasks, such as joins, aggregations, and user-defined functions using Hive and Pig. **(Cognitive Knowledge Level: Apply)**
CO5	Apply R programming language for big data analytics, employing the BigR framework to implement machine learning algorithms effectively. **(Cognitive Knowledge Level: Apply)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3									3
CO2	2	1	3									3
CO3	2	1	3									3
CO4	2	1	3									3
CO5	2	1	3									3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test 1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓

Analyse			✓	
Evaluate			✓	
Create			✓	

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : INTRODUCTION TO BIG DATA

Classification of Digital Data, Structured and Unstructured Data – Introduction to Big Data: Characteristics – Evolution – Definition - Challenges with Big Data - Other Characteristics of Data - Why Big Data - Traditional Business Intelligence versus Big Data - Data Warehouse and Hadoop Environment Big Data Analytics: Classification of Analytics – Challenges - Big Data Analytics important - Data Science - Data Scientist - Terminologies used in Big Data Environments - Basically Available Soft State Eventual Consistency - Top Analytics Tools

MODULE II : INTRODUCTION TO TECHNOLOGY LANDSCAPE

NoSQL, Comparison of SQL and NoSQL, Hadoop -RDBMS Versus Hadoop - Distributed Computing Challenges – Hadoop Overview - Hadoop Distributed File System - Processing Data with Hadoop - Managing Resources and Applications with Hadoop YARN - Interacting with Hadoop Ecosystem.

MODULE III : INTRODUCTION TO MONGODB AND MAP REDUCE PROGRAMMING

MongoDB: Why Mongo DB - Terms used in RDBMS and Mongo DB - Data Types - MongoDB Query Language MapReduce: Mapper – Reducer – Combiner – Partitioner – Searching – Sorting – Compression

MODULE IV : INTRODUCTION TO HIVE AND PIG Hive

Introduction – Architecture - Data Types - File Formats - Hive Query Language Statements – Partitions – Bucketing – Views - Sub- Query – Joins – Aggregations - Group by and Having - RCFile Implementation - Hive User Defined Function - Serialization and Deserialization. Pig: Introduction - Anatomy – Features – Philosophy - Use Case for Pig - Pig Latin Overview - Pig Primitive Data Types - Running Pig - Execution Modes of Pig - HDFS Commands - Relational Operators - Eval Function - Complex Data Types - Piggy Bank - User-Defined Functions - Parameter Substitution - Diagnostic Operator - Word Count Example using Pig - Pig at Yahoo! - Pig Versus Hive

MODULE V : INTRODUCTION TO DATA ANALYTICS WITH R

Machine Learning: Introduction, Supervised Learning, Unsupervised Learning, Machine Learning Algorithms: Regression Model, Clustering, Collaborative Filtering, Associate Rule Making, Decision Tree, Big Data Analytics with BigR

Text books

1. Seema Acharya, Subhashini Chellappan, “Big Data and Analytics”, Wiley Publications, First Edition,2015

Reference books

1. Judith Huruwitz, Alan Nugent, Fern Halper, Marcia Kaufman, Big data for dummies, John Wiley & Sons, Inc.(2013)
2. Tom White, Hadoop The Definitive Guide, O’Reilly Publications, Fourth Edition,2015
3. Dirk Deroos, Paul C.Zikopoulos, Roman B.Melnky, Bruce Brown, Rafael Coss, Hadoop For Dummies, Wiley Publications,2014
4. Robert D.Schneider, Hadoop For Dummies, John Wiley & Sons, Inc.(2012)
5. Paul Zikopoulos, Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data, McGraw Hill, 2012

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1		
1.1	Classification of Digital Data, Structured and Unstructured Data	1

1.2	Introduction to Big Data: Characteristics – Evolution – Definition	1
1.3	Challenges with Big Data - Other Characteristics of Data - Why Big Data	1
1.4	Traditional Business Intelligence versus Big Data	1
1.5	Data Warehouse and Hadoop Environment Big Data Analytics: Classification of Analytics – Challenges	1
1.6	Big Data Analytics important - Data Science - Data Scientist - Terminologies used in Big Data Environments	1
1.7	Basically Available Soft State Eventual Consistency - Top Analytics Tools	2
MODULE II		
2.1	NoSQL, Comparison of SQL and NoSQL	1
2.2	Hadoop -RDBMS Versus Hadoop - Distributed Computing Challenges	1
2.3	Hadoop Overview - Hadoop Distributed File System	1
2.4	Processing Data with Hadoop	1
2.5	Managing Resources and Applications with Hadoop YARN	2
2.6	Interacting with Hadoop Ecosystem.	1
MODULE III		
3.1	MongoDB: Why Mongo DB	1
3.2	Terms used in RDBMS and Mongo DB - Data Types	1
3.3	MongoDB Query Language MapReduce: Mapper – Reducer – Combiner – Partitioner – Searching – Sorting – Compression	3
MODULE IV		
4.1	Introduction – Architecture - Data Types - File Formats	1
4.2	Hive Query Language Statements – Partitions – Bucketing – Views - Sub- Query – Joins – Aggregations - Group by and Having - RCFile Implementation	2
4.3	Hive User Defined Function - Serialization and Deserialization.	1
4.4	Pig: Introduction - Anatomy – Features – Philosophy	1

4.5	Use Case for Pig - Pig Latin Overview - Pig Primitive Data Types - Running Pig - Execution Modes of Pig	1
4.6	HDFS Commands - Relational Operators - Eval Function	1
4.7	Complex Data Types - Piggy Bank - User-Defined Functions, Parameter Substitution - Diagnostic Operator	1
4.8	Word Count Example using Pig - Pig at Yahoo! - Pig Versus Hive	
	MODULE V	
5.1	Machine Learning: Introduction, Supervised Learning, Unsupervised Learning	1
5.2	Machine Learning Algorithms: Regression Model	1
5.3	Clustering, Collaborative Filtering	1
5.4	Associate Rule Making	1
5.5	Decision Tree	1
5.6	Big Data Analytics with BigR	2

CO Assessment Questions	
1	1. Define and provide examples of both structured and unstructured data. How does the classification of digital data impact big data analytics? 2. Can you identify and explain some best practices in big data analytics, and how have these practices contributed to successful implementations? 3. How do the characteristics of big data (Volume, Velocity, Variety, Veracity, and Value) impact the way data is processed and analyzed in big data systems? 4. What techniques can be employed to validate the value derived from big data initiatives, and why is validation crucial for the success of these initiatives?
2	1. Compare SQL and NoSQL databases, highlighting their strengths and weaknesses. When and why would you choose one over the other? 2. Provide an overview of Hadoop, detailing its components and role in distributed computing. What are the challenges associated with distributed computing? 3. Describe the Hadoop Distributed File System (HDFS) and its significance. How does Hadoop YARN manage resources and

	applications in the ecosystem?
3	1. Explain why MongoDB is preferred over traditional relational databases. What are the key terms used in both RDBMS and MongoDB? 2. Define Mapper, Reducer, Combiner, and Partitioner in the context of MapReduce. How is MapReduce used for searching, sorting, and compression?
4	1. Describe the architecture of Hive and its file formats. How does Hive handle partitions and bucketing? 2. Explain the features and use cases of Pig. How does Pig differ from Hive, and what are its primary advantages?
5	1. Provide an introduction to machine learning, differentiating between supervised and unsupervised learning. What are the fundamental machine learning algorithms? 2. Explain the application of R in big data analytics. How does BigR facilitate machine learning tasks in the big data domain?

24CSE773	Web mining	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course enables the learners to understand the various techniques used for collecting, understanding, and analyzing data from the web. It covers topics such as Information Retrieval and Web Search, Link Analysis, Web Crawling, Opinion Mining, and Web Usage Mining. These topics enable students to extract valuable insights from the vast information available on the World Wide Web and facilitate data-driven decision-making, enhance user experiences, and support business intelligence.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the basic principles and different strategies in web information Retrieval. **(Understand Level)**
CO2	Make use of the concept of link analysis techniques to identify meaningful patterns from web data. **(Apply Level)**
CO3	Illustrate the principles of various web crawling algorithms and assess their implementation challenges in the context of web data retrieval. **(Apply Level)**
CO4	Apply the concept of sentiment analysis and feature-based opinion mining to solve real world problems. **(Apply Level)**
CO5	Apply distinct pattern discovery techniques to web usage data for decision-making, incorporating relevant preprocessing techniques. **(Apply Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										3
CO2	3	3										3
CO3	3	3	2									3
CO4	3	3	2									3
CO5	3	3	2									3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test 1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	

Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Information Retrieval and Web Search (9 hrs)

Basic Concepts of Information Retrieval (IR). IR Methods – Boolean Model, Vector Space Model and Statistical Language Model. Relevance Feedback. Evaluation Measures. Text Preprocessing- Stopword Removal, Stemming. Web Page Preprocessing-Duplicate Detection. Inverted Index and Its Compression – Inverted Index, Search using Inverted Index, Index Construction, Index Compression. Meta-Search and Combining Multiple Rankings. Web Spamming- Content spamming, Link spamming.

MODULE II: Link Analysis (8 hrs)

Link Analysis – Social Network Analysis. Co-Citation and Bibliographic Coupling. Page Rank-Algorithm, Strengths and Weaknesses, Timed pageRank. HITS-Algorithm, Relationships with Co-Citation and Bibliographic Coupling, Strengths and Weaknesses of HITS. Community Discovery-Problem Definition, Bipartite Core Communities, Maximum

Flow Communities, Email Communities Based on Betweenness, Overlapping Communities of Named Entities.

MODULE III: Web Crawling (6 hrs)

Web Crawling – A Basic Crawler Algorithm-Breadth First Crawlers, Preferential Crawlers. Implementation Issues- Fetching, Parsing, Stopword Removal and stemming, Link Extraction and Canonicalization, Spider Traps, Page Repository, Concurrency. Universal Crawlers, Focused Crawlers, Topical Crawlers, Crawler Ethics and Conflicts.

MODULE IV : Opinion Mining (7 hrs)

Sentiment Classification –Classification based on Sentiment Phrases, Classification Using Text Classification Methods, Classification Using a Score Function. Feature based Opinion Mining and Summarization – Problem Definition, Object feature extraction, Feature Extraction from Pros and Cons of Format1, Feature Extraction from Reviews of Format 2 and 3, Opinion Orientation Classification. Comparative Sentence and Relation Mining, Opinion Search and Opinion Spam.

MODULE V : Web Usage Mining (6 hrs)

Data Collection and Preprocessing- Sources and Types of Data, Key Elements of Web usage Data Preprocessing. Data Modeling for Web Usage Mining. Discovery and Analysis of Web usage Patterns -Session and Visitor Analysis, Cluster Analysis and Visitor Segmentation, Association and Correlation Analysis, Analysis of Sequential and Navigation Patterns.

Text books

1. Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data, 2nd Edition, Springer July 2011.
2. Data Mining the Web -Uncovering Patterns in Web Content, Structure, and Usage, Zdravko Markov and Daniel T. Larose Central Connecticut State University, New Britain, CT, 2007.
3. Introduction to Information Retrieval, Cambridge University Press, 2008. Christopher D. Manning, Prabhakar Raghavan and Hinrich Schütze

Reference books

1. Data Mining: Concepts and Techniques, Second Edition Jiawei Han, Micheline Kamber, 2012.
2. Web Mining: Applications and Techniques by Anthony Scime, 2004.
3. Mining the Web: Discovering Knowledge from Hypertext Data by Soumen Chakrabarti, 2002.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36 hrs)
MODULE 1		
1.1	Basic Concepts of Information Retrieval (IR)	1
1.2	IR Methods – Boolean Model, Vector Space Model and Statistical Language Model	1
1.3	Relevance Feedback, Evaluation Measures	1

1.4	Text Preprocessing – Stopword Removal, Stemming. Other Pre-Processing Tasks for Text	1
1.5	Web Page Preprocessing, Duplicate Detection	1
16	Inverted Index and Its Compression – Inverted Index, Search using Inverted Index	1
1.7	Index Construction, Index Compression	1
1.8	Meta-Search and Combining Multiple Rankings	1
1.9	Web Spamming-Content spamming, Link spamming	
MODULE II		
2.1	Link Analysis – Social Network Analysis	1
2.2	Co-Citation and Bibliographic Coupling	1
2.3	Page Rank -Algorithm	1
2.4	Strengths and Weaknesses, Timed pageRank	
2.5	HITS-Algorithm	1
2.6	Relationships with Co-Citation and Bibliographic Coupling, Strengths and Weaknesses of HITS	
2.7	Community Discovery-Problem Definition, Bipartite Core Communities	1
2.8	Email Communities Based on Betweenness, Overlapping Communities of Named Entities	1
MODULE III		
3.1	Web Crawling – A Basic Crawler Algorithm-Breadth First Crawlers, Preferential Crawlers	1
3.2	Implementation Issues- Fetching, Parsing, Stopword Removal and stemming	1
3.3	Link Extraction, Spider Traps, Page Repository, Concurrency	1
3.4	Universal Crawlers, Focused Crawlers	1
3.5	Topical Crawlers	1
3.6	Crawler Ethics and Conflicts	1
MODULE IV		
4.1	Sentiment Classification –Classification based on Sentiment Phrases, Classification Using Text Classification Methods, Classification Using a Score Function	1
4.2	Feature based Opinion Mining and Summarization – Problem Definition	1
4.3	Object feature extraction, Feature Extraction from Pros and Cons of Format1, Feature Extraction from Reviews of Format 2 and 3	1
4.4	Opinion Orientation Classification	1
4.5	Comparative Sentence and Relation Mining	1

4.6	Opinion Search	1
4.7	Opinion Spam	1
	MODULE V	
5.1	Data Collection and Preprocessing- Sources and Types of Data.	1
5.2	Key Elements of Web usage Data Preprocessing	1
5.3	Data Modeling for Web Usage Mining	1
5.4	Discovery and Analysis of Web usage Patterns -Session and Visitor Analysis, Cluster Analysis and Visitor Segmentation	1
5.5	Association and Correlation Analysis	1
5.6	Analysis of Sequential and Navigation Patterns	1

CO Assessment Questions	
1	a. Explain the concept of indexing in web information retrieval and its significance in enhancing search efficiency. b. Describe the role of algorithms in web information retrieval strategies. How do they influence the ranking and relevance of search results? c. Explain different types of web information retrieval strategies and their applications in various domains.
2	a. Imagine you are a data analyst tasked with improving the user experience on a popular e-commerce website. The company has provided you with a dataset containing user interactions, including clicks, purchases, and reviews. Apply link analysis techniques to identify meaningful patterns in the web data that can inform decisions on product recommendations and website layout. Consider how the discovered patterns could be utilized to enhance the overall user engagement and satisfaction on the platform. Discuss the specific link analysis methods you would employ and the potential impact on the e-commerce platform's success. b. You have been hired as a consultant for a new online content platform that aims to showcase articles and blogs. The platform is looking to improve its visibility and user engagement. Explain how the HITS (Hyperlink-Induced Topic Search) or PageRank algorithm can be utilized to evaluate the importance of different articles based on their hyperlink structure. Propose a strategy for the platform to enhance the visibility of high-quality content and increase user interaction. Consider how the chosen algorithm aligns with the platform's goals and discuss potential challenges in implementing and maintaining the selected algorithm.
3	Imagine you are leading the development team of a new search engine startup. Your team is tasked with selecting and implementing an efficient

	web crawling algorithm to ensure the search engine's success. Apply your knowledge of web crawling algorithms by illustrating the principles of two different algorithm. Assess the implementation challenges your team might encounter, considering factors like scalability, handling dynamic content, and avoiding common pitfalls like spider traps. Propose a strategy to overcome these challenges and ensure the search engine delivers reliable and up-to-date search results.
4	a. You are a data scientist working for an online product review platform. Explain how the concepts of sentiment classification and feature-based opinion mining can be used to enhance the platform's user experience and content quality. b. Imagine you are a consultant for an e-commerce company seeking to implement opinion mining to improve its product recommendations. Explain how the concept of Comparative Sentence and Relation Mining can be used to enhance the platform's recommendation engine.
5	You are a data scientist working for an e-commerce platform. a. Select a preprocessing technique that is suitable for handling noisy data in web usage logs. Justify your choice and describe how this preprocessing step enhances the quality of the web usage data. b. Explain how two distinct pattern discovery techniques, such as clustering and association analysis, can be applied to the preprocessed web usage data.

<table>
<tr><td rowspan="2">24CSE783</td><td rowspan="2">Advanced Social, Text and Media Analytics</td><td>L</td><td>T</td><td>P</td><td>J</td><td>S</td><td>C</td><td>Year of Introduction</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>3</td><td>3</td><td>2024</td></tr>
</table>

Preamble:

This course offers fundamental training in modern text processing technologies, including topic modeling and clustering, with a strong emphasis on practical applications. It maintains a well-rounded approach by balancing theoretical concepts with real-life problems and data examples. Crafted to align with contemporary industry and research requirements, the course instructs students on leveraging social media data for insights into organizations, actionable recommendations, and strategic decision-making. It introduces mining concepts and approaches specific to social media data, covering data acquisition, exploration, network mining, and text mining from social platforms. The course enables students to apply their data mining knowledge to the familiar domain of social media, teaching them to explore, model, and predict using network and textual data from existing social platforms.

Prerequisite: Basics of Data Mining, Data Analytics and Machine Learning

Course Outcomes: After the completion of the course the student will be able to

CO1	Familiarize the text analytics framework analyze various sources of text data. **(Understand Level)**
CO2	Interpret the results, gain insights, and recommend possible actions from analytics performed on text data. **(Analyze Level)**
CO3	Familiarize with the advanced concepts of social media analytics and understand its significance. **(Understand Level)**
CO4	Develop skills required for analyzing the effectiveness of social media for business purposes. **(Understand Level)**
CO5	Evaluate effectiveness of different social media campaigns using various analytical tools. **(Evaluate Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2									3
CO2	3	3	2									3
CO3	3	3	2									3
CO4	3	3	2									3
CO5	3	3	2									3
CO6	3	3										3

Assessment Pattern

<table>
<tr><td rowspan="2">Bloom's Category</td><td colspan="3">Continuous Assessment Tools</td><td rowspan="2">End Semester Examination</td></tr>
<tr><td>Test1</td><td>Test2</td><td>Other tools</td></tr>
<tr><td>Remember</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Understand</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Apply</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
</table>

Analyse			✓	✓
Evaluate			✓	
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

Module I: Text Processing (9hours)

Introduction to information retrieval, Inverted indices and Boolean queries, Processing unstructured and semi-structured data. Text encoding, tokenization, lemmatization and stop words, Proximity and phrase queries, Positional indices, Index compression, lexicon compressing and posting list compression, Gap encoding, gamma codes, Zipf's law.

Module II: Text Analytics (8hours)

Text classification techniques, Topic model fundamentals, Document-term matrix, Latent Dirichlet Allocation (LDA), Latent Semantic Indexing (LSI), Other topic modeling algorithms, Practical aspects of topic model tuning.

Module III: Social Media Analytics (6hours)

Social Media Data Processing - Social media data basics, Classification of social data, Modeling of social data. Purpose of Social Media Analytics, Social Media vs. Traditional Business Analytics, Seven Layers of Social Media Analytics, Types of Social Media Analytics, Social Media Analytics Cycle, Challenges to Social Media Analytics, Social Media Analytics Tools

Module IV: Social Media Network and Hyperlink Analytics (6hours)

Social Media Network Analytics - Common Network Terms, Common Social Media Network Types, Common Network Terminologies, Network Analytics Tools. Social Media Action Analytics - Common Social Media Actions, Actions Analytics Tools. Social Media Hyperlink Analytics - Types of Hyperlinks, Types of Hyperlink Analytics, Hyperlink Analytics Tools

Module V: Social Media Location and Search Engine Analytics (7hours)

Location Analytics - Sources of Location Data, Categories of Location Analytics, Location Analytics and Privacy Concerns, Location Analytics Tools. Search Engine Analytics - Types of Search Engines, Search Engine Analytics, Search Engine Analytics Tools. Social Information Filtering - Social Sharing and filtering, Automated Recommendation systems, Traditional Vs social Recommendation Systems

Text books

1. Matthew Ganis, Avinash Kohirkar. Social Media Analytics: Techniques and Insights for Extracting Business Value Out of Social Media, Pearson, 2016.

Reference books

1. Avinash Kaushik,Web Analytics 2.0: The Art of Online Accountability and Science of Customer Centricity,
2. Marshall Sponder. Social Media Analytics. McGraw Hill

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. ofHours
MODULE 1		
1.1	Introduction to information retrieval, Inverted indices and Boolean queries.	1
1.2	Processing unstructured and semi-structured data.	1
1.3	Text encoding, tokenization, lemmatization and stop words.	2
1.4	Proximity and phrase queries, Positional indices	1
1.5	Index compression, lexicon compressing and posting list compression	2
1.6	Gap encoding	1
1.7	Gamma codes, Zipf's law.	1
MODULE II		

2.1	Text classification techniques.	1
2.2	Topic model fundamentals.	1
2.3	Document-term matrix, Latent Dirichlet Allocation (LDA)	2
2.4	Latent Semantic Indexing (LSI)	1
2.5	Other topic modeling algorithms	2
2.6	Practical aspects of topic model tuning.	1
MODULE III		
3.1	Social Media Data Processing - Social media data basics, Classification of social data.	1
3.2	Modeling of social data. Purpose of Social Media Analytics, Social Media vs. Traditional Business Analytics	1
3.3	Seven Layers of Social Media Analytics, Types of Social Media Analytics	2
3.4	Social Media Analytics Cycle, Challenges to Social Media Analytics	1
3.5	Social Media Analytics Tools	1
MODULE IV		
4.1	Social Media Network Analytics - Common Network Terms, Common Social Media Network Types.	1
4.2	Common Network Terminologies, Network Analytics Tools	1
4.3	Social Media Action Analytics - Common Social Media Actions, Actions Analytics Tools.	2
4.4	Social Media Hyperlink Analytics - Types of Hyperlinks, Types of Hyperlink Analytics.	1
4.5	Hyperlink Analytics Tools	1
MODULE V		
5.1	Location Analytics - Sources of Location Data, Categories of Location Analytics.	1
5.2	Location Analytics and Privacy Concerns, Location Analytics Tools	1
5.3	Search Engine Analytics - Types of Search Engines, Search Engine Analytics.	1
5.4	Search Engine Analytics Tools.	1
5.5	Social Information Filtering - Social Sharing and filtering	1
5.6	Automated Recommendation systems	1
5.7	Traditional Vs social Recommendation Systems	1

CO Assessment Questions	
CO1	1. Discuss the significance of techniques such as tokenization, stemming, and stop-word removal in the context of text analytics. 2. Provide examples of how preprocessing may vary for social media text versus formal documents.
CO2	1. Discuss how the text analytics results contribute to a deeper understanding of the underlying themes or sentiments within the analyzed text data. 2. Provide examples of insights gained and their potential implications for decision-making.
CO3	1. Provide examples of situations where real-time insights from social media analytics can influence decision-making. 2. Provide examples of how understanding social network structures can be valuable for organizations.
CO4	1. Discuss the challenges and considerations involved in attributing financial value to social media efforts. 2. Discuss how content analysis can inform content strategy for improved engagement and reach.
CO5	1. Identify and justify the selection of analytical tools for assessing social media campaign effectiveness. 2. Explain the criteria considered when choosing specific tools and platforms

24CSE793	Digital Currency Programming	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The aim of this course is to explain how bitcoin works, from when a transaction is created, to when it is considered part of the blockchain. This course includes introducing the students to the Bitcoin Script language and exposing them to the P2P network, how it operates, the different kinds of potential network forks and explain Bitcoin's network mechanisms for maintaining and upgrading.

Prerequisite: 23CSP602 Introductory Cyber security and 23CSI625 Blockchain Technology

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the technology components of Bitcoin and how it really works behind-the scenes. **(Understand Level)**
CO 2	Explain in detail how keys and addresses work on Bitcoin. **(Understand Level)**
CO 3	Develop scripts using the Bitcoin Script language and have a deep understanding of the provided API. **(Apply Level)**
CO 4	Develop programs to create Bitcoin scripts and interact with Bitcoin nodes. **(Apply Level)**
CO 5	Understand how the Bitcoin P2P network operates and how it can evolve. **(Understand Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2	1				1						3
CO 2	2	2				1						3
CO 3	3	2	2			1						3
CO 4	3	2	2			1						3
CO 5	3	2	2			1						3

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✔	✔	✔	✔
Understand	✔	✔	✔	✔
Apply	✔	✔	✔	✔
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : How Bitcoin works (7 hrs)

How Bitcoin works - Bitcoin Overview, Bitcoin Transactions, Constructing a transaction, Creating the outputs. Bitcoin Mining - Mining Transactions in Blocks, Spending the Transaction.

MODULE II : Keys & Addresses (7 hrs)

Keys & Addresses - Introduction, Public Key Cryptography and Cryptocurrency, Bitcoin Addresses, Implementing Keys and Addresses in Python. Advanced Keys and Addresses, Wallets - Mnemonic Code Words, Creating an HD Wallet from the Seed.

MODULE III : Scripting (7 hrs)

Transactions - Transaction in detail, Transaction Outputs and Inputs, Transaction Fees. Transaction Scripts and Script Language - how to create scripts, P2PKH transaction types with examples.

MODULE IV : Advanced Scripting (7 hrs)
Advanced Transactions and Scripting - Multisignature, Pay-to-Script-Hash (P2SH), Data Recording Output, Timelocks, Scripts with Flow Control, Segregated Witness.
MODULE V : Bitcoin Networks (8 hrs)
The Bitcoin Network - Peer-to-Peer Network Architecture, Node Types and Roles, Extended Bitcoin Network, Bitcoin Relay Networks, Network Discovery, Full Nodes, Exchanging Inventory, Simplified Payment Verification (SPV) Nodes, Bloom Filters, How Bloom Filters Work, How SPV Nodes Use Bloom Filters, SPV Nodes and Privacy, Encrypted and Authenticated Connections, Transaction Pools.
Text books 1. Andreas M Antonopoulos, Mastering Bitcoin, O'Reilly Publishers, 2017.
Reference books 1. Jimmy Song , Programming Bitcoin, O'Reilly Publishers, 2019. 2. Roger Wattenhofer, The Science of the Blockchain, CreateSpace Independent Publishing Platform, 2016.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	How Bitcoin works - Bitcoin Overview.	1
1.2	Bitcoin Transactions.	1
1.3	Constructing a transaction (Lecture 1).	1
1.4	Constructing a transaction (Lecture 2).	1
1.5	Creating the outputs.	1
1.6	Bitcoin Mining - Mining Transactions in Blocks.	1
1.7	Spending the Transaction.	1
	MODULE II	
2.1	Keys & Addresses - Introduction.	1
2.2	Public Key Cryptography and Cryptocurrency.	1
2.3	Bitcoin Addresses.	1
2.4	Implementing Keys and Addresses in Python.	1
2.5	Advanced Keys and Addresses.	1
2.6	Wallets - Mnemonic Code Words.	1
2.7	Creating an HD Wallet from the Seed.	1
	MODULE III	
3.1	Transaction in detail.	1
3.2	Transaction Outputs and Inputs.	1
3.3	Transaction Fees.	1
3.4	Transaction Scripts and Script Language - how to create scripts (Lecture 1).	1
3.5	Transaction Scripts and Script Language - how to create scripts (Lecture 2).	1
3.6	P2PKH transaction types with examples (Lecture 1).	1

3.7	P2PKH transaction types with examples (Lecture 2).	1
	MODULE IV	
4.1	Advanced Transactions and Scripting - Multisignature.	1
4.2	Pay-to-Script-Hash (P2SH) (Lecture 1).	1
4.3	Pay-to-Script-Hash (P2SH) (Lecture 2).	1
4.4	Data Recording Output.	1
4.5	Timelocks.	1
4.6	Scripts with Flow Control.	1
4.7	Segregated Witness.	1
	MODULE V	
5.1	Peer-to-Peer Network Architecture.	1
5.2	Node Types and Roles, Extended Bitcoin Network.	1
5.3	Bitcoin Relay Networks, Network Discovery.	1
5.4	Full Nodes, Exchanging Inventory.	1
5.5	Simplified Payment Verification (SPV) Nodes.	1
5.6	Bloom Filters, How Bloom Filters Work.	1
5.7	How SPV Nodes Use Bloom Filters.	1
5.8	SPV Nodes and Privacy, Encrypted and Authenticated Connections, Transaction Pools.	1

	CO Assessment Questions
CO1	1. What role do private and public keys play in securing Bitcoin transactions?. 2. Explain the concept of mining difficulty and how it adjusts in the Bitcoin network. 3. Describe the components of a typical Bitcoin transaction.
CO2	1. What role do keys and addresses play in the context of cryptocurrencies like Bitcoin? 2. How are Bitcoin addresses generated from public keys in the Bitcoin network? 3. Explain the role of elliptic curve cryptography (ECC) in generating Bitcoin key pairs. 4. How does the use of the BIP39 standard enhance the interoperability of cryptocurrency wallets?
CO3	1. How are transaction outputs represented in a Bitcoin transaction, and what information do they include? 2.Demonstrate how P2PKH transactions can be created using script language. Provide code examples to illustrate the scripting process for P2PKH transactions. 3. How is the Bitcoin script language used to define conditions for spending transaction outputs?
CO4	1. Explain the concept of Pay-to-Script-Hash (P2SH) and its advantages in Bitcoin scripting.

	2. How does a multisignature transaction enhance security in Bitcoin transactions? 3. What challenges can arise from the use of timelocks in Bitcoin transactions, and how can they be addressed? 4. Propose a practical use case where data recording outputs are employed for ensuring data integrity and facilitating transparent auditing processes. 5. Discuss challenges associated with implementing SegWit and provide solutions to overcome these challenges.
CO5	1. How does the extended Bitcoin network contribute to the resilience and redundancy of the system? 2. Describe the role of Simplified Payment Verification (SPV) nodes in the Bitcoin ecosystem. 3. Explain the technical workings of Bloom filters and their applications in the context of Bitcoin. 4. How do SPV nodes use Bloom filters to retrieve relevant transaction information from the network?

24CSE7103	Android Programming	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This comprehensive course is designed to equip you with the skills and knowledge needed to thrive in the rapidly evolving field of mobile application development.

Prerequisite: Basic Knowledge of OOPS concept and Core java

Course Outcomes: After the completion of the course the student will be able to

CO 1	Demonstrate a comprehensive understanding of Android architecture, including activities and their life cycle dynamics. (**Understand level**)
CO 2	Utilize acquired knowledge to proficiently design a user interface by leveraging Android UI principles and component integration (**Apply level**)
CO 3	Proficiently administer both local system database and remote database operations through the utilization of web services and Firebase technologies (**Understand level**)
CO 4	Leverage understanding and expertise in maps, location services, graphics, Android systems, and background services to effectively apply knowledge in practical scenarios (**Apply level**)
CO 5	Effectively deploy and distribute Android applications through proficient publishing processes (**Apply level**)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	3									
CO 2	3	3	3									
CO 3	3	3	3		3				2			
CO 4	3	3	2									2
CO 5	3		3									

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA							
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Practical [P]		Total Marks
		Assignment	Test-1	Test-2	Class work	Lab Exam	
3-0-0-0	5	15	10	10			**40**

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Android OS (6 hours)

Introduction to Android, Android System with Architecture, Android Architecture, Development with Android – Platforms, Tools, Versions, Setup Android Environment, Say Hello to Android Application, Building Blocks of Android Application, Work with Activity, Activity Lifecycle, Intents Fragments, Fragment Lifecycle

MODULE II: Android UI And Component using Fragments (6 hours)

Create Android UI, Working with Layout, Create Custom Layouts, Work with UI Components and Events, Material Design Toolbar, Tab Layout, Recycler View and Card View, Android Menus

Module III: Database Connectivity (10 hours)

Storage in Android, Shared Preferences, Shared Preferences Layout, Android Requesting Permission at run time (Android 6.0), Work with SD Card and Files, Database in Android, Realm-No SQL Database.
Web services and Parsing, JSON Parsing, Access web data with JSON, Connect to Web Services, Using Async Task and Party Library: Retrofit

MODULE IV: Location Services and Maps (7 hours)

Google Map, Location Service, and GPS Creating Google Map, Work with Location, Location service with Location Manager, Find Current Location, Geocoding.

Work with 2D Graphics, Bitmap, Animation, Frame Animation, Tween Animation, View Animation, Multimedia in Android, Play Audio Files, Play Video Files		
MODULE V: Web Application Scanning Tools (7 hours)		
Work in Background, Services, Notification Services, Broadcast Receiver Introduction to Firebase with simple CRUID Operation, Text to Speech, Camera, Taking Pictures with Camera, Managing Bluetooth Connection, Monitor and Managing Wi-Fi, Accelerometer Sensor, Gyroscope. Publishing and Distributing Android Application: Signing the Android Application, Versioning the Android Application, Publishing the Android Application.		
Textbooks 1. Android Application Development Black Book by Pradeep Kothari, DreamTech 2. Beginning Android 4 Application Development by Wei Meng Lee, Wrox		
Reference books 1. Android Wireless Application Development By Lauren Darcey, Shane Conder, Pearson		
COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
MODULE 1		
1.1	Introduction to Android, Android System with Architecture, Android Architecture,	2
1.2	Development with Android – Platforms, Tools, Versions, Setup Android Environment, Say Hello to Android Application,	2
1.3	Building Blocks of Android Application, Work with Activity, Activity Lifecycle, Intents Fragments, Fragment Lifecycle	2
MODULE II		
2.1	Create Android UI, Working with Layout, Create Custom Layouts,	1
2.2	Work with UI Components and Events,	2
2.3	Material Design Toolbar, Tab Layout,	2
2.4	Recycler View and Card View, Android Menus	1
MODULE III		
3.1	Storage in Android, Shared Preferences, Shared Preferences Layout,	2
3.2	Android Requesting Permission at run time (Android 6.0),	2
3.3	Work with SD Card and Files, Database in Android, Realm-No SQL Database.	2
3.4	Web services and Parsing, JSON Parsing, Access web data with JSON,	2
3.5	Connect to Web Services, Using Async Task & Third Party Library Retrofit	2
MODULE IV		
4.1	Google Map, Location Service and GPS, Creating Google Map,	2
4.2	Work with Location, Location service with Location Manager, Find Current Location, Geocoding	2

4.3	Graphics and Animation, Work with 2D Graphics, Bitmap, Animation, Frame Animation, Tween Animation, View Animation,	2
4.4	Multimedia in Android, Play Audio Files, Play Video Files	1
MODULE V		
5.1	Work in Background, Services, Notification Services,	1
5.2	Broadcast Receiver Introduction to Firebase with simple CRUID Operation, Text to Speech, Camera, Taking Pictures with Camera,	2
5.3	Manage Bluetooth Connection, Monitor and Manage Wi-Fi, Accelerometer Sensor & Gyroscope.	2
5.4	Signing the Android Application, Versioning the Android Application, Publishing the Android Application	2

CO Assessment Questions	
1	Briefly describe the Android system architecture, highlighting its open-source nature and compatibility with diverse devices.
2	Differentiate between Linear layout and Relative layout in Android layouts. Provide examples of scenarios where each layout type is most appropriate and explain how they contribute to effective UI design.
3	Describe the steps involved in establishing database connectivity in Android applications.
4	Describe the mechanisms for receiving location updates in real-time within an Android application. Discuss the options available for optimizing location update frequency.
5	Describe the key components and functionalities of the Android Notification service. How can developers enhance user engagement through the effective use of notifications in their applications?

24CSE7113	Networks and Systems Security	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course helps the learners to explore various network and system security protocols. This course covers authentication protocols, firewalls and security protocols from different layers such as data link, network, transport and application. The concepts covered in this course enable the learners in effective use of security protocols for securing network applications.

Prerequisite:. A fundamental knowledge in the concepts of Computer Networks.

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain authentication protocols, X.509 authentication service and Public Key Infrastructure (PKI). **(Cognitive Knowledge Level : Understand)**
CO2	Identify the security mechanisms in E mail security services. **(Cognitive Knowledge Level: Understand)**
CO3	Summarize the network and transport layer security services provided in a secure communication scenario. **(Cognitive Knowledge Level: Apply)**
CO4	Describe real time communication security and application layer security protocols. **(Cognitive Knowledge Level: Apply)**
CO5	Explain the concepts of firewalls and wireless network security. **(Cognitive Knowledge Level: Understand)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3		3									3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3			3						3
CO5	3	3	3									3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test 1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate			✓	
Create				

Mark Distribution of CIA

Course Structure	Atte	Theory [L- T]	Total

[L-T-P-J]		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Authentication Protocols (7 hours)

Authentication Protocols – Mutual authentication, One way authentication. Kerberos –Kerberos Version 4, Kerberos Version 5. X.509 Authentication service. Public Key Infrastructure (PKI) – Trust models, Revocation.

MODULE II : E-mail Security (6 hours)

Pretty Good Privacy (PGP) – Operational Description, Cryptographic keys and key rings, Message format, PGP message generation, PGP message reception, Public key management. S/MIME – Functionality, Messages, Certificate processing, Enhanced security services.

MODULE III : Network Layer Security and Web Service (7 hours)

Internet Protocol Security (IPSec) – Overview, IP security architecture, Authentication Header (AH), Encapsulating Security Payload (ESP), Combining Security Associations, Key management. Internet Key Exchange (IKE) - Phases. Web Security – Web security considerations. Secure Socket Layer and Transport Layer Security (SSL/TLS) – SSL Architecture, SSL protocols, Cryptographic computations, Transport layer security.

MODULE IV : Real-time Security and Application Layer Security (6 hours)

Real-time communication security – Perfect Forward Secrecy (PFS), Denial-of-Service protection, Endpoint identifier hiding, Live partner reassurance. Hypertext Transfer Protocol Secure (HTTPS) – Connection initiation, Closure. Secure Shell (SSH) – Transport layer protocol, User authentication protocol, Connection protocol. Secure Electronic Transaction (SET) – Overview, Features, Participants, Dual signature, Payment processing.

MODULE V : System Security and Wireless Security (9 hours)

Firewalls – Firewall characteristics, Types of Firewalls, Firewall configurations, Encrypted Tunnels, Trusted systems – Data access control, The concept of Trusted Systems, Trojan horse defense. IEEE 802.11i wireless LAN security - Services, Phases of operation, Wired Equivalent Privacy (WEP), Wi-Fi Protected Access (WPA), WPA2.

Text books

1. William Stallings, Cryptography and Network Security Principles and Practice, 4/e, Pearson Ed.
2. C. Kaufman, R. Perlman and M. Speciner, "Network Security: Private Communication in a Public World", 2/e, PHI.

Reference books

1. Behrouz A. Forouzan, DebdeepMukhopadhyay, "Cryptography and Network Security", 3/e, Tata McGraw Hill.
2. Tyler Wrightson, "Wireless Network Security A Beginner's Guide", 2012, Tata McGraw Hill.
3. William Stallings, "Network Security Essentials: Applications and Standards", 4/e, Prentice Hall.
4. Schiller J., Mobile Communications, 2/e, Pearson Education.
5. Roberta Bragg et. al., "Network Security: The Complete Reference", Tata McGraw Hill

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Authentication Protocols	1
1.2	Mutual authentication.	1
1.3	One way authentication.	1
1.4	Kerberos –Kerberos Version 4, Kerberos Version 5.	1

1.5	X.509 Authentication service.	1
1.6	Public Key Infrastructure (PKI) – Trust models, Revocation	1
1.7	Public Key Infrastructure (PKI) – Trust models, Revocation	1
MODULE 2		
2.1	Pretty Good Privacy (PGP) – Operational Description	1
2.2	Cryptographic keys and key rings Message format	1
2.3	PGP message generation, PGP message reception	1
2.4	Public key management.	1
2.5	S/MIME – Functionality, Messages, Certificate processing,	1
2.6	Enhanced security services.	1
MODULE 3		
3.1	Internet Protocol Security (IPSec) – Overview, IP security architecture	1
3.2	Authentication Header (AH), Encapsulating Security Payload (ESP)	1
3.3	Combining Security Associations, Key management. Internet Key Exchange (IKE) - Phases.	1
3.4	Web Security – Web security considerations.	1
3.5	Secure Socket Layer and Transport Layer Security (SSL/TLS) – SSL Architecture,	1
3.6	SSL protocols	1
3.7	Cryptographic computations, Transport layer security.	1
MODULE 4		
4.1	Real-time communication security – Perfect Forward Secrecy (PFS)	1
4.2	Denial-of-Service protection, Endpoint identifier hiding, Live partner reassurance.	1
4.3	Denial-of-Service protection, Endpoint identifier hiding, Live partner reassurance.	1
4.4	Hypertext Transfer Protocol Secure (HTTPS) – Connection initiation, Closure.	1

4.5	Secure Shell (SSH) – Transport layer protocol, User authentication protocol, Connection protocol.	1
4.6	Secure Electronic Transaction (SET) – Overview, Features, Participants, Dual signature, Payment processing.	1
	MODULE 5	
5.1	Firewalls – Firewall characteristics	1
5.2	Types of Firewalls, Firewall configurations	1
5.3	Encrypted Tunnels	1
5.4	Trusted systems – Data access control,	1
5.5	The concept of Trusted Systems, Trojan horse defense.	1
5.6	IEEE 802.11i wireless LAN security - Services	1
5.7	Phases of operation	1
5.8	Wired Equivalent Privacy (WEP)	1
5.9	Wi-Fi Protected Access (WPA), WPA2	1

CO Assessment Questions	
1	1. Elaborate on the key differences between Kerberos Version 4 (K4) and Kerberos Version 5 (K5) authentication protocols? 2. What are the typical applications or protocols that leverage X.509 certificates for authentication? 3. How does the web of trust model differ from the hierarchical trust model in PKI?
2	1. In what ways does PGP ensure the confidentiality and integrity of the message during the generation process? 2. How does PGP balance usability and security in its operational design, and what measures are in place to prevent common security risks? 3. Explain the role of certificates in S/MIME, particularly in the context of verifying the authenticity of digital signatures and facilitating secure communication.
3	1. How does IPSec ensure the confidentiality and integrity of data through the use of its Authentication Header (AH) and Encapsulating Security Payload (ESP)?

	2. Explain the key management aspects in IPSec, including how cryptographic keys are negotiated and maintained for securing data traffic. 3. Explain the cryptographic computations involved in SSL/TLS, focusing on how these protocols use encryption and hashing algorithms to achieve secure communication.
4	1. Explain the key differences between regular key exchange methods and PFS in the context of real-time communication security? 2. In what ways does the implementation of DoS protection impact the overall performance and reliability of real-time communication systems? 3. How does Secure Shell (SSH) operate as a transport layer protocol, and what security features does it provide for secure communication over a network?
5	1. Describe the various types of firewalls, including packet-filtering, stateful inspection, and proxy firewalls. What are the specific strengths and weaknesses of each type? 2. Explain the concept of encrypted tunnels in the context of firewalls. How do these tunnels contribute to securing communication over the internet? 3. Explain the defense mechanisms employed against Trojan horses in trusted systems. What proactive measures can be taken to prevent the infiltration of malicious software?

24CSE7123	Ethical Hacking	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The aim of the course is to introduce the methodologies and framework of ethical hacking for enhancing the security. The course includes impacts of Hacking, types of Hackers, Information Security Models, Information Security Program, Business Perspective, Planning a Controlled Attack, Framework of Steps (Reconnaissance, Enumeration, Vulnerability Analysis, Exploitation, Deliverable and Integration).

Prerequisite: 23CSP403 Operating Systems, 23CSP402 Computer Networks, 23CSP602 Introductory Cyber Security.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand hacking impacts, the hacker framework, information security models . **(Understand Level)**
CO 2	Integrate the business perspective to strategically plan and execute controlled cyber attacks. **(Apply Level)**
CO 3	Demonstrate advanced skills in ethical hacking, focusing on technical preparation, strategic engagement management, and adept utilization of reconnaissance methods to proactively address cybersecurity challenges. **(Understand Level)**
CO 4	Apply enumeration, exploitation, and comprehensive assessment for robust cybersecurity defense. **(Apply Level)**
CO 5	Generate ethical hacking deliverables, align findings strategically, integrate results effectively, and plan robust cybersecurity defense. **(Apply Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3				3		3		1		3
CO 2	3	3		1		3		3		2		3
CO 3	3	3		1		3		3		2		3
CO 4	3	3		1		3		3		2		3
CO 5	3	3		2		3		3		2		3

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✔	✔	✔	✔
Understand	✔	✔	✔	✔
Apply	✔	✔	✔	✔
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Introduction (7 hrs)

Introduction- Hacking Impacts, The Hacker. Framework- Planning the test, Sound Operations, Reconnaissance, Enumeration, Vulnerability Analysis, Exploitation, Final Analysis, Deliverable, Integration. Information Security Models - Computer Security, Network Security, Service Security, Application Security, Security Architecture. Information Security Program - The Process of Information Security, Component Parts of Information Security Program, Risk Analysis and Ethical Hacking.

MODULE II: Planning for a Controlled Attack (8 hrs)

The Business Perspective- Business Objectives, Security Policy, Previous Test Results, Business Challenges. Planning for a Controlled Attack- Inherent Limitations, Imposed Limitations, timing is Everything, Attack Type, Source Point, Required Knowledge, Multi-Phased Attacks, Teaming and Attack Structure, Engagement Planner, The Right Security Consultant, The Tester, Logistics, Intermediates, Law Enforcement.

MODULE III: Preparing for a Hack (6 hrs)

Preparing for a Hack- Technical Preparation, Managing the Engagement. Reconnaissance- Social Engineering, Physical Security, Internet Reconnaissance.

MODULE IV: Enumeration & Exploitation (8 hrs)

Enumeration- Enumeration Techniques, Soft Objective, Looking Around or Attack, Elements of Enumeration, Preparing for the Next Phase. Exploitation- Intutive Testing, Evasion, Threads and Groups, Operating Systems, Password Crackers, RootKits, applications, Wardialing, Network, Services and Areas of Concern.

MODULE V: Deliverable & Integration (7 hrs)

Deliverable- The Deliverable, The Document, Overall Structure, Aligning Findings, Presentation. Integration- Integrating the Results, Integration Summary, Mitigation, Defense Planning, Incident Management, Security Policy, Conclusion.

Text books

1. James S. Tiller, The Ethical Hack: A Framework for Business Value Penetration Testing, Auerbach Publications, CRC Press, 2004.

Reference books

1. EC-Council, Ethical Hacking and Countermeasures Attack Phases, Cengage Learning, 2009.
2. Michael Simpson, Kent Backman, James Corley, Hands-On Ethical Hacking and Network Defense, Cengage Learning, 2010.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Introduction- Hacking Impacts, The Hacker.	1
1.2	Planning the test, Sound Operations, Reconnaissance, Enumeration, Vulnerability Analysis.	1
1.3	Exploitation, Final Analysis, Deliverable, Integration.	1
1.4	Computer Security, Network Security.	1
1.5	Service Security, Application Security, Security Architecture.	1
1.6	The Process of Information Security, Component Parts of Information Security Program.	1
1.7	Risk Analysis and Ethical Hacking.	1
	MODULE II	
2.1	Business Objectives, Security Policy.	1
2.2	Previous Test Results, Business Challenges.	1
2.3	Inherent Limitations, Imposed Limitations.	1
2.4	Timing is Everything, Attack Type, Source Point.	1
2.5	Required Knowledge, Multi-Phased Attacks.	1
2.6	Teaming and Attack Structure, Engagement Planner.	1
2.7	The Right Security Consultant, The Tester.	1
2.8	Logistics, Intermediates, Law Enforcement.	1

MODULE III		
3.1	Preparing for a Hack - Technical Preparation.	1
3.2	Managing the Engagement.	1
3.3	Reconnaissance: Social Engineering (Lecture 1).	1
3.4	Reconnaissance: Social Engineering (Lecture 2).	1
3.5	Physical Security.	1
3.6	Internet Reconnaissance.	1
MODULE IV		
4.1	Enumeration Techniques, Soft Objective, Looking Around or Attack.	1
4.2	Elements of Enumeration.	1
4.3	Preparing for the Next Phase.	1
4.4	Exploitation- Intutive Testing.	1
4.5	Evasion, Threads and Groups.	1
4.6	Operating Systems, Password Crackers.	1
4.7	RootKits, applications, Wardialing	1
4.8	Network, Services and Areas of Concern.	1
MODULE V		
5.1	The Deliverable, The Document.	1
5.2	Overall Structure.	1
5.3	Aligning Findings, Presentation.	1
5.4	Integrating the Results.	1
5.5	Integration Summary, Mitigation.	1
5.6	Defense Planning, Incident Management.	1
5.7	Security Policy, Conclusion.	1

CO Assessment Questions	
CO1	1. Identify and explain the component parts integral to an information security program. 2. Discuss fundamental concepts in security architecture and their role in designing secure systems.
CO2	1. Provide an example of how leveraging insights from previous security tests influenced strategic decisions in a subsequent testing cycle, contributing to improved security posture. 2. Illustrate a situation where a multi-phased attack approach was applied, detailing the phases involved and explaining the rationale for a multi-phased strategy.
CO3	1. How can industry standards be incorporated into the technical preparation phase of ethical hacking? 2. Discuss the pivotal role of reconnaissance in enhancing cybersecurity

	measures.
CO4	1. Discuss a situation where ethical considerations played a crucial role in deciding whether to use password crackers during a penetration test. How did you ensure responsible and ethical use? 2. Provide an example of a situation where having a "soft objective" in the enumeration phase significantly influenced the overall success of a penetration test. How did it impact decision-making? 3. Describe a scenario where intuitive testing revealed an unexpected vulnerability during the exploitation phase. How did this discovery impact the overall testing strategy?
CO5	1. When preparing a security testing deliverable, how do you ensure that it provides a comprehensive overview, including key findings, recommendations, and actionable insights for stakeholders? 2. Discuss a situation where the overall structure of a security testing document significantly impacted the clarity and effectiveness of the message conveyed to both technical and non-technical stakeholders. 3. When integrating technical details into reports for non-technical stakeholders, how do you strike a balance between providing sufficient information and avoiding unnecessary complexity?

24CSE7133	GPU Architecture and Programming	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The course aims to equip students with a comprehensive understanding of Graphics Processing Units (GPUs) as parallel computing devices. Students will delve into the evolution of GPU computing, exploring the architecture of modern GPUs and their historical context within graphics pipelines. The primary objectives include providing insights into parallel programming languages and models, with a specific focus on CUDA and OpenCL. The course aims to foster a deep comprehension of performance considerations in GPU programming, covering aspects like thread execution, memory bandwidth optimization, and debugging techniques. By the end of the course, students should be proficient in leveraging GPUs for parallel processing, be capable of optimizing code for efficient execution on these architectures, and possess a solid foundation in the principles underlying GPU programming and architecture.

Prerequisite: Basic knowledge in Programming and Data Structures, Digital Logic and Computer architecture.

Course Outcomes: After the completion of the course the student will be able to

CO1	Understand GPU computing architecture **(Understand Level)**
CO2	Code with GPU programming environments **(Apply Level)**
CO3	Design and develop programs that make efficient use of the GPU processing power. **(Apply Level)**
CO4	Analyze the methods of performance improvement in GPU **(Analyze Level)**
CO5	Design and develop programs using CUDA and Open CL **(Apply Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2									1
CO2	2	3	2									1
CO3	2	2	2									
CO4	3	2	2									
CO5	3	2	2				1					1
CO6	3	2										

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	✓
Evaluate			✓	
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

Module I (GPU Structure) (7 hours)

Graphics Processing Units (GPU) as Parallel Computers - Understanding Parallelism with GPU- Architecture of a modern GPU - Parallel Programming Languages and Models - Overarching Goals - History of GPU computing - Evolution of Graphics Pipelines - GPU Computing.

Module II (Parallel Programming) (7 hours)

Goals of Parallel Programming - Problem Decomposition - Algorithm Selection - Computational Thinking - Some Common Parallel Patterns- Loop-based patterns - Fork/join pattern - Tiling/grids - Divide and conquer.

Module III (CUDA Programming) (8 hours)

Data Parallelism - CUDA Program Structure – Matrix Multiplication Example - Device Memories and Data Transfer - Kernel Functions and Threading -

Function declarations - Kernel launch - Predefined variables - Runtime API - CUDA Threads: CUDA Thread Organization -Thread Assignment - Thread Scheduling and Latency Tolerance - CUDA Memories: Importance of Memory Access Efficiency - CUDA Device Memory Types - A Strategy for Reducing Global Memory Traffic.

Module IV (Performance considerations) (7 hours)

Thread execution - Global memory bandwidth - Dynamic partitioning of SM resources - Data prefetching Instruction mix - Thread Granularity - Floating Point considerations: FP format - Representable numbers – Special bit patterns and precision - Arithmetic accuracy and rounding - Algorithm considerations - Debugging and Profiling: Debugging CUDA programs - Profiling CUDA programs

Module V (OpenCL Basics) (7 hours)

Introduction to OPENCL: Data Parallelism Model - Device Architecture - Kernel Functions – Device Management and Kernel Launch - Memory Model - Basic OpenCL Examples.

Text books:

1. David Kirk, Wen-mei Hwu, Programming Massively Parallel Processors: A Hands-on Approach, Third Edition, Morgan Kaufmann, 2017.
2. Shane Cook, CUDA Programming: A Developer's Guide to Parallel Computing with GPUs (Applications of GPU Computing), First Edition, Morgan Kaufmann, 2012.
3. David R. Kaeli, Perhaad Mistry, Dana Schaa, Dong Ping Zhang, Heterogeneous computing with OpenCL, 3rd Edition, Morgan Kauffman, 2015.

References:

1. Nicholas Wilt, CUDA Handbook: A Comprehensive Guide to GPU Programming, Addison – Wesley, 2013.
2. Jason Sanders, Edward Kandrot, CUDA by Example: An Introduction to General Purpose GPU Programming, Addison – Wesley, 2010.
3. http://www.nvidia.com/object/cuda_home_new.html
4. http://www.openCL.org

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Graphics Processing Units (GPU) as Parallel Computers and Understanding Parallelism with GPU	1
1.2	Architecture of a modern GPU (Lecture 1)	1
	Architecture of a modern GPU (Lecture 2)	1
1.3	Parallel Programming Languages and Models	1

1.4	History of GPU computing	1
1.5	Evolution of Graphics Pipelines	1
1.6	GPU Computing	1
MODULE II		
2.1	Goals of Parallel Programming, Problem Decomposition	1
2.2	Algorithm Selection	1
2.3	Computational Thinking	1
2.4	Some Common Parallel Patterns, Loop-based patterns	1
2.5	Fork/join pattern	1
2.6	Tiling/grids	1
2.7	Divide and conquer.	1
MODULE III		
3.1	Data Parallelism, CUDA Program Structure	1
3.2	Matrix Multiplication Example, Device Memories and Data Transfer	1
3.3	Kernel Functions and Threading, Function declarations	1
3.4	Kernel launch, Predefined variables, Runtime API	1
3.5	CUDA Threads: CUDA Thread Organization, Thread Assignment.	1
3.6	Thread Scheduling and Latency Tolerance	1
3.7	CUDA Memories: Importance of Memory Access Efficiency	1
3.8	CUDA Device Memory Types, A Strategy for Reducing Global Memory Traffic.	1
MODULE IV		
4.1	Thread execution, Global memory bandwidth	1
4.2	Dynamic partitioning of SM resources, Data prefetching Instruction mix	1

4.3	Thread Granularity	1
4.4	Floating Point considerations: FP format, Representable numbers, Special bit patterns and precision	1
4.5	Arithmetic accuracy and rounding, Algorithm considerations	1
4.6	Debugging and Profiling: Debugging CUDA programs	1
4.7	Profiling CUDA programs	1
	MODULE V	
5.1	Introduction to OPENCL: Data Parallelism Model	1
5.2	Device Architecture	1
5.3	Kernel Functions	1
5.4	Device Management and Kernel Launch	1
5.5	Memory Model	1
5.6	Basic OpenCL Examples (Lecture 1)	1
	Basic OpenCL Examples (Lecture 2)	1

	CO Assessment Questions
1	Explain the key components of a modern GPU architecture and how they contribute to parallel processing. Provide examples of GPU-specific features that distinguish them from traditional CPU architectures.
2	Write a CUDA program that utilizes parallel threads to perform matrix multiplication. Discuss the key elements of the code that enable efficient parallel execution on the GPU, and compare the performance with a corresponding CPU implementation.
3	Given a real-world computing problem, design and implement a GPU-accelerated solution using OpenCL. Justify your design choices and discuss how the program efficiently harnesses the processing power of the GPU to achieve performance gains.
4	Compare and contrast different methods for improving GPU performance, such as optimizing memory access patterns, using shared memory, and reducing global memory traffic. Provide examples of scenarios where each

	method would be most effective.
5	Develop a program that solves a computationally intensive problem using both CUDA and OpenCL. Compare the development experiences, syntax, and performance characteristics of the two programming models. Discuss the factors that might influence the choice between CUDA and OpenCL for a given application.

24CSE7143	Software Defined Networks	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The aim of this course is for the students to understand the need for Software Defined Networks and its data plane operations and to explore various techniques of network function virtualization.

Prerequisite: 23CSP402 Computer Networks, 23CSP403 Operating Systems

Course Outcomes: After the completion of the course the student will be able to

CO 1	Describe the motivation behind SDN. **(Understand Level)**
CO 2	Identify the functions of the data plane and control plane. **(Understand Level)**
CO 3	Design and develop network applications using SDN. **(Apply Level)**
CO 4	Orchestrate network services using NFV. **(Understand Level)**
CO 5	Explain various use cases of SDN and NFV. **(Understand Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	1	1	1							3
CO 2	3	2	1	1	1							3
CO 3	3	2	2	1	1							3
CO 4	3	2	1	1	1							3
CO 5	3	2	1	1	1							3

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✔	✔	✔	✔
Understand	✔	✔	✔	✔
Apply	✔	✔	✔	✔
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: SDN- Introduction (6 hrs)

Evolving Network Requirements – The SDN Approach – SDN architecture - SDN Data Plane , Control plane and Application Plane.

MODULE II: SDN Data Plane And Control Plane (9 hrs)

Data Plane functions and protocols - OpenFLow Protocol - Flow Table - Control Plane Functions - Southbound Interface, Northbound Interface – SDN Controllers - Ryu, OpenDaylight, ONOS - Distributed Controllers.

MODULE III: SDN Applications (7 hrs)

SDN Application Plane Architecture – Network Services Abstraction Layer – Traffic Engineering – Measurement and Monitoring – Security – Data Center Networking.

MODULE IV: Network Function Virtualization (7 hrs)

Network Virtualization - Virtual LANs – OpenFlow VLAN Support - NFV Concepts – Benefits and Requirements – Reference Architecture.

MODULE V: NFV Functionality (7 hrs)

NFV Infrastructure – Virtualized Network Functions – NFV Management and Orchestration – NFV Use cases – SDN and NFV.

Text books

1. William Stallings, Foundations of Modern Networking: SDN, NFV, QoE, IoT and Cloud, Pearson Education, 1st Edition, 2015.

Reference books

1. Ken Gray, Thomas D. Nadeau, Network Function Virtualization, Morgan Kauffman, 2016.
2. Thomas D Nadeau, Ken Gray, SDN: Software Defined Networks, O'Reilly Media, 2013.

3. Fei Hu, Network Innovation through OpenFlow and SDN: Principles and Design, 1st Edition, CRC Press, 2014.
4. Paul Goransson, Chuck Black Timothy Culver, Software Defined Networks: A Comprehensive Approach, 2nd Edition, Morgan Kaufmann Press, 2016.
5. Oswald Coker, Siamak Azodolmolky, Software-Defined Networking with OpenFlow, 2nd Edition, O'Reilly Media, 2017.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Evolving Network Requirements.	1
1.2	The SDN Approach.	1
1.3	SDN architecture.	1
1.4	SDN Data Plane.	1
1.5	Control plane.	1
1.6	Application Plane.	1
	MODULE II	
2.1	Data Plane functions and protocols.	1
2.2	OpenFLow Protocol.	1
2.3	Flow Table.	1
2.4	Control Plane Functions.	1
2.5	Southbound Interface.	1
2.6	Northbound Interface.	1
2.7	SDN Controllers - Ryu.	1
2.8	OpenDaylight, ONOS	1
2.9	Distributed Controllers.	1
	MODULE III	
3.1	SDN Application Plane Architecture (Lecture 1).	1
3.2	SDN Application Plane Architecture (Lecture 2).	1
3.3	Network Services Abstraction Layer.	1
3.4	Traffic Engineering.	1
3.5	Measurement and Monitoring.	1
3.6	Security.	1
3.7	Data Center Networking.	1
	MODULE IV	
4.1	Network Virtualization.	1
4.2	Virtual LANs.	1
4.3	OpenFlow VLAN Support.	1
4.4	NFV Concepts – Benefits and Requirements (Lecture 1).	1
4.5	NFV Concepts – Benefits and Requirements (Lecture 2).	1
4.6	Reference Architecture (Lecture 1).	1

4.7	Reference Architecture (Lecture 2).	1
MODULE V		
5.1	NFV Infrastructure (Lecture 1).	1
5.2	NFV Infrastructure (Lecture 2).	1
5.3	Virtualized Network Functions.	1
5.4	NFV Management and Orchestration (Lecture 1).	1
5.5	NFV Management and Orchestration (Lecture 2).	1
5.6	NFV Use cases – SDN and NFV (Lecture 1).	1
5.7	NFV Use cases – SDN and NFV (Lecture 2).	1

CO Assessment Questions	
CO1	1. How does SDN enhance network programmability compared to traditional networking? 2. Explain the role of the Data Plane in SDN architecture. 3. Why is the separation of the data plane and control plane important in SDN? 4. What types of applications can be integrated into the SDN Application Plane?
CO2	1. How does the OpenFlow Protocol enable communication between the SDN Controller and the network devices? 2. Compare and contrast the functions of the Southbound Interface and the Northbound Interface in SDN. 3. What challenges might arise in the deployment of distributed SDN Controllers, and how can they be addressed? 4. How does OpenDaylight contribute to SDN Controller capabilities and functionalities?
CO3	1. Discuss a scenario where Traffic Engineering in SDN can be beneficial for load balancing. 2. Discuss the impact of the Network Services Abstraction Layer on simplifying application development in SDN. 3. Describe the role of the Application Plane in implementing security policies in SDN.
CO4	1. Describe the basic principles of Network Functions Virtualization (NFV). 2. Describe the components of the NFV reference architecture and their interactions.
CO5	1. Explain the concept of Virtualized Network Functions (VNFs) in the context of NFV. 2. Describe the role of NFV Management and Orchestration (MANO) in the deployment of virtualized network functions. 3. Describe a scenario where NFV can enhance network service agility and flexibility. 4. Discuss the role of NFV in optimizing resource utilization and reducing operational costs.

24CSE7153	AWS Cloud Computing	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course enables students to understand the fundamental principles and features of Amazon Web Services, recognized as the industry's leading cloud platform. The syllabus covers the topics like fundamentals of AWS, compute and storage services, security measures and networking solutions and AWS cloud governance and optimization. This helps the students to equip with the knowledge and skills needed to thrive in the dynamic landscape of cloud computing.

Prerequisite: Cloud Computing

Course Outcomes: After the completion of the course the student will be able to

CO1	Select suitable AWS services for the given scenario. **(Understand Level)**
CO2	Utilize the principles of storage and compute services in AWS for the secure storage of the data. **(Apply Level)**
CO3	Explain the shared responsibility model and the role of AWS in ensuring security. **(Understand Level)**
CO4	Apply the principle of networking on AWS while developing AWS based solutions. **(Apply Level)**
CO5	Explain the basic principles of AWS cloud governance and optimization. **(Understand Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										3
CO2	3	3										3
CO3	3	3										3
CO4	3	3										3
CO5	3	3										3
CO6	3	3										3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test 1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate			✓	
Create			✓	

Mark Distribution of CIA						
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Basics of AWS (8 hrs)

Cloud computing -Overview, Advantages and disadvantages, Types of cloud services. AWS Fundamentals- History and evolution of AWS, Global Infrastructure, Security and Compliance. AWS Cloud Computing Platform- Accessing the Platform, Compute and Networking Services, Storage and Content Delivery, Database Services, Management Tools, Security and Identity, Application Services.

MODULE II: Compute services on AWS (6 hrs)

AWS Compute Services - Amazon EC2 (Elastic Compute Cloud)-Features, Amazon machine Image (AMI), Security Group, Instance Types: General Purpose, Compute optimized, Storage Optimized, Memory optimized. EC2 Instance Launch Types: On-demand Instances, Reserved Instances, Spot Instances, Dedicated Host, Dedicated Instances. Elastic Load Balancing and Auto Scaling (ELB and ASG).

MODULE III : Storage services and Security on AWS (9 hrs)
Amazon Simple Storage Service(S3)- Object Storage versus Traditional Block and File Storage, Understanding S3 buckets and objects, S3 storage classes and features, Versioning and lifecycle policies. Amazon Elastic Block Store (EBS)- Block storage concepts, Creating and attaching EBS volumes. AWS Identity and Access management (AWS IAM) – Root User, IAM Users, Groups, Roles, Policy. Security and Compliance – The shared responsibility model, DDoS Attack (Brief Description), AWS Shield, AWS Web Application Firewall (WAF), AWS Artifact.
MODULE IV: Networking on AWS (6 hrs)
Networking and Content Delivery - AWS Virtual Private Cloud (VPC)-Subnet, Route tables, Internet Gateway, Dynamic Host Configuration Protocol (DHCP) Option Sets, Network Access Control List (NACL), Network Address Translation (NAT) Instances and NAT Gateways. Amazon Route 53 – DNS concepts and basics, Configuring domain registration and routing, Health checks and failover configurations.
MODULE V: AWS Cloud Governance and Optimization (7 hrs)
AWS Organization: Organizational Unit, Service Control Policy. Cloud Integration-Simple Notification Service (SNS), Simple Queue Service (SQS). Cloud Monitoring-CloudWatch, Cloud Trail. AWS Support Plan-Basic, Developer, Business, Enterprise. Cost Management and Optimization-AWS Cost Explorer, AWS Budgets.
Text books 1. AWS Certified Solutions Architect – Official Study Guide" by Joe Baron, Hisham Baz, Tim Bixler, Biff Gaut, Kevin E. Kelly, Sean Senior, and John Stamper, 2016. 2. Learning Amazon Web Services (AWS): A Hands-On Guide to the Fundamentals of AWS Cloud 1st Edition by Mark Wilkins, 2019.
Reference books 1. Amazon Web Services in Action by Andreas Wittig and Michael Wittig, 2nd edition.2015. **2.** AWS: The Ultimate Guide from Beginners to Advance for The Amazon Web Services by Theo H. King, 2020.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36 hrs)
	MODULE 1	
1.1	Cloud computing -Overview, Advantages and disadvantages, Types of cloud services	1
1.2	AWS Fundamentals- History and evolution of AWS, Global Infrastructure	1
1.3	Security and Compliance	1
1.4	AWS Cloud Computing Platform	1

1.5	AWS Cloud Computing Platform- Accessing the Platform, Compute and Networking Services.	1
1.6	Storage and Content Delivery, Database Services, Management Tools	1
1.7	Security and Identity	1
1.8	Application Services.	1
	MODULE II	
2.1	AWS Compute Services - Amazon EC2 (Elastic Compute Cloud)- Features, Amazon machine Image (AMI).	1
2.2	Security Group	1
2.3	Instance Types: General Purpose, Compute optimized, Storage Optimized, Memory optimized	1
2.4	EC2 Instance Launch Types: On-demand Instances, Reserved Instances.	1
2.5	Spot Instances, Dedicated Host, Dedicated Instances	1
2.6	Elastic Load Balancing and Auto Scaling (ELB and ASG).	1
	MODULE III	
3.1	Amazon S3- Object Storage versus Traditional Block and File Storage, Understanding S3 buckets and objects	1
3.2	S3 storage classes and features	1
3.3	Versioning and lifecycle policies	1
3.4	Amazon Elastic Block Store (EBS)- Block storage concepts	1
3.5	Creating and attaching EBS volumes.	1
3.6	AWS Identity and Access management (AWS IAM) – Root User, IAM Users	1
3.7	Groups, Roles, Policy.	1
3.8	Security and Compliance - DDoS Attack (Brief Description), AWS Shield.	1
3.9	AWS Web Application Firewall (WAF), AWS Artifact.	1
	MODULE IV	
4.1	Networking and Content Delivery - AWS Virtual Private Cloud (VPC)-Subnet, Route tables, Internet Gateway.	1
4.2	Dynamic Host Configuration Protocol (DHCP) Option Sets, Network Access Control List (NACL).	1
4.3	Network Address Translation (NAT) Instances and NAT Gateways	1
4.4	Amazon Route 53 – DNS concepts and basics	1
4.5	Configuring domain registration and routing	1
4.6	Health checks and failover configurations	1
	MODULE V	
5.1	AWS Organization: Organizational Unit, Service Control Policy	1
5.2	Cloud Integration- Simple Notification Service (SNS).	1

5.3	Simple Queue Service (SQS).	1
5.4	Cloud Monitoring- CloudWatch, Cloud Trail.	1
5.5	AWS Support Plan-Basic, Developer, Business, Enterprise	1
5.6	Cost Management and Optimization-AWS Cost Explorer	1
5.7	AWS Budgets	1

CO Assessment Questions	
1	a) Your company experiences fluctuations in traffic patterns to their e-commerce website based on flash sales. What service can help your company dynamically match the required compute capacity to the spike in traffic during flash sales? Explain. b) Your company provides an online photo sharing service. The development team is looking for ways to deliver image files with the lowest latency to end users so the website content is delivered with the best possible performance. What service can help speed up distribution of these image files to end users around the world? Explain. c) Your company runs an Amazon Elastic Compute Cloud (Amazon EC2) instance periodically to perform a batch processing job on a large and growing filesystem. At the end of the batch job, you shut down the Amazon EC2 instance to save money but need to persist the filesystem on the Amazon EC2 instance from the previous batch runs. What AWS Cloud service can you leverage to meet these requirements? Explain.
2	a) Explain the key characteristics of Amazon Simple Storage Service. b) Your application stores critical data in Amazon Simple Storage Service (Amazon S3), which must be protected against inadvertent or intentional deletion. How can this data be protected?
3	a) How many access keys may an AWS Identity and Access Management (IAM) user have active at one time? b) Explain the technology which does Amazon Workspaces use to provide data security? c) You have launched an Amazon Linux Elastic Compute Cloud (Amazon EC2) instance into EC2-Classic, and the instance has successfully passed the System Status Check and Instance Status Check. You attempt to securely connect to the instance via Secure Shell (SSH) and receive the response, “WARNING: UNPROTECTED PRIVATE KEY FILE,” after which the login fails. Explain the cause of the failed login? d) Your application stores critical data in Amazon Simple Storage Service (Amazon S3) which must be protected against inadvertent or intentional deletion. How can this data be protected?
4	a) You are a solutions architect working for a large travel company that is migrating its existing server estate to AWS. You have recommended that they use a custom Amazon VPC, and they have agreed to proceed. They

	will need a public subnet for their web servers and a private subnet in which to place their databases. They also require that the web servers and database servers be highly available and that there be a minimum of two web servers and two database servers each. How many subnets should you have to maintain high availability? b) You create a new subnet and then add a route to your route table that routes traffic out from that subnet to the Internet using an IGW. What type of subnet have you created? Explain. c) You have created a custom Amazon VPC with both private and public subnets. You have created a NAT instance and deployed this instance to a public subnet. You have attached an EIP address and added your NAT to the route table. Unfortunately, instances in your private subnet still cannot access the Internet. What may be the cause of this?
5	a) You are designing a new application, and you need to ensure that the components of your application are not tightly coupled. You are trying to decide between the different AWS Cloud services to use to achieve this goal. Your requirements are that messages between your application components may not be delivered more than once, tasks must be completed in either a synchronous or asynchronous fashion, and there must be some form of application logic that decides what do when tasks have been completed. What application service should you use? b) How does Amazon Simple Queue Service (Amazon SQS) deliver messages?

24CSE7163	Soft Computing	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course focus on giving introduction to some new fields in soft computing with its principal components of fuzzy logic and GA which helps students to differentiate traditional and genetic algorithm. This course gives insightful study about problems incurred in various domains and the comprehensive soft computing techniques provides solution to these problems benefiting the students for the pursuit of allied research.

Prerequisite: Basics of Machine Learning

Course Outcomes: After the completion of the course the student will be able to

CO1	Describe soft computing techniques and the basic models of Artificial Neural Network **(Understand Level)**
CO2	Develop practical problems using neural networks (**Apply Level)**
CO3	Illustrate the operations and functions of fuzzy system **(Apply Level)**
CO4	Illustrate the concepts of Genetic Algorithm **(Apply level)**
CO5	Describe the concepts of multi-objective optimization models and the need for using hybrid soft computing approaches **(Understand level**)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3					3				3
CO2	3	3	3	1				3				3
CO3	3	3	3	1				3				3
CO4	3	3	3	1				3				3
CO5	3	3	3					3				3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Introduction to Soft Computing and Neural Networks

Concept of computing - soft computing vs. hard computing, Techniques, Applications, Characteristics, Hybrid computing. Artificial Neural Networks - Basic Concepts, The Biological Neuron, The Artificial Neuron. Basic models of artificial neural networks – Connections, Learning, Activation Functions. Linear separability, The XOR Problem.

MODULE II: Artificial Neural Networks

Neural Network Architectures, Hebb Rule, Hebb Nets, Perceptrons - Training & Testing Algorithms, Delta Rule, Adaline, Madaline, The Backpropagation Algorithm - Training & Testing Algorithms

MODULE III: Introduction to Fuzzy Logic

Fuzzy sets – properties, operations on fuzzy set. Fuzzy membership functions, Methods of membership value assignments – intuition, inference, Rank Ordering. Fuzzy relations– operations, Fuzzy Propositions. Fuzzy implications. Defuzzification– Lamda cuts, Defuzzification methods.

MODULE IV :Evolutionary Computing

Genetic Algorithms - Chromosomes, Population, GA Operators, GA Parameters, Convergence. Simulated Annealing (SA), Ant Colony Optimization, Particle Swam Optimization.

MODULE V :Advanced Search Techniques

Multi Objective Optimization Problem Formulation, The Pareto-optimal Front, Pareto-optimal Ranking, Multi-objective Fitness, Multi-objective GA Process.

Text books

1. Introduction to Soft Computing - Neuro Fuzzy and Genetic Algorithms- Samir Roy, Udit Chakraborty - Pearson, New Delhi, India, 2013.
2. Principles of Soft Computing, Dr. S N Sivanandam, Dr. S N Deepa, 3rd Edition,Wiley India, 2019
3. Evolutionary Computing : A Unified Approach - K. A. De Jong (Prentice Hall Inc, USA) 2009

Reference books

1. Evolutionary Algorithm for Solving Multi-objective Optimization Problems (2nd Edition) Collelo, Lament, Veldhnizer (Spring, 2010)
2. An Introduction to Genetic Algorithm Melanic Mitchell (MITPress, 2000)
3. Soft Computing : Fundamentals and Applications (2nd Ed.) D. K. Pratihar (Narosa, 2013)
4. Foundation of Neural Network, Fuzzy Systems & Knowledge Engineering by Nikole K Kashov (MIT Press, 1998)
5. Neural Network, Fuzzy Logic and Genetic Algorithm : Synthesis and Applications, S. Rajasekaran and G. A. Vijayalakshmi Pai (Prentice Hall India, 2010)

Suggested MOOC Courses

1. NPTEL Course - Introduction To Soft Computing, By Prof. Debasis Samanta, IIT Kharagpur
2. Fuzzy Logic and Neural Networks By Prof. Dilip Kumar Pratihar | IIT Kharagpur

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Concept of computing - soft computing vs. hard computing,	1
1.2	Techniques, Applications, Characteristics, Hybrid computing.	1

1.3	Artificial Neural Networks - Basic Concepts.	1
1.4	The Biological Neuron, The Artificial Neuron.	1
1.5	Basic models of artificial neural networks – Connections.	1
1.6	Learning, Activation Functions. Linear separability.	1
1.7	The XOR Problem.	1
MODULE II		
2.1	Neural Network Architectures	1
2.2	Hebb Rule, Hebb Nets (Lecture - 1)	1
2.3	Hebb Rule, Hebb Nets (Lecture - 2)	1
2.4	Perceptrons - Training & Testing Algorithms (Lecture - 1)	1
2.5	Perceptrons - Training & Testing Algorithms (Lecture - 2)	1
2.6	Delta Rule, Adaline, Madaline	1
2.7	The Backpropagation Algorithm - Traing (Lecture - 1)	1
2.8	The Backpropagation Algorithm - Testing (Lecture - 2)	1
MODULE III		
3.1	Fuzzy sets – properties, operations on fuzzy set.	1
3.2	Fuzzy membership functions	1
3.3	Methods of membership value assignments – intuition,	1
3.4	inference, Rank Ordering	1
3.5	Fuzzy relations– operations, Fuzzy Propositions	1
3.6	Fuzzy implications. Defuzzification– Lamda cuts	1
3.7	Defuzzification methods	1

MODULE IV		
4.1	Genetic Algorithms - Chromosomes	1
4.2	Population, GA Operators	1
4.3	GA Parameters, Convergence	1
4.4	Simulated Annealing (SA)	1
4.5	Ant Colony Optimization	1
4.6	Particle Swam Optimization (Lecture - 1)	1
4.7	Particle Swam Optimization (Lecture - 2)	1
MODULE V		
5.1	Multi Objective Optimization Problem Formulation (Lecture - 1)	1
5.2	Multi Objective Optimization Problem Formulation (Lecture - 2)	1
5.3	The Pareto-optimal Front	1
5.4	Pareto-optimal Ranking	1
5.5	Multi-objective Fitness	1
5.6	Multi-objective GA Process (Lecture - 1)	1
5.7	Multi-objective GA Process (Lecture - 2)	1

CO Assessment Questions	
1	1. Using linear separability concept, obtain the response for NAND function. (take bipolar inputs and bipolar targets). 2. List out the steps in perceptron learning algorithm for single output classes. 3. Implement NAND function using McCulloch-Pitts neuron model. (Use binary data representation).

2

1. Use Adaline network to train AND NOT function with bipolar inputs and targets. Calculate total mean error after 1 epoch of training. Initially the weights and bias have assumed a random value say 0.2.

x1	x2	b	t
1	1	1	-1
1	-1	1	1
-1	1	1	-1
-1	-1	1	-1

The learning rate is also set to 0.2.

2. Find the weights required to perform classification of patterns shown below using perceptron network. The patterns (1,1,-1) and (1, -1,-1) are belonging to the target class -1. The patterns (-1,1,1) and (-1,-1,1) are belonging to the target class +1. Assume suitable learning rate and initial weights.

3

1. Consider the two fuzzy sets

$$\underset{\sim}{A} = \left\{\frac{0}{0.2} + \frac{0.8}{0.4} + \frac{1}{0.6}\right\} \quad \underset{\sim}{B} = \left\{\frac{0.9}{0.2} + \frac{0.7}{0.4} + \frac{0.3}{0.6}\right\}$$

Using Zadeh's notation express the fuzzy sets into λ- cut sets for λ=0.4 for the following operations.

(i) $\underset{\sim}{A} \cap \underset{\sim}{B}$ (ii) $\underset{\sim}{A} \cup \underset{\sim}{B}$ (iii) $\overline{\underset{\sim}{A}} \cup \overline{\underset{\sim}{B}}$ (iv) $\overline{\underset{\sim}{A}} \cap \overline{\underset{\sim}{B}}$ (v) $\overline{\underset{\sim}{B}}$

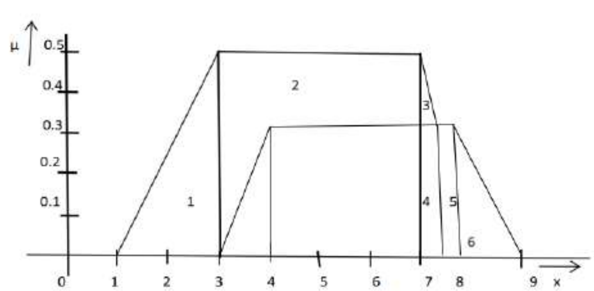
2. Consider two fuzzy set

$$\widetilde{A} = \left\{\frac{0.2}{1} + \frac{0.3}{2} + \frac{0.4}{3} + \frac{0.5}{4}\right\} \text{ and } \widetilde{B} = \left\{\frac{0.1}{1} + \frac{0.2}{2} + \frac{0.2}{3} + \frac{1}{4}\right\}$$

Find the algebraic sum, algebraic product, bounded sum and bounded difference of the given fuzzy sets.

3. a. Find the defuzzified value x* from the above fuzzy sets using COG method

   b. Mention the difference between COS and COG methods.



4	1. Using Genetic algorithm with Roulette wheel selection method maximize the function f(x)=x2 over {0, 1, 2, ..., 31} with initial x values of (13, 24, 8, 19). Show one crossover and mutation. 2. Explain the difference between the Ant System (AS), Max-Min Ant System (MMAS) and Ant Colony System (ACS) algorithms. 3. Discuss how to use PSO for permutation problems and use the traveling sales person as an example to illustrate your answer
5	1. Explain convex and non convex MOOP? How to find a non dominated set. 2. What are the properties of dominance relation? 3. Differentiate between linear and nonlinear Multi Objective Optimization Problem.

Open Elective 1/ Industry Elective

24CSO714	Data Structures	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble:

The course is intended to provide the foundations of the practical implementation and usage of Data Structures and algorithms. This course covers basic concepts of Data Structures such as array, stack, queue, tree, graph and hash table that equip the students to solve problems, and design data structures that can tackle real-world challenges.

Prerequisite: Topics covered under the course Problem solving and Programming 23ESP204

Course Outcomes: After the completion of the course the student will be able to

CO 1	Estimate the time and space complexity and choose the most efficient data structure for specific tasks. **(Cognitive Level : Apply)**
CO 2	Explain and implement fundamental data structures such as arrays, linked lists, stacks, queues, trees and graph **(Cognitive Level : Apply)**
CO 3	Identify the appropriate Hash Function and memory management techniques to enable efficient access of data. **(Cognitive Level : Apply)**
CO 4	Explain various sorting algorithms and compare their time and space complexities. **(Cognitive Level : Apply)**
CO 5	Solve the real world problems using suitable data-structures and calculate the time and space complexity **(Cognitive Level : Apply)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	3	1								3
CO 2	3	3	3	1								3
CO 3	3	3	3	1								3
CO 4	3	3	3	1								3
CO 5	3	3	3	1								3

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate			✓	
Create			✓	

Assessment Pattern for Lab component

Bloom's Category	Continuous Assessment Tools	
	Class work	Test1
Remember		✓
Understand	✓	✓
Apply	✓	✓
Analyse	✓	
Evaluate	✓	
Create	✓	

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Practical [P]		Total Marks
		Assignment	Test-1	Test-2	Class work	Lab Exam	
2-1-2-0	5	15	10	10	-	-	**40**

Total Marks distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
	Total Marks: 0	Total Marks: [5x8 = 40 marks]	
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Basic Concepts of Data Structures (7 hours)

Introduction: Abstract Data Types and Data Structures. Basic complexity analysis – Best, Worst, and Average Cases – Asymptotic Analysis -Analyzing Programs – Space Bounds, Complexity Calculation of Simple Algorithms.

MODULE II : Array and Linked List (9 hours)

Array - Stacks, Queues-Circular Queues, Double Ended Queues, Evaluation of Expressions. Linked List - Self Referential Structures, Dynamic Memory Allocation, Singly Linked List-Operations on Linked List. Doubly Linked List, Circular Linked List, Stacks and Queues using Linked List. Applications of array and linked list - Linear Search, Binary Search, Polynomial representation.

MODULE III : Trees and Graphs (8 hours)

Trees -Binary Trees - Binary Tree Representation, Tree Traversals, Priority Queues and Heaps, Binary Search Trees- Binary Search Tree Operations. Graphs, Representation of Graphs, Depth First Search and Breadth First Search on Graphs.

MODULE IV : Sorting and Memory Allocation (5 hours)

Sorting – Internal Sorting -Bubble sort, insertion sort, selection sort— Merge Sort – Quick Sort. External Memory Sorting- The principle behind external sorting Sorting with tapes: balanced merge. Memory allocation and de-allocation-First-fit, Best-fit and Worst-fit allocation schemes.

MODULE V : Hashing Table (6 hours)

Map ADT - Hash Tables and implementation of Map using Hash Tables - Design of hash functions - Collision resolution schemes: chaining, open addressing schemes - linear probing, quadratic probing, double hashing. Applications of Hashing: finding duplicates, set intersection.

Text books

1. Ellis Horowitz, Satraj Sahni and Susan Anderson-Freed, Fundamentals of Data Structures in C, W. H. Freeman and Company.
2. Seymour Lipschutz , Data Structures, Schaum's Outlines Series, Tata McGraw-Hill.
3. Aaron M. Tenenbaum, Yedidyah Langsam and Moshe J. Augenstein , Data Structures Using C and C++, Prentice Hall of India.
4. R. Kruse et al. , Data Structures and Program Design in C, Pearson Education.

Reference books/online Resources

1. Introduction to Algorithms, 4th Edition, Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, MIT Press/McGraw-Hill.
2. Richard F. Gilberg, Behrouz A. Forouzan, Data Structures: A Pseudocode Approach with C, 2/e, Cengage Learning.
3. Aho A. V., J. E. Hopcroft and J. D. Ullman, Data Structures and Algorithms, Pearson Publication.
4. Tremblay J. P. and P. G. Sorenson, Introduction to Data Structures with Applications, Tata McGraw Hill.

5. Peter Brass, Advanced Data Structures, Cambridge University Press.
6. Lipschuts S., Theory and Problems of Data Structures, Schaum's Series.
7. Wirth N., Algorithms + Data Structures = Programs, Prentice Hall.

Suggested MOOC Courses

1. Data Structures And Algorithms, by Prof. Naveen Garg IIT Delhi

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Introduction ;Abstract Data Types and Data Structures.	1
1.2	Basic complexity analysis – Best, Worst, and Average Cases – Asymptotic Analysis	1
1.3	Basic complexity analysis – Best, Worst, and Average Cases – Asymptotic Analysis	1
1.4	Analyzing Programs – Space Bounds	1
1.5	Complexity Calculation of Simple Algorithms	1
1.6	Complexity Calculation of Simple Algorithms	1
1.7	Complexity Calculation of Simple Algorithms	1
	MODULE II	
2.1	Array	1
2.2	Stacks, Queues	1
2.3	Circular Queues, Double Ended Queues	1
2.4	Evaluation of Expressions.	1
2.5	Linked List - Self Referential Structures, Dynamic Memory Allocation	1
2.6	Singly Linked List-Operations on Linked List.	1
2.7	Doubly Linked List, Circular Linked List	1
2.8	Stacks and Queues using Linked List.	1

2.9	Applications of array and linked list - Linear Search, Binary Search, Polynomial representation.	1
	MODULE III	
3.1	Trees- Binary Trees	1
3.2	Binary Tree Representation	1
3.3	Tree Traversals	1
3.4	Priority Queues and Heaps	
3.5	Binary Search Trees- Binary Search Tree Operations.	1
3.6	Graphs- Representation of Graphs	1
3.7	Depth First Search	1
3.8	Breadth First Search	1
	MODULE IV	
4.1	Sorting – Linear Sorting	1
4.2	Merge Sort	1
4.3	Quick Sort	1
4.4	External Memory Sorting	1
4.5	Memory allocation and de-allocation-First-fit Best-fit and Worst-fit allocation schemes	1
	MODULE V	
5.1	Map ADT	1
5.2	Hash Tables and implementation of Map using Hash Tables	1
5.3	Design of hash functions	1
5.4	Collision resolution schemes: chaining, open addressing schemes - linear probing, quadratic probing, double hashing.	1
5.5	linear probing, quadratic probing, double hashing	1

5.6	Applications of Hashing: finding duplicates, set intersection.	1

CO Assessment Questions

1

i) If T1(n) and T2(n) are the time complexities of two program fragments P1 and P2, where T1(n) = O(f(n)) and T2(n) =O(g(n)), find T1(n) +T2(n) and T1(n).T2(n)

ii) Two algorithms *A* and *B* report time complexities expressed by the functions n^2 and 2^n, respectively. They are to be executed on a machine *M* that consumes 10^{-6} s to execute an instruction. What is the time taken by the algorithms to complete their execution on machine *A* for an input size of 50? If another machine *N* that is 10 times faster than machine *M* is provided for the execution, what is the largest input size that can be handled by the two algorithms on machine *N*? What are your observations?

iii) Analyse the behaviour of the following program, which computes the n^{th} Fibonacci number, for appropriate values of n. Obtain the frequency count of the statements (that are given line numbers) for various cases of n. (n < 0, n = 0, n = 1, n > 1)

```
procedure Fibonacci(n)
1.      read(n);
2-4.    if (n<0) then print ("error"); exit();
5-7.    if (n=0) then print ("Fibonacci number is 0");
                  exit();
8-10.   if (n=1) then print ("Fibonacci number is 1");
                  exit();
11-12. f1=0;
       f2=1;
13.     for i = 2 to n do
14-16.    f  = f1 + f2;
          f1 = f2;
          f2 = f;
17.     end
18.     print("Fibonacci number is", f);
end Fibonacci
```

2

i) Implement an abstract data type STAQUE, which is a combination of a linked stack and a linked queue. Develop procedures to perform an insert and delete operation, termed

		PUSHINS and POPDEL, respectively, on a non-empty STAQUE. PUSHINS inserts an element at the top or rear of the STAQUE based on an indication given to the procedure, and POPDEL deletes elements from the top/front of the list.
	ii)	Write a procedure to check if an input string is balanced or not. The string may have letters and the following characters “(“, “)”, “{“, “}”, “[“, “]”, “<”, and “>”.
3	i)	Insert the following data into a hash table implemented using linear open addressing. Assume that the buckets have three slots each. Make use of the hash function h(X) = X mod 9. {17, 09, 34, 56, 11, 71, 86, 55, 22, 10, 4, 39, 49, 52, 82, 13, 40, 31, 35, 28, 44}
	ii)	Comment on the statement: “To minimize collisions in a linear open addressed hash table it is recommended that the ratio of the number of buckets in a hash table to the number of keys to be stored in the hash table is made bigger”.
4	i)	Quick sort the list L = {A, B, N, M, P, R}. What are your observations? How can the observations help you in determining the worst-case complexity of quick sort?
	ii)	Trace the passes bubble sort algorithm on the list L = {K, Q, A, N, C, A, P, T, V, B}. Verify the stability of bubble sort over L.
5	Design a system to efficiently track and manage the inventory of a large e-commerce platform. The inventory consists of various products, each with a unique ID, a name, a category, a price, and a quantity in stock. The system should support the following operations: *Add Product:* Add a new product to the inventory with its details (ID, name, category, price, quantity). *Update Product*: Update the details of an existing product, such as its price or quantity. *Remove Product:* Remove a product from the inventory when it's no longer available. *Search Product:* Search for products based on criteria such as category, price range, or availability. *Get Product Details:* Retrieve detailed information about a specific product given its ID. *Restock Product:* Increase the quantity of a product in stock. *Track Low Stock:* Identify and report products with a quantity below a certain threshold.	

	Generate Sales Report: Generate a report of all products sold within a specified time frame. *Calculate Revenue:* Calculate the total revenue earned from product sales. *Top Selling Products:* Identify and display the top-selling products.

24CSO724	Introduction to Soft Computing	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course enables the learners to understand the concepts of Soft Computing techniques and its applications. It covers Artificial Neural Networks, operations and models of fuzzy logic, genetic algorithms. This course helps the students to develop algorithms and solutions for different real world applications.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Describe soft computing techniques and the basic models of Artificial Neural Network **(Understand Level)**
CO2	Solve practical problems using neural networks (**Apply Level)**
CO3	Apply supervised and unsupervised learning techniques in different architectures **(Apply Level)**
CO4	Illustrate the operations, model and applications of fuzzy logic **(Understand level)**
CO5	Illustrate the concepts of FIS and Genetic Algorithm **(Understand level**)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3					3				3
CO2	3	3	3	1				3				3
CO3	3	3	3	1				3				3
CO4	3	3	3	1				3				3
CO5	3	3	3					3				3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Introduction to Soft Computing and Neural Networks

Introduction to Soft Computing, Difference between Hard Computing and soft Computing, Applications of Soft Computing, Artificial Neurons Vs Biological Neurons, Basic models of artificial neural networks – Connections, Learning, Activation Functions, Important terminologies of ANN

MODULE II : Artificial Neural Networks

Perceptron Network, Preceptron learning rule, Perceptron for classification and its limitations, Architectures of multilayer feed-forward neural networks, Backpropagation - Training & Testing algorithms, Limitations of MLP.

MODULE III : Supervised and Unsupervised Learning

Hebb's learning rule for competitive learning, Hebb network, Kohonen's self-organizing map and network topology, applications of SOM, Hopfield network and its topology, Boltzman Machines, Adaptive Resonance Theory.

MODULE IV : Fuzzy Set Theory

Fuzzy sets – properties, operations on fuzzy set. Fuzzy membership functions, Methods of membership value assignments – intuition, inference, Rank Ordering, Fuzzy relations– operations on fuzzy relation. Defuzzification– Lamda cuts, Defuzzification methods.

MODULE V : Fuzzy Inference System and Genetic Algorithm

Fuzzy Inference Systems - Mamdani and Sugeno types, Fuzzy Logic Controller, Concepts of genetic algorithm, Operators in genetic algorithm - coding, selection, cross over, mutation, Stopping condition for genetic algorithm.

Text books

1. Principles of Soft Computing, Dr. S N Sivanandam, Dr. S N Deepa, 3rd Edition,Wiley India, 2019
2. Introduction to Soft Computing - Neuro Fuzzy and Genetic Algorithms- Samir Roy, Udit Chakraborty - Pearson, New Delhi, India, 2013.

Reference books

1. Timothy J Ross, Fuzzy Logic with Engineering Applications, John Wiley & Sons, 2016.
2. T.S.Rajasekaran, G.A.Vijaylakshmi Pai "Neural Networks, Fuzzy Logic & Genetic Algorithms Synthesis and Applications", Prentice-Hall India.
3. Soft Computing : Fundamentals and Applications (2nd Ed.) D. K. Pratihar (Narosa, 2013)
4. Foundation of Neural Network, Fuzzy Systems & Knowledge Engineering by Nikole K Kashov (MIT Press, 1998)
5. Neural Network, Fuzzy Logic and Genetic Algorithm : Synthesis and Applications, S. Rajasekaran and G. A. Vijayalakshmi Pai (Prentice Hall India, 2010)

Suggested MOOC Courses

1. NPTEL Course - Introduction To Soft Computing, By Prof. Debasis Samanta, IIT Kharagpur

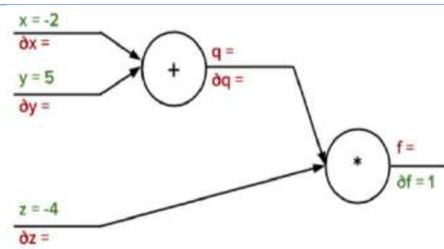
COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1		
1.1	Introduction to Soft Computing	1
1.2	Difference between Hard Computing & Soft Computing	1
1.3	Applications of Soft Computing	1

1.4	Artificial Neurons Vs Biological Neurons	1
1.5	Basic models of artificial neural networks – Connections	1
1.6	Learning, Activation Functions	1
1.7	Important terminologies of ANN	1
	MODULE II	
2.1	Perceptron Network	1
2.2	Preceptron learning rule	1
2.3	Perceptron for classification and its limitations	1
2.4	Architectures of multilayer feed-forward neural networks	1
2.5	Back propagation - Training algorithm	1
2.6	Back propagation - Testing algorithms	1
2.7	Limitations of MLP	1
	MODULE III	
3.1	Hebb's learning rule for competitive learning	1
3.2	Hebb network	1
3.3	Kohonen's self-organizing map and network topology	1
3.4	applications of SOM	1
3.5	Hopfield network and its topology	1
3.6	Boltzman Machines	1
3.7	Adaptive Resonance Theory	1
	MODULE IV	
4.1	Fuzzy sets – properties	1
4.2	operations on fuzzy set	1

4.3	Fuzzy membership functions	1
4.4	Methods of membership value assignments – intuition	1
4.5	inference, Rank Ordering	1
4.6	Fuzzy relations– operations on fuzzy relation	1
4.7	Defuzzification– Lamda cuts	1
4.8	Defuzzification methods	1
	MODULE V	
5.1	Fuzzy Inference Systems - Mamdani and Sugeno types	1
5.2	Fuzzy Logic Controller	1
5.3	Concepts of genetic algorithm	1
5.4	Operators in genetic algorithm	1
5.5	coding, selection	1
5.6	cross over, mutation	1
5.7	Stopping condition for genetic algorithm	1

CO Assessment Questions	
1	1. Explain the architecture of a simple Artificial Neural network? Compare it with a biological neuron. 2. Compare the three learning approaches in Artificial Neural Network. How is the critic information used in learning process. 3. Examine the various aspects of sigmoidal activation function. List the drawbacks.
2	1. Implement one epoch of Perceptron training algorithm for OR logic function. 2. Let's assume we have a simple function f(x,y,z) = (x+y)z. We can break this up into the equations q = x+y and f(x,y,z) = qz. Using this simplified notation, we can also represent this equation as a computation graph:

	 Illustrate the Back propogation algorithm using the above network.
3	1. Design a Hebb net to implement logical AND function (use bipolar inputs and targets) 2. Use Hebb rule, find the weights required to perform following classifications. The vectors (1,-1,1,-1) and (1,1,1,-1) belong to class (target value +1). vectors (-1,-1,1,1) and (1,1,-1,-1) do not belong to class (target value -1). Also using each of training x vectors as input, test the response of net.
4	1. Consider the two fuzzy sets $\underset{\sim}{A} = \{\frac{0}{0.2} + \frac{0.8}{0.4} + \frac{1}{0.6}\}$ $\underset{\sim}{B} = \{\frac{0.9}{0.2} + \frac{0.7}{0.4} + \frac{0.3}{0.6}\}$ Using Zadeh's notation express the fuzzy sets into λ- cut sets for λ=0.4 for the following operations. (i) $A_\sim \cap B_\sim$ (ii) $A_\sim \cup B_\sim$ (iii) $\overline{A_\sim} \cup \overline{B_\sim}$ (iv) $\overline{A_\sim} \cap \overline{B_\sim}$ (v) $\overline{B_\sim}$ 2. Consider two fuzzy set $\widetilde{A} = \{\frac{0.2}{1} + \frac{0.3}{2} + \frac{0.4}{3} + \frac{0.5}{4}\}$ and $\widetilde{B} = \{\frac{0.1}{1} + \frac{0.2}{2} + \frac{0.2}{3} + \frac{1}{4}\}$ Find the algebraic sum, algebraic product, bounded sum and bounded difference of the given fuzzy sets.
5	1. Using Genetic algorithm with Roulette wheel selection method maximize the function f(x)=x2 over {0, 1, 2, ..., 31} with initial x values of (13, 24, 8, 19). Show one crossover and mutation. 2. Using inference approach, find the membership values for each of the triangular shapes (I, R, IR, T) for a triangle with angles 120°, 50°, 10°.

24CSO734	Development of Mobile Apps	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course is concerned with the development of applications on mobile and wireless computing platforms. Android will be used as a basis for teaching programming techniques and design patterns related to the development of standalone applications and mobile portals for enterprise and m-commerce systems.

Prerequisite: Basic Knowledge of OOPS concept and Core java

Course Outcomes: After the completion of the course the student will be able to

CO 1	Identify various concepts of mobile programming that make it unique from programming for other platforms. (**Understand level**)
CO 2	Critique mobile applications on their design pros and cons. (**Understand level**)
CO 3	Utilize rapid prototyping techniques to design and develop sophisticated mobile interfaces. (**Apply level**)
CO 4	Program mobile applications for the Android operating system that use basic and advanced phone features. (**Apply level**)
CO 5	Deploy applications to the Android marketplace for distribution. (**Apply level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3		2			1						
CO 2	2	3										
CO 3	1		3		3				2			
CO 4	3		1			1						2
CO 5			3			1						

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA							
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Practical [P]		Total Marks
		Assignment	Test-1	Test-2	Class work	Lab Exam	
3-0-0-0	5	15	10	10			40

Total Marks distribution			
Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Introduction to Android (7 hours)

The Android Platform, Android SDK, Eclipse Installation, Android Installation, Building your First Android application, Understanding Anatomy of Android Application, Android Manifest file.

MODULE II: Android Application Design Essentials (7 hours)

Anatomy of Android applications, Android terminologies, Application Context, Activities, Services, Intents, Receiving and Broadcasting Intents, Android Manifest File and its common settings, Using Intent Filter, Permissions.

Module III: Android User Interface Design Essentials (8 hours)

User Interface Screen elements, Designing User Interfaces with Layouts, Drawing and Working with Animation.

MODULE IV: Testing Android applications (7 hours)

: Publishing Android applications, Using Android preferences, Managing Application resources in a hierarchy, working with different types of resources.

MODULE V: Using Common Android APIs (7 hours)

Using Android Data and Storage APIs, Managing data using Sqlite, Sharing Data between Applications with Content Providers, Using Android Networking APIs, Using Android Web APIs, Using Android Telephony APIs, Deploying Android Application to the World.

Textbooks

1. T1. Lauren Darcey and Shane Conder, "Android Wireless Application Development", Pearson Education, 2nd ed. (2011)

Reference books

1. Reto Meier, "Professional Android 2 Application Development", Wiley India Pvt Ltd
2. Mark L Murphy, "Beginning Android", Wiley India Pvt Ltd
3. Android Application Development All in One for Dummies by Barry Burd, Edition: I

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1		
1.1	The Android Platform, Android SDK,	1
1.2	Eclipse Installation, Android Installation,	2
1.3	Building your First Android application,	2
1.4	Understanding the anatomy of Android applications, Android Manifest file.	2
MODULE II		
2.1	Anatomy of Android applications, Android terminologies	1
2.2	Application Context, Activities, Services	2
2.3	Intents, Receiving and Broadcasting Intents	2
2.4	Android Manifest File and its common settings, Using Intent Filter, Permissions.	1
MODULE III		
3.1	User Interface Screen elements,	2
3.2	Designing User Interfaces with Layouts	2
3.3	Drawing and Working with Animation.	2
3.4	Drawing and Working with Animation.	2
MODULE IV		
4.1	Testing Android applications,	2
4.2	Publishing Android applications, Using Android preferences,	2
4.3	Managing Application resources in a hierarchy	2
4.4	working with different types of resources.	1
MODULE V		
5.1	Using Android Data and Storage APIs, Managing data using Sqlite.	1
5.2	Sharing Data between Applications with Content Providers.	2
5.3	Using Android Networking APIs, Using Android Web APIs.	2
5.4	Using Android Telephony APIs, Deploying Android Application to	2

	the World.	

CO Assessment Questions	
1	Elaborate on the significance of the Android SDK in the development of Android applications. Discuss the essential components included in the SDK.
2	Explain the significance of designing Android applications that are adaptable to various devices, considering different screen sizes and resolutions.
3	Describe common navigation patterns used in Android UI design, highlighting their significance in enhancing user flow and accessibility.
4	Explain two fundamental types of testing commonly performed on Android applications, highlighting their significance in ensuring app quality and user satisfaction.
5	Enumerate two advantages of using SQLite as the database management system in Android applications, considering factors such as performance and compatibility.

24CSO744	E-Commerce	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course enables the learners to understand the essential competencies and proficiencies needed to effectively plan, execute, and manage e-commerce activities. This course covers the fundamentals of e-commerce, e-commerce website development, e-commerce security, marketing and rights and online community management. It will help the students to practice modern business strategies, with a strong focus on internet-based enterprises and their establishment.

Prerequisite:NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Identify the key components of E-Commerce business models. **(Apply Level)**
CO2	Illustrate the features and services of Internet and web to support e-commerce applications. **(Apply Level)**
CO3	Identify potential security threats in E-commerce environment and choose technologies to secure those environments. **(Apply Level)**
CO4	Describe E-Commerce marketing process from fan acquisition to sales and the marketing capabilities of social marketing platforms.**(Apply Level)**
CO5	Explain the major trends in online retailing and online networking community. **(Apply Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										3
CO2	3	3	3									3
CO3	3	3										3
CO4	3	3										3
CO5	3	3										3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test 1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA						
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Introduction to E-commerce (7 hrs)

E-Commerce - Introduction, Seven unique features, Types of E-commerce, Organizing Themes. E-Commerce Business Models – Eight key elements, Business to Consumer model, Business to Business Models, Consumer to Consumer Models, Peer to Peer Models, M-Commerce business models.

MODULE II : Building an E-Commerce Website (8 hrs)

Internet and the Web - Features and Services, Mobile Apps, Building an E-Commerce website- Systematic Approach, Choosing Software and Hardware, Other E-commerce Site tools, Developing a Mobile Website and Building Mobile Applications.

MODULE III : E-commerce Security Environment (7 hrs)

Introduction, Security threats, Technology Solutions, Policies, Procedures and Laws, E-Commerce Payment systems, Electronic Billing Presentment and Payment.

MODULE IV : E-Commerce Marketing and rights (7 hrs)

Consumers Online, Basic Marketing Concepts, Internet Marketing Technologies, Social Marketing, Mobile Marketing, Local marketing, Privacy and Intellectual rights, Intellectual property rights.

MODULE V : Online Retailing and Online Community (7 hrs)

Online Retail Sector, E-tailing Business models, Online Content, Online Publishing Industry, Social Networks and Online Community, Online Auctions, E-commerce portals.

Text books

1. E-Commerce: Business, Technology, Society, Kenneth C. Laudon and Carol Guercio Traver, 13/e, Pearson, 2017.

Reference books

1. E-Commerce: an Indian perspective, S. J. Joseph,5/e, PHI, 2015.
2. Elias. M. Awad, " Electronic Commerce", Pearson, 1/e, 2001.
3. Ravi Kalakota, Andrew Winston," Frontiers of Electronic Commerce", Pearson Education Asia, 2010 edition.

Suggested MOOC Courses

1. E-commerce Technologies, Mrs. G. Selva Jeba | Madurai Kamaraj University, Madurai, Tamil Nadu.
2. BCOS-184: E-Commerce, Dr. Subodh Kesharwani | Indira Gandhi National Open University (IGNOU), New Delhi.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	E-Commerce - Introduction, Seven unique features	1
1.2	Types of E-commerce, Organizing Themes	1
1.3	E-Commerce Business Models – Eight key elements	1
1.4	Business to Consumer model	1
1.5	Business to Business Models	1
1.6	Consumer to Consumer Models	1
1.7	Peer to Peer Models, M-Commerce business models	1
	MODULE II	
2.1	Internet and the Web - Features and Services	1

2.2	Mobile Apps	1
2.3	Building an E-Commerce website- Systematic Approach	1
2.4	Choosing Software and Hardware – Lecture 1	1
2.5	Choosing Software and Hardware – Lecture 2	1
2.6	Other E-commerce Site tools	1
2.7	Developing a Mobile Website and Building Mobile Applications – Lecture 1	1
2.8	Developing a Mobile Website and Building Mobile Applications – Lecture 2	1
MODULE III		
3.1	Introduction, Security threats	1
3.2	Technology Solutions	1
3.3	Policies, Procedures and Laws	1
3.4	E-Commerce Payment systems – Lecture 1	1
3.5	E-Commerce Payment systems – Lecture 2	1
3.6	Electronic Billing Presentment and Payment – Lecture 1	1
3.7	Electronic Billing Presentment and Payment – Lecture 2	1
MODULE IV		
4.1	Consumers Online	1
4.2	Basic Marketing Concepts	1
4.3	Internet Marketing Technologies	1
4.4	Social Marketing	1
4.5	Mobile Marketing, Local marketing	1
4.6	Privacy and Intellectual rights	1

4.7	Intellectual property rights	1
	MODULE V	
5.1	Online Retail Sector	1
5.2	E-tailing Business models	1
5.3	Online Content	1
5.4	Online Publishing Industry	1
5.5	Social Networks and Online Community	1
5.6	Online Auctions	1
5.7	E-commerce portals	1

	CO Assessment Questions
1	1. Analyze the development and history of e-commerce in the years from 1995–2016. What do you predict we will see during the next five years of e-commerce? Describe some of the technological, business, and societal shifts that may occur as the Internet continues to grow and expand. Prepare a brief presentation or written report to explain your vision of what e-commerce will look like in 2030. 2. Would you say that Amazon and eBay are direct or indirect competitors? (You may have to visit the websites or apps to answer.) 3. What are the major differences between virtual storefronts, such as Bluefly, and bricks-and-clicks operations, such as Walmart? What are the advantages and disadvantages of each? 4. Examine the experience of shopping online versus shopping in a traditional environment. Imagine that you have decided to purchase a digital camera (or any other item of your choosing). First, shop for the camera in a traditional manner. Describe how you would do so (for example, how you would gather the necessary information you would need to choose a particular item, what stores you would visit, how long it would take, prices, etc.). Next, shop for the item on the Web or via a mobile app. Compare and contrast your experiences. What were the advantages and disadvantages of each? Which did you prefer and why?
2	1. Define the systems development life cycle and discuss the various steps involved in creating an e-commerce site. 2. Visit several e-commerce sites and evaluate the effectiveness of the sites

	according to the eight basic criteria/functionalities. Choose one site you feel does an excellent job on all the aspects of an effective site and create an electronic presentation, including screen shots, to support your choice. 3. Identify and understand the major considerations involved in choosing web server and e-commerce merchant server software. 4. Go to the website of Wix, Weebly, or another provider of your choosing that allows you to create a simple e-tailer website for a free trial period. Create a website. The site should feature at least four pages, including a home page, product page, shopping cart, and contact page. Extra credit will be given for additional complexity and creativity. Come to class prepared to present your e-tailer concept and website.
3	1. Describe the features and functionality of electronic billing presentment and payment systems. 2. Is a computer with anti-virus software protected from viruses? Why or why not? 3. Given the shift toward m-commerce, do a search on m-commerce (or mobile commerce) crime. Identify and discuss the security threats this type of technology creates. Prepare a presentation outlining your vision of the new opportunities for cybercrime that m-commerce may provide. 4. Research the challenges associated with payments across international borders. Do most e-commerce companies conduct business internationally? How do they protect themselves from repudiation?
4	1. Research has shown that many consumers use the Internet to investigate purchases before actually buying, which is often done in a physical storefront. What implication does this have for online merchants? What can they do to entice more online buying, rather than pure research? 2. Explain different factors that make social, local, and mobile marketing different from traditional online marketing. 3. Visit two websites of your choice and apply the social marketing process model to both. Critically compare and contrast the effectiveness of these sites in terms of the dimensions of the social marketing process. How well do these sites acquire fans, generate engagement, amplify responses, create a community, and strengthen their brands? What recommendations can you make for these sites to improve their effectiveness? 4. How could the Internet potentially change protection given to intellectual property? What capabilities make it more difficult to enforce intellectual property law?

5	1. Describe the technological retail revolution that preceded the growth of e-commerce. What were some of the innovations that made later online retailing possible? 2. Together with a teammate, investigate the use of mobile apps in the online retail or financial services industries. Prepare a short joint presentation on your findings. 3. What types of products are well suited for an auction market? At what points in the product life cycle can auction markets prove beneficial for marketers? 4. Go to Amazon and explore the different digital media products that are available. For each kind of digital media product, describe how Amazon's presence has altered the industry that creates, produces, and distributes this content.

24CSI714	Cyber Laws and Ethics	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course enables the learners to get the knowledge of current Cyber laws. The course provides an insight into the laws keeping in view of the latest developments in IPRs related to computer field and growing cyber related crimes. The course also helps to create an understanding on Intellectual Properties and the importance of it, trademarks and Trade secrets and to create awareness of unfair competition and its methods.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the fundamentals and importance of Cyber space and IT act. **(Understand Level)**
CO2	Comprehend the importance and need for Electronic Governance, internet service providers and their liability.**(Understand Level)**
CO3	Use the provision of Cyber law to deal with types of Cyber Crimes, Cybercrime Complaints and National cyber security policy.**(Understand Level)**
CO4	Explain the procedure for registration, characteristics, publication, infringement and term of copyright and also know the other forms of IPR.**(Understand Level)**
CO5	Deduce the legal aspects of Domain name and other cyber related disputes. **(Understand Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3				3						3
CO2	3	3				3						3
CO3	3	3				3						3
CO4	3	3				3						3
CO5	3	3				3						3

Assessment Pattern

Bloom'sCategory	ContinuousAssessmentTools			EndSemesterExamination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply			✓	
Analyse				
Evaluate				

Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Cyber Space (6 hours)

Fundamental definitions -Interface of Technology and Law – Jurisprudence and-Jurisdiction in Cyber Space - Indian Context of Jurisdiction - Enforcement agencies – Need for IT act - UNCITRAL – E Commerce basics .Information Technology Act, 2000 - Aims and Objects — Overview of the Act – Jurisdiction

MODULE II: Electronic Governance (8 hours)

Legal Recognition of Electronic Records and Electronic Evidence -Digital Signature Certificates - Securing Electronic records and secure digital signatures - Duties of Subscribers - Role of Certifying Authorities - Regulators under the Act -The Cyber Regulations Appellate Tribunal - Internet Service Providers and their Liability– Powers of Police under the Act – Impact of the Act on other Laws . Cyber Crimes -Meaning of Cyber Crimes –Different Kinds of Cyber crimes – Cyber crimes under IPC

MODULE III: Cr.P.C and Indian Evidence Law (8 hours)

Cybercrimes under the Information Technology Act 2000 - Cyber crimes under International Law – Hacking, Child Pornography, Cyber Stalking, Denial of service Attack, Virus Dissemination, Software Piracy, Internet Relay Chat (IRC) Crime, Credit Card Fraud, Net Extortion, Phishing etc - Cyber Terrorism Violation of Privacy on Internet - Data Protection and Privacy – Indian Court cases

MODULE IV : Intellectual Property Rights (7 hours)

Copyrights- Software – Copyrights vs Patents debate - Authorship and Assignment Issues - Copyright in Internet - Multimedia and Copyright issues - Software Piracy - Trademarks - Trademarks in Internet – Copyright and Trademark cases.

MODULE V : Patents and Legal aspects (7 hours)

Understanding Patents - European Position on Computer related Patents, Legal position on Computer related Patents - Indian Position on Patents – Case Law, Domain names - registration - Domain Name Disputes-Cyber Squatting-IPR cases.

Text books

1. Justice Yatindra Singh,” Cyber Laws”, Universal Law Publishing Co., New Delhi, 2020
2. Farouq Ahmed,”Cyber Law in India”, New Era publications, New Delhi,2017
3. S.R.Myneni, “Information Technology Law(Cyber Laws)”, Asia Law House, Hyderabad,3rd Edition, 2024

Reference books

1. Chris Reed, “Internet Law-Text and Materials”, Cambridge University Press, 2nd Edition,2004

2. Pawan Duggal,” Cyber Law- the Indian perspective”, Universal Law Publishing Co., New Delhi,2016.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Fundamental definitions -Interface of Technology and Law	1
1.2	Jurisprudence and-Jurisdiction in Cyber Space - Indian Context of Jurisdiction	1
1.3	-Enforcement agencies	1
1.4	–Need for IT act - UNCITRAL – E Commerce basics	1
1.5	Information Technology Act 2000	1
1.6	Aims and Objects — Overview of the Act – Jurisdiction.	1
	MODULE II	
2.1	Legal Recognition of Electronic Records and Electronic Evidence	1
2.2	Digital Signature Certificates - Securing Electronic records and secure	1

	digital signatures	
2.3	Duties of Subscribers - Role of Certifying Authorities	1
2.4	Regulators under the Act	
2.5	The Cyber Regulations Appellate Tribunal - Internet Service Providers and their Liability	1
2.6	–Powers of Police under the Act – Impact of the Act on other Laws	1
2.7	Cyber Crimes -Meaning of Cyber Crimes –Different Kinds of Cyber crimes –	1
2.8	Cyber crimes under IPC	1
MODULE III		
3.1	Introduction	1
3.2	Cybercrimes under the Information Technology Act 2000	1
3.3	Cyber crimes under International Law	1
3.4	Hacking, Child Pornography, Cyber Stalking	1
3.5	Denial of service Attack, Virus Dissemination, Software Piracy	1
3.6	Internet Relay Chat (IRC) Crime, Credit Card Fraud, Net Extortion, Phishing	1
3.7	Cyber Terrorism Violation of Privacy on Internet	1
3.8	Data Protection and Privacy – Indian Court cases	1
MODULE IV		
4.1	Introduction	1
4.2	Copyrights- Software – Copyrights vs Patents debate	1
4.3	Authorship and Assignment Issues	1
4.4	Copyright in Internet	1
4.5	Multimedia and Copyright issues	1
4.6	Software Piracy - Trademarks	1
4.7	Trademarks in Internet – Copyright and Trademark cases.	1
MODULE V		
5.1	Understanding Patents - European Position on Computer related Patents	1
5.2	Legal position on Computer related Patents	1
5.3	-Indian Position on Patents	1
5.4	Case Law, Domain names	1
5.5	Domain name registration - Domain Name Disputes-	1
5.6	Cyber Squatting	1
5.7	IPR cases	1

CO Assessment Questions	
1	a. What do you mean by cyber space? Explain the interface of technology and law. b. Write down the need for IT act and explain IT act 2000.
2	a. Discuss about different cybercrimes under IPC.
3	a. What is cyberstalking? What are its implications and how the case laws are applied?
4	a. Describe the various types of intellectual property rights and state its objectives b. Explain authorship and assignment issues.
5	a. Differentiate between Legal position on Computer related Patents and Indian Position on Patents. b. How laws are applied on infringement of Domain name disputes?

Honors- S7

24CSH709	Evolutionary Algorithms	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	4	4	2024

Preamble: This course enables the learners to engage the field of EC and exposes them to the nuances of applying and designing EAs for problems encountered in a wide range of application domains. This course covers the preliminaries of evolutionary computing, Genetic Algorithms, Evolution strategies, Parameter Control, multimodal optimization, multi-objective optimization and special forms of evolution.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the concepts and the terminology needed for evolutionary computing strategies. **(Understand Level)**
CO2	Formulate a problem as an evolutionary computation search/optimization by specifying representations, selection and recombination and mutation operators. **(Apply level)**
CO3	Apply appropriate evolution strategies and parameter tuning mechanisms for an application. **(Apply level)**
CO4	Apply evolutionary optimization techniques to real world problems. **(Apply level)**
CO5	Examine the relevance of Co-evolution and Interactive Evolution in computational problems. **(Apply level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3									3
CO5	3	3	3									3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test 1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
4-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Evolutionary Computing Preliminaries (9 hrs)

Introduction, Components of Evolutionary Algorithms – Representation, Evaluation Function (Fitness Function), Population, Parent Selection Mechanism, Variation Operators, Survivor Selection, Mechanism (Replacement), Initialization, Termination Condition. Example Applications - The 8-Queens Problem, The Knapsack Problem. Working of an Evolutionary Algorithm, Evolutionary Computing and Global Optimization.

MODULE II : Genetic Algorithms (10 hrs)

Representation of Individuals, Mutation and Recombination – Binary, Integer, Real-valued or Floating-Point, Permutation Representations, Multiparent recombination. Population Models, Parent Selection - Fitness Proportional Selection, Ranking Selection, Implementing Selection Probabilities, Tournament Selection. Survivor Selection - Age-Based Replacement, Fitness Based Replacement. Example Application: Solving a Job Shop Scheduling Problem.

MODULE III : Evolution strategies and Parameter control (8 hrs)

Evolution Strategy operators – Selection, Crossover, Mutation. A generic Evolution strategy Algorithm. Examples of Changing Parameters - Changing the Mutation Step Size. Changing the Penalty Coefficients. Classification of Control Techniques, Examples of Varying EA Parameter. Varying Several Parameters Simultaneously.

MODULE IV : Multimodal and multiobjective optimization (9 hrs)

Multi-Modal Problems – Introduction. Genetic Drift, Biological Motivations and Algorithmic Approaches. Algorithmic vs. Genetic vs. Solution Space. Multi-Objective Evolutionary Algorithms – Example. Dominance and Pareto optimality. EA Approaches to Multi-Objective Optimization. Particle Swarm Optimization, Differential Evalution. Example Application: Distributed Co-Evolution of Job-shop Schedules.

MODULE V : Special form of Evolutions (8 hrs)

Co-evolution - Cooperative co-evolution. Competitive co-evolution, Example Application: Co-evolutionary Constraint Satisfaction. Interactive Evolution – Optimization. Design, Exploration. Interactive Evolutionary Design and Art, Example Application - The Mondriaan Evolver. Non-Stationary Function Optimization - Algorithmic Approaches, Selection and Replacement Policies. Example Application - The Time Varying Knapsack Problem.

Text books

1. A.E. Eiben and J.E. Smith, Introduction to Evolutionary Computing, Springer, Natural Computing Series 1st edition, 2003.
2. Bäck, T, 2000. Evolutionary Computation 1: Basic Algorithms and Operators. Institute of Physics Publishing, Bristol.

Reference books

1. S. Rajasekharan, G.A. Vijayalakshmi Pai, Neural Networks, Fuzzy Systems and Evolutionary Algorithms – Synthesis and Applications, PHI Learning, 2/e, 2017.
2. Alex A.Freitas, Data Mining and Knowledge Discovery with Evolutionary Algorithms, Springer, 1/e, 2008.
3. Melanie Mitchell, An Introduction to Genetic Algorithms, MIT Press, 1996.
4. John Koza, Genetic Programming, MIT Press, 1992.
5. Genetic Programming: An Introduction, Wolfgang Banzhaf, Peter Nordin, Robert E. Keller, and Frank D. Francone, Morgan Kaufmann Publishers, 1998.

Suggested MOOC Courses

1. NPTEL: Evolutionary Computation for Single and Multi-Objective Optimization, Prof. Deepak Sharma, IIT Guwahati

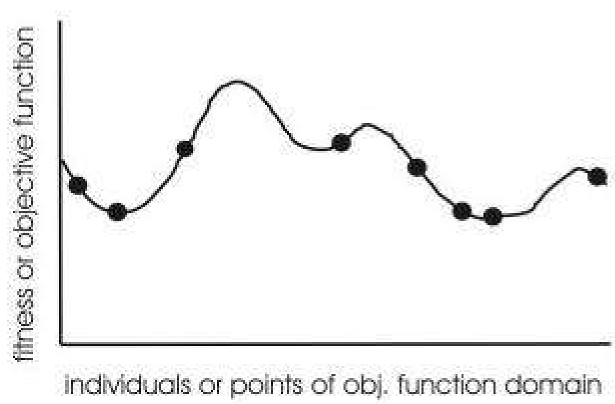
COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
MODULE 1		
1.1	Introduction, Components of Evolutionary Algorithms – Representation	1
1.2	Evaluation Function (Fitness Function), Population, Parent Selection Mechanism	1
1.3	Variation Operators, Survivor Selection – Lecture 1	1
1.4	Variation Operators, Survivor Selection – Lecture 2	1
1.5	Variation Operators, Survivor Selection – Lecture 3	1
1.6	Mechanism (Replacement), Initialization, Termination Condition	1
1.7	Example Applications - The 8-Queens Problem	1
1.8	The Knapsack Problem	
1.9	Working of an Evolutionary Algorithm, Evolutionary Computing and Global Optimization	
MODULE II		
2.1	Representation of Individuals	1
2.2	Mutation	1
2.3	Recombination	1
2.4	Binary, Integer, Real-valued or Floating-Point, Permutation Representations	1
2.5	Multiparent recombination, Population Models (Lecture - 1)	1
2.6	Multiparent recombination, Population Models (Lecture - 2)	1
2.7	Parent Selection - Fitness Proportional Selection, Ranking Selection	1
2.8	Implementing Selection Probabilities, Tournament Selection	1
2.9	Survivor Selection- Age-Based Replacement Fitness Based Replacement	1
2.10	Example Application: Solving a Job Shop Scheduling Problem	1

MODULE III		
3.1	Evolution Strategy operators – Selection, Crossover, Mutation – Lecture 1	1
3.2	Evolution Strategy operators – Selection, Crossover, Mutation – Lecture 2	1
3.3	A generic Evolution strategy Algorithm	1
3.4	Examples of Changing Parameters - Changing the Mutation Step Size	1
3.5	Changing the Penalty Coefficients	1
3.6	Classification of Control Techniques	1
3.7	Examples of Varying EA Parameter	1
3.8	Varying Several Parameters Simultaneously	1
MODULE IV		
4.1	Multi-Modal Problems – Introduction	1
4.2	Genetic Drift, Biological Motivations and Algorithmic Approaches	1
4.3	Algorithmic vs. Genetic vs. Solution Space	1
4.4	Multi-Objective Evolutionary Algorithms – Examples	1
4.5	Dominance and Pareto optimality	1
4.6	EA Approaches to Multi-Objective Optimization	1
4.7	Particle Swarm Optimization	1
4.8	Differential Evalution	1
4.9	Example Application: Distributed Co-Evolution of Job-shop Schedules.	1
MODULE V		
5.1	Co-evolution - Cooperative co-evolution	1
5.2	Competitive co-evolution, Example Application: Co-evolutionary Constraint Satisfaction	1
5.3	Interactive Evolution - Optimization	1

5.4	Design, Exploration	1
5.5	Interactive Evolutionary Design and Art, Example Application: The Mondriaan Evolver	1
5.6	Non-Stationary Function Optimization - Algorithmic Approaches	1
5.7	Selection and Replacement Policies	1
5.8	Example Application: The Time Varying Knapsack Problem	1

<table>
<tr><th colspan="2">CO Assessment Questions</th></tr>
<tr><td>1</td><td>
1. Find a problem where EAs would certainly perform very poorly compared to alternative approaches. Explain why you expect this to be the case.

2. Consider the beginning phase of an evolutionary search process as depicted in the figure below. Is exploration or exploitation the dominant force in this stage? What about the end phase?



3. There is much current research in producing autonomous vehicles that can be used on real roads. For each of the following capabilities that such a system should exhibit, state whether they are an optimization, modelling, or simulation problem.
a. Learning to recognize traffic signs.
b. Recognizing a traffic sign in a video feed as the vehicle drives along.
c. Planning shortest, or quickest, route between two places.
d. Avoiding a child that runs into the road.
e. Steering in the middle of the road.
</td></tr>
</table>

2	1. In a 0-1 knapsack problem, how could you implement a repair mutation to transform infeasible solutions into feasible ones? (i.e. make the sum of costs of the selected items go below the budget). 2. A mountain bike designer is trying to create a frame with certain desirable characteristics under simulation. To do this they must specify a set of n tube lengths and m angles between them. What representation do you think would be most suitable for this problem? 3. You are given the fitness function $f(x) = x^2 + 10$ and a population of three individuals $\{a,b,c\}$. When decoded their genes when decoded give the values 1, 2 and 3 respectively. When you pick a single parent using Fitness Proportionate Selection, what is the probability that it is *b*? 4. A generational EA has a population size of 100, uses fitness proportionate selection without elitism, and after t generations has a mean population fitness of 76.0. There is one copy of the current best member, which has fitness 157.0. What is the expectation for the number of copies of the best individual present in the mating pool? What is the probability that there will be no copies of that individual in the mating pool, if selection is implemented using the roulette wheel algorithm?
3	1. Take a numerical optimization problem and a GA that is suited to solve it, i.e., uses the appropriate representation. (You can write your own code, or download it from the Web.) Select 3 different values for each of the parameters population size μ, mutation rate p_m, and crossover rate p_c. Execute 30 runs with each of the 27 different GA instances and for each run save the best fitness at termination, the number of fitness evaluations and the CPU time needed to complete the run. Perform a simple statistical analysis on the spread of the outcomes, e.g., calculate the minimum, the maximum, the average, the standard deviation, etc. Use all 27 setups as the basis of your statistics first, then fix one parameter at one of its values and do the same analysis for the 9 corresponding runs. How does this change your results? Summarise your observations in a short report. 2. Give arguments why mutation strength (e.g., p_m or σ) should be increased during a run. Give arguments why it should be decreased. 3. Explain the General Evolution Strategy algorithm with suitable examples.

4	1. Describe the main components necessary to add to a “standard” EA in order to tackle a multiobjective problem. 2. A simple multiobjective problem has two objective functions, $f_1(x) = x_1$ and $f_2(x) = x_2$ and is subject to the constraints $x_1^2 + x_2^2 \leq 10$. What will the Pareto front for this problem look like? 3. Identify an application where multimodal and multiobjective optimization is needed and design the algorithm based on the concept of evolutionary computing.
5	1. Implement a two-population cooperative GA where the solutions in each population code for half of a 50-bit OneMax problem, and the populations take it in turns to evolve for a generation. Use 100 in each population, binary tournament selection, 1-point crossover with probability 0.7 and bit-wise mutation with probability 0.01. Investigate the effect of random versus best pairing strategies. 2. Now repeat this experiment, but this time use a competitive model. Let the fitness that one population gets be the OneMax score and the fitness that the other gets be (50 – OneMax) i.e., ZeroMax. What happens to the two populations? 3. Compare and contrast Cooperative co-evolution and Competitive co-evolution.

24CSH710	Advanced Computer Architecture	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	0	4	2024

Preamble: This course aims to provide students with an in-depth knowledge to a range of advanced topics in computer architecture by addressing key issues such as instruction set design, micro-architecture of superscalar processors, its interaction with other hardware components, and constraints to be addressed when going from single- core to multi-core systems. This course covers the basics of computer design and analysis, memory hierarchy, different levels of parallelism and some design trade-offs. This course helps the learner to develop software/hardware applications based on architectural framework.

Prerequisite: Topics covered under the course Computer Organization and Architecture (23CSP305)

Course Outcomes: After the completion of the course the student will be able to

CO1	Understand different processor architectures, system-level design processes and design challenges. **(Cognitive Level: Understand)**
CO2	Analyze and interpret the performance of a processor based on various metrices. **(Cognitive Level: Analyze)**
CO3	Understand the components and operation of a memory hierarchy and analyze the range of performance issues influencing its design. **(Cognitive Level: Analyze)**
CO4	Identify the challenges of realizing different kinds of parallelism and leverage them for performance advancement. **(Cognitive Level: Apply)**
CO5	Explore emerging computing trends, computing platforms, and design trade-offs and familiarize recent research themes and challenges. **(Cognitive Level: Understand)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓								✓
CO2	✓	✓	✓	✓						✓		✓
CO3	✓	✓	✓	✓						✓		✓
CO4	✓	✓	✓	✓						✓		✓
CO5	✓	✓	✓							✓		✓

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate			✓	

Create			✓	

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
4-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I :<<Fundamentals of Quantitative Design and Analysis >>

Classes of Computers- Classes of parallelism and Parallel Architectures. Trends in Technology, Power and Cost. Measuring, Reporting and Summarizing Performance. Quantitative Principles of Computer Design. The Processor Performance. Basics of Memory Hierarchy, Cache Performance and Optimizations.

MODULE II :<< Instruction Level Parallelism>>

Instruction Level Parallelism- Concepts and Challenges. Basic Compiler Techniques for Exposing ILP, Advanced Branch Prediction - Intel Core i7 Branch Predictor, Overcoming Data Hazards with Dynamic Scheduling- Tomasulo's Approach. Hardware-Based Speculation. Multiple Issue and Static Scheduling, Exploiting IPL using Dynamic Scheduling, Multiple Issue and Static Scheduling.

MODULE III :<< Data and Thread Level Parallelism >>

Data Level Parallelism- Vector Architecture, Graphics Processing Units. Thread Level Parallelism- Multithreading: Exploiting Thread-Level Parallelism, Centralized Shared Memory, Basic Schemes for enforcing Coherence, Snooping Coherence Protocols, Distributed Shared Memory.

MODULE IV :<< Warehouse-Scale Computers >>

Warehouse-Scale Computers- Programming Models and Workloads for WSC, Computer Architecture of Warehouse-Scale Computers, Physical Infrastructure and Cost of WSC, Measuring Efficiency of WSC Cost of WSC. Cloud Computing.
Domain-Specific Architectures -Google's Tensor Processing Unit.

MODULE V :<< Modern Parallel Computing Paradigms >>

Overview Superscalar and VLIW architectures- EPIC, The Intel IA-64 Architecture. Multi- core architectures- Data marshaling for multi-core architectures, Heterogeneous core design, Core Fusion. On-chip interconnects (Network-on-Chip). Polymorphic architecture.
Processing-in-Memory (PIM).

Text books

1. David. A. Patterson, John L. Hennessy, "Computer Architecture: A Quantitative approach", Morgan Kaufmann, 6th Edition 2019.

Reference books

1. K.Hwang, Naresh Jotwani, "Advanced Computer Architecture, Parallelism, Scalability, Programmability", Tata McGraw Hill, 2nd Edition 2010
2. An Introduction to Parallel Programming, Peter S. Pacheco, 2011, 1st Edition, Morgan Kaufmann Publishers.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Classes of Computers - Classes of parallelism and Parallel Architectures.	1
1.2	Trends in Technology, Power and Cost.	2
1.3	Measuring, Reporting and Summarizing Performance.	1
1.4	Quantitative Principles of Computer Design.	2
1.5	Basics of Memory Hierarchy	1
1.6	Cache Performance.	1
1.7	Cache Optimizations.	2
	MODULE II	

2.1	Instruction Level Parallelism- Concepts and Challenges.	1
2.2	Basic Compiler Techniques for Exposing ILP	1
2.3	Advanced Branch Prediction	1
2.4	Intel Core i7 Branch Predictor	1
2.5	Dynamic Scheduling	1
2.6	Tomasulo’s Algorithm, Illustration with example	1
2.7	Hardware-Based Speculation	1
2.8	Multiple Issue and Static Scheduling	1
2.9	Exploiting IPL using Dynamic Scheduling, Multiple Issue and Static Scheduling	1
	MODULE III	
3.1	Vector Architecture	1
3.2	Graphics Processing Units- Architecture	2
3.3	Similarities and Differences between Vector Architectures and GPUs	1
3.4	Multithreading: Exploiting Thread-Level Parallelism	1
3.5	Centralized Shared Memory architecture.	1
3.6	Basic Schemes for enforcing Coherence	1
3.7	Snooping Coherence Protocols	1
3.8	Distributed Shared Memory.	1
	MODULE IV	
4.1	Programming Models and Workloads for WSC.	1
4.2	Computer Architecture of Warehouse-Scale Computers	1
4.3	Physical Infrastructure and Cost of WSC	1

4.4	Measuring Efficiency of WSC.	1
4.5	Cost of WSC	1
4.6	Cloud Computing.	2
4.7	Domain-Specific Architectures- Guidelines	1
4.8	Google's Tensor Processing Unit.	2
	MODULE V	
5.1	VLIW architectures.	1
5.2	EPIC, The Intel IA-64 Architecture.	2
5.3	Data marshaling for multi-core architectures	1
5.4	Heterogeneous core design, Core Fusion.	1
5.5	On-chip interconnects	1
5.6	Polymorphic architecture	1

CO Assessment Questions	
1	1. Describe the importance of ISA in the design process. How does the choice of ISA impact the overall system design? Provide examples of ISAs and their applications.
2	1. Suppose we made the following measurements: Frequency of FP operations = 25%, Average CPI of FP operations = 4.0, Average CPI of other instructions = 1.33, Frequency of FSQRT = 2%, CPI of FSQRT = 20 Assume that the two design alternatives are to decrease the CPI of FSQRT to 2 or to decrease the average CPI of all FP operations to 2.5. Compare these two design alternatives using the processor performance equation
3	1. Determine whether a 32 KB four-way set associative L1 cache has a faster memory access time than a 32 KB two-way set associative L1 cache. Assume the miss penalty to L2 is 15 times the access time for the faster L1 cache. Ignore misses beyond L2. Which has the faster average memory access time? (Miss rate for two-way set associative cache is 0.038 and four-way set associative cache is 0.037)

4	1. Suppose we have a deeply pipelined processor, for which we implement a branch-target buffer for the conditional branches only. Assume that the misprediction penalty is always four cycles and the buffer miss penalty is always three cycles. Assume a 90% hit rate, 90% accuracy, and 15% branch frequency. How much faster is the processor with the branch-target buffer versus a processor that has a fixed two-cycle branch penalty? Assume a base clock cycle per instruction (CPI)) without branch stalls of one.
5	1. Explore the challenges associated with data movement in traditional architectures and how Processing-in-Memory aims to address these challenges. What impact does this have on energy efficiency?

24CSH711	Time Series Analysis and Forecasting	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course introduces the important time series models and their applications in various fields, creating ability to students to formulate real life problems using time series models and use statistical software to estimate the models from real data, and draw conclusions and develop solutions from the estimated models. The course uses visual and numerical diagnostics to assess the soundness of their model and make students to communicate the statistical analyses and combine and adapt different statistical models to analyse larger and more complex data.

Prerequisite: Computational Fundamentals for Machine Learning

Course Outcomes: After the completion of the course the student will be able to

CO1	Demonstrate a comprehensive understanding of time series data, including the ability to identify and analyze stationary models, and elimination of trends and seasonal components. **(Cognitive Knowledge Level: Understand)**
CO2	Interpret spectral densities and the application of time-invariant linear filters with proficiency in modeling and forecasting with ARMA processes. (**Cognitive Knowledge Level: Apply)**
CO3	Analyze nonstationary and seasonal time series models **(Cognitive Knowledge Level:Understand)**
CO4	Demonstrating competence in analyzing second-order properties, estimating the mean and covariance, and interpreting multivariate ARMA processes. (**Cognitive Knowledge Level: Apply)**
CO5	Describe state-space models, state-space representations, and the basic structure model.**(Cognitive Knowledge Level: Understand)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3									3
CO2	2	1	3									3
CO3	2	1	3									3
CO4	2	1	3									3
CO5	2	1	3									3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test 1	Test 2	Other tools	
Remember	✓	✓	✓	✓

Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I :<< Introduction to Time Series >>

Introduction to time series, Stationary models and autocorrelation function, Estimation and elimination of trend and seasonal components
Stationary Process and ARMA Models, Basic properties and linear processes, Introduction to ARMA models, properties of sample mean and autocorrelation function, Forecasting stationary time series, ARMA(p, q) processes, ACF and PACF,

Forecasting of ARMA processes

MODULE II :<< Spectral Analysis >>

Spectral Analysis, Spectral densities, Time-invariant linear filters, The spectral density of an ARMA process
Modeling and Forecasting with ARMA Processes, Preliminary estimation, Maximum likelihood estimation, Diagnostics, Forecasting, Order selection

MODULE III :<< Nonstationary Time Series Models >>

Nonstationary and Seasonal Time Series Models, ARIMA models, Identification techniques, Unit roots in time series, Forecasting ARIMA models, Seasonal ARIMA models, Regression with ARMA errors

MODULE IV :<< Multivariate Time Series Analysis >>

Multivariate Time Series, Second-order properties of multivariate time series, Estimation of the mean and covariance, Multivariate ARMA processes, Best linear predictors of second-order random vectors, Modeling and forecasting

MODULE V :<< State-Space Models and Forecasting Techniques >>

State-Space Models, State-space representations, The basic structure model, State-space representation of ARIMA models, The Kalman Recursions, Estimation for state-space models Forecasting Techniques, The ARAR algorithm, The Holt-Winter algorithm, The Holt-Winter seasonal algorithm

Text books

1. Brockwell, Peter J. and Davis, Richard A. (2002). Introduction to Time Series and Forecasting, 2nd edition. Springer-Verlag, New York.

Reference books

1. Box, G.E.P., Jenkins, G.M. and Reinsel, G.C. (1994). Time Series Analysis: Forecasting and Control, 3rd Edition, Prentice Hall, New Jersey.
2. Chatfield, C. (1996). The Analysis of Time Series, 5th edition, Chapman and Hall, New York.
3. Shumway, R.H., Stoffer, D.S. (2006). Time Series Analysis and Its Applications (with Rexamples). Springer-Verlag, New York.
4. James D. Hamilton (1994). Time Series Analysis, 1st Edition, Princeton University Press,
5. Galit Shmueli and Kenneth C. Lichtendahl Jr (2016). Practical Time Series Forecasting with R: A Hands-On Guide, 2nd Edition, Axelrod Schnall Publishers.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Overview of Time Series Analysis, Definition and importance of time series data.	1
1.2	Applications of time series analysis in various fields. Basic concepts: time points, observations, and temporal ordering.	1

1.3	Autocorrelation function (ACF): Definition and interpretation, Identification of stationary and non-stationary time series.	2
1.4	Methods for estimating trend and seasonal components.	1
1.5	Basic properties and linear processes in time series. Overview of ARMA (AutoRegressive Moving Average) models.	2
1.6	Analyzing ACF and PACF (Partial Autocorrelation Function).	1
1.7	Forecasting techniques for stationary time series using ARMA models.	1
MODULE II		
2.1	Introduction to spectral analysis	1
2.2	Spectral densities of time series.	1
2.3	Time-invariant linear filters and their role in spectral analysis.	2
2.4	Modeling and Forecasting with ARMA Processes	1
2.5	Preliminary estimation in time series modeling	1
2.6	Maximum likelihood estimation for ARMA processes.	2
2.7	Model diagnostics, order selection, and forecasting	1
MODULE III		
3.1	Introduction to nonstationary time series. ARIMA models and their applications.	1
3.2	Identification techniques for nonstationary time series.	1
3.3	Understanding unit roots in time series.	1
3.4	Forecasting techniques for ARIMA models.	2
3.5	Seasonal ARIMA models and their implementation.	2
3.6	Incorporating ARMA errors in regression models. Practical examples of regression with ARMA errors.	2
MODULE IV		
4.1	Introduction to multivariate time series	1
4.2	Second-order properties and covariance matrix.	2
4.3	Estimation of the mean and covariance in multivariate time series.	1
4.4	Understanding Multivariate ARMA processes.	1
4.5	Best linear predictors of second-order random vectors.	2

4.6	Modeling and forecasting in multivariate time series.	1
	MODULE V	
5.1	Introduction to state-space models.	1
5.2	State-space representation of ARIMA models.	1
5.3	The Kalman Recursions and estimation for state-space models	2
5.4	Overview of forecasting techniques.	1
5.5	The ARAR algorithm and its application.	2
5.6	The Holt-Winter algorithm and seasonal forecasting.	2
5.7	Case studies on time series analysis and forecasting.	1

CO Assessment Questions	
1	1. Explain the concept of stationarity in time series. How does it impact the modeling and analysis of time series data? 2. Describe the autocorrelation function (ACF) and its significance in the context of time series analysis. 3. What methods can be employed for the estimation and elimination of trend and seasonal components in time series data? 4. Provide an overview of ARMA models. How do ARMA(p, q) processes contribute to forecasting stationary time series?
2	5. Define spectral analysis and its relevance in the study of time series. How is it different from other analysis techniques? 6. Explain the concept of spectral densities in the context of time series. How are spectral densities used in time-invariant linear filters? 7. Discuss the significance of the spectral density of an ARMA process. How does it influence modeling and forecasting? 8. What are the key steps involved in modeling and forecasting with ARMA processes? Discuss preliminary estimation and maximum likelihood estimation. 9. How do you determine the order selection for ARMA processes? What role do diagnostics play in this process?

3	1. What distinguishes nonstationary and seasonal time series models? How are ARIMA models used for modeling such data? 2. Discuss identification techniques for ARIMA models. How do unit roots in time series impact the modeling process? 3. Explain the concept of forecasting in ARIMA models. How are seasonal ARIMA models different from regular ARIMA models? 4. How is regression incorporated with ARMA errors in time series modeling? What are the implications for the analysis? 5. Provide an overview of techniques used for forecasting ARIMA models. What challenges might arise in the forecasting process?
4	1. Define multivariate time series. How do second-order properties play a crucial role in the analysis of such data? 2. Discuss the methods for estimating the mean and covariance in multivariate time series. 3. What are multivariate ARMA processes, and how do they differ from univariate ARMA processes? 4. Explain the concept of best linear predictors of second-order random vectors in the context of multivariate time series analysis. 5. How does modeling and forecasting in multivariate time series differ from univariate time series? Discuss the challenges and advantages?
5	1. What are state-space models, and how are they represented in time series analysis? Discuss the basic structure model. 2. Explain the state-space representation of ARIMA models. How do the Kalman Recursions contribute to this representation? 3. What are the key aspects of estimation for state-space models in time series analysis? 4. Discuss the ARAR algorithm and its role in forecasting. How does it differ from other forecasting techniques? 5. Provide an overview of the Holt-Winter algorithm and the Holt- Winter seasonal algorithm. How are these algorithms applied in forecasting time series data?

Minor- S7

24CSM709	Project in Minor	L	T	P	J	S	C	Year of Introduction
		0	0	4	0	0	4	2024

Preamble: The objective of this course is to apply the fundamental concepts of different courses learned in respective Minor Streams. This course helps the learners to get an exposure to the development of application software/hardware solutions/ software simulations in the field of Computer Science and Engineering. It enables the learners to understand the different steps to be followed such as literature review and problem identification, preparation of requirement specification & design document, testing, development and deployment. Mini project enables the students to boost their skills, widen the horizon of thinking and their ability to resolve real life problems.

Prerequisite: A sound knowledge in courses studied in respective minor stream.

Course Outcomes: After the completion of the course the student will be able to

CO1	Identify technically and economically feasible problems. **(Apply level)**
CO2	Identify and survey the relevant literature for getting exposed to related solutions. (**Apply level)**
CO3	Perform requirement analysis, identify design methodologies and develop adaptable & reusable solutions of minimal complexity by using modern tools & advanced programming techniques **(Apply level)**
CO4	Prepare technical report and deliver presentation. **(Apply level)**
CO5	Apply engineering and management principles to achieve the goal of the project. **(Apply level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	3	3	3	3	3		3
CO2	3	3	3	2	3	3	3	3	3	3		3
CO3	3	3	3	3	3	3	3	3	3	3	3	3
CO4						3		3	3	3		3
CO5	3	3	3	3	3	3	3	3	3	3		3

Project Guidelines

- **a.** Student Groups with 4 or 5 members should identify a topic of interest in consultation with a Faculty Advisor/Project Coordinator/Guide.
- **b.** Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives.
- **c.** Carryout the design/fabrication or develop codes/programs to achieve the objectives by strictly following steps specified in the teaching plan.
- **d.** Innovative design concepts, performance, scalability, reliability considerations, aesthetics/ergonomic, user experience and security aspects taken care of in the project shall be given due weight.
- **e.** The progress of the project is evaluated based on three reviews, two interim reviews and a final review.

f. A report is required at the end of the semester.

g. All students doing a project in the eighth semester, shall prepare a Poster as part of their project highlighting their work.

h. The poster carries 5% weightage of the total marks of the project course and to be prepared based on the guidelines issued time to time.

Total Marks distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	100	--	--

Mark Distribution

a. Work assessed by the project guide – 25%

b. Three-member Continuous Internal Evaluation Committee - 20% (Guide shall be one member in the CIE committee)

c. Final Evaluation by a three-member Committee comprising of the department project coordinator, guide and an external expert. The external expert shall be an academician or from industry. The industry expert is preferred: 30%

d. Draft report – 5 % Final Report - 15%

e. Preparing and presenting poster -5%

f. One third of the project shall be completed in VII semester and two third in VIII semester.

EIGHTH SEMESTER													
Sl No	Slot	Code	Category	Title	L	T	P	J	S	No. of Hours	No. of Credits	Total Marks	
												CIA	ESE
1	A	24CSE8X1	PEC	Professional Elective-4 /MOOC	3	0	0	0	3	3	3	40	60
2	B	24CSO8X2	OEC	Open Elective-2/ MOOC	3	0	0	0	3	3	3	40	60
3	C	24CSO8X3	OEC	Open Elective- 3/ MOOC	3	0	0	0	3	3	3	40	60
4	U	24CSD804 / 24CSN804	PR/IP	PROJECT/ INTERNSHIP	0	0	14	0	14	14	7	100	
5	H	23CSH809	PRH	PROJECT IN HONORS	0	0	0	4			4	100	
TOTAL									23	23	16		

Professional Elective 4

Slot	Course Code	Course Name
A	24CSE811	Reinforcement Learning
	24CSE821	Explainable AI
	24CSE831	Mobile Adhoc Networks
	24CSE841	Total Quality Management*
	24CSE851	Software Project Management*
	24CSE861	Swarm Intelligence
	24CSE871	Social Network Analytics
	24CSE881	Time Series Analysis and Forecasting
	24CSE891	Quantum Computing
	24CSE8101	Data Compression
	24CSE8111	Cloud security
	24CSE8121	Cyber Forensics*

	24CSE8131	IoT Security
	24CSE8141	Introduction to Devops*
	24CSE8151	Augmented and Virtual Reality
	24CSE8161	Human Computer Interaction

Open Elective 2/MOOC

Slot	Course Code	Course Name
B	24CSO812	Computer Graphics
	24CSO822	Artificial Intelligence
	24CSO832	Python Programming
	24CSO842	Data Management and Analysis
	24CSO852	Mobile Computing

Open Elective 3/MOOC

Slot	Course Code	Course Name
C	24CSO813	Machine Learning
	24CSO823	Scripting Languages
	24CSO833	Database Management Systems
	24CSO843	Computer Architecture
	24CSO853	Big Data Analytics

HONORS BUCKETS						
SEMESTER	BUCKET 1		BUCKET 2		BUCKET 3	
	Specialization - Data Structures and Algorithms		Specialization - Systems Engineering		Specialization - Data Science	
	Course Code	Course Name	Course Code	Course Name	Course Code	Course Name
S8	24CSH809	Project in Honors	24CSH809	Project in Honors	24CSH809	Project in Honors

Professional Elective IV/ MOOC

24CSE811	Reinforcement Learning	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course covers fundamental principles and techniques in reinforcement learning introducing the paradigm that learn how to predict and act in a stochastic environment, based on past experience. It will equip the students with the knowledge and skills needed to design, implement, and analyze RL algorithms. The course delves into the principles of reward-based learning, explore various RL architectures, and discover how these techniques are applied in diverse fields such as robotics, game playing, and autonomous systems.

Prerequisite: Computational Fundamentals for Machine Learning

Course Outcomes: After the completion of the course the student will be able to

CO1	Solve computational problems using probability and random variables. **(Cognitive Knowledge Level: Apply)**
CO2	Apply policy iteration and value iteration reinforcement learning algorithms. **(Cognitive Knowledge Level: Apply)**
CO3	Use of Monte Carlo reinforcement learning algorithms. **(Cognitive Knowledge Level: Apply)**
CO4	Apply temporal-difference reinforcement learning algorithms. (**Cognitive Knowledge Level: Apply)**
CO5	Compare on-policy and off-policy reinforcement learning algorithms with function approximation. (**Cognitive Knowledge Level: Understand)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	2	3						3
CO2	2	1	3	3	2	3						3
CO3	2	1	3	3	2	3						3
CO4	2	1	3	3	2	3						3
CO5	2	1	3	3	2	2						3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test 1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate			✓	
Create			✓	

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks) Total Marks: 20	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours Total Marks: [5x8 = 40 marks]	60

SYLLABUS

MODULE I : Introduction

Probability concepts review - Axioms of probability, concepts of random variables, probability mass function, probability density function, cumulative density functions, Expectation. Concepts of joint and multiple random variables, joint, conditional and marginal distributions. Correlation and independence.

MODULE II : Markov Decision Process

Introduction to Reinforcement Learning(RL) terminology - Examples of RL, Elements of RL, Limitations and Scope of RL.

Finite Markov Decision Processes - The Agent–Environment Interface, Goals and Rewards, Returns and Episodes, Policies and Value Functions, Optimal Policies and Optimal Value Functions.

MODULE III : Prediction And Control

Dynamic Programming - Policy Evaluation (Prediction), Policy Improvement, Policy Iteration, Value Iteration.

Monte Carlo (MC) for model free prediction and control - Monte Carlo Prediction, Monte Carlo Estimation of Action Values, Monte Carlo Control, Monte Carlo Control without Exploring Starts, Off-policy Prediction via Importance Sampling, Incremental Implementation, Off-policy Monte Carlo Control.

MODULE IV : Temporal-Difference (TD) Methods For Model Free Prediction And Control

TD Methods - TD Prediction, Advantages of TD Prediction Methods, Optimality of TD(0), Sarsa: On-policy TD Control, Q-learning: Off-policy TD Control, Expected Sarsa.

n-step Bootstrapping- n-step TD Prediction, n-step Sarsa, step Off-policy Learning, Off-policy Learning Without Importance Sampling: The n-step Tree Backup Algorithm.

MODULE V : Function Approximation Method

On-policy Prediction with Approximation - Value-function Approximation, The Prediction Objective, Stochastic-gradient Methods, Linear Methods.

Eligibility Traces - The λ-return, TD(λ), n-step Truncated λ-return Methods, Sarsa(λ).

Policy Gradient Methods - Policy Approximation and its Advantages, The Policy Gradient Theorem, REINFORCE: Monte Carlo Policy Gradient, REINFORCE with Baseline, Actor– Critic Methods.

Text books

1. Richard S. Sutton and Andrew G. Barto, Reinforcement Learning: An Introduction, 2nd Edition
2. Alberto Leon-Garcia, Probability, Statistics, and Random Processes for Electrical Engineering, 3rd Edition,

Reference books

1. Reinforcement Learning: State-of-the-Art, Marco Wiering and Martijn van Otterlo, Eds
2. Algorithms for Reinforcement Learning, Szepesvari (2010), Morgan & Claypool.
3. Artificial Intelligence: A Modern Approach, Stuart J. Russell and Peter Norvig
4. Mathematical Statistics and Data Analysis by John A. Rice,University of California, Berkeley, Third edition, published by Cengage.
5. Machine Learning: A Probabilistic Perspective, Kevin P. Murphy

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Axioms of probability, concepts of random variables	1
1.2	Probability mass function, Probability density function Cumulative density functions	1
1.3	Expectation of random variables	1
1.4	Joint and multiple random variables	1
1.5	Conditional and marginal distributions	1
1.6	Correlation and independence	1
	MODULE II	
2.1	Introduction to Reinforcement Learning(RL) terminology - Examples of RL, Elements of RL, Limitations and Scope of RL	1
2.2	Finite Markov Decision Processes	1
2.3	The Agent–Environment Interface	1
2.4	Goals and Rewards	1
2.5	Returns and Episodes	1

2.6	Policies and Value Functions	1
2.7	Optimal Policies and Optimal Value Functions	1
	MODULE III	
3.1	Policy Evaluation (Prediction)	1
3.2	Policy Improvement, Policy Iteration, Value Iteration Monte Carlo Prediction	2
3.3	Monte Carlo Estimation of Action Values	1
3.4	Monte Carlo Control, Monte Carlo Control without Exploring Starts	1
3.5	Off-policy Prediction via Importance Sampling	1
3.6	Incremental Implementation	1
3.7	Off-policy Monte Carlo Control	1
	MODULE IV	
4.1	TD Prediction, Advantages of TD Prediction Methods	1
4.2	Optimality of TD(0)	1
4.3	Sarsa: On-policy TD Control	1
4.4	Q-learning: Off-policy TD Control	1
4.5	Expected Sarsa	1
4.6	n-step TD Prediction, n-step Sarsa, n-step Off-policy Learning	1
4.7	Off-policy Learning Without Importance Sampling: The n-step Tree Backup Algorithm	1
	MODULE V	
5.1	Value-function Approximation	1
5.2	The Prediction Objective	1

5.3	Stochastic-gradient Methods	1
5.4	Linear Methods	1
5.5	The Lambda-return , TD(Lambda)	1
5.6	n-step Truncated Lambda-return Methods, Sarsa(Lambda)	1
5.7	Policy Approximation and its Advantages, The Policy Gradient Theorem, REINFORCE: Monte Carlo Policy Gradient	1
5.8	REINFORCE with Baseline, Actor–Critic Methods	1

<table>
<tr><th colspan="2">CO Assessment Questions</th></tr>
<tr><td>1</td><td>a) A biased coin (with probability of obtaining a head equal to $p > 0$) is tossed repeatedly and independently until the first head is observed. Compute the probability that the first head appears at an even numbered toss.
b) Two players A and B are competing at a quiz game involving a series of questions. On any individual question, the probabilities that A and B give the correct answer are p and q respectively, for all questions, with outcomes for different questions being independent. The game finishes when a player wins by answering a question correctly. Compute the probability that A wins if
i. A answers the first question,
ii. B answers the first question.

c) A coin for which P(heads) = p is tossed until two successive tails are obtained. Find the probability that the experiment is completed on the n^{th} toss.
d) An urn contains p black balls, q white balls, and r red balls; and n balls are chosen without replacement.
i. Find the joint distribution of the numbers of black, white, and red balls in the sample.
ii. Find the joint distribution of the numbers of black and white balls in the sample.
iii. Find the marginal distribution of the number of white balls in the sample.</td></tr>
<tr><td>2</td><td>a) Give examples of Markovian and non-Markovian environments?
b) What are the advantages and disadvantages of value methods vs</td></tr>
</table>

	policy methods? c) Define the optimal state-value function V*(s) for an MDP. d) Imagine that the rewards are at most 1 everywhere. What is the maximum value that the discounted return can attain ? Why ? e) Write down the Bellman optimality equation for state-value functions
3	a) Explain policy iteration and value iteration? What are their similarities and differences? b) Why Monte Carlo methods for learning value functions require episodic tasks? How is it that n-step TD methods avoid this limitation and can work with continuing tasks? c) List any three uses of the depth parameter in the Monte-Carlo tree search procedure. d) Given that $q\pi(s, a) > v\pi(s)$, can we conclude that π is not an optimal policy. Justify
4	a) How would you differentiate between learning algorithms using on-policy from those that use off-policy? b) When using Temporal Difference learning, why is it better to learn action values (Q- values) rather than state values (V-values)? c) Supose that a Q-learning agent always chooses the action which maximizes the Q-value. What is one potential problem with that approach? d) Describe any two ways that will force a Q-learning agent to explore. e) Why and when do we need importance sampling?
5	f) How do you deal with a large possible action space in reinforcement learning? g) List any two benefits of policy gradient methods over value function based methods. h) What is the relation between Q-learning and policy gradients methods? i) Consider a five state random walk. There are five states, s1, s2, ..., s5, in a row with two actions each, left and right. There are two terminal states at each end, with a reward of +1 for terminating on the right, after s5 and a reward of 0 for all other transitions, including the one terminating on the left after s1. In designing a linear function approximator, what is the least number of state features required to represent the value of the equi-probable random policy?

24CSE821	Explainable AI	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course provides a comprehensive introduction to the field of Explainable Artificial Intelligence (XAI). Students will gain insights into various techniques and methods for making AI systems interpretable and understandable by humans. The course combines theoretical concepts with hands-on applications to equip students with the knowledge and skills needed to design and evaluate explainable AI models.

Prerequisite: Computational Fundamentals for Machine Learning

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain significance of interpretability in AI and its impact on the acceptance of AI technologies in real-world applications. **(Cognitive Knowledge Level: Understand)**
CO2	Understand the interpretability aspects of linear models and logistic regression, **(Cognitive Knowledge Level: Understand)**
CO3	Understand the interpretability aspects of neural networks, sequential models and reinforcement learning models. **(Cognitive Knowledge Level: Understand)**
CO4	Use model-agnostic methods and comprehend how these methods contribute to the interpretability of diverse machine learning models. **(Cognitive Knowledge Level: Apply)**
CO5	Identify Emerging Trends in XAI Research and explain Open Challenges and Opportunities. **(Cognitive Knowledge Level: Understand)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3									3
CO2	2	1	3									3
CO3	2	1	3									3
CO4	2	1	3									3
CO5	2	1	3									3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test 1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate			✓	

Create			✓	

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Overview of AI interpretability and explainability

Introduction: Interpretability-importance,scope, Taxonomy of Interpretability Methods, evolution, Properties of Explanations-Human friendly Explanations.
Importance of XAI in real-world applications
Ethical considerations in AI and the need for transparency

MODULE II : Inherent Model Transparency

Inherent Model Transparency: Decision Trees and Rule-based Models
Rule-based Models: Association rule mining, Sequential rule mining, Rule-based systems in AI, Linear Models and Logistic Regression, Generalized Additive Models (GAM)

MODULE III : Interpretable Neural Networks

Overview of neural network interpretability:-Saliency maps and gradient-based methods, Layer-wise relevance propagation (LRP) Time Series and Sequence Data Interpretability: Interpretable models for time series data, Sequence- to-sequence models and attention mechanisms
MODULE IV : Explainable Reinforcement Learning and Model-Agnostic Methods
Explainable Reinforcement Learning: Importance of explainability in reinforcement learning, State-of-the-art methods in explaining RL decisions Model-Agnostic Methods -introduction, LIME (Local Interpretable Model-agnostic Explanations) SHAP (SHapley Additive exPlanations), Anchors
MODULE V : XAI in Industry and Real-world Applications
XAI in Industry and Real-world Applications: Case studies of XAI implementation in various industries, Challenges and success stories, Regulatory aspects and compliance Future Trends and Research Directions:- Emerging trends in XAI research Open challenges and opportunities
Text books 1. Christoph Molnar, Interpretable Machine Learning: A Guide For Making Black Box Models Explainable, Second edition, Leanpub publications, 2019, ISBN-13: 978-3-9819525-1-3
Reference books 1. Michael Hindle and Sebastian Raschka, Explainable AI: Interpreting, Explaining, and Visualizing Deep Learning 2. Terence Parr, Explainable AI: A Practical Guide to Building Transparent Models for the Real World 3. Kelleher, D., Mac Namee, B., & D'Arcy, Interpretable Models: From Machine Learning to Deep Learning

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
	MODULE 1	
1.1	Introduction to Interpretability/ Explainability	1
1.2	Interpretability-importance, scope	1
1.3	Taxonomy of Interpretability Methods	1
1.4	Evolution of Interpretability Methods	1
1.5	Properties of Explanations-Human friendly Explanations	1
1.6	Importance of XAI in real-world application	1

1.7	Ethical considerations in AI and the need for transparency	2
	MODULE II	
2.1	Overview of model transparency and its importance in machine learning.	1
2.2	The concept, use, and advantages and limitations of Decision Trees	1
2.3	Introduction to Association Rule Mining and Sequential Rule Mining. Examples of real-world applications for rule-based models.	1
2.4	Exploring rule-based systems and their role in artificial intelligence.	1
2.5	Principles of linear and Logistic Regression models in machine learning. Interpretability aspects of linear models.	1
2.6	Introduction to Generalized Additive Models (GAM). Flexibility and interpretability in GAM.	1
2.7	Integrating the concepts learned into real-world scenarios.	1
2.8	Optimal Policies and Optimal Value Functions	1
	MODULE III	
3.1	Overview of neural network interpretability:-, , and attention mechanisms	1
3.2	Explanation on Saliency maps and gradient-based methods	1
3.3	Layer-wise relevance propagation (LRP)	1
3.4	Time Series and Sequence Data Interpretability:	1
3.5	Interpretable models for time series data	1
3.6	Interpretability in Sequence-to-sequence models	1
3.7	Interpretability in attention models	1
	MODULE IV	
4.1	Explainable Reinforcement Learning: Importance of explainability in reinforcement learning	1
4.2	State-of-the-art methods in explaining RL decisions	1
4.3	Model-Agnostic Methods -introduction	1
4.4	LIME (Local Interpretable Model-agnostic Explanations)	1

4.5	SHAP (SHapley Additive exPlanations)	1
4.6	Introduction to Anchors	1
	MODULE V	
5.1	XAI in Industry and Real-world Applications: Case studies in the healthcare industry.	1
5.2	Case Studies in Various Industries - Applications of XAI in financial services, banking, XAI implementation in manufacturing	1
5.3	Identifying challenges in implementing XAI, Regulatory aspects and compliance	1
5.4	Current state-of-the-art in XAI research	1
5.5	Exploration of emerging trends and methodologies.	1
5.6	Identification of open challenges and opportunities.	1

CO Assessment Questions	
1	1. Why is interpretability considered a crucial aspect in the field of artificial intelligence, and how does it impact the adoption of AI technologies in real-world applications? 2. Provide an overview of the different categories in the taxonomy of interpretability methods. How do these categories help in understanding and categorizing various interpretability techniques? 3. Trace the evolution of interpretability in AI. How have interpretability methods changed over time, and what factors have driven these changes? 4. Explore the ethical considerations associated with AI models, especially in terms of transparency. How can interpretable AI contribute to addressing ethical concerns in AI applications?
2	1. Discuss the interpretability aspects of linear models and logistic regression. How do these models provide inherent transparency, and what are their limitations? 2. What is the role of Generalized Additive Models in achieving interpretability? Provide examples of scenarios where GAMs can be particularly useful. 3. Explain the concept of association rule mining. How is it used in building interpretable models, and what are its limitations? 4. Identify and discuss the challenges associated with the implementation

	of rule-based systems in AI. How can these challenges be addressed?
3	1. Explain how saliency maps and gradient-based methods contribute to the interpretability of neural networks. Provide examples of their applications. 2. Discuss the concept of Layer-wise Relevance Propagation. How does it enhance our understanding of the decision-making process in neural networks? 3. Why is explainability particularly important in the context of reinforcement learning? Discuss the challenges associated with understanding and interpreting RL decisions
4	1. What is the motivation behind using model-agnostic methods? How do these methods contribute to the interpretability of diverse machine learning models? 2. Provide a comparative analysis of LIME, SHAP, and Anchors. In what scenarios would one method be preferred over the others?
5	1. What are the current open challenges in XAI, and what opportunities exist for further advancements in the field? How can these challenges be turned into avenues for research and innovation? 2. Identify and discuss recent trends in XAI research. How are researchers addressing the evolving needs for interpretability in AI?

24CSE831	Mobile Ad Hoc Networks	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course covers major aspects of ad hoc networks, from design through performance issues to application requirements. It starts with characteristics, applications of ad-hoc networks, modulation techniques, and voice coding. It also covers the IEEE 802 Networking Standard, Bluetooth, Cellular Architecture, Mobile IP, Ad Hoc Wireless Networks, MAC Protocols, Routing Protocols, TCP, and Quality of Service.

Prerequisite: Computer Networks

Course Outcomes: After the completion of the course the student will be able to

CO1	Summarize the characteristics of an Ad hoc Network **(Understand Level)**
CO2	Outline the features of WANs **(Understand Level)**
CO3	Explain the basics of MAC protocols used in mobile Ad hoc networks **(Understand Level)**
CO4	Identify the Routing protocols used in mobile Ad hoc networks . **(Apply Level)**
CO5	Outline the transport layer protocols and achieving QoS in mobile Ad hoc networks. **(Understand Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										3
CO2	3	3										3
CO3	3	3										3
CO4	3	3										3
CO5	3	3										3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Introduction to Adhoc Networks (6hrs)

Introduction to Ad Hoc networks- definition, characteristics, applications. Characteristics of Wireless channel, Modulation techniques, Multiple access techniques, Voice coding, Error control, Computer networks, Computer networks software, Computer network architecture, IEEE 802 Networking standard, Fundamentals of WLANs, Bluetooth.

MODULE II : Wireless WANs (5hrs)

Cellular concept, Cellular architecture, First generation cellular systems, Second generation cellular systems, Third generation cellular systems, Wireless in local loop, IEEE 802.11standard, IEEE 802.16 standard, Wireless Internet- Mobile IP, Ad Hoc Wireless Networks- Introduction, Issues in Ad Hoc Wireless Networks, Ad

Hoc Wireless Internet.

MODULE III : MAC Protocols (6hrs)

MAC Protocols- Design issues, goals, and classification, Contention-based protocols, Contention based protocols with reservation mechanisms, Contention based MAC protocols with Scheduling mechanisms, MAC protocols use directional antennas, Other MAC protocols.

MODULE IV : Routing Protocols (8hrs)

Routing Protocols- Design issues and classifications. Table-driven routing protocols, On-demand routing protocols, Hybrid routing protocols, Hierarchical routing protocols, Multicast routing in Ad hoc wireless networks- Issues in designing a multicast routing protocols, operation of multicast routing protocols, Tree based multicast routing protocols, Mesh based multicast routing protocols

MODULE V : Transport layer and security protocols (7hrs)

Transport layer protocols- Design issues, goals, and classification,
TCP over Ad Hoc wireless networks, Security in ad hoc wireless networks- issues and challenges in security provisioning, Network security attacks, Key management, Secure routing in Ad hoc wireless networks, QoS in Ad Hoc Wireless networks: Classifications of QoS solutions, MAC layer solutions, Network layer solutions.

Textbooks

1. C.Siva Ram Murthy and B.S.Manoj, "Adhoc Wireless Networks Architectures and protocols", 2nd edition, Pearson Education. 2007.
2. Jun Zheng, Abbas Jamalipour, Wireless Sensor Networks: A Networking Perspective,John Wiley, 2009

Reference books

1. Mohammad Ilyas, "The handbook of adhoc wireless networks", CRC press, 2002
2. Stefano Basagni, Marco Conti, Silvia Giordano and Ivan stojmenovic, Mobile ad-hoc networking, Wiley-IEEE press, 2004

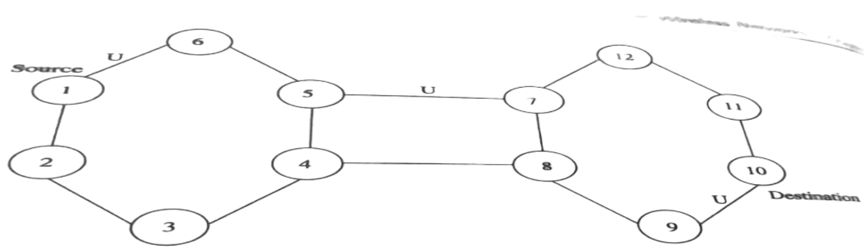
COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Definition, characteristics, and applications of Ad Hoc networks.	1
1.2	Characteristics of Wireless channel, Modulation techniques.	1
1.3	Multiple access techniques, Voice coding, Error control	1
1.4	Computer networks, Computer networks software, Computer network architecture	1
1.5	IEEE 802 Networking standard	1

1.6	Fundamentals of WLANs, Bluetooth	1
	MODULE II	
2.1	Cellular concept	1
2.2	Cellular architecture, Different generations of cellular systems	1
2.3	Wireless in local loop, IEEE 802.11standard, IEEE 802.16 standard	1
2.4	Mobile IP	1
2.5	Introduction, Issues in Ad Hoc Wireless Networks, Ad Hoc Wireless Internet.	1
	. **MODULE III**	
3.1	MAC protocols Design issues, goals, and classification	1
3.2	Contention based protocols	1
3.3	Contention based protocols with reservation mechanisms,	1
3.4	Contention based MAC protocols with Scheduling mechanisms	1
3.5	MAC protocols use directional antennas	1
3.6	Other MAC protocols	1
	MODULE IV	
4.1	Routing Protocols: Design issues, and classification	1
4.2	Table driven routing protocols,	1
4.3	On-demand routing protocols	1
4.4	Hybrid routing protocols	1
4.5	Hierarchical routing protocols	1
4.6	Issues in designing a multicast routing protocols, operation of multicast routing protocols	1
4.7	Tree based multicast routing protocols	1

4.8	Mesh based multicast routing protocols	1
	MODULE V	
5.1	Design issues, goals, and classification	1
5.2	TCP over Ad Hoc wireless networks	1
5.3	Security in ad hoc wireless networks, network security attacks, key management	1
5.4	Secure routing in Ad Hoc wireless networks	1
5.5	Issues and Challenges in providing QoS, Classification of QoS Solutions	1
5.6	MAC Layer Solutions	1
5.7	Network layer Solutions.	1

CO Assessment Questions	
1	1. Compare and Contrast infrastructure networks with ad hoc networks. Give example situation where one type of network is preferred to another. 2. Assume that in one slot in Bluetooth 256 bits of payload could be transmitted. How many slots are needed if the payload size is (a) 512 bits, (b) 728 bits, and (c) 1,024 bits. Assume that the non pay load portions do not change.
2	1. How does frequency reuse enhance cellular network capacity?. Consider an are of 1,000 sq.Km to be covered by a cellular network. If each user requires 25 KHz for communication, and the total available spectrum is 50 MHz, how many users can be supported without frequency reuse? If cells of area 50 sq.Km are used, how many users can be supported with a cluster size of 3,4,and 7? Besides the number of users, what other major influences the decision on cluster size? 2. How do you separate the different layers (macro, micro, and pico) of a cellular network in order to avoid co-channel interference across layers?

3	1. Compare the pros and cons of using scheduling-based MAC protocols over reservation-based MAC protocols. 2. IN FPRP, can a situation occur where a requesting node is not able to detect collisions that have occurred in the reservation request phase? If so, suggest simple modifications to solve the problem.
4	1. Consider the topology given in the figure. Simulate DSR,SSA, and ABR protocols for path establishment from node1 to node 10, find the paths found and the ratio of the number of *RouteRequest* packets sent in the network.(Links labeled "U" refer to unstable ones.) 
5	1. During a research discussion, one of your colleagues suggested an extension of split TCP where every intermediate node acts as a proxy node. What do you think would be the implications of such a protocol? 2. What are the pros and cons of using the hop-by-hop path bandwidth calculation algorithm proposed in the BR and OQR protocols over the approach used during the unipath discovery operation of the OLMQR protocol for the end-to-end path bandwidth calculation.

24CSE841	Total Quality Management	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course enables the learners to familiarize the principles of Total Quality Management (TQM), tools and the need for various quality systems to ensure the quality of both products and processes. This covers the fundamental concepts and principles of TQM, Statistical process control, TQM tools and Quality system that helps the students to gain insights into how TQM can be effectively implemented to enhance organizational performance and customer satisfaction.

Prerequisite: Software Engineering

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the basic concepts of total quality management. **(Understand Level)**
CO2	Apply TQM principles to Real-world Business Scenarios. **(Apply Level)**
CO3	Use various statistical process control for quality management. **(Apply Level)**
CO4	Explain purposes and functions of various TQM tools utilized for effective quality management. **(Understand Level)**
CO5	Use the knowledge of quality standards to identify their relevance and potential implementation in specific organizational contexts. **(Apply Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										3
CO2	3	3										3
CO3	3	3										3
CO4	3	3										3
CO5	3	3										3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test 1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Introduction (7 hrs)

Introduction- Definition of quality, Dimensions of quality, Quality planning, Quality costs, Analysis techniques for quality cost. Basic concepts of total quality management – Historical review, Principles of TQM. Leadership – Concepts, Role of senior management. Quality council – Quality statements –Strategic planning – Deming philosophy – Barriers to TQM implementation.

MODULE II : TQM Principles (8 hrs)

TQM Principles-Customer satisfaction – Customer perception of quality – Customer complaints – Service quality –Customer retention – Employee involvement – Motivation, empowerment, teams, recognition and reward – Performance appraisal – Benefits – Continuous process improvement – Juran trilogy – PDSA cycle – 5S – Kaizen – Supplier partnership – Partnering – Sourcing – Supplier selection – Supplier

rating – Relationship development – Performance measures – Basic concepts – Strategy –Performance measure.		
MODULE III : Statistical Process Control (7 hrs)		
Statistical Process Control-The seven tools of quality – Statistical fundamentals – Measures of central tendency and dispersion – Population and sample – Normal curve – Control charts for variables and attributes – Process capability – Concept of six sigma – New seven management tools.		
MODULE IV : TQM Tools (7 hrs)		
TQM Tools- Benchmarking – Reasons to benchmark – Benchmarking process – Quality Function Deployment (QFD) – House of quality – QFD process – Benefits – Taguchi quality loss function – Total Productive Maintenance (TPM) – Concept – Improvement needs – FMEA – Stages of FMEA.		
MODULE V : Quality Systems (7 hrs)		
Quality Systems- Need for ISO 9000 and other quality systems – ISO 9000:2000 Quality system – Elements – Implementation of quality system – Documentation – Quality auditing – TS 16949 – ISO 14000 –Concept – Requirements and benefits.		

Text books

1. Besterfiled, D.H. “Total Quality Management”, Pearson Education, Inc. 2003.
2. Zeiri., “Total Quality Management for Engineers”, Wood Head Publishers, 1991.

Reference books

1. Evans, J. R., and Lidsay, W.M., “The Management and Control of Quality”, 5th Edition, South-Western (Thomson Learning), 2002.
2. Oakland.J.S. “Total Quality Management”, Butterworth – Hcinemann Ltd., Oxford, 1989.
3. Narayana V. and Sreenivasan, N.S., “Quality Management – Concepts and Tasks”, New Age International, 1996.

Suggested MOOC Courses

1. Total Quality Management – I By Prof. Raghu Nandan Sengupta, IIT Kanpur

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1		
1.1	Definition of quality – Dimensions of quality – Quality planning	1
1.2	Quality costs – Analysis techniques for quality costs	1
1.3	Basic concepts of total quality management – Historical review – Principles of TQM	1
1.4	Leadership – Concepts – Role of senior management	1
1.5	Quality council – Quality statements	1

1.6	Strategic planning – Deming philosophy	1
1.7	Barriers to TQM implementation.	1
MODULE II		
2.1	Customer satisfaction – Customer perception of quality —Customer complaints	1
2.2	Service quality –Customer retention	1
2.3	Employee involvement – Motivation, empowerment, teams, recognition and reward	1
2.4	Performance appraisal – Benefits – Continuous process improvement	1
2.5	Juran trilogy – PDSA cycle-5S – Kaizen	1
2.6	Supplier partnership – Partnering- Sourcing – Supplier selection – Supplier rating)	1
2.7	Supplier partnership – Partnering- Sourcing – Supplier selection – Supplier rating	1
2.8	Relationship development – Performance measures – Basic concepts – Strategy –Performance measure.	1
MODULE III		
3.1	The seven tools of quality	1
3.2	Statistical fundamentals – Measures of central tendency and dispersion	1
3.3	Population and sample – Normal curve	1
3.4	Control charts for variables and attributes	1
3.5	Process capability – Concept of six sigma	1
3.6	Process capability – Concept of six sigma	1
3.7	New seven management tools.	1
MODULE IV		
4.1	Benchmarking – Reasons to benchmark	1
4.2	Benchmarking process	1
4.3	Quality Function Deployment (QFD)	1

4.4	House of quality – QFD process – Benefits	1
4.5	Taguchi quality loss function – Total Productive Maintenance (TPM)	1
4.6	Concept – Improvement needs	1
4.7	FMEA – Stages of FMEA.	
MODULE V		
5.1	Need for ISO 9000 and other quality systems	1
5.2	ISO 9000:2000 Quality system – Elements – Implementation of quality system	1
5.3	ISO 9000:2000 Quality system – Elements – Implementation of quality system	1
5.4	Documentation – Quality auditing – TS 16949 – ISO 14000	1
5.5	Documentation – Quality auditing – TS 16949 – ISO 14000	1
5.6	Concept – Requirements and benefits.	2

CO Assessment Questions	
1	a) Working as an individual or in a team of three or more people, determine two or more obstacles to implementing TQM in one or more of the organizations listed below. i. Large bank ii. Health-Care facility iii. University Academic department iv. Large grocery store b) Out of the six basic TQM concepts, which were the most effective in World War II? Explain.' c) Select a product or service and describe how the dimensions of quality influence its acceptance.
2	a) As a manager of a small sporting goods store, describe how you would train front-line employees to handle customer complaints.? b) Mechanical products, such as cars, break down. Cars often are serviced by the car dealer. How can a car dealer use the service department to encourage future car sales.
3	a) Design a check sheet for the maintenance of a piece of equipment such as a gas furnace, laboratory scale or typewriter.

	b) A major record -of-the-month club collected data on the reasons for returned shipments during a quarter. Results are: wrong selection. 50,000; refused, 1,95,000; wrong address, 68,000; order canceled, 5,000; and other, 15,000. Construct a Pareto diagram.
4	a) Identify and explain the three main types of benchmarking. In what circumstances would each type be most appropriate? b) What difficulties are typically encountered when benchmarking direct competitors? Describe several ways to work around these problems? c) Why are companies encrypting instant messages and e-mail? What are the advantages of using instant messaging instead of email?
5	a) Determine which element of ISO 9001 is referenced in each of the following situation: i. An audit found that no supplier reviews were being performed. ii. There were no inspection records iii. During an audit , it was found that a punch press operator had not received the technical instructions necessary for running the punch press. iv. During an audit, it was discovered that no manager had been given the responsibility of ensuring that the quality system was being maintained. b) List five benefits that could be realized by implementing an ISO 9000 quality system.

24CSE851	Software Project Management	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	0	0	2024

Preamble: This course provides fundamental knowledge about how to manage a software project. It covers Software Development, Quality Assurance, Project Management concepts and technology trends. This course enables the learners to apply state of the art industry practices in Software Management.

Prerequisite: Familiarity with basics in software engineering and software testing.

Course Outcomes: After the completion of the course the student will be able to

CO1	Demonstrate Traditional and Agile Software Development approaches. **(Understand Level)**
CO2	Familiarize the different methods and techniques used for project management.(**Understand Level)**
CO3	Evaluate a project to develop the scope of work, provide accurate cost estimates and to plan the various activities. **(Analyze Level)**
CO4	Identify the resources required for a project and to produce a work plan and resource schedule. **(Apply level)**
CO5	Understand the basics and benefits of software quality engineering. **(Understand Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3			1							3
CO2	3	3	1						3			3
CO3	3	3	1									3
CO4	3	3			3				3			3
CO5	3	3	3	3					1			3
CO6	3	1			3							3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓		✓
Understand	✓	✓		✓
Apply	✓	✓		✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : INTRODUCTION (6 hrs)

Defining Software Development Process - Process - Tailoring the Process - Improving the process discipline - Need for implementing discipline. Software Production Process- Identify the Software Model - Software Process Models: Waterfall Model, Prototyping Model, RAD Model, Incremental Model, Spiral Model, Agile Software Development.

MODULE II : PLANNING (5 hrs)

Project management fundamentals-Approaches-Challenges-Project management cycle- Management spectrum- Role of Project Manager-Planning

Fundamentals – Major issues in software project planning – Planning activities - Risk Management - Configuration Management.

MODULE III : PROJECT ESTIMATION (9 hrs)

Project estimation- techniques-Size estimation– Major issues in estimating software cost – Cost estimation methods – Experience based model – Parameter based model – COCOMO – Versions of COCOMO – Software size estimation – Function points – Staffing Level Estimation-Project Scheduling-organization and Team Structures.

MODULE IV : PROJECT SCHEDULING (6 hrs)

Time management: importance of Project schedules, schedules and activities, sequencing and scheduling activities, Network Planning models, duration estimation and schedule development, Critical path analysis, PERT, Use of software (Microsoft project) to assist in project scheduling

MODULE V : SOFTWARE QUALITY (8 hrs)

Software Quality - Quality Measures - FURPS - Software Quality Assurance, Software Reviews - Format Technical Review (FTR) Formal Approaches to SQA - Software Reliability - Introduction to SQA - The Software Quality Assurance Plan – Formal approaches to SQA - Cleanroom Methodology.

Text books

1. Software Engineering - Ian Sommerville, Pearson Education, Tenth edition, 2015.
2. Software Engineering: A practitioner's approach - Roger S. Pressman, McGraw Hill publication, Eighth edition, 2014
3. Fundamentals of Software Engineering - Rajib Mall, Eastern Economy Edition,Fifth edition, 2018.

Reference books

1. Software Project Management Subramanian Chandramouli Saikat Dutt, Pearson Education Publishing, 2015.
2. Engineering Software Products: An Introduction to Modern Software Engineering - Ian Sommerville, Pearson Education, First Edition, 2020.

Suggested MOOC Courses

1. Prof. Rajib Mall & Prof. Durga Prasad Mohapatra /IIT Kharagpur , https://onlinecourses.nptel.ac.in.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Defining of Software Development Process- Process - Tailoring the Process	1
1.2	Improving the process discipline- Need for implementing discipline. Software Production Process	1
1.3	Identify the Software Model - Software Process Models: Waterfall Model	1
1.4	Prototyping Model, RAD Model, Incremental Model	1

1.5	Spiral Model	1
1.6	Agile software development .	1
MODULE II		
2.1	Project management fundamentals-Approaches- Challenges	1
2.2	Role of Project Manager- Planning Fundamentals	1
2.3	Major issues in software project planning- Planning Activities	1
2.4	Project plan	1
2.5	Risk Management- Configuration Management	1
MODULE III		
3.1	Project estimation- techniques-Size estimation	1
3.2	Major issues in estimating software cost	1
3.3	Cost estimation methods – Experience based model	1
3.4	Parameter based model	1
3.5	COCOMO Model- Versions of COCOMO	1
3.6	Software size estimation – Function points	1
3.7	Staffing Level Estimation	1
3.8	Project Scheduling- Project organization	1
3.9	Team Structures	1
MODULE IV		
4.1	Time management: importance of Project schedules, schedules and activities	1
4.2	Sequencing and scheduling activities, Network Planning models	1
4.3	Duration estimation and schedule development	1
4.4	Critical path analysis	1
4.5	PERT	1

4.6	Use of software (Microsoft project) to assist in project scheduling	1
	MODULE V	
5.1	Software Quality - Quality Measures	1
5.2	FURPS - Software Quality Assurance	1
5.3	Software Reviews - Format Technical Review (FTR) Formal Approaches to SQA	1
5.4	Software Reliability	1
5.5	Introduction to SQA	1
5.6	The Software Quality Assurance Plan	1
5.7	Formal approaches to SQA	1
5.8	Clean room Methodology	1

CO Assessment Questions	
1	1. Illustrate agile software development and traditional software development with a socially relevant case study. 2. Explain the criteria of process model selection.
2	1. Demonstrate the risk management process with the help of examples. 2. Write a case study to illustrate the importance of communications in a project team. Assume that some team members work remotely and it is impossible to get the whole team together at short notice.
3	1. A system has 12 external inputs, 24 external outputs, fields 30 different external queries, manages 4 internal logical files, and interfaces with 6 different legacy systems (6 EIFs). All of these data are of average complexity and the overall system is relatively simple. Compute FP for the system? 2. Suppose you are developing a software product of organic type. You have estimated the size of the product to be about 100000 LOC. Compute the nominal effort and development time.

4	1. How is Gantt chart useful in software project management? What problems might be encountered, if project monitoring and control is carried out using a Gantt chart? 2. The following table indicates the various tasks involved in completing a software project, the corresponding activities, and the estimated effort for each task in person-months. The precedence relation Ti ≤ {Tj, Tk} implies that the task Ti must complete before either task Tj or Tk can start. The following precedence relation is known to hold among different tasks: T1 ≤ T2 ≤ {T3, T4, T5, T6} ≤ T7. (a) Draw the Activity network representation of the tasks. (b) Determine ES, EF and LS, LF for every task. (c) Develop the Gantt chart representations for the project.

Notation	Activity	Effort in person-months
T_1	Requirements specification	1
T_2	Design	2
T_3	Code actuator interface module	2
T_4	Code sensor interface module	5
T_5	Code user interface part	3
T_6	Code control processing part	1
T_7	Integrate and test	6
T_8	Write user manual	3

5	1. Assume that 10 errors have been introduced in the requirements model and that each error will be amplified by a factor of 2:1 into design and an additional 20 design errors are introduced and then amplified 1.5:1 into code where an additional 30 errors are introduced. Assume further that all unit testing will find 30 percent of all errors, integration will find 30 percent of the remaining errors, and validation tests will find 50 percent of the remaining errors. No reviews are conducted. How many errors will be released to the field. 2. Reconsider the situation described in Problem 1, but now assume that requirements, design, and code reviews are conducted and are 60 percent effective in uncovering all errors at that step. How many errors will be released to the field? 3. Reconsider the situation described in Problems 1 and 2. If each of the errors released to the field costs \$4,800 to find and correct and each error found in review costs \$240 to find and correct, how much money is saved by conducting reviews?

24CSE861	Swarm Intelligence	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course is designed to present an overview of Swarm Intelligence (SI) topic, including both behavioral swarm Intelligence and computational swarm intelligence, and applications of SI. The students will learn different swarm intelligence algorithms that are inspired by natural systems such as ant colonies, bird flocking, animal herding, bacterial growth, fish schooling and microbial intelligence. The students will implement different swarm intelligence algorithms, visualize and apply them to solve real problems such as optimization problems.

Prerequisite: Machine Learning Concepts, Algorithms and Optimization, basic knowledge in Simulation and Modeling.

Course Outcomes: After the completion of the course the student will be able to

CO1	Acquire knowledge of individual/intelligent agents for modeling of industrial, social and biological systems. **(Understand Level)**
CO2	Familiarize the modeling swarms/social agents in complex landscapes. **(Understand Level)**
CO3	Develop simulation models based on swarms of intelligent agents. **(Apply Level)**
CO4	Determine and analyze the key commonalities and differences in various evolutionary and swarm-based models. **(Analyze Level)**
CO5	Apply swarm intelligence algorithms to solve real optimization problems. **(Apply Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2									1
CO2	2	3	2									1
CO3	3	2	2	1								
CO4	3	2	2	2								
CO5	3	2	2				1					1
CO6	3	2										

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	✓
Evaluate			✓	
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

Module I: Agent-based modeling (7hours)

Agent-based modeling: Bottom-up modeling method. individual agents. System theory and complex systems. Multi-agent systems, Practical design of intelligent agent System.

Module II: Behavioral swarm intelligence (6hours)

Biological Foundations of Swarm Intelligence, Swarm Intelligence in Optimization, Behavioral swarm intelligence - Modeling flocking behavior. Boids model. Flocking behavior applications - agents queuing and homing.

Module III: Computational Swarm Intelligence-I (7hours)

Optimization theory and multi-objective optimization. Particle swarm optimization (PSO) **–** Algorithm, PSO System Parameters**,** Modifications to PSO, Applications, PSO Algorithm Based on Graphic Processing Units**.**

Module IV: Computational Swarm Intelligence-II (9hours)
Ant colony optimization (ACO) – Algorithm, Ant Colonies and Clustering, Applications. Bees colony optimization (BCO)- Algorithm, Artificial Bees Colony (ABC), Parallel Approaches for the Artificial Bee Colony Algorithm, Bumble Bees Mating Optimization Algorithm for the Vehicle Routing Problem.
Module V (Advanced Swarm Techniques) (7hours)
Optimization Based-On Hybrid Swarm Intelligence, Glowworm Swarm Optimization for Multimodal Search Spaces, Direct and Inverse Modeling of Plants Using Cat Swarm Optimization, Parallel Bacterial Foraging Optimization. Swarm robotics.

Text books

1. Bijaya Ketan Panigrahi, Yuhui Shi, and Meng-Hiot Lim. Handbook of Swarm Intelligence – Concepts, Principle and Applications, Springer
2. Aboul Ella Hassanien, Eid Emary. Swarm Intelligence-Principles, Advances, and Applications, CRC Press.
3. Intelligent software agents: foundations and applications by Walter Brenner, Rudiger Zarnekow, Hartmut Witting Springer, 1998.

Reference books

1. Andries P. Engelbrecht, Fundamentals of computational swarm intelligence, Wiley (2015).
2. James Kenndey and Rusell C. Eberhart, Swarm Intelligence, Mkf (2001), ISBN: 978-1-55860-595-4.
3. Jun Sun, Choi-Hong Lai and Xiao-Jun Wu, Particle Swarm Optimization - Classical and Quantum perspectives, CRC Press (2019).

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. ofHours
	MODULE 1	
1.1	Bottom-up modeling method	2
1.2	Individual agents	1
1.3	System theory and complex systems.	2
1.4	Multi-agent systems	1
1.5	Practical design of intelligent agent System.	1
	MODULE II	
2.1	Biological Foundations of Swarm Intelligence	1
2.2	Swarm Intelligence in Optimization	1
2.3	Behavioral swarm intelligence - Modeling flocking behavior	1
2.4	Boids model	1
2.5	Flocking behavior applications - agents queuing and homing	2
	MODULE III	
3.1	Optimization theory and multi-objective optimization.	1

3.2	Particle swarm optimization (PSO) – Algorithm	2
3.3	PSO System Parameters, Modifications to PSO	1
3.4	Applications	1
3.5	PSO Algorithm Based on Graphic Processing Units.	2
	MODULE IV	
4.1	Ant colony optimization (ACO) – Algorithm	2
4.2	Ant Colonies and Clustering, Applications.	1
4.3	Bees colony optimization (BCO)- Algorithm	2
4.4	Artificial Bees Colony (ABC), Parallel Approaches for the Artificial Bee Colony Algorithm	2
4.5	Bumble Bees Mating Optimization Algorithm for the Vehicle Routing Problem	2
	MODULE V	
5.1	Optimization Based-On Hybrid Swarm Intelligence	2
5.2	Glowworm Swarm Optimization for Multimodal Search Spaces	2
5.3	Direct and Inverse Modeling of Plants Using Cat Swarm Optimization	1
5.4	Parallel Bacterial Foraging Optimization	1
5.5	Swarm robotics	1

CO Assessment Questions	
CO1	1. How can the knowledge of individual/intelligent agents contribute to a more effective representation of complex biological systems? Provide examples and discuss the significance of this modeling approach. 2. Explain the concept of individual/intelligent agents and how they are utilized in modeling industrial systems. Provide examples to illustrate their application.
CO2	1. Describe a real-world example where modeling swarms agents has been applied to understand and navigate a complex landscape. Discuss the specific challenges addressed and the outcomes achieved. 2. Explain the role of swarm agents in adapting to changes within a complex landscape. Provide examples of how these agents can dynamically respond to environmental variations.

CO3	Critically evaluate the role of agent-based modeling in simulating complex systems. Provide examples where swarm intelligence has been effectively applied in simulation models.
CO4	Discuss the ethical considerations associated with the use of evolutionary and swarm-based models. Consider issues related to transparency, accountability, and potential biases in decision-making.
CO5	Discuss the impact of parameter settings, such as pheromone evaporation rate and exploration-exploitation balance, on the performance of the ACO algorithm. Discuss how tuning these parameters can influence the algorithm's behavior.

24CSE871	Social Network Analytics	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course enables the learners to investigate different quantitative measures for defining the structure of a network and identify the strength and pitfalls of each network model based on the requirements. This course covers the preliminaries for defining a network, architecture of different network models, link analysis and prediction as well as anomaly detection methods in social community networks. It helps the learners to choose appropriate network model for real world application scenarios.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Identify the relationship between physical society and online social network, and quantitatively analyze the microscopic, mesoscopic and macroscopic structure of a network. **(Apply Level)**
CO2	Identify the shortcomings of the existing network models to replicate the evolution of new real-world network. **(Apply Level)**
CO3	Explain how the network links help in measuring the importance of nodes in a network. **(Apply Level)**
CO4	Choose an appropriate link prediction algorithm for an unknown task depending on the strengths and limitations of the existing link prediction methods. **(Apply Level)**
CO5	Compare and contrast various anomaly detection methods.**(Apply Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3		3							3
CO2	3	3	3		3							3
CO3	3	3	3									3
CO4	3	3	3									3
CO5	3	3	3									3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Networks and Society (8 hrs)

Introduction, Applications of social Network Analysis, Preliminaries, Three levels of Social Network Analysis, Graph Visualization tools. Network Measures – Basics, Node Centrality, Assortativity, Transitivity, Reciprocity, Similarity, Degeneracy.

MODULE II : Network Growth Models (7 hrs)

Properties of Real-World Networks, Random Network Model, Ring lattice Network Model, Watts – Strogatz Model, Preferential Attachment Model, Price's Model, Network model with Accelerating Growth.

MODULE III : Link Analysis (7 hrs)

Signed networks – Balance theory, Status theory, Triad Balance and Status, Strong and Weak Ties- Strength, Triadic Closure, Dunbar Number, Local bridges, Link Analysis algorithms, Page Rank, Personalized Page rank, Applications of Link

Analysis.

MODULE IV : Link Prediction (6 hrs)

Temporal changes in Network, Evaluating link prediction methods – Train test split, Positive Negative Samples, Evaluation Metric, Heuristic Models – Local and Global, Probabilistic Models.

MODULE V : Anomaly detection in networks (8 hrs)

Outliers Vs Networks based anomalies, Challenges, Anomaly detection Static Networks – Plain Networks, Attributed Networks, Relational Learning, Anomaly detection in dynamic networks – Feature based approaches, Decomposition based, Community based, Window Based.Case studies – Modelling the spread of Covid-19, Collusion in Online Social Networks

Text books

1. Tanmoy Chakraborthy," Social Network Analysis", Wiley India, 1st edition, 2021.

Reference books

1. Ajith Abraham, Aboul Ella Hassanien, Vaclav Snasel , "Computational Social Network Analysis: Trends, Tools and Research Advances", Springer, 2012.
2. Borko Furht, "Handbook of Social Network Technologies and Applications", Springer, 1st edition, 2011.
3. Charu C. Aggarwal, "Social Network Data Analytics", Springer, 2014.
4. Giles, Mark Smith, John Yen, "Advances in Social Network Mining and Analysis", Springer, 2010.
5. Guandong Xu, Yanchun Zhang and Lin Li, "Web Mining and Social Networking – Techniques and applications", Springer, 1st edition, 2012.

Suggested MOOC Courses

1. **NPTEL:**Social Network Analysis, Prof. Tanmoy Chakraborty | IIT Delhi.
2. **NPTEL:**Social Networks, Prof. Sudarshan Iyengar | IIT Ropar

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE I	
1.1	Introduction and Applications of Social Network Analysis	1
1.2	Preliminaries	1
1.3	Three levels of Social Network Analysis	1
1.4	Graph Visualization tools	1
1.5	Network Measures – Basics	1
1.6	Node Centrality, Assortativity	1

1.7	Transitivity, Reciprocity	1
1.8	Similarity, Degeneracy	1
MODULE II		
2.1	Properties of Real World Networks	1
2.2	Random Network Model	1
2.3	Ring lattice Network Model	1
2.4	Watts – Strogatz Model	1
2.5	Preferential Attachment Model	1
2.6	Price's Model	1
2.7	Network model with Accelerating Growth	1
MODULE III		
3.1	Signed networks – Balance theory, Status theory	1
3.2	Triad Balance and Status	1
3.3	Strong and Weak Ties- Strength, Triadic Closure	1
3.4	Dunbar Number, Local bridges	1
3.5	Link Analysis algorithms	1
3.6	Page Rank, Personalized Page rank	1
3.7	Applications of Link Analysis	1
MODULE IV		
4.1	Temporal changes in Network	1
4.2	Evaluating link prediction methods – Train test split	1
4.3	Positive Negative Samples	1
4.4	Evaluation Metric	1

4.5	Heuristic Models – Local and Global	1
4.6	Probabilistic Models	1
	MODULE V	
5.1	Outliers Vs Networks based anomalies and Challenges	1
5.2	Anomaly detection Static Networks – Plain Networks, Attributed Networks	1
5.3	Relational Learning	1
5.4	Anomaly detection in dynamic networks	1
5.5	Feature based approaches, Decomposition based	1
5.6	Community based, Window Based	1
5.7	Case studies – Modelling the spread of Covid-19	1
5.8	Collusion in Online Social Networks.	1

CO Assessment Questions	
1	1. Under Covid-19 pandemic situation, people are talking about social distancing. Illustrate with justification the structure of the social network using the SARS-CoV-2 virus causing the pandemic is spreading. 2. You are given a task to model an online discussion forum such as Reddit using a network. What would be your approach? 3. Choose a network from the UCI network repository and visualize it using Gephi. 4. Explain the concept of Katz centrality and how it varies with the change in the attenuation factor. 5. Suppose you are an Intelligence Officer in Research and Analysis Wing. For a very long time, your missions for intercepting the enemy are failing as every time you try to catch them, they leave a few minutes ago. You come to know that someone is tipping the enemy from inside your organization and you know which department to look for but do not know where to start. Explain in network terminology where to start.
2	1. List the two major drawbacks in the assumptions of the Watts-Strogatz model with respect to the real world network.

<table>
<tr><td></td><td>
2. Draw a graph showing the evolution of a random network and explain the phases of transition.
3. List any two real world properties captured by the Barabasi-Albert model. What are the assumptions/open ended questions regarding the basic Barabasi-Albert.
</td></tr>
<tr><td>3</td><td>
1. Consider that you got an offer as a data analysis from a multinational company of food and drink suppliers. Being your first task, you have to provide a ranked list of the locations in your company’s network. What factors would you consider? Explain
2. Consider a restaurant review network containing objects of two types – restaurant® and user (U). there exists a review relationship between U and R. Consider the adjacency matrix as shown below, where each cell shows the number of reviews given by the user to a restaurant. Find the peer restaurant for Mint.
<table>
<tr><td></td><td>Michelle</td><td>Alice</td><td>Bob</td><td>Eve</td></tr>
<tr><td>Mint</td><td>2</td><td>4</td><td>0</td><td>0</td></tr>
<tr><td>Pavilion</td><td>4</td><td>0</td><td>2</td><td>1</td></tr>
<tr><td>Symposium</td><td>2</td><td>4</td><td>0</td><td>0</td></tr>
<tr><td>Sky Route</td><td>0</td><td>0</td><td>1</td><td>3</td></tr>
</table>
3. Explain the working of the Page Rank algorithm with proper examples.
</td></tr>
<tr><td>4</td><td>
1. Link prediction can be used for predicting missing links in graphs at current state and for predicting future links. Provide mathematical formulation for both problems.
2. You are a freelancer network researcher. Recently, Japanese health ministry has contracted you to analyse their organization structure on various metrics that can be further used to understand and improve the organization. In order to complete the said task, they have provided a graph of the organization in which nodes are employees and an edge between two employees indicates that they communicate with each other for work. Due to some negligence, you accidentally deleted a few edges from the edge list file. You are afraid of asking for a newer copy since it can spoil you reputation to the high valued client. Therefore, you have decided to use a link prediction algorithm to approximate-deleted edges. Which link prediction algorithm will be suitable for this task and explain in detail?
3. Explain the reasoning behind the names of Hub promoted/Depresses Index.
</td></tr>
<tr><td>5</td><td>
1. You have an anomaly detection system that gives 95% accuracy. Would you be satisfied with this performance? Why?
2. You read a published paper that says that the number of edges connected to a node in a network is directly proportional to the age
</td></tr>
</table>

	of the node. This study was published in 2005. Would you blindly follow this study in 2024? Justify your answer with reasons. 3.S tate and explain some practical data specific challenges that arise in anomaly detection problems.

24CSE881	Time Series Analysis and Forecasting	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course introduces the important time series models and their applications in various fields, creating ability to students to formulate real life problems using time series models and use statistical software to estimate the models from real data, and draw conclusions and develop solutions from the estimated models. The course uses visual and numerical diagnostics to assess the soundness of their model and make students to communicate the statistical analyses and combine and adapt different statistical models to analyse larger and more complex data.

Prerequisite: Computational Fundamentals for Machine Learning

Course Outcomes: After the completion of the course the student will be able to

CO1	Demonstrate a comprehensive understanding of time series data, including the ability to identify and analyze stationary models, and elimination of trends and seasonal components. **(Cognitive Knowledge Level: Understand)**
CO2	Interpret spectral densities and the application of time-invariant linear filters with proficiency in modeling and forecasting with ARMA processes, **(Cognitive Knowledge Level: Apply)**
CO3	Analyze nonstationary and seasonal time series models **(Cognitive Knowledge Level: Understand)**
CO4	Demonstrating competence in analyzing second-order properties, estimating the mean and covariance, and interpreting multivariate ARMA processes. **(Cognitive Knowledge Level: Apply)**
CO5	Describe state-space models, state-space representations, and the basic structure model. **(Cognitive Knowledge Level: Understand)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3									3
CO2	2	1	3									3
CO3	2	1	3									3
CO4	2	1	3									3
CO5	2	1	3									3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test 1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓

Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate			✓	
Create			✓	

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Introduction to Time Series

Introduction to time series, Stationary models and autocorrelation function, Estimation and elimination of trend and seasonal components
Stationary Process and ARMA Models, Basic properties and linear processes, Introduction to ARMA models, properties of sample mean and autocorrelation function, Forecasting stationary time series, ARMA(p, q) processes, ACF and PACF, Forecasting of ARMA processes

MODULE II : Spectral Analysis

Spectral Analysis, Spectral densities, Time-invariant linear filters, The spectral density of an ARMA process
Modeling and Forecasting with ARMA Processes, Preliminary estimation, Maximum likelihood estimation, Diagnostics, Forecasting, Order selection

MODULE III : Nonstationary Time Series Models

Nonstationary and Seasonal Time Series Models, ARIMA models, Identification techniques, Unit roots in time series, Forecasting ARIMA models, Seasonal ARIMA models, Regression with ARMA errors

MODULE IV : Multivariate Time Series Analysis

Multivariate Time Series, Second-order properties of multivariate time series, Estimation of the mean and covariance, Multivariate ARMA processes, Best linear predictors of second-order random vectors, Modeling and forecasting

MODULE V : State-Space Models and Forecasting Techniques

State-Space Models, State-space representations, The basic structure model, State-space representation of ARIMA models, The Kalman Recursions, Estimation for state-space models
Forecasting Techniques, The ARAR algorithm, The Holt-Winter algorithm, The Holt-Winter seasonal algorithm

Text books

1. Brockwell, Peter J. and Davis, Richard A. (2002). Introduction to Time Series and Forecasting, 2nd edition. Springer-Verlag, New York.

Reference books

1. Box, G.E.P., Jenkins, G.M. and Reinsel, G.C. (1994). Time Series Analysis: Forecasting and Control, 3rd Edition, Prentice Hall, New Jersey.
2. Chatfield, C. (1996). The Analysis of Time Series, 5th edition, Chapman and Hall, New York.
3. Shumway, R.H., Stoffer, D.S. (2006). Time Series Analysis and Its Applications (with R examples). Springer-Verlag, New York.
4. James D. Hamilton (1994). Time Series Analysis, 1st Edition, Princeton University Press,
5. Galit Shmueli and Kenneth C. Lichtendahl Jr (2016). Practical Time Series Forecasting with R: A Hands-On Guide, 2nd Edition, Axelrod Schnall Publishers.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Overview of Time Series Analysis, Definition and importance of time series data.	1
1.2	Applications of time series analysis in various fields. Basic concepts: time points, observations, and temporal ordering.	1

1.3	Autocorrelation function (ACF): Definition and interpretation, Identification of stationary and non-stationary time series.	1
1.4	Methods for estimating trend and seasonal components.	1
1.5	Basic properties and linear processes in time series. Overview of ARMA (AutoRegressive Moving Average) models.	1
1.6	Analyzing ACF and PACF (Partial Autocorrelation Function).	1
1.7	Forecasting techniques for stationary time series using ARMA models.	1
MODULE II		
2.1	Introduction to spectral analysis,	1
2.2	Spectral densities of time series.	1
2.3	Time-invariant linear filters and their role in spectral analysis.	1
2.4	Modeling and Forecasting with ARMA Processes	1
2.5	Preliminary estimation in time series modeling	1
2.6	Maximum likelihood estimation for ARMA processes.	1
2.7	Model diagnostics, order selection, and forecasting	1
MODULE III		
3.1	Introduction to nonstationary time series. ARIMA models and their applications.	1
3.2	Identification techniques for nonstationary time series.	1
3.3	Understanding unit roots in time series.	1
3.4	Forecasting techniques for ARIMA models.	1
3.5	Seasonal ARIMA models and their implementation.	1
3.6	Incorporating ARMA errors in regression models. Practical examples of regression with ARMA errors.	2
MODULE IV		
4.1	Introduction to multivariate time series	1
4.2	Second-order properties and covariance matrix.	2
4.3	Estimation of the mean and covariance in multivariate time series.	1

4.4	Understanding Multivariate ARMA processes.	1
4.5	Best linear predictors of second-order random vectors.	1
4.6	Modeling and forecasting in multivariate time series.	1
	MODULE V	
5.1	Introduction to state-space models.	1
5.2	State-space representation of ARIMA models.	1
5.3	The Kalman Recursions and estimation for state-space models	1
5.4	Overview of forecasting techniques.	1
5.5	The ARAR algorithm and its application.	1
5.6	The Holt-Winter algorithm and seasonal forecasting.	1
5.7	Case studies on time series analysis and forecasting.	1

CO Assessment Questions	
1	1. Explain the concept of stationarity in time series. How does it impact the modeling and analysis of time series data? 2. Describe the autocorrelation function (ACF) and its significance in the context of time series analysis. 3. What methods can be employed for the estimation and elimination of trend and seasonal components in time series data? 4. Provide an overview of ARMA models. How do ARMA(p, q) processes contribute to forecasting stationary time series?
2	1. Define spectral analysis and its relevance in the study of time series. How is it different from other analysis techniques? 2. Explain the concept of spectral densities in the context of time series. How are spectral densities used in time-invariant linear filters? 3. Discuss the significance of the spectral density of an ARMA process. How does it influence modeling and forecasting? 4. What are the key steps involved in modeling and forecasting with ARMA processes? Discuss preliminary estimation and maximum likelihood estimation. 5. How do you determine the order selection for ARMA processes? What role do diagnostics play in this process?

3	1. What distinguishes nonstationary and seasonal time series models? How are ARIMA models used for modeling such data? 2. Discuss identification techniques for ARIMA models. How do unit roots in time series impact the modeling process? 3. Explain the concept of forecasting in ARIMA models. How are seasonal ARIMA models different from regular ARIMA models? 4. How is regression incorporated with ARMA errors in time series modeling? What are the implications for the analysis? 5. Provide an overview of techniques used for forecasting ARIMA models. What challenges might arise in the forecasting process?
4	1. Define multivariate time series. How do second-order properties play a crucial role in the analysis of such data? 2. Discuss the methods for estimating the mean and covariance in multivariate time series. 3. What are multivariate ARMA processes, and how do they differ from univariate ARMA processes? 4. Explain the concept of best linear predictors of second-order random vectors in the context of multivariate time series analysis. 5. How does modeling and forecasting in multivariate time series differ from univariate time series? Discuss the challenges and advantages?
5	1. What are state-space models, and how are they represented in time series analysis? Discuss the basic structure model. 2. Explain the state-space representation of ARIMA models. How do the Kalman Recursions contribute to this representation? 3. What are the key aspects of estimation for state-space models in time series analysis? 4. Discuss the ARAR algorithm and its role in forecasting. How does it differ from other forecasting techniques? 5. Provide an overview of the Holt-Winter algorithm and the Holt-Winter seasonal algorithm. How are these algorithms applied in forecasting time series data?

24CSE891	Quantum Computing	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: Quantum computers are not yet built. If such machines become a reality, they will fundamentally change how we perform calculations, and the implications on many applications such as communication and computer security will be tremendous. This course aims to provide a first introduction to quantum computing with a general understanding of how quantum mechanics can be applied to computational problems. It highlights the paradigm change between conventional computing and quantum computing, and introduces several basic quantum algorithms.

Prerequisite: 23MAT101 Calculus and Linear Algebra, 23CSP602 Introductory Cyber Security

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the basic concepts of Quantum Computing. **(Understand Level)**
CO 2	Understand the background of Quantum Mechanics. **(Understand Level)**
CO 3	Analyze the computation models. **(Apply Level)**
CO 4	Model the circuits using quantum computation, environments and frameworks. **(Apply Level)**
CO 5	Understand quantum noise and error correction for fault tolerant computation. **(Understand Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2										2
CO 2	3	2										2
CO 3	3	3	2	2								2
CO 4	3	3	2									2
CO 5	3	3	2									2

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✔	✔	✔	✔
Understand	✔	✔	✔	✔
Apply	✔	✔	✔	✔
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Quantum Computing Basic Concepts (6 hrs)

Complex Numbers - Linear Algebra - Matrices and Operators - Global Perspectives Postulates of Quantum Mechanics – Quantum Bits - Representations of Qubits - Superpositions.

MODULE II : Quantum Gates And Circuits (7 hrs)

Universal logic gates - Basic single qubit gates - Multiple qubit gates - Circuit development -Quantum error correction.

MODULE III : Quantum Algorithms (8 hrs)

Quantum parallelism - Deutsch's algorithm - The Deutsch–Jozsa algorithm - Quantum Fourier transform and its applications - Quantum Search Algorithms: Grover's Algorithm.

MODULE IV : Quantum Information Theory (7 hrs)

Data compression - Shannon's noiseless channel coding theorem - Schumacher's quantum noiseless channel coding theorem - Classical information over noisy quantum channels.

MODULE V : Quantum Cryptography (7 hrs)
Classical cryptography basic concepts - Private key cryptography - Shor's Factoring Algorithm - Quantum Key Distribution - BB84 - Ekart 91.
Text books 1.Parag K Lala, Quantum Computing, A Beginners Introduction, McGraw Hill Education, First edition, 2020. 2. Michael A. Nielsen, Issac L. Chuang, Quantum Computation and Quantum Information, Cambridge University Press, Tenth Edition, 2010. 3. Chris Bernhardt, Quantum Computing for Everyone, The MIT Press, Reprint edition, 2020 .
Reference books 1. Scott Aaronson, Quantum Computing Since Democritus, Cambridge University Press, 2013. 2. N. David Mermin, Quantum Computer Science: An Introduction, Cambridge University Press, 2007.

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
	MODULE 1	
1.1	Complex Numbers.	1
1.2	Linear Algebra - Matrices and Operators.	1
1.3	Global Perspectives Postulates of Quantum Mechanics.	1
1.4	Quantum Bits - Representations of Qubits (Lecture 1).	1
1.5	Quantum Bits - Representations of Qubits (Lecture 2).	1
1.6	Superpositions.	1
	MODULE II	
2.1	Universal logic gates.	1
2.2	Basic single qubit gates.	1
2.3	Multiple qubit gates.	1
2.4	Circuit development (Lecture 1).	1
2.5	Circuit development (Lecture 2).	1
2.6	Quantum error correction (Lecture 1).	1
2.7	Quantum error correction (Lecture 2).	1
	MODULE III	
3.1	Quantum parallelism.	1
3.2	Deutsch's algorithm (Lecture 1).	1
3.3	Deutsch's algorithm (Lecture 2).	1
3.4	The Deutsch–Jozsa algorithm (Lecture 1).	1
3.5	The Deutsch–Jozsa algorithm (Lecture 2).	1
3.6	Quantum Fourier transform and its applications.	1
3.7	Quantum Search Algorithms: Grover's Algorithm (Lecture 1).	1
3.8	Quantum Search Algorithms: Grover's Algorithm (Lecture 2).	1

MODULE IV		
4.1	Data compression.	1
4.2	Shannon's noiseless channel coding theorem (Lecture 1).	1
4.3	Shannon's noiseless channel coding theorem (Lecture 2).	1
4.4	Schumacher's quantum noiseless channel coding theorem (Lecture 1).	1
4.5	Schumacher's quantum noiseless channel coding theorem (Lecture 2).	1
4.6	Classical information over noisy quantum channels (Lecture 1).	1
4.7	Classical information over noisy quantum channels (Lecture 2).	1
MODULE V		
5.1	Classical cryptography basic concepts.	1
5.2	Private key cryptography (Lecture 1).	1
5.3	Private key cryptography (Lecture 2).	1
5.4	Shor's Factoring Algorithm (Lecture 1).	1
5.5	Shor's Factoring Algorithm (Lecture 2).	1
5.6	Quantum Key Distribution - BB84.	1
5.7	Ekert 91.	1

CO Assessment Questions	
CO1	1. What role does quantum mechanics play in the foundation of quantum computation? 2. Discuss the idea of superpositions in quantum mechanics and how it relates to the state of a qubit.
CO2	1. Discuss the principles behind multiple qubit gates and their significance in quantum information processing. 2. Discuss the advantages and challenges associated with implementing quantum algorithms using quantum circuits.
CO3	1. Provide examples of practical applications where Deutsch's algorithm can be effectively employed. How does this algorithm offer advantages over classical algorithms in specific scenarios? 2. Explain the use of the Deutsch–Jozsa algorithm in cryptographic hash functions. How does this algorithm contribute to improving the security of hash functions in quantum environments? 3. Illustrate how Quantum Fourier Transform is utilized in Quantum Phase Estimation. Provide examples of scenarios where accurate phase estimation is crucial. 3. Discuss how Grover's Algorithm can be applied to optimize database searches. How does it outperform classical search algorithms in terms of efficiency?

CO4	1. How does Shannon's Noiseless Channel Coding Theorem formalize the relationship between entropy and achievable code lengths? 2. Illustrate quantum communication protocols that leverage the principles of quantum noiseless channel coding. How do these protocols ensure secure and efficient quantum information transmission? 3. Explain how quantum error correction strategies, influenced by Schumacher's theorem, contribute to the stability and reliability of quantum networks.
CO5	1. What is Shor's Factoring Algorithm, and how does it impact classical cryptographic systems? 2. How does Quantum Key Distribution (QKD) address the challenge of secure key exchange in quantum communication? 3. How does Ekert 91 protocol ensure the security of key distribution using entangled particles?

24CSE8101	Data Compression	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course helps the learners to understand compression techniques on text, image, audio, and video data. It covers lossy & lossless compression, RLE, JPEG, MPEG, and its variants This course enables the students to develop and implement compression algorithms on different domains.

Prerequisite: Knowledge of probability theory, computation on matrices, basic topics in data structures, storage and efficiency

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the fundamental principles of data compression. **(Understand Level)**
CO2	Make use of statistical and dictionary-based compression techniques for various applications. **(Apply Level)**
CO3	Summarize various image compression standards. **(Understand Level)**
CO4	Interpret the fundamental properties of digital audio to compress audio data. **(Understand Level)**
CO5	Summarize video compression mechanisms to reduce the redundancy in video **(Understand Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											3
CO2	3	3	3		3							3
CO3	3	3	3									3
CO4	3	3	3									3
CO5	3											3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure	Att	Theory [L- T]	Total

[L-T-P-J]	end anc e	Assignme nt	Test-1	Test-2	Marks
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Compression Techniques and Modeling (7hrs)

Introduction to Compression Techniques- Lossy compression and lossless compression, Measures of Performance, Modeling and Coding. Mathematical modelling for Lossless and lossy compression- Physical models and Probability models.

MODULE II: Basic Compression Methods (7hrs)

Basic Compression Technique- Run length encoding, RLE Text compression. Statistical Methods- Variable Size Codes, Prefix Codes, Binary Huffman coding, non-binary Huffman Algorithms, Arithmetic Coding.

MODULE III: Text and Image Compression (6hrs)

Dictionary based Coding- LZ77, LZ78 and LZW compression. Image Compression- Image standards, JPEG image Compression- Baseline JPEG, JPEG-LS.

MODULE IV: Audio Compression (6hrs)

Audio Compression- Basics of Digital Audio, Basic Audio Compression Techniques, MPEG Audio Compression-Layer I coding. Layer II coding and Layer

III coding.

MODULE V: Video Compression (6hrs)

Video Compression- Analog video, Composite and Components Video, Digital Video, Motion Compensation. MPEG standards- MPEG 1, MPEG 4

Text books

1. David Solomon, Data compression: the complete reference, 4/e, Springer, January 2007
2. 2. Khalid Sayood, Introduction to data compression, Morgan Kaufmann Publishers,2003.

Reference books

1. Stephen Welstead, Fractal and wavelet Image Compression techniques, PHI, 1999.
2. Sleinreitz, Multimedia System. Addison Wesley.
3. Mark Nelson and Jean-loup Gailly. The Data Compression Book, M&T Books

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Introduction to Compression Techniques- Lossy compression & Lossless compression	1
1.2	Measures of Performance	1
1.3	Modeling and coding	1
1.4	Physical model for lossless compression	1
1.5	Physical model for lossy compression	1
1.6	probability model for lossless compression	1
1.7	probability model for lossy compression	1
	MODULE II	
2.1	Run length encoding, RLE Text compression	1
2.2	Variable Size Codes, Prefix Codes	1
2.3	Binary Huffman coding	1
2.4	Illustration of Binary Huffman coding	1

2.5	Non-binary Huffman Algorithms	1
2.6	Arithmetic Coding Algorithm	1
2.7	Illustration of Arithmetic Coding Algorithm	2
	MODULE III	
3.1	LZ77 Compression	1
3.2	LZ78 Compression	1
3.3	LZW Compression	1
3.4	Basics of Image Compression and Image Standards,	1
3.5	Baseline JPEG Image Compression	1
3.6	JPEG-LS Image Compression	1
	MODULE IV	
4.1	Basics of Audio Compression, Digital Audio	1
4.2	Basic Audio Compression Techniques.	1
4.3	MPEG Audio Compression Basics-Frequency Domain Coding	1
4.4	Encoding: Layer I and Layer II	1
4.5	Encoding: Layer II-Psychoacoustic Models	1
4.6	Psychoacoustic Models - Encoding: Layer III	1
	MODULE V	
5.1	Analog video, Composite and Components Video, Digital Video	1
5.2	Motion Compensation	1
5.3	MPEG-1 standard and Video Syntax	1
5.4	MPEG-1 Pel Reconstruction	1
5.5	MPEG-4 standard	1

5.6	Functionalities for MPEG-4	1

CO Assessment Questions	
1	1. Discuss any probability model and identify the shortcomings of the solution. 2. Identify the mathematical preliminaries for Lossless Compression.
2	1. With the help of a flowchart discuss the RLE text compression for text data given below "ABBBBBBBBBCDEEEEF" 2. Calculate the compression ratio for the example while taking repetitions =4
3	1. Explain in detail the working of LZ78 with example and dictionary Tree. 2. Illustrate with example, how the compression factor LZW differs from the LZ78
4	1. Discuss the Format of Compressed Data and Encoding in layer I and layer II. 2. Discuss the complexity of Layer III compared to others in MPEG Audio Coding
5	1. With the help of equations discuss Composite and Components Video 2. Differentiate the major changes in MPEG - 2 and MPEG-4 video

24CSE8111	Cloud Security	L	T	P	J	S	C	YearofIntroduction
		3	0	0	0	3	3	2024

Preamble: This course enables the learners to understand the various techniques for implementing privacy and security in cloud. It covers topics such as fundamentals of cloud security, security design and architecture, cloud access control and identity management, security design patterns and auditing and management. These topics enable students to get familiarize with cloud security and privacy requirements and select best practices for cloud security using different design patterns with proper auditing and management.

Prerequisite: Fundamentals knowledge of cyber security and cloud computing

Course Outcomes: After the completion of the course the student will be able to

CO1	Introduce Cloud Computing terminology, definition & concepts. **(Understand Level)**
CO2	Explain the security design and architectural considerations for Cloud .**(Apply Level)**
CO3	Understand the Identity and Access control in Cloud.**(Understand Level)**
CO4	Select best practices for Cloud security using various design patterns.**(Understand Level)**
CO5	Monitor and audit cloud applications for security. **(Apply Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										3
CO2	3	3										3
CO3	3	3			3							3
CO4	3	3										3
CO5	3	3			3							3

Assessment Pattern

Bloom'sCategory	ContinuousAssessmentTools			EndSemesterExamination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

<u>End Semester Examination [ESE]: Pattern</u>

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Fundamentals of Cloud Security (8 hours)

Basic terms and concepts in security- Threat agents, Cloud security threats/risks, Trust. Operating system security-Virtual machine security- Security of virtualization- Security Risks Posed by Shared Images, Security Risks Posed by Management OS. Infrastructure security, Network Level Security, Host Level Security, Application level security, Security of the Physical Systems. Identity & Access Management- Access Control.

MODULE II: Security Design and Architecture for Cloud (7 hours)

Security design principles for Cloud Computing - Comprehensive data protection - End-to-end access control - Common attack vectors and threats - Network and Storage - Secure Isolation Strategies - Virtualization strategies - Inter-tenant network segmentation strategies - Data Protection strategies: Data retention, deletion and archiving procedures for tenant data, Encryption, Data Redaction, Tokenization, Obfuscation, PKI and Key.

MODULE III: Access Control and Identity Management (6 hours)

Access control requirements for Cloud infrastructure - User Identification - Authentication and Authorization - Roles-based Access Control - Multi-factor authentication - Single Sign-on, Identity Federation - Identity providers and service consumers - Storage and network access control options - OS Hardening and minimization - Verified and measured boot - Intruder Detection and prevention

MODULE IV : Cloud security Design Patterns (6 hours)

Introduction to Design Patterns, Cloud bursting, Geo-tagging, Secure Cloud Interfaces, Cloud Resource Access Control, Secure On-Premise Internet Access, Secure External Cloud

MODULE V : Monitoring Auditing and Management (9 hours)

Proactive activity monitoring - Incident Response, Monitoring for unauthorized access, malicious traffic, abuse of system privileges - Events and alerts - Auditing – Record generation, Reporting and Management, Tamper-proofing audit logs, Quality of Services, Secure Management, User management, Identity management, Security Information and Event Management

Text books

1. Raj Kumar Buyya , James Broberg, andrzejGoscinski, “Cloud Computing: Principles and Paradigms” , Wiley 2013
2. Dave shackleford, “Virtualization Security (Protecting Virtualized Environments)”, SYBEX a wiley Brand 2013.
3. Mather, Kumaraswamy and Latif, “Cloud Security and Privacy, OREILLY 2011.

Reference books

1. Mark C. Chu-Carroll “Code in the Cloud,CRC Press, 2011
2. Mastering Cloud Computing Foundations and Applications Programming RajkumarBuyya, Christian Vechhiola, S. ThamaraiSelvi, MK,2013.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. ofHours
	MODULE 1	
1.1	Basic terms and concepts in security, Threat agents.	1
1.2	Cloud security threats/risks, Trust.	1
1.3	Operating system security, Virtual machine security.	1
1.4	Security of virtualization	1
1.5	Security Risks posed by Shared Images, Security Risks posed by Management OS.	1
1.6	Infrastructure security: - Network Level Security, Host Level Security,	1
1.7	Application level security, Security of the Physical Systems.	1
1.8	Identity & Access Management, Access Control.	1
	MODULE II	
2.1	Security design principles for Cloud Computing - Comprehensive data protection	1

2.2	End-to-end access control - Common attack vectors and threats - Network and Storage	1
2.3	Secure Isolation Strategies - Virtualization strategies - Inter-tenant network segmentation strategies	1
2.4	Data Protection strategies: Data retention, deletion and archiving procedures for tenant data	1
2.5	Encryption, Data Redaction	1
2.6	Tokenization, Obfuscation	1
2.7	PKI and Key	1
	MODULE III	
3.1	Access control requirements for Cloud infrastructure	1
3.2	-User Identification - Authentication and Authorization - Roles-based Access Control	1
3.3	Multi-factor authentication - Single Sign-on, Identity Federation	1
3.4	Identity providers and service consumers - Storage and network access control options	1
3.5	OS Hardening and minimization - Verified and measured boot	1
3.6	Intruder Detection and prevention	1
	MODULE IV	
4.1	Introduction to Design Patterns	1
4.2	Cloud bursting, Geo-tagging	1
4.3	Secure Cloud Interfaces	1
4.4	Cloud Resource Access Control	1
4.5	Secure On-Premise Internet Access	1
4.6	Secure External Cloud	1
	MODULE V	
5.1	Proactive activity monitoring	1
5.2	Incident Response, Monitoring for unauthorized access	1
5.3	Malicious traffic, abuse of system privileges	1
5.4	Events and alerts	1
5.5	Auditing – Record generation, Reporting and Management	1
5.6	Tamper-proofing audit logs	1
5.7	Quality of Services, Secure Management	1
5.8	User management, Identity management	1
5.9	Security Information and Event Management	1

CO Assessment Questions	
1	a. Why is it harder to establish security in the cloud? b. Explain in detail about the security issues one should discuss with a cloud-computing vendor c. List and Explain major cloud security challenges.
2	a. Implement any one image obfuscation mechanism b. Discuss about different secure isolation strategies
3	a. What are the access control requirements for cloud infrastructure? b. Implement a role-based access control mechanism in a specific scenario
4	a. Explain how cloud resource access control is done in a secure cloud environment b. How do we select a design pattern for a cloud security scenario? Illustrate with an example scenario.
5	a. Develop a log monitoring system with incident management in the cloud b. How do we prevent the abuse of system privileges?

24CSE8121	Cyber Forensics	L	T	P	J	S	C	YearofIntroduction
		3	0	0	0	3	3	2024

Preamble: This course enables the learners to explore the basics of Cyber Forensics and Cyber security, the forensic investigation process and principles and the different types of cybercrimes and threats. It covers topics such as forensic analysis of File systems, the Network, the Windows and Linux Operating systems. The course gives a basic understanding of the forensics analysis tools and a deep understanding of Anti forensics practices and methods. These topics enable students to get familiarize with cyber forensics policies, approaches and tools.

Prerequisite: Fundamentals knowledge of operating systems, computer networks and cyber security.

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the basic concepts in cyber forensics, forensics Investigation Process and the usage of Cyber Forensics Tools in investigations. **(Understand Level)**
CO2	Infer the basic concepts of file systems, its associated attribute definitions.**(Understand Level)**
CO3	Utilize the methodologies used in memory analysis and network analysis for detection of artifacts.**(Apply Level)**
CO4	Explain the basic concepts in cyber security and study the essence of IT Act.**(Understand Level)**
CO5	Summarize anti forensics practices and data hiding methods. **(Understand Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										3
CO2	3	3										3
CO3	3	3			3							3
CO4	3	3										3
CO5	3	3										3

Assessment Pattern

Bloom'sCategory	ContinuousAssessmentTools			EndSemesterExamination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				

Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Cyber Forensics and Computer Forensic Investigations (7 hours)

Cyber Forensics: Cyber Technology- Technological Aspects of Cyber Forensics-Governance Aspects of Cyber Forensics- Judicial Aspects of Cyber Forensics- Legal Perspective of Cyber Forensic investigations.

Computer Forensic Investigations: -Preparing for computer investigations, understanding Public and private investigations. Forensics Investigation Principles - Forensic Protocol for Evidence Acquisition - Digital Forensics Standards and Guidelines - Digital Evidence – Data Acquisition - storage formats for digital evidence, determining the best acquisition method, contingency planning for image acquisitions.

MODULE II: Cyber Forensics Tools and Types of Forensics (8 hours)

Cyber Forensics Tools-Computer Forensics software and hardware tools -Open Source and

Proprietary -Challenges in Cyber Forensics, Skills Required to Become a Cyber Forensic Expert, Physical Requirements of a Cyber forensics Lab,Types of Cyber forensics.

File System Forensics-Working with windows and DOS systems- file systems, exploring Microsoft file structures, examining FAT and NTFS disks, whole disk encryption, the windows registry, Microsoft and MS-DOS startup tasks, Examining UNIX and LINUX disk structures and boot processes, examining CD data structures, examining IDE/EIDE and SATA devices.

MODULE III: OS and Network Forensics (10 hours)

Windows Forensics-Live Response: Data Collection- Introduction , Locard's Exchange Principle, Order of Volatility - Volatile and Non Volatile Data Live-Response Methodologies: Data Analysis, Windows Memory Analysis, Rootkits and Rootkit detection.

Linux Forensics: Live Response Data Collection- Data Analysis- Log Analysis, Keyword Searches, User Activity, Network Connections, Running Processes, Open File Handlers, The Hacking Top Ten, Reconnaissance Tools.

Network Forensics: The OSI Model, Forensic Footprints, Seizure of Networking Devices, Network Forensic Artifacts, ICMP Attacks, Drive-By Downloads, Network Forensic Analysis Tools, Case Study: Wireshark. Web Attack Forensics: OWASP Top 10, Web Attack Tests, Penetration Testing.

MODULE IV : Cyber crimes and security (5 hours)

Cyber Security: Cybercrimes, Types of Cybercrimes –Cyber Security Steps taken to protect ICT and prevent Misuse of Internet- IT Act 2000- Social Cyber Media.

MODULE V : Anti-Forensics (6 hours)

Anti-forensic Practices - Data Wiping and Shredding- Data Remanence, Degaussing, Case Study: USB Oblivion, Eraser - Trail Obfuscation: Spoofing, Data Modification, Case Study: Timestamp – Encryption, Case Study: VeraCrypt, Data Hiding: Steganography and Cryptography, Case Study: SilentEye, Anti-forensics Detection Techniques, Case Study: Stegdetect.

Text books

1. Nishesh Sharma "Cyber Forensics in India- A Legal Perspective", Universal Law Publishing, First Edition,March 2017

2. Bill Nelson, Amelia Philipps and Christopher Steuart, "Computer forensics- Guide to computer forensics and investigations", Course Technology Inc,3rd Edition,2009

3. Brian Carrier "File System Forensic Analysis, Addison-Wesley,1st Edition, 2005

4. Harlan Carvey, "Windows Forensics Windows Forensic Analysis DVD Toolkit" O'Reilly,2nd Edition, 2018.

5. Chris Pogue , Cory Altheide, Todd Haverkos, "Linux Forensics- Unix and Linux Forensic Analysis DVD Toolkit",Syngress,First Edition,2008

6. William Stallings "Network Security Essentials Applications and Standards" Pearson Education,4th Edition,2011.

7. E. Maiwald, "Fundamentals of Network Security", McGraw-Hill,First Edition, 2004

Reference books

1. Michael. E. Whitman, Herbet. J. Mattord,“Cyber Security Principles of Information Security”,Course Technology Ptr ,4th Edition,2011.

2. William Stallings “Cryptography and Network Security”,Pearson,5th Edition,2018.

3. Niranjan Reddy, “Practical Cyber Forensics: An Incident-Based Approach to Forensic Investigations”, Apress, First Edition, 2019

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. ofHours
	MODULE 1	
1.1	Cyber Technology- Technological Aspects of Cyber Forensics	1
1.2	Governance Aspects of Cyber Forensics- Judicial Aspects of Cyber Forensics- Legal Perspective of Cyber Forensic investigations.	1
1.3	Preparing for computer investigations, understanding Public and private investigations.	1
1.4	Forensics Investigation Principles - Forensic Protocol for Evidence Acquisition	1
1.5	Digital Forensics Standards and Guidelines - Digital Evidence	1
1.6	Data Acquisition - storage formats for digital evidence,	1
1.7	Determining the best acquisition method, contingency planning for image acquisitions.	1
	MODULE II	
2.1	Computer Forensics software and hardware tools -Open Source and Proprietory	1
2.2	Challenges in Cyber Forensics, Skills required to become a Cyber Forensic Expert.	1
2.3	Physical Requirements of a Cyber forensics Lab,Types of Cyber forensics.	1
2.4	Working with windows and DOS systems- file systems	1
2.5	Exploring Microsoft file structures, examining FAT and NTFS disks	1
2.6	Whole disk encryption, the windows registry, Microsoft and MS-DOS startup tasks	1
2.7	Examining UNIX and LINUX disk structures and boot processes	1
2.8	Examining CD data structures, examining IDE/EIDE and SATA devices.	1
	MODULE III	
3.1	Windows Forensics-Live Response: Data Collection- Introduction , Locard’s Exchange Principle, Order of Volatility - Volatile and Non Volatile Data	1

3.2	Live-Response Methodologies: Data Analysis, Windows Memory Analysis, Rootkits and Rootkit detection	1
3.3	Linux Forensics: Live Response Data Collection- Data Analysis- Log Analysis	1
3.4	Keyword Searches, User Activity, Network Connections, Running Processes, Open File Handlers	1
3.5	The Hacking Top Ten, Reconnaissance Tools	1
3.6	Network Forensics: The OSI Model, Forensic Footprints	1
3.7	Seizure of Networking Devices, Network Forensic Artifacts, ICMP Attacks	1
3.8	Drive-By Downloads, Network Forensic Analysis Tools	1
3.9	Case Study: Wireshark	1
3.10	Web Attack Forensics: OWASP Top 10, Web Attack Tests, Penetration Testing	1
MODULE IV		
4.1	Cyber Security: Cybercrimes, Types of Cybercrimes	1
4.2	Cyber Security Steps taken to protect ICT and prevent Misuse of Internet	1
4.3	IT Act 2000 – Lecture I	1
4.4	IT Act 2000 – Lecture II	1
4.5	Social Cyber Media	1
MODULE V		
5.1	Anti-forensic Practices - Data Wiping and Shredding	1
5.2	Data Remanence, Degaussing USB Oblivion, Eraser	1
5.3	Trail Obfuscation: Spoofing, Data Modification, Timestamp	1
5.4	Encryption Case Study: VeraCrypt	1
5.5	Data Hiding: Steganography and Cryptography, Case Study: SilentEye	1
5.6	Anti-forensics Detection Techniques, Case Study: Stegdetect	1

CO Assessment Questions	
1	a. Explain the Forensics principles and protocols for evidence acquisition. b. Explain the different storage formats tools used for Digital evidence.
2	a. Explain the pros and cons of NTFS and FAT File systems. b. Give the challenges the Investigators would face in extracting evidence from these file systems.
3	a. Describe any memory forensics methodologies/tools to extract volatile and nonvolatile data from a Windows based system.

	b. Use web attacks test tools like netcraft to identify web application vulnerabilities of a particular site say www.xyz.com
4	a. Explain the different steps taken to protect ICT and prevent Misuse of Internet. b. Explain the impact of Section 66 in IT Act to General Public
5	a. Explain the different anti-forensics practices used to destroy or conceal data in order to prevent others from accessing it. b. What is the difference between a Cryptographer and a Crypter?

24CSE8131	IoT Security	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The course on IoT Security is designed to provide participants with comprehensive knowledge and skills in securing Internet of Things (IoT) ecosystems

Prerequisite: Basic Knowledge of Networking essentials, IoT concepts, Cryptography, and programming skills.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Recognize and analyze the various security challenges associated with IoT, including vulnerabilities and potential threats. (**Apply level**)
CO 2	Explore effective key management strategies and practices for IoT devices, ensuring the secure generation, distribution, and storage of cryptographic keys. (**Understand level**)
CO 3	Develop a comprehensive understanding of the security challenges in the Internet of Things (IoT) and the crucial role Identity & Access Management (IAM) plays in addressing these challenges. (**Apply level**)
CO 4	Gain a deep understanding of the privacy challenges specific to the Internet of Things (IoT) landscape, covering data collection, communication, and storage. (**Understand level**)
CO 5	Identify the differences between cloud-based IoT systems and traditional data collection systems, recognizing the unique challenges and solutions associated with cloud security in IoT. (**Understand level**)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	2			1						
CO 2	3	3	3									
CO 3	3	3	3		3				2			
CO 4	3	3	1			1						2
CO 5	3	3	3			1						

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA							
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Practical [P]		Total Marks
		Assignment	Test-1	Test-2	Class work	Lab Exam	
3-0-0-0	5	15	10	10			40

Total Marks distribution			
Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Introduction: Securing the Internet of Things (7 hours)

Security Requirements in IoT Architecture, Security in Enabling Technologies, Security Concerns in IoT Applications. Security Architecture in the Internet of Things, Security Requirements in IoT, Insufficient Authentication/Authorization, Insecure Access Control, Threats to Access Control, Privacy, and Availability, Attacks Specific to IoT. Vulnerabilities, Secrecy and Secret, Key Capacity, Authentication/Authorization for Smart Devices, Transport Encryption, Attack and Fault trees, The secure IoT system implementation lifecycle.

MODULE II: Cryptographic Fundamentals for IoT (7 hours)

Cryptographic primitives and its role in IoT, Encryption and Decryption, Hashes, Digital Signatures, Random number generation, Cipher suites, Key management fundamentals, Cryptographic controls built into IoT messaging and communication protocols, IoT Node Authentication

Module III: Identity & Access Management Solutions for IoT (7 hours)

Identity lifecycle, Authentication credentials, IoT IAM infrastructure, Authorization with

Publish/Subscribe schemes, Access control.
MODULE IV: Privacy Preservation for IoT (8 hours)
Privacy Preservation Data Dissemination, Privacy Preservation for IoT Used in Smart Building, Exploiting Mobility Social Features for Location Privacy Enhancement in Internet of Vehicles, Lightweight and Robust Schemes for Privacy Protection in Key Personal IoT Applications: Mobile WBSN and Participatory Sensing
MODULE V: Cloud Security for IoT (7 hours)
Cloud services and IoT, Offerings related to IoT from cloud service providers, Cloud IoT security controls, An enterprise IoT cloud security architecture, and New directions in cloud-enabled IoT computing.
Textbooks 1. Fei HU, "Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations", CRC Press,2016 2. Russell, Brian and Drew Van Duren, "Practical Internet of Things Security", Packt Publishing, 2016.
Reference books 1. Ollie Whitehouse, "Security of Things: An Implementers' Guide to Cyber-Security for Internet of Things Devices and Beyond", NCC Group, 201

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
	MODULE 1	
1.1	Security Requirements in IoT Architecture, Security in Enabling Technologies, Security Concerns in IoT Applications.	1
1.2	Security Architecture in the Internet of Things, Security Requirements in IoT,	1
1.3	Insufficient Authentication/Authorization, Insecure Access Control	
1.4	Threats to Access Control, Privacy, and Availability, Attacks Specific to IoT.	1
1.5	Vulnerabilities, Secrecy and Secret, Key Capacity, Authentication/Authorization for Smart Devices,	2
1.6	Transport Encryption, Attack and Fault trees, The secure IoT system implementation lifecycle	2
	MODULE II	
2.1	Cryptographic primitives and its role in IoT,	1
2.2	Encryption and Decryption, Hashes, Digital Signatures,	2
2.3	Random number generation, Cipher suites, Key management fundamentals,	2
2.4	Cryptographic controls built into IoT messaging and communication protocols, IoT Node Authentication	2
	MODULE III	

3.1	Identity lifecycle,	1
3.2	Authentication credentials,	2
3.3	IoT IAM infrastructure,	2
3.4	Authorization with Publish/Subscribe schemes, Access control	2
	MODULE IV	
4.1	Privacy Preservation Data Dissemination, Privacy Preservation for IoT Used in Smart Building,	2
4.2	Exploiting Mobility Social Features for Location Privacy Enhancement in Internet of Vehicles,	2
4.3	Lightweight and Robust Schemes for Privacy Protection in Key	2
4.4	Personal IoT Applications: Mobile WBSN and Participatory Sensing	2
	MODULE V	
5.1	Cloud services and IoT,	1
5.2	Offerings related to IoT from cloud service providers,	2
5.3	Cloud IoT security controls, An enterprise IoT cloud security architecture,	2
5.4	New directions in cloud-enabled IoT computing	2

CO Assessment Questions	
1	Explain the significance of security in the Internet of Things (IoT) landscape
2	Outline the potential challenges and considerations in implementing cryptographic solutions for IoT security.
3	Evaluate the challenges associated with implementing IAM solutions for diverse IoT devices and propose strategies to address these challenges
4	Discuss the role of machine learning in addressing privacy challenges within the Internet of Things (IoT) ecosystem
5	Explore the role of cloud computing in facilitating IoT applications and the security challenges that arise in this interconnected environment

24CSE8141	Introduction to Devops	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course enables the learners to understand the fundamental concepts of Devops and provide them with the necessary skills to streamline software development processes and enhance collaboration within organizational frameworks. This course covers the topics like fundamentals of DevOps, Version Control and Collaboration, Infrastructure as Code, Continuous Integration and Continuous Deployment and Containerization and Orchestration which helps the students to gain a holistic understanding of the key pillars in modern software development and IT operations.

Prerequisite: Software Engineering

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the principles, key practices, and cultural aspects of DevOps. **(Understand Level)**
CO2	Make use of the concept of Version Control and Collaboration Techniques for software development. **(Apply Level)**
CO3	Explain the fundamental principles of Continuous Integration (CI) and Continuous Deployment (CD) pipelines in the context of software development. **(Understand Level)**
CO4	Apply the knowledge of Terraform basics by constructing a simple infrastructure using Terraform. **(Apply Level)**
CO5	Make use of the concept of Docker and Kubernetes for deploying and managing applications in a containerized environment. **(Apply Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3									3
CO5	3	3	3									3
CO6	3	3	3									3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test 1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	

Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

<u>End Semester Examination [ESE]: Pattern</u>

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Introduction to DevOps (8 hrs)

Definition, principles, and goals of DevOps. Evolution and historical context. Key practices and cultural aspects. Key DevOps Practices- Continuous Integration (CI), Continuous Delivery/Deployment (CD), Infrastructure as Code (IaC), Configuration Management. DevOps Culture and Tools- Collaboration and communication, Automation mindset, Measurement and sharing, Introduction to popular DevOps tools.

MODULE II: Version Control and Collaboration (8 hrs)

Version Control Basics- Introduction to version control systems (e.g., Git), Branching strategies and best practices. Collaboration Tools and Git Workflows- Using collaboration tools (e.g., GitHub, GitLab), Pull Requests and Code Reviews, Feature branching and Gitflow workflow. Git Advanced Topics- Rebasing and merging strategies, Managing conflicts, Git hooks.

MODULE III: Continuous Integration and Continuous Deployment (8 hrs)

Continuous Integration and Automated Testing-CI fundamentals and benefits, Setting up a CI pipeline (using Jenkins), Types of automated tests and frameworks. Continuous Deployment-CD principles and practices, Blue-Green deployments and Canary releases, Monitoring and Logging. Introduction to monitoring tools (e.g., Prometheus, Grafana), Logging best practices.

MODULE IV : Infrastructure as Code (7 hrs)

Introduction to IaC and Terraform Basics-Definition and benefits of IaC, Popular IaC tools (e.g., Terraform), Infrastructure provisioning and declarative configuration. Terraform Advanced Topics-Modules and workspaces, Terraform state and backends. Configuration Management with Ansible-Introduction to Ansible. Ansible playbooks and roles.

MODULE V : Containerization and Orchestration (6 hrs)

Containerization Basics and Docker-Introduction to containers (Docker), Docker basics and commands. Docker Compose and Container Orchestration with Kubernetes-Defining multi-container applications using Docker Compose, Introduction to Kubernetes, Deploying applications on Kubernetes. Kubernetes Advanced Topics- Helm charts, Kubernetes networking. Stateful Sets and Daemon Sets.

Text books

1. The DevOps Handbook: How to Create World-Class Agility, Reliability, and Security in Technology Organizations, Gene Kim, John Willis, Patrick Debois, Jez Humb,1st Edition, O'Reilly publications, 2016.
2. What is Devops? Infrastructure as code, 1st Edition, Mike Loukides, O'Reilly publications, 2012
3. Practical DevOps By Joakim Verona, 2016.
4. Version Control with Subversion -O'Reilly Media; Second edition, 2009.
5. Version Control with Git -O'Reilly Media; Second edition, 2008
6. Jenkins: The Definitive Guide" by John Ferguson Smart, 2011.

Reference books

1. DevOps for Developers by Michael Huttermann, 2012.
2. The DevOps 2.0 Toolkit: Automating the Continuous Deployment Pipeline With Containerized Microservices, 1st Edition, Viktor Farcic, CreateSpace Independent Publishing Platform publications, 2016
3. Continuous Delivery: Reliable Software Releases Through Build, Test, and Deployment Automation, 1st Edition, Jez Humble and David Farley, 2010
4. Achieving DevOps: A Novel About Delivering the Best of Agile, DevOps, and microservices, 1st Edition, Dave Harrison, Knox Lively, Apress publications, 2019.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36 hrs)
	MODULE I	
1.1	Definition, principles, and goals of DevOps. Evolution and historical context	1
1.2	Key DevOps Practices- Continuous Integration (CI), Continuous Delivery/Deployment (CD)	1
1.3	Infrastructure as Code (IaC)	1
1.4	Configuration Management	1
1.5	DevOps Culture and Tools- Collaboration and communication	1
16	Automation mindset	1
1.7	Measurement and sharing	1
1.8	Introduction to popular DevOps tools	1
	MODULE II	
2.1	Version Control Basics- Introduction to version control systems (e.g., Git)	1
2.2	Branching strategies and best practices	1
2.3	Collaboration Tools and Git Workflows- Using collaboration tools (e.g., GitHub, GitLab)	1
2.4	Pull Requests and Code Reviews	1
2.5	Feature branching and Gitflow workflow	1
2.7	Git Advanced Topics- Rebasing and merging strategies	1
2.8	Managing conflicts, Git hooks.	
	MODULE III	
3.1	Continuous Integration and Automated Testing-CI fundamentals and benefits	1
3.2	Setting up a CI pipeline (using Jenkins)	1
3.3	Types of automated tests and frameworks	
3.4	Continuous Deployment-CD principles and practices	1
3.5	Blue-Green deployments and Canary releases	1
3.6	Monitoring and Logging	1
3.7	Introduction to monitoring tools (e.g., Prometheus, Grafana)	1
3.8	Logging best practices	1
	MODULE IV	
4.1	Introduction to IaC and Terraform Basics-Definition and benefits of IaC	1
4.2	Popular IaC tools (e.g., Terraform)	1
4.3	Infrastructure provisioning and declarative configuration	1

4.4	Terraform Advanced Topics-Modules and workspaces	1
4.5	Terraform state and backends	1
4.6	Configuration Management with Ansible-Introduction to Ansible	1
4.7	Ansible playbooks and roles	1
MODULE V		
5.1	Containerization Basics and Docker-Introduction to containers (Docker)	1
5.2	Docker basics and commands	1
5.3	Docker Compose and Container Orchestration with Kubernetes-Defining multi-container applications using Docker Compose	1
5.4	Introduction to Kubernetes, Deploying applications on Kubernetes	1
5.5	Kubernetes Advanced Topics- Helm charts, Kubernetes networking	1
5.6	Stateful Sets and Daemon Sets	1

CO Assessment Questions	
1	a. Explain how the principles of DevOps contribute to improved collaboration and efficiency in software development. b. How does DevOps foster a culture of collaboration between development and operations teams? c. Explain how the principles, key practices, and cultural aspects of DevOps work together to enhance the software development lifecycle.
2	a. You've just joined a new development team, and they are transitioning to using version control. Outline the steps you would take to initiate the project with version control, considering collaboration and tracking changes. b. Your team receives a critical feature request that requires simultaneous contributions from multiple members. Explain how you would use version control to manage and merge these feature developments without disrupting the main codebase. c. During a code review, you notice conflicting changes made by two team members. How would you utilize version control to address these conflicts and ensure a smooth code review process while maintaining collaboration?
3	a. Explain how CD principles differ from CI principles and their combined impact on the software delivery process. b. Explain the role of automated testing in maintaining the reliability of CI/CD pipelines. c. How does Continuous Integration (CI) contribute to efficient code integration and collaboration among team members? d. How do CI pipelines ensure early detection of integration issues and

	maintain code quality?
4	As a DevOps engineer, you have been tasked with deploying a new microservices-based application on the cloud infrastructure. The development team has provided you with the necessary application code, and you need to set up the infrastructure using Terraform. The infrastructure includes a virtual network, multiple virtual machines for the microservices, and a load balancer to distribute incoming traffic. i. Describe the basic design of the infrastructure you plan to create using Terraform for the microservices application. ii. Provide a snippet of Terraform configuration code that defines the virtual network, virtual machines, and load balancer for the microservices application. iii. Explain how you would handle dependencies between different resources in your Terraform configuration, ensuring proper order of resource creation.
5	You are a DevOps engineer responsible for deploying and managing a microservices-based application in a containerized environment using Docker and Kubernetes. The application consists of multiple services that need to be containerized, deployed, and orchestrated for efficient scaling and management. i. Describe how you would containerize each microservice using Docker. Provide an example Dockerfile for one of the microservices. ii. Explain how Docker Compose can be utilized for local development and testing of the entire microservices application. Provide a sample Docker Compose configuration. iii. Create Kubernetes deployment manifests for two microservices within the application. Specify resource requirements, replicas, and any necessary environment variables. iv. Discuss how Kubernetes handles service discovery and load balancing. Explain how the microservices communicate with each other within the Kubernetes cluster.

24CSE8151	Augmented and Virtual Reality	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course equips the learners with an understanding of fundamentals, technologies, and applications of Virtual Reality (VR) and Augmented Reality (AR).This course covers various areas of AR and VR like the hardware and software components, examine the challenges, and evaluate the applications of both VR and AR. This course helps the learners to acquire the knowledge and practical skills to navigate the rapidly evolving immersive technologies, preparing them for exciting opportunities in fields ranging from engineering and entertainment to science, training, and game development.

Prerequisite:

Course Outcomes: After the completion of the course the student will be able to

CO1	Describe the concept of virtual reality ,virtual environment and real time computer graphics. **(Understand level)**
CO2	Identify theoretical and practical aspects of computer graphics and virtual reality, using fundamental principles in both technologies. **(Understand level)**
CO3	Describe various input and output devices used in virtual reality systems and also to identify basic techniques in animating virtual environments.**(Understand level)**
CO4	Illustrate the challenges associated with the implementation of AR technology and various methods to enhance intractivity and visualization techniques in AR environment. **(Understand level)**
CO5	Interpret the human factors, hardware, software, and diverse applications of Virtual and Augmented Reality. **(Understand level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										3
CO2	3	3										3
CO3	3	3										3
CO4	3	3										3
CO5	3	3										3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Introduction to Virtual Reality (VR) (7 hrs)

Virtual Reality and Virtual Environment, Computer graphics, Real time computer graphics, Input/Output Devices: Input (Tracker, Sensor, Digital Gloves, Movement Capture, Videobased Input, 3D Menus & 3D Scanner, etc.), Output (Visual/Auditory/Haptic Devices), Virtual environment requirement, benefits of virtual reality, Historical development of VR, Scientific Landmark.

MODULE II : Computer Graphics and Geometric Modelling (8 hrs)

The Virtual world space, positioning the virtual observer, the perspective projection, human vision, stereo perspective projection, Color theory, Conversion From 2D to 3D, 3D space curves, 3D boundary representation, Simple 3D modelling, 3D clipping, Illumination models, Reflection models, Shading algorithms, Geometrical

Transformations: Introduction, Frames of reference, Modelling transformations, Instances, Picking, Flying, Scaling the VE, Collision detection.
MODULE III : Virtual Environment (6 hrs)
Generic VR system: Introduction, Virtual environment, Computer environment, VR technology, Model of interaction, VR Systems, Animating the Virtual Environment: Introduction, The dynamics of numbers, Linear and Nonlinear interpolation, the animation of objects, linear and non-linear translation, shape & object in between, free from deformation, particle system.
MODULE IV : Augmented Reality (AR) (7 hrs)
Taxonomy, Technology and Features of Augmented Reality, AR Vs VR, Challenges with AR, AR systems and functionality, Augmented Reality Methods, Visualization Techniques for Augmented Reality, Enhancing interactivity in AR Environments, Evaluating Arsystems.
MODULE V : Development Tools and Frameworks (7 hrs)
Human factors: Introduction, the eye, the ear, the somatic senses. Hardware: Introduction, sensor hardware, Head-coupled displays, Acoustic hardware, Integrated VR systems. Software: Introduction, Modelling virtual world, Physical simulation, VR toolkits, Introduction to VRML. AR / VR Applications: Introduction, Engineering, Entertainment, Science, Training, Game Development

Text books

1. Coiffet, P., Burdea, G. C., (2003), "Virtual Reality Technology," Wiley-IEEE Press, ISBN: 9780471360896
2. Schmalstieg, D., Höllerer, T., (2016), "Augmented Reality: Principles & Practice," Pearson, ISBN: 9789332578494
3. Norman, K., Kirakowski, J., (2018), " Wiley Handbook of Human Computer Interaction," Wiley-Blackwell, ISBN: 9781118976135

Reference books

1. LaViola Jr., J. J., Kruijff, E., McMahan, R. P., Bowman, D. A., Poupyrev, I., (2017), "3D User Interfaces: Theory and Practice," Pearson, ISBN: 9780134034324
2. Fowler, A., (2019), "Beginning iOS AR Game Development: Developing Augmented Reality Apps with Unity and C#," Apress, ISBN: 9781484246672

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1		
1.1	Virtual Reality and Virtual Environment	1
1.2	Computer graphics, Real time computer graphics.	1
1.3	Input/Output Devices: Input (Tracker, Sensor, Digital Gloves, Movement Capture, Videobased Input, 3D Menus & 3D Scanner, etc.), Output (Visual/Auditory/Haptic Devices) – Lecture 1	1
1.4	Input/Output Devices: Input (Tracker, Sensor, Digital Gloves, Movement Capture, Videobased Input, 3D Menus & 3D Scanner, etc.),	1

	Output (Visual/Auditory/Haptic Devices) – Lecture 2	
1.5	Virtual environment requirement.	1
1.6	Benefits of virtual reality.	1
1.7	Historical development of VR, Scientific Landmark.	1
	MODULE II	
2.1	The Virtual world space, Positioning the virtual observer.	1
2.2	The perspective projection, human vision.	1
2.3	Stereo perspective projection	1
2.4	Color theory, Conversion From 2D to 3D, 3D space curves, 3D boundary representation.	1
2.5	Simple 3D modelling, 3D clipping,	1
2.6	Illumination models, Reflection models, Shading algorithms.	1
2.7	Geometrical Transformations: Introduction, Frames of reference, Modelling transformations.	1
2.8	Instances, Picking, Flying, Scaling the VE, Collision detection.	1
	MODULE III	
3.1	Generic VR system: Introduction, Virtual environment, Computer environment.	1
3.2	VR technology, Model of interaction, VR Systems.	1
3.3	Animating the Virtual Environment: Introduction, The dynamics of numbers, Linear and Nonlinear interpolation.	1
3.4	The animation of objects.	1
3.5	Linear and non-linear translation, shape & object in between.	1
3.6	Free from deformation, particle system.	1
	MODULE IV	
4.1	Taxonomy, Technology and Features of Augmented Reality.	1
4.2	AR Vs VR, Challenges with AR.	1

4.3	AR systems and functionality.	1
4.4	Augmented Reality Methods.	1
4.5	Visualization Techniques for Augmented Reality.	1
4.6	Enhancing interactivity in AR Environments.	1
4.7	Evaluating Arsystems.	1
	MODULE V	
5.1	Human factors: Introduction, the eye, the ear, the somatic senses.	1
5.2	Hardware: Introduction, sensor hardware.	1
5.3	Head-coupled displays, Acoustic hardware, Integrated VR systems.	1
5.4	Software: Introduction, Modelling virtual world.	1
5.5	Physical simulation, VR toolkits, Introduction to VRML.	1
5.6	AR / VR Applications: Introduction, Engineering, Entertainment.	1
5.7	Science, Training, Game Development.	1

CO Assessment Questions	
1	1. Discuss the applications of Virtual Environments in various fields 2. Define Real-Time Computer Graphics and its significance in VR applications.
2	1. Compare and contrast perspective projection with other projection techniques. 2. Explain the process of simple 3D modeling and its applications in virtual environments.
3	1. Introduce the components of a Generic VR System, highlighting the roles of the virtual environment and computer environment. 2. What is the significance of animation in the Virtual Environment? Provide examples of applications where animation is crucial.
4	1. How can gesture recognition and voice commands be leveraged to enhance interactivity in Augmented Reality environments? Provide examples.

	2. Enumerate and explain three visualization techniques commonly used in Augmented Reality to enhance user perception and understanding.
5	1. Describe the role of somatic senses (touch, temperature, pressure) in enhancing the sense of presence and interaction within virtual environments. 2. Discuss the diverse applications of Augmented Reality and Virtual Reality, highlighting the impact of immersive technologies across various domains.

24CSE8161	Human Computer Interaction	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The aim of this course is for the students, working in teams, to propose a new human computer interface, or an improvement to an existing interface, to solve a particular problem. The course Human Computer Interface Foundation, Designing Interaction, Interaction Design Models, Guidelines in HCI and Collaboration, Human Factors, Security and Validation Concepts.

Prerequisite: 23HUL111 Design Thinking and 23CSE6164 Computer Graphics

Course Outcomes: After the completion of the course the student will be able to

CO 1	Describe the basic concepts of human, computer interactions. **(Understand Level)**
CO 2	Depict the processes of human computer interaction life cycle. **(Understand Level)**
CO 3	Discuss the various interaction design models. **(Understand Level)**
CO 4	Apply design standards/guidelines for evaluating the developed interactions. **(Apply Level)**
CO 5	Describe the principles of human computer interactions through the prototype mode and validations. **(Understand Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2				2				2		3
CO 2	3	2	2	2		2				2		3
CO 3	3	3	2	2		2				2		3
CO 4	3	3	2	2		3				2		3
CO 5	3	3	2	2		2				2		3

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✔	✔	✔	✔
Understand	✔	✔	✔	✔
Apply	✔	✔	✔	✔
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: HCI Foundations (7 hrs)

Input–output channels, Human memory- Thinking: reasoning and problem solving, Emotion, Individual differences, Psychology and the design of interactive systems, Text entry devices – Positioning, pointing and drawing, Display devices, Devices for virtual reality and 3D interaction - Physical controls, sensors and special devices.

MODULE II: Designing Interaction (6 hrs)

Models of Interaction, Frameworks and HCI, Interaction Styles, Contexts of Interaction, The Process of Design, Navigation Design, Screen Design and Layout, Iteration and Prototyping.

MODULE III: Cognitive Models (9 hrs)

Goal and Task hierarchy, GOMS, Linguistic Models, Physical and device Models, Cognitive architectures, Communication and collaboration models, Face to face communication, Text Based communication, Group working, Task Analysis, Task decomposition.

MODULE IV: Design Rules, Guidelines in HCI and Evaluation (6 hrs)
Principles to support usability, standards and guidelines, Shneideman's eight golden rules, Nielsen's ten heuristics, Heuristic evaluation, contextual evaluation, Evaluation through expert analysis, evaluation through user participation
MODULE V: Human Factors And Security and Validation Concepts (7 hrs)
Groupware systems, computer mediated communication, Meeting and decision support systems, Shared applications and artifacts, Frameworks for groupware Implementing synchronous groupware, Augmented and Virtual Reality, Validations - Usability testing, Interface Testing, User Acceptance Testing
Text books 1. A Dix, Janet Finlay, G D Abowd, R Beale, Human-Computer Interaction, 3rd Edition, Pearson Publishers, 2008. 2. Shneiderman, Plaisant, Cohen and Jacobs, Designing the User Interface: Strategies for Effective Human Computer Interaction, 5th Edition, Pearson Publishers, 2010.
Reference books 1. Rogers, Sharp & Preece, Interaction Design, Beyond Human-Computer Interaction, Third Edition, Wiley, 2014. 2. Pamayiotis Zaphiris & Sri Kurniawan, Human Computer Interaction research in Web Design and Evaluation, First Edition, Idea Group Publishing, 2007. 3. Dan, R. Olsen, Jy, Human Computer Interaction, First Edition, Cengage Learning, 2010.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1		
1.1	Input–Output channels.	1
1.2	Human memory Thinking: reasoning and problem solving, Emotion (Lecture 1).	1
1.3	Human memory Thinking: reasoning and problem solving, Emotion (Lecture 2).	1
1.4	Individual differences.	1
1.5	Text entry devices.	1
1.6	Display devices.	1
1.7	Devices for virtual reality and 3D interaction.	1
MODULE II		
2.1	Models of Interaction, Frameworks and HCI.	1
2.2	Interaction Styles.	1
2.3	Contexts of Interaction.	1
2.4	The Process of Design, Navigation Design.	1
2.5	Screen Design and Layout.	1
2.6	Iteration and Prototyping.	1
MODULE III		
3.1	Goal and Task hierarchy.	1
3.2	GOMS, Linguistic Models.	1

3.3	Physical and device Models.	1
3.4	Cognitive architectures.	1
3.5	Communication and collaboration models.	1
3.6	Face to face communication, Text Based communication.	1
3.7	Group working.	1
3.8	Task Analysis.	1
3.9	Task decomposition.	1
MODULE IV		
4.1	Principles to support usability, standards, and guidelines.	1
4.2	Shneideman's eight golden rules.	1
4.3	Nielsen's ten heuristics, Heuristic evaluation.	1
4.4	Contextual evaluation	1
4.5	Evaluation through expert analysis.	1
4.6	Evaluation through user participation	1
MODULE V		
5.1	Groupware systems..	1
5.2	Computer mediated communication.	
5.3	Meeting and decision support systems, Shared applications and artifacts.	1
5.4	Frameworks for groupware.	1
5.5	Implementing synchronous groupware.	1
5.6	Augmented and Virtual Reality.	1
5.7	Usability testing, Interface Testing, User Acceptance Testing perceptual interface.	1

CO Assessment Questions	
CO1	1. Describe the relation between psychology and the design of interactive systems. 2. Differentiate between text entry devices and display devices. 3. Explain about virtual reality and 3D interaction devices.
CO2	1. Illustrate the known interactive design models. 2. Explain about the framework used for discovery. 3. Explain what is meant by Iteration and prototyping?
CO3	1. Explain GOMS Analysis. 2. Explain the working of communication and collaborative models.
CO4	1. Conduct a heuristic evaluation of an e-commerce platform, considering Nielsen's principles. Identify specific usability issues and propose improvements based on heuristic guidelines. 2. Evaluate the user interface of a gaming application using heuristic evaluation principles. Identify specific usability challenges and propose design modifications to enhance the gaming experience.

	3. How can user participation provide valuable insights into user behaviors and preferences, influencing design decisions?
CO5	1. Identify the frameworks for groupware. 2. What is cognitive walk-through? 3. Explain the applications of augmented and Virtual reality. 4. How do you implement synchronous groupware?

Open Elective II/ MOOC

24CSO812	Computer Graphics	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course creates an awareness about various graphics input and display devices and also to understand the various concepts in computer graphics. This course helps the learner to understand three-dimensional environment representation in a computer, transformation of 2D/3D objects and basic mathematical techniques and algorithms used to build useful applications. The study of computer graphics develops the ability to build algorithms for emerging display technologies.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Compare various graphics devices. **(Understand level)**
CO2	Illustrate algorithms for line drawing, circle drawing and polygon filling.**(Apply level)**
CO3	Apply geometrical transformation on 2D and 3D objects.**(Apply level)**
CO4	Implement algorithms for clipping.**(Apply level)**
CO5	Apply various projection techniques on 3D objects.**(Apply level)**
CO6	Summarize types of projections and visible surface detection methods. **(Understand level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											3
CO2	3	3	3	1								3
CO3	3	3	3	1								3
CO4	3	3	3	1								3
CO5	3	3	3	1								3
CO6	3		3									3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Introduction (9 hrs)

Basic concepts in Computer Graphics and its applications– Video Display devices- Refresh Cathode Ray Tubes, Random Scan Displays and systems, Raster scan displays and systems, Color CRT displays, Flat panel display and its categories.

MODULE II : Line and Circle Drawing and Polygon Filling Algorithms (6 hrs)

Line Drawing Algorithm- DDA, Bresenham's algorithm – Circle Generation Algorithms –Mid point circle algorithm, Bresenham's algorithm- Scan Conversion-frame buffers – solid area scan conversion – polygon filling algorithms

MODULE III : 2D transformations and Windowing concepts (8 hrs)

Two dimensional transformations. Homogeneous coordinate systems – matrix formulation and concatenation of transformations.

Windowing concepts –Window to Viewport Transformation- Two dimensional clipping-Line clipping – Cohen Sutherland, Midpoint Subdivision algorithm.

MODULE IV : Polygon Clipping (6 hrs)

Polygon clipping-Sutherland Hodgeman algorithm, Weiler-Atherton algorithm, Three dimensional object representation-Polygon surfaces, Quadric surfaces – Basic 3D transformations.

MODULE V : Projections and Visible surface detection methods (7 hrs)

Projections – Parallel and perspective projections – vanishing points.

Visible surface detection methods– Back face removal- Z-Buffer algorithm, A-buffer algorithm, Depth-sorting method, Scan line algorithm.

Text books

1. D. Hearn and M.P. Baker, Computer Graphics, C Version, Pearson Education, 2002.
2. James D. Foley, A. Van Dam, S.K. Feiner, and J.F. Hughes, Computer Graphics: Principles and Practice, 2nd ed. in C, Addison-Wesley Publishing Company, 1996.

Reference books

1. D. Hearn and M.P. Baker, Computer Graphics with OpenGL Version, 3 rd ed., Pearson Education, 2004.
2. Rogers B., Mathematical Elements of Computer Graphics, Tata McGraw Hill, 2002

Suggested MOOC Courses

1. Computer Graphics-IIT Madras, Prof.Sukhendu Das

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Basic concepts in Computer Graphics and its applications	1
1.2	Video Display devices- Refresh Cathode Ray Tubes- Lecture 1	1
1.3	Video Display devices- Refresh Cathode Ray Tubes- Lecture 2	1
1.4	Raster Scan Displays	1
1.5	Raster Scan Systems	1
1.6	Random Scan Displays	1
1.7	Random Scan Systems	1
1.8	Color CRT displays	1

1.9	Flat panel display and its categories	1
MODULE II		
2.1	Line Drawing Algorithm- DDA.	1
2.2	Bresenham's algorithm	1
2.3	Circle Generation Algorithms –Mid point circle algorithm.	1
2.4	Bresenham's algorithm	1
2.5	Scan Conversion-frame buffers – solid area scan conversion.	1
2.6	Polygon filling algorithms.	1
MODULE III		
3.1	Two dimensional transformations-Lecture 1.	1
3.2	Two dimensional transformations-Lecture 2	1
3.3	Homogeneous coordinate systems – matrix formulation.	1
3.4	Concatenation of transformations.	1
3.5	Windowing concepts –Window to Viewport Transformation.	1
3.6	Two dimensional clipping-Line clipping.	1
3.7	Cohen Sutherland.	1
3.8	Midpoint Subdivision algorithm.	1
MODULE IV		
4.1	Polygon clipping-Sutherland Hodgeman algorithm.	1
4.2	Weiler-Atherton algorithm.	1
4.3	Three dimensional object representation-Polygon surfaces.	1
4.4	Quadric surfaces.	1
4.5	Basic 3D transformations- Lecture 1	1

4.6	Basic 3D transformations- Lecture 2	1
MODULE V		
5.1	Projections – Parallel projections.	1
5.2	Perspective projections – vanishing points.	1
5.3	Visible surface detection methods– Back face removal.	1
5.4	Z-Buffer algorithm	1
5.5	A-buffer algorithm.	1
5.6	Depth-sorting method.	1
5.7	Scan line algorithm.	1

CO Assessment Questions	
1	1. Compare the working principle of raster scan systems and random scan systems. 2. How much time is spent scanning across each row of pixels during screen refresh on a raster system with resolution of 1280*1024 and a refresh rate of 60 frames per second?
2	1. Rasterize the line with end points(2,3) and (5,8) using Bresenham's line drawing algorithm. 2. Explain how the 4-connected area filling approach differs from 8- connected area filling in boundary filling algorithm
3	1. Rotate a triangle ABC 45 degree counter clockwise about the pivot point (10,3), where the position vector of the coordinate ABC is given as A(4,1), B(5,2) and C(4,3). 2. A triangle ABC with coordinates with A(0,0) B(6,5) C(6,0) is scaled with scaling factors Sx=2 and Sy=3 about the vertex C(6,0). Find the transformed coordinate points.
4	1. Given a clipping window A(20,20), B(60,20), C(60,40) and D(20,40). Using Cohen Sutherland algorithm, find the visible portion of the line segment joining the points P(40,80) and Q(120,30).
5	Prove that the multiplication of 3D transformation matrices for each of the following sequence of operations is commutative. a) Any two successive translations. b) Any two successive scaling operations.

	c) Any two successive rotations abot any one of the co-ordinate axes.
6	1. Explain scan line algorithm for detecting visible surfaces in an object. 2. Point out the differences between Z-Buffer method and A-Buffer method for determining visible surfaces.

24CSO822	ARTIFICIAL INTELLIGENCE	L	T	P	J	S	C	Year of Introduction
		2	1	0	0	3	3	2024

Preamble: The course aims to introduce the fundamental principles of intelligent systems to students. This course enables the student to identify the characteristics of intelligent systems, knowledge representation schemes, logic and inference mechanisms. This helps the learner to understand the design of self-learning systems along with some of their typical applications in the emerging scenario.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the fundamental concepts of intelligent systems and their architecture. **(Cognitive Knowledge Level: Understanding)**
CO2	Illustrate uninformed and informed search techniques for problem solving in intelligent systems. **(Cognitive Knowledge Level: Understanding)**
CO3	Solve Constraint Satisfaction Problems using search techniques. **(Cognitive Knowledge Level: Apply)**
CO4	Represent AI domain knowledge using logic systems and use inference techniques for reasoning in intelligent systems. **(Cognitive Knowledge Level: Apply)**
CO5	Illustrate different types of learning techniques used in intelligent systems **(Cognitive Knowledge Level: Understand)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3									3
CO5	3	3	3									3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test 1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Introduction

Introduction – What is Artificial Intelligence(AI) ? The Foundations of AI, History of AI, Applications of AI. Intelligent Agents – Agents and Environments, Good behavior: The concept of rationality, nature of Environments, Structure of Agents.

MODULE II : Problem Solving

Solving Problems by searching-Problem solving Agents, Example problems, Searching for solutions, Uninformed search strategies, Informed search strategies, Heuristic functions.

MODULE III : Search in Complex environments

Adversarial search - Games, Optimal decisions in games, The Minimax algorithm, Alpha-Beta pruning. Constraint Satisfaction Problems – Defining CSP, Constraint Propagation- inference in CSPs, Backtracking search for CSPs, Structure of CSP problems.

MODULE IV : Knowledge Representation and Reasoning

Logical Agents – Knowledge based agents, Logic, Propositional Logic, Propositional Theorem proving, Agents based on Propositional Logic. First Order Predicate Logic – Syntax and Semantics of First Order Logic, Using First Order Logic, Knowledge representation in First Order Logic. Inference in First Order Logic – Propositional Vs First Order inference, Unification and Lifting, Forward chaining, Backward chaining, Resolution.

MODULE V : Machine Learning

Learning from Examples – Forms of Learning, Supervised Learning, Learning Decision Trees, Evaluating and choosing the best hypothesis, Regression and classification with Linear models.

Text books

1. Stuart Russell and Peter Norvig. Artificial Intelligence: A Modern Approach, 3rd Edition. Prentice Hall.

References

1. Nilsson N.J., Artificial Intelligence - A New Synthesis, Harcourt Asia Pvt. Ltd.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Introduction, what is Artificial Intelligence (AI)?	1
1.2	The foundations of AI, The history of AI	1
1.3	Applications of AI	1
1.4	Intelligent Agents – Agents and Environments	1
1.5	Good behavior: The concept of rationality	1
1.6	The nature of Environments	1
1.7	structure of Agents	1
	MODULE II	
2.1	Solving Problems by searching-Problem solving Agents	1
2.2	Illustration of the problem solving process by agents	1

2.3	Searching for solutions	1
2.4	Uninformed search strategies: BFS, Uniform-cost search, DFS, Depth- limited search, Iterative deepening depth-first search	1
2.5	Informed search strategies: Best First search	1
2.6	Informed search strategies: A* Search	1
2.7	Heuristic functions	1
	MODULE III	
3.1	Adversarial search - Games	1
3.2	Optimal decisions in games, The Minimax algorithm	1
3.3	Alpha-Beta pruning	1
3.4	Constraint Satisfaction Problems – Defining CSP	1
3.5	Constraint Propagation- inference in CSPs	1
3.6	Backtracking search for CSPs	1
3.7	The structure of problems	1
	MODULE IV	
4.1	Logical Agents – Knowledge based agents and logic, Propositional Logic	1
4.2	Propositional Theorem proving, Agents based on Propositional Logic	1
4.3	First Order Predicate Logic – Syntax and Semantics of First Order Logic	1
4.4	Using First Order Logic, Knowledge representation in First Order Logic	1
4.5	Inference in First Order Logic – Propositional Vs First Order inference, Unification and Lifting	1
4.6	Forward chaining, Backward chaining	1
4.7	Resolution	1
	MODULE V	

5.1	Co-evolution - Cooperative co-evolution	1
5.2	Competitive co-evolution, Example Application: Co-evolutionary Constraint Satisfaction	1
5.3	Interactive Evolution - Optimization	1
5.4	Design, Exploration	1
5.5	Interactive Evolutionary Design and Art, Example Application: The Mondriaan Evolver	1
5.6	Non-Stationary Function Optimization - Algorithmic Approaches, Selection and Replacement Policies	1
5.7	Example Application: The Time Varying Knapsack Problem	1

CO Assessment Questions	
1	1.Explain about the basic types of agent programs in intelligent systems. 2. For the following activities, give a PEAS description of the task environment and characterize it in terms of the task environment properties. a) Playing soccer. b) Bidding on an item at an auction.
2	1.Differentiate between uninformed and informed search strategies in intelligent systems. 2. Illustrate the working of Minimax search procedure.
3	1. Solve the following crypt arithmetic problem by hand, using the strategy of backtracking with forward checking and the MRV & least-constraining-value heuristics. T W O + T W O F O U R
4	1. Prove, or find a counter example to, the following assertion:If $\alpha \models \gamma$ or $\beta \models \gamma$ (or both) then $(\alpha \wedge \beta) \models \gamma$ 2. 2. For each pair of atomic sentences, find the most general unifier if it exists: a) P (A, B, B), P (x, y, z). b) Q(y, G(A, B)), Q(G(x, x), y).

5

1. Consider the following data set comprised of three binary input attributes (A1 , A2 , and A3) and one binary output.

Example	A1	A2	A3	Output y
X1	1	0	0	0
X2	1	0	1	0
X3	0	1	0	0
X4	1	1	1	1
X5	1	1	0	1

Use the DECISION-TREE-LEARNING algorithm to learn a decision tree for this data. Show the computations made to determine the attribute to split at each node.

24CSO832	Python Programming	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The objective of the course is to equip the learners to develop multi-module software solutions for real world computational problems using Python. It encompasses the Python programming environment, syntax, data representations, intermediate level features, GUI programming, Object Oriented Programming and data processing. This course lays the foundation to develop modular software solutions including complex interactive applications, network applications, and data-driven intelligent applications.

Prerequisite: Basic knowledge in Computational Problem Solving and any programming language.

Course Outcomes: After the completion of the course the student will be able to

CO1	Illustrate the use of conditional and iterative statements in Python programs. **(Apply level)**
CO2	Develop programs by utilizing the Python programming constructs such as Lists, Tuples, Sets and Dictionaries. **(Apply level)**
CO3	Implement programs involving strings, files and functions. **(Apply level)**
CO4	Develop graphical user interface for solutions using Python libraries. **(Apply level)**
CO5	Write programs in Python to process data stored in files by utilizing Numpy, Matplotlib, and Pandas. **(Apply level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										3
CO2	3	3										3
CO3	3	3										3
CO4	3	3	3									3
CO5	3	3	3									3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA						
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Programming Environment and Python Basics (6 hrs)

Getting started with Python programming – Interactive shell, IDLE, iPython Notebooks. Datatypes and character s Control Flow Statements: If Statement, Switch Statement, Unconditional Branching using goto statement, While Loop, For Loop, Break and Continue statements.(Simple programs covering control flow).

MODULE II : Python List, Dictionaries and Tuples (8 hrs)

Lists- Basic list operations and functions, List of lists, Slicing, Searching and sorting list, List comprehension. Tuples and Dictionaries - Dictionary functions, dictionary literals, adding and removing keys, accessing and replacing values, traversing dictionaries, reverse lookup. Sample Programs

MODULE III :Strings, Functions and Files (7 hrs)

Strings - String methods, Working with files. Design with Functions – Functions as

Abstraction Mechanisms, Problem solving with top-down design, Design with recursive functions. Sample Programs.

MODULE IV : Graphics and Graphical User Interfaces (7 hrs)

Graphics – Terminal-based programs, Simple Graphics using Turtle, Operations, 2D Shapes, Colors and RGB Systems, Image Processing – Basic image processing with inbuilt functions. Graphical User Interfaces – Event-driven programming, Coding simple GUI-based programs : Windows, Labels, Displaying images, Input text entry, Popup dialog boxes, Command buttons.

MODULE V : Data Processing (8 hrs)

The os and sys modules, NumPy - Basics, Creating arrays, Arithmetic, Slicing, Matrix Operations, Random numbers. Plotting and visualization. Matplotlib - Basic plot, Ticks, Labels, and Legends. Working with CSV files – Pandas - Reading, Manipulating, and Processing Data.

Text books

1. Kenneth A Lambert., Fundamentals of Python : First Programs, 2/e, Cengage Publishing, 2016
2. Wes McKinney, Python for Data Analysis, 2/e, Shroff / O'Reilly Publishers, 2017
3. Flask: Building Python web services, Jack Stouffer, Shalabh Aggarwal, Gareth Dwyer, PACKT Publishing Limited, 2018

Reference books

1. Zed A Shaw, Learn Python 3 The Hard Way, Addison-Wesley, 2017
2. Allen B. Downey, Think Python: How to Think Like a Computer Scientist, 2/e, Schroff, 2016
3. Michael Urban and Joel Murach, Python Programming, Shroff/Murach, 2016

Suggested MOOC Courses

1. NPTEL: Programming in Python, Dr. Rizwan Rehman | Dibrugarh University

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE I	
1.1	Getting started with Python programming – Interactive shell, IDLE, iPython Notebooks.	1
1.2	Datatypes and characters,Control Flow Statements: If Statement	1
1.3	Switch Statement, Unconditional Branching using goto statement	1
1.4	While Loop, For Loop	1
1.5	Break and Continue statements	1
1.6	Simple programs covering control flow	1
	MODULE II	

2.1	Lists- Basic list operations and functions	1
2.2	List of lists, Slicing	1
2.3	Searching and sorting list, List comprehension.	1
2.4	Tuples and Dictionaries	1
2.5	Dictionary functions, dictionary literals	1
2.6	Adding and removing keys, accessing and replacing values	1
2.7	Traversing dictionaries, reverse lookup	1
2.8	Sample Programs	1
	MODULE III	
3.1	Strings - String methods	1
3.2	Working with files	1
3.3	Design with Functions	1
3.4	Functions as Abstraction Mechanisms	1
3.5	Problem solving with top-down design	1
3.6	Design with recursive functions	1
3.7	Sample Programs	1
	MODULE IV	
4.1	Graphics – Terminal-based programs	1
4.2	Simple Graphics using Turtle	1
4.3	Operations, 2D Shapes, Colors and RGB Systems	1
4.4	Image Processing – Basic image processing with inbuilt functions.	1
4.5	Graphical User Interfaces – Event-driven programming	1

4.6	Coding simple GUI-based programs : Windows, Labels, Displaying images	1
4.7	Input text entry, Popup dialog boxes, Command buttons.	1
	MODULE V	
5.1	The os and sys modules,	1
5.2	NumPy - Basics, Creating arrays, Arithmetic	1
5.3	Slicing,Matrix Operations	1
5.4	Random numbers	1
5.5	Plotting and visualization	1
5.6	Matplotlib - Basic plot, Ticks, Labels, and Legends	1
5.7	Working with CSV files	1
5.8	Pandas - Reading, Manipulating, and Processing Data.	1

CO Assessment Questions	
1	1. Write a Python program which takes an integer n as input and calculates the sum of first n natural numbers. 2. What is the output of the following program? *i = 1* *while True:* *if i%3 == 0:* *break* *print(i)* *i + = 1*
2	1. What is the output of the following program? *L1 = []* *L1.append([1, [2, 3], 4])* *L1.extend([7, 8, 9])* *print(L1[0][1][1] + L1[2])* 2. Write a Python program to get a list, sorted in increasing order by the last element in each tuple from a given list of non-empty tuples.
3	1. Write a Python program to count the number of lines in a text file. 2. Predict the output of the following code snippet *my_string = 'engineering'*

	for i in range(len(my_string)): *print (my_string)* *my_string = 'a'* 3. Write a Python function that checks whether a passed string is a palindrome or not.
4	1. A bouncy program is defined as follows – The program computes and displays the total distance traveled by a ball, given three inputs—the initial height from which it is dropped, its bounciness index, and the number of bounces. Given the inputs write a GUI-based program to compute the total distance traveled. 2. Write a Python program to find the quadrant of a point p(x,y).
5	1. Given a file "auto.csv" of automobile data with the fields index, company, body-style, wheel- base, length, engine-type, num-of-cylinders, horsepower, average-mileage, and price, write python code to 1. Clean and Update the CSV file 2. Print total cars of all companies 3. Find the average mileage of all companies 4. Find the highest priced car of all companies. 2. Given two matrices A and B, write a program to find the product of A and B^T using numpy arrays.

24CSO842	Data Management and Analysis	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: Courses covering the fundamentals of data science, including data exploration, visualization, and basic analytics techniques.

Prerequisite: Foundation in mathematics and statistics, Knowledge in programming languages such as Python and SQL

Course Outcomes: After the completion of the course the student will be able to

CO 1	Grasp foundational concepts of data analysis, including its role, significance, and key terminology (**Understand level**)
CO 2	Develop a deep understanding of fundamental data concepts, including collection, processing, and interpretation. (**Apply level)**
CO 3	Gain knowledge of algorithmic solutions tailored for mining data streams, addressing issues like limited memory, changing distributions, and concept drift. (**Understand level**)
CO 4	Develop skills in evaluating the results of frequent itemsets mining and clustering, and the ability to interpret findings in a meaningful and actionable manner. (**Apply level)**
CO 5	Develop proficiency in utilizing frameworks for data analysis and visualization, such as D3.js, Matplotlib, and other relevant tools. (**Apply level**)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	3									
CO 2	3	3										
CO 3	3	3	3		3				2			
CO 4	3	3	3									2
CO 5	3	3	3									

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate				
Create				

Mark Distribution of CIA							
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Practical [P]		Total Marks
		Assignment	Test-1	Test-2	Class work	Lab Exam	
3-0-0-0	5	15	10	10			**40**

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub-divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : INTRODUCTION TO DATA ANALYTICS (7 hours)

Introduction to Data Analytics: Sources and nature of data, Classification of data (structured, semi-structured, unstructured), Characteristics of data, Introduction to Big Data platform, Need of data analytics, Evolution of analytic scalability, Analytic process and tools, Analysis vs reporting, Modern data analytic tools, Applications of data analytics.

Data Analytics Lifecycle**:** Need, key roles for successful analytic projects, Various phases of data analytics lifecycle – discovery, Data preparation, model planning, model building, Communicating results, operationalization

MODULE II: DATA ANALYSIS (7 hours)

Regression modeling, Multivariate analysis, Bayesian modeling inference and Bayesian networks, Support vector and kernel methods, Analysis of time series: linear systems analysis & nonlinear dynamics, Rule induction, Principal component analysis and neural networks, Fuzzy logic: extracting fuzzy models from data, Fuzzy decision trees, Stochastic search methods.

Module III: MINING DATA STREAMS (8 hours)

Introduction to stream concepts, Stream data model and architecture, Stream computing, Sampling data in a stream, filtering streams, Counting distinct elements in a stream, Estimating moments, Counting oneness in a window, decaying window, Real-time Analytics Platform (RTAP) applications, Case studies – real time sentiment analysis, Stock market predictions

MODULE IV: FREQUENT ITEMSETS & CLUSTERING (7 hours)

Mining frequent itemset, Market-based modelling, Apriori algorithm, Handling large data sets in main memory, Limited pas algorithm, Counting frequent itemset in a stream, Clustering techniques: hierarchical, K-means, Clustering high dimensional data, CLIQUE and ProCLUS, Frequent pattern-based clustering methods

MODULE V: FRAME WORKS & VISUALIZATION (7 hours)

Frame Works and Visualization: MapReduce, Hadoop, Pig, Hive, HBase, MapR, Sharding, NoSQL Databases, S3, Hadoop Distributed File Systems,

Visualization: visual data analysis techniques, interaction techniques, systems and applications.

Introduction to R – R graphical user interfaces, data import and export, attribute and data types, descriptive statistics, exploratory data analysis, visualization before analysis, and analytics for unstructured data.

Textbooks

1. Data Analytics Made Accessible by Dr. Anil Maheshwari
2. Python for Everybody: Exploring Data by Dr. Charles Severance
3. Data Streams in Data Mining Simplified 101By: Nidhi B

Reference books

1. Introduction to Data Mining by Tan, Steinbach, and Kumar
2. Interactive Data Visualization for the Web by Scott Murray

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1		
1.1	Sources and nature of data, Classification of data (structured, semi-structured, unstructured), Characteristics of data, Introduction to Big Data platform,	1
1.2	Need of data analytics, Evolution of analytic scalability, Analytic process and tools, Analysis vs reporting, Modern data analytic tools, Applications of data analytics	2
1.3	Need, key roles for successful analytic projects, Various phases of the data analytics lifecycle	2
1.4	Data preparation, model planning, model building, Communicating results, operationalization	2
MODULE II		
2.1	Regression modeling, Multivariate analysis, Bayesian modeling inference and Bayesian networks,	2
2.2	Support vector and kernel methods	1

2.3	Analysis of time series: linear systems analysis & nonlinear dynamics, Rule induction	1
2.4	Principal component analysis and neural networks,	1
2.5	Fuzzy logic: extracting fuzzy models from data, Fuzzy decision trees, Stochastic search methods.	2
	MODULE III	
3.1	Introduction to stream concepts, Stream data model and architecture, Stream computing,	2
3.2	Sampling data in a stream, filtering streams, Counting distinct elements in a stream,	2
3.3	Estimating moments, Counting oneness in a window, decaying window,	2
3.4	Real-time Analytics Platform (RTAP) applications, Case studies – real time sentiment analysis, Stock market predictions	2
	MODULE IV	
4.1	Mining frequent itemset, Market-based modelling, Apriori algorithm,	2
4.2	Handling large data sets in main memory, Limited pass algorithm, Counting frequent itemset in a stream,	2
4.3	Clustering techniques: hierarchical, K-means, Clustering high dimensional data,	2
4.4	CLIQUE and ProCLUS, Frequent pattern-based clustering methods	1
	MODULE V	
5.1	Frame Works and Visualization: MapReduce, Hadoop, Pig, Hive, HBase, MapR, Sharding, NoSQL Databases, S3, Hadoop Distributed File Systems,	2
5.2	Visualization: visual data analysis techniques, interaction techniques, systems and applications.	2
5.3	Introduction to R – R graphical user interfaces, data import and export, attribute and data types, descriptive statistics	2
5.4	exploratory data analysis, visualization before analysis, and analytics for unstructured data	1

CO Assessment Questions	
1	Discuss the ethical considerations associated with data analytics, including privacy concerns and responsible data usage.
2	Explore Bayesian modeling inference, detailing how it differs from traditional statistical methods and its significance in updating probabilities based on evidence

3	Explain the fundamental concepts of stream data processing, including the key components of stream data architecture and the stream data model.
4	Discuss strategies to efficiently manage and process extensive datasets within the constraints of main memory.
5	Outline the core components of the Hadoop framework.

24CSO852	Mobile Computing	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The course is designed to equip engineering students with the knowledge and skills necessary to comprehend communication protocols, diverse architectures, and security mechanisms employed in the realm of mobile computing. The curriculum encompasses fundamental mobile computing principles and intricacies of wireless transmission system architectures.

Prerequisite: Knowledge in computer networks

Course Outcomes: After the completion of the course the student will be able to

CO1	Compare the various mobile computing applications, services, design considerations and architectures **(Understand Level)**
CO2	Identify the various technology trends for next generation cellular wireless networks and use the spreading concept on data transmission **(Understand Level)**
CO3	Explain the architecture of various wireless LAN technologies **(Understand Level)**
CO4	Outline the roles and tasks carried out by the mobile network layer and transport layer. **(Understand Level)**
CO5	Summarize the characteristics of Wireless Application Protocol **(Understand Level)**
CO6	Explain the security concerns and challenges in the realm of mobile computing **(Understand Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										3
CO2	3	3	3	1								3
CO3	3	3	3									3
CO4	3	3	3		1							3
CO5	3	3	3									3
CO6	3	3	3									3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Basics of Mobile Computing (7hrs)

Introduction to mobile computing — Functions, Networks, Middleware and Gateways, Applications and services. Mobile computing architecture — Internet: The Ubiquitous network, Three-tier architecture for Mobile Computing, Design considerations for mobile computing, Mobile Computing through the Internet.

MODULE II: Wireless Transmission and Telecommunications Systems (8hrs)

Signal Propagation-Path loss of radio signals, Additional Signal Propagation effects, Multi-path propagation, Spread spectrum — Direct sequence, Frequency hopping. Medium Access Control — Space Division Multiple Access (SDMA), Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), and Code

Division Multiple Access (CDMA). Telecommunication Systems - Global System for Mobile Communication (GSM), Satellite Systems — Geostationary Earth Orbit (GEO), Low Earth Orbit(LEO), Medium Earth Orbit (MEO), Routing, Localization, Handover.

MODULE III: Wireless LANs (7hrs)

Wireless LAN – Infrared vs radio transmission, Infrastructure and Ad-hoc mode, IEEE 802.11 System Architecture, Protocol Architecture, Physical layer, Medium Access Control layer, HIPERLAN-1, Bluetooth.

MODULE IV: Mobile Network Layer (5hrs)

Network layer — Mobile Internet Protocol (IP)- Dynamic Host Configuration Protocol (DHCP), Mobile ad-hoc networks — Routing, Dynamic Source Routing (DSR), Destination Sequence Distance Vector (DSDV), Ad-hoc routing protocols.

MODULE V: Mobile Transport Layer and Security (6hrs)

Mobile transport layer — Traditional Transmission Control Protocol (TCP), Improvements in Classical TCP. Wireless Application Protocol (WAP) - Architecture, Wireless Datagram Protocol (WDP), Wireless Transport Layer Security (WTLS), Wireless Transaction Protocol (WTP), Wireless Session Protocol (WSP). Security issues in mobile computing - Information security, Security techniques, and algorithms, Security models

Textbooks

1. Asoke K. Talukder, Hasan Ahmad, Roopa R Yavagal, Mobile Computing Technology-Application and Service Creation, 2/e, McGraw Hill Education.
2. Jochen Schiller, Mobile Communications, Pearson Education Asia, 2008.
3. Jonathan Rodriguez, Fundamentals of 5G Mobile Networks, Wiley Publishers,2015.

Reference books

1. Raj Kamal, Mobile Computing, 2/c, Oxford University Press.
2. Andrew S. Tanenbaum, Computer Networks, PHI, 3/e, 2003
3. Theodore S. Rappaport, Wireless Communications Principles and Practice, 2/e, PHI, New Delhi, 2004.
4. Curt M. White, Fundamentals of Networking and Communication 7/c, Cengage learning.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1		

1.1	Introduction to mobile computing – Functions ,Networks	1
1.2	Middleware and Gateways	1
1.3	Application and services	1
1.4	Internet: The Ubiquitous network	1
1.5	Three-tier architecture for Mobile Computing	1
1.6	Design considerations for mobile computing 1	1
1.7	Mobile Computing through Internet.	1
MODULE II		
2.1	Direct sequence spread spectrum, Frequency hopping spread spectrum	1
2.2	Space Division Multiple Access (SDMA), Frequency Division Multiple Access (FDMA)	1
2.3	Time Division Multiple Access (TDMA)	1
2.4	Code Division Multiple Access (CDMA)	1
2.5	Global System for Mobile Communication (GSM) services, Architecture	1
2.6	Satellite Systems Basics, Applications, Geostationary Earth Orbit (GEO), Low Earth Orbit (LEO), Medium Earth Orbit (MEO)	1
2.7	Routing, Localization, Handover	1
2.8	Handover, Security	1
MODULE III		
3.1	Wireless LAN - Wireless LAN – Infra red vs radio transmission, Infrastructure and Ad-hoc mode	1
3.2	IEEE 802.11 System Architecture	1
3.3	Protocol Architecture	1
3.4	Physical layer	1
3.5	Medium Access Control layer	1
3.6	HIPERLAN-1	1

3.7	Bluetooth	1
	MODULE IV	
4.1	Mobile Internet Protocol (IP)	1
4.2	Dynamic Host Configuration Protocol (DHCP)	1
4.3	Mobile ad-hoc networks – Routing, Dynamic Source Routing (DSR)	1
4.4	Destination Sequence Distance Vector (DSDV)	1
4.5	Ad-hoc routing protocols	1
	MODULE V	
5.1	Traditional Transmission Control Protocol (TCP), Improvements in Classical TCP	1
5.2	Wireless Application Protocol (WAP) – Architecture, Wireless Datagram Protocol (WDP)	1
5.3	Wireless Transport Layer Security (WTLS)	1
5.4	Wireless Transaction Protocol (WTP), Wireless Session Protocol (WSP	1
5.5	Information security, Security techniques	1
5.6	Security algorithms, Security models	1

CO Assessment Questions	
1	1. Describe the design considerations of three tier architecture of mobile computing. 2. Explain any four functions and applications of mobile computing
2	1. Demonstrate the encoding, decoding, and channel sharing procedures in a CDMA (Code Division Multiple Access) scenario involving four stations transmitting data, where station 3 intercepts data from station 1, with the data values being 1, 1, 1, and 0, respectively. 2. Compare the influence of near/far effect and its countermeasures in TDMA and CDMA systems.
3	1. Describe the protocol architecture of IEEE 802.11 2. Explain the phases in Elimination-yield non-preemptive priority multiple access of HIPERPLAN-1

4	1. With the help of an example, show the routing table creation using Destination Sequence Distance Vector Routing protocol in mobile ad-hoc networks 2. List the entities of a mobile IP. With the help of an example, explain how packet delivery is done to and from a fixed node..
5	1 How does WAP push operation differ from pull operation? 2 With the help of a neat sketch explain the secure session establishment using WTLS.
6	1. Elaborate on the security framework established by the 3rd Generation Partnership Project (3GPP) for enhancing mobile security. 2. Describe the features of the policy-based security model.

Open Elective III/ MOOC

24CSO813	Machine Learning	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble:

This course introduces machine learning concepts and popular machine learning algorithms. It will cover the standard and most popular supervised learning algorithms including linear regression, logistic regression, decision trees, k-nearest neighbour, an introduction to Bayesian learning and the naive Bayes algorithm, support vector machines and kernels and basic clustering algorithms. Dimensionality reduction methods and some applications to real world problems will also be discussed. It helps the learners to develop application machine learning based solutions for real world applications.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Analyse the Machine Learning concepts, classifications of Machine Learning algorithms and basic parameter estimation methods. **(Cognitive Knowledge Level: Analyse)**
CO2	Illustrate the concepts of regression and classification techniques (**Cognitive Knowledge Level: Apply)**
CO3	Describe unsupervised learning concepts and dimensionality reduction techniques. **(Cognitive Knowledge Level: Apply)**
CO4	Explain Support Vector Machine concepts and graphical models**.(Cognitive Knowledge Level: Apply)**
CO5	Choose suitable model parameters for different machine learning techniques and to evaluate a model performance. **(Cognitive Knowledge Level: Apply)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2								3
CO2	3	3	2									3
CO3	3	3	2	2								3
CO4	3	3	2	2	2							3
CO5	3	3	2		2							3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test 1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	

Evaluate			✓	
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Parameter Estimation and Regression (7 hours)

Overview of machine learning: supervised, semi-supervised, unsupervised learning, reinforcement learning. Basics of parameter estimation: Maximum Likelihood Estimation(MLE), Maximum a Posteriori Estimation (MAP). Gradient Descent Algorithm, Batch Gradient Descent, Stochastic Gradient Descent. Regression algorithms: least squares linear regression, normal equations and closed form solution, Polynomial regression.

MODULE II :Regularization techniques and Classification algorithms (9 hours)

Overfitting, Regularization techniques - LASSO and RIDGE. Classification algorithms: linear and non-linear algorithms, Perceptrons, Logistic regression, Naive Bayes, Decision trees. Neural networks : Concept of Artificial neuron, Feed-Forward Neural Network, Back propagation algorithm.

MODULE III :Unsupervised learning (5 hours)

Unsupervised learning: clustering, k-means, Hierarchical clustering, Principal component analysis, Density-based spatial clustering of applications with noise (DBSCAN). Gaussian mixture models:
Expectation Maximization (EM) algorithm for Gaussian mixture model.

MODULE IV :Support Vector Machine and Graphical Models (6 hours)

Support vector machines and kernels : Max margin classification, Nonlinear SVM and the kernel trick, nonlinear decision boundaries, Kernel functions. Basics of graphical models - Bayesian networks, Hidden Markov model - Inference and estimation.

MODULE V : Evaluation Metrics and Sampling Methods (8 hours)

Classification Performance Evaluation Metrics: Accuracy, Precision, Precision, Recall, Specificity, False Positive Rate (FPR), F1 Score, Receiver Operator Characteristic (ROC) Curve, AUC. Regression Performance Evaluation Metrics: Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), R Squared/Coefficient of Determination. Clustering Performance Evaluation Metrics: Purity, Jaccard index, Normalized Mutual Information, Clustering Accuracy, Silhouette Coefficient, Dunn's Index. Boosting: AdaBoost, gradient boosting machines. Resampling methods: cross-validation, bootstrap. Ensemble methods: bagging, boosting, random forests Practical aspects in machine learning: data preprocessing, overfitting, accuracy estimation, parameter and model selection Bias-Variance tradeoff

Text books

1. Christopher Bishop. Neural Networks for Pattern Recognition, Oxford University Press, 1995.

Reference books

1. Kevin P. Murphy. Machine Learning: A Probabilistic Perspective, MIT Press 2012.
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements Of Statistical Learning, Second edition Springer 2007.
3. Ethem Alpaydin, Introduction to Machine Learning, 2nd edition, MIT Press 2010.
4. Tom Mitchell, Machine Learning, McGraw-Hill, 1997.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1 (Parameter Estimation and Regression)		
1.1	Overview of machine learning: supervised, semi-supervised, unsupervised learning, reinforcement learning.	1

1.2	Basics of parameter estimation: Maximum Likelihood Estimation(MLE)	1
1.3	Basics of parameter estimation: Maximum Likelihood Estimation(MLE) - Examples	1
1.4	Basics of parameter estimation: Maximum a Posteriori Estimation (MAP)	1
1.5	Gradient Descent Algorithm, Batch Gradient Descent, Stochastic Gradient Descent	1
1.6	Regression algorithms: least squares linear regression, normal equations and closed form solution	1
1.7	Polynomial regression	1
MODULE 2 (Regularization techniques and Classification algorithms)		
2.1	Overfitting, Regularization techniques - LASSO and RIDGE	1
2.2	Classification algorithms: linear and non-linear algorithms	1
2.3	Perceptrons	1
2.4	Logistic regression	1
2.5	Naive Bayes	1
2.6	Decision trees	1
2.7	Neural networks : Concept of Artificial neuron	1
2.8	Feed-Forward Neural Network	1
2.9	Back propagation algorithm	
MODULE 3 (Unsupervised learning))		
3.1	Unsupervised learning: clustering, k-means	1
3.2	Hierarchical clustering	1
3.3	Principal component analysis	1
3.4	Density-based spatial clustering of applications with noise (DBSCAN)	1
3.5	Gaussian mixture models: Expectation Maximization (EM) algorithm for Gaussian mixture model	1
MODULE 4 (Support Vector Machine and Graphical Models)		

4.1	Support vector machines and kernels : Max margin classification	1
4.2	Support vector machines: Max margin classification	1
4.3	Nonlinear SVM and the kernel trick, nonlinear decision boundaries	1
4.4	Kernel functions	1
4.5	Basics of graphical models - Bayesian networks	1
4.6	Hidden Markov model - Inference and estimation	1
MODULE 5		
5.1	Classification Performance Evaluation Metrics: Accuracy, Precision, Precision, Recall, Specificity, False Positive Rate (FPR), F1 Score, Receiver Operator Characteristic (ROC) Curve, AUC	1
5.2	Regression Performance Evaluation Metrics: Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), R Squared/Coefficient of Determination	1
5.3	Clustering Performance Evaluation Metrics: Purity, Jaccard index, Normalized Mutual Information, Clustering Accuracy, Silhouette Coefficient, Dunn's Index	1
5.4	Boosting: AdaBoost, gradient boosting machines	1
5.5	Resampling methods: cross-validation, bootstrap	1
5.6	Ensemble methods: bagging, boosting, random forests	1
5.7	Practical aspects in machine learning: data preprocessing, overfitting, accuracy estimation, parameter and model selection	1
5.8	Bias-Variance tradeoff	

CO Assessment Questions	
1	a) Suppose that X is a discrete random variable with the following probability mass function: where $0 \leq \theta \leq 1$ is a parameter. The following 10 independent observations were taken from such a distribution: (3, 0, 2, 1, 3, 2, 1, 0, 2, 1). What is the maximum likelihood estimate of θ.

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<tr><td></td><td>
<table>
<tr><td>X</td><td>0</td><td>1</td><td>2</td><td>3</td></tr>
<tr><td>$P(X)$</td><td>$2\theta/3$</td><td>$\theta/3$</td><td>$2(1-\theta)/3$</td><td>$(1-\theta)/3$</td></tr>
</table>

b) What is the difference between Maximum Likelihood estimation (MLE) and Maximum a Posteriori (MAP) estimation?
</td></tr>
<tr><td>2</td><td>
a) How can we interpret the output of a two-class logistic regression classifier as a probability?
b) Suppose you have a 3-dimensional input x = (x1, x2, x3) = (2, 2, 1) fully connected with weights (0.5, 0.3, 0.2) to one neuron which is in the hidden layer with sigmoid activation function. Calculate the output of the hidden layer neuron.
c) Consider the case of the XOR function in which the two points {(0, 0),(1, 1)} belong to one class, and the other two points {(1, 0),(0, 1)} belong to the other class. Design a multilayer perceptron for this binary classification problem.
d) Why does a single perceptron cannot simulate simple XOR function? Explain how this limitation is overcome?
e) Consider a naive Bayes classifier with 3 boolean input variables, X1, X2 and X3, and one boolean output, Y. How many parameters must be estimated to train such a naive Bayes classifier? How many parameters would have to be estimated to learn the above classifier if we do not make the naive Bayes conditional independence assumption?
</td></tr>
<tr><td>3</td><td>
a) Describe the basic operation of k-means clustering.
b) A Poisson distribution is used to model data that consists of non-negative integers. Suppose you observe m integers in your training set. Your model assumption is that each integer is sampled from one of two different Gaussian distributions. You would like to learn this model using the EM algorithm. List all the parameters of the model. Derive the E-step and M-step for this model.
c) A uni-variate Gaussian distribution is used to model data that consists of non-negative integers. Suppose you observe m integers in your training set. Your model assumption is that each integer is sampled from one of two different Gaussian distributions. You would like to learn this model using the EM algorithm. List all the parameters of the model. Derive the E-step and M-step for the model.
</td></tr>
<tr><td>4</td><td>
a) Describe how Support Vector Machines can be extended to make use of kernels. Illustrate with reference to the Gaussian kernel $K(x, y) = e^{-y}$, where $y = (x-y)^2$.
b) Suppose that you have a linear support vector machine(SVM) binary classifier. Consider a point that is currently classified correctly, and is far away from the decision boundary. If you remove the point from
</td></tr>
</table>

	the training set, and re-train the classifier, will the decision boundary change or stay the same? Justify your answer. c) What is the primary motivation for using the kernel trick in machine learning algorithms? d) Show that the Boolean function $(x1 \wedge x2) \vee (\neg x1 \wedge \neg x2)$ is not linearly separable (i.e. there is no linear classifier sign $(w1\ x1 + w2\ x2 + b)$ that classifies all 4 possible input points correctly). Assume that "true" is represented by 1 and "false" is represented by −1. Show that there is a linear separator for this Boolean function when we use the kernel $K(x, y) = (x \cdot y)^2$ (x.y denotes the ordinary inner product) . Give the weights and the value of b for one such separator.
5	a) With an example classification problem, explain the following terms: a) Hyper parameters b) Training set c) Validation sets d) Bias e) Variance. b) What is ensemble learning? Can ensemble learning using linear classifiers learn classification of linearly non-separable sets? c) Describe boosting. What is the relation between boosting and ensemble learning? d) Classifier A attains 100% accuracy on the training set and 70% accuracy on the test set. Classifier B attains 70% accuracy on the training set and 75% accuracy on the test set. Which one is a better classifier. Justify your answer. e) What are ROC space and ROC curve in machine learning? In ROC space, which points correspond to perfect prediction, always positive prediction and always negative prediction? Why? f) Suppose there are three classifiers A,B and C. The (FPR, TPR) measures of the three classifiers are as follows – A (0, 1), B (1, 1) , C (1,0.5). Which can be considered as a perfect classifier? Justify your answer. g) What does it mean for a classifier to have a high precision but low recall?

24CSO823	Scripting Languages	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course enables the learners to understand the fundamental concepts of different types of scripting languages and provide them with the necessary skills to develop dynamic applications quickly and with minimal code. This course covers the topics like fundamentals of scripting language, PERL, Advanced Perl, Tool Command language, PhP and Ruby which helps the students to solve diverse problems and the adaptability to choose the most appropriate tool for a given task.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Compare the features of scripting language **(Understand Level)**
CO2	Make use of the concepts of Perl language to develop OS and internet base application **(Apply Level)**
CO3	Develop event driven application programme using Tool Command Language **(Apply Level)**
CO4	Make use of the concepts of PHP to develop web application programs. **(Apply Level)**
CO5	Illustrate the concepts of Ruby Programming language **(Apply Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3			3							3
CO2	3	3			3							3
CO3	3	3			3							3
CO4	3	3			3							3
CO5	3	3			3							3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test 1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate			✓	
Create			✓	

Mark Distribution of CIA						
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Introduction to Scripting and PERL (8 hrs)

Scripts and Programs-Characteristics & uses of Scripting Languages, PERL- Names and Values, Variables, Scalar Expressions, Control Structures, arrays, list, hashes, strings, pattern and regular expressions, subroutines.

MODULE II : Advanced PERL (7 hrs)

Finer points of looping, pack and unpack, filesystem, eval, data structures, packages, modules, objects, interfacing to the operating system, Creating Internet ware applications, Dirty Hands Internet Programming, security Issues.

MODULE III : Introduction to Tool command language(8 hrs)

TCL-structure, syntax. Variables and Data in TCL, Control Flow, Data Structures, input/output, procedures, strings, patterns, files, Advance TCL- eval, source, exec and uplevel commands, Name spaces, trapping errors, event driven programs.

MODULE IV :Introduction to PHP (7 hrs)		
Origins and Uses of PHP, Overview of PHP - General Syntactic Characteristics - Primitives, Operations, and Expressions - Control Statements, Arrays, Functions, Pattern Matching, Form Handling, Cookies, Session Tracking		
MODULE V : Introduction to Ruby (6 hrs)		
Ruby, Rails, the structure and Execution of Ruby Programs, Package Management with RUBYGEMS, Ruby and web: Writing CGI scripts, cookies, Choice of Webservers, SOAP and webservices RubyTk – Simple Tk Application, widgets, Binding events, Canvas, scrolling		
Text books 1. The World of Scripting Languages, David Barron, Wiley Publications, 2009. 2. Ruby Programming language by David Flanagan and Yukihiro Matsumoto O'Reilly, 2008. 3. Programming Ruby, The Pramatic Programmers guide by Dabve Thomas, Second edition, 2004. 4. Programming Perl – Larry Wall, Tom Christiansen and John Orwant, 3rdEdition, O'Reilly, 2000. (ISBN 0596000278)		
Reference books 1. Learning Perl – 4th Ed. Randal Schwartz, Tom Phoenix and Brain d foy. 2005. 2. Open Source Web Development with LAMP using Linux Apache, MySQL, Perl and PHP, J. Lee and B. Ware (Addison Wesley), Pearson Education, 2002. 3. Perl by Example, E. Quigley, Pearson Education, 2014. 4. Tcl and the Tk Tool kit, Ousterhout, Pearson Education, 2010. 5. Perl Power, J. P. Flynt, Cengage Learning, 2006. 6. Perl in 24 Hours – 3rd Ed., Clinton Pierce, 2005, Sams Publishing		
COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours (36 hrs)
MODULE 1		
1.1	Scripts and Programs, Origin of Scripting,	1
1.2	Characteristics and uses of Scripting Languages	1
1.3	PERL- Names and Values, Variables	1
1.4	Scalar Expressions	1
1.5	Control Structures	1
16	Collections of data- arrays, list, hashes	1
1.7	Strings, pattern and regular expressions	1
1.8	Subroutines.	1
MODULE II		
2.1	Finer points of looping, Finer points of subroutine.	1
2.2	Working with filesystem	1

2.3	Eval, data structures	1
2.4	packages, modules,	1
2.5	Objects, interfacing to the operating system,	1
2.7	Creating Internet ware applications,	1
	MODULE III	
3.1	TCL-structure, syntax. Variables and Data in TCL	1
3.2	Control Flow	1
3.3	Data Structures	
3.4	input/output, procedures, Strings	1
3.5	Patterns, files	1
3.6	Advance TCL- eval, source, exec and uplevel commands	1
3.7	Name spaces, trapping errors	1
3.8	Event driven programs.	1
	MODULE IV	
4.1	Origins and Uses of PHP, Overview of PHP	1
4.2	General Syntactic Characteristics - Primitives, Operations, and Expressions	1
4.3	Control Statements	1
4.4	Arrays, Functions	1
4.5	Pattern Matching	1
4.6	Form Handling,	1
4.7	Cookies, Session Tracking	1
	MODULE V	
5.1	Ruby, Rails, The structure and Execution of Ruby Programs	1
5.2	Package Management with RUBYGEMS	1
5.3	Ruby and web: Writing CGI scripts, cookies, Choice of Webservers	1
5.4	SOAP and webservices	1
5.5	RubyTk – Simple Tk Application, widgets	1
5.6	Binding events, Canvas, scrolling	1

CO Assessment Questions	
1	a. What are the key characteristics that distinguish scripting languages from other programming languages? b. Compare the features of Perl, PHP, and Ruby in terms of syntax, usage, and strengths in different application domains. c. How do scripting languages differ from compiled languages, and what advantages do they offer in specific scenarios? d. Discuss the role of scripting languages in the development lifecycle

	and their relevance in modern software engineering.
2	a. Develop a Perl script that simulates a basic operating system task, such as file manipulation or process management. Explain the key features and functions of Perl that you utilized in creating this OS-related script. Additionally, discuss how Perl's characteristics make it suitable for handling OS-related tasks. b. Design a Perl script for an internet-based application that involves retrieving data from a web API or processing user input through web forms. Highlight the specific features of Perl that contribute to the development of robust and efficient internet-based applications. Explain the advantages of using Perl in this context compared to other scripting languages.
3	a. Using the Tool Command Language (TCL), develop an event-driven application program that responds to user interactions, such as button clicks or keyboard input. Provide a detailed explanation of the event-driven paradigm in TCL and illustrate how your program effectively utilizes this approach. Highlight key TCL commands and features relevant to building responsive and interactive applications. b. Develop a Tool Command Language (TCL) script for a graphical user interface (GUI) application that responds to events like mouse clicks or menu selections. Describe the event-handling mechanisms within TCL and demonstrate how your script effectively captures and processes these events to enhance user interaction. Discuss the advantages of using TCL for event-driven programming and how it facilitates the development of responsive graphical applications.
4	a. Design a PHP script for a dynamic web page that interacts with a database to retrieve, update, or display information. Describe the key PHP concepts and functions involved in connecting to a database, executing queries, and processing the results. Discuss the role of PHP in creating dynamic content and how it enhances the user experience in web applications. b. Develop a PHP-based web application program that incorporates user authentication and session management. Explain how PHP's concepts, such as server-side scripting, form handling, and session handling, are utilized in building secure and interactive web applications. Discuss the advantages of using PHP for web development and how it addresses common challenges in this context.
5	a. Create a Ruby script that utilizes modules and mixins to demonstrate code reuse and encapsulation. Explain how modules are defined, included, and extended in Ruby, and illustrate their role in enhancing code organization and maintainability. Discuss the benefits of using modules and mixins in Ruby programming.

	b. Design a Ruby program that employs exception handling to gracefully manage errors and unexpected situations. Demonstrate the use of begin, rescue, ensure, and raise statements in your script. Explain how Ruby's approach to exception handling enhances program robustness and maintainability. Discuss scenarios in which effective exception handling is crucial in Ruby programming.

24CSO833	DATABASE MANAGEMENT SYSTEMS	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course provides a clear understanding of fundamental principles of Database Management Systems (DBMS) with special focus on relational databases to the learners. The topics covered in this course are basic concepts of DBMS, Entity Relationship (ER) model, Relational Database principles, Relational Algebra, Structured Query Language (SQL), Physical Data Organization, Normalization, Processing Concepts, Transactions, Concurrency and Recovery. This course helps the learners to manage data efficiently by identifying suitable structures to maintain data assets of organizations and to develop applications that utilize database technologies.

Prerequisite: Topics covered under the course Data Structures

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the need and basic characteristics of database management systems **(Understand Level)**
CO2	Construct ER models for real-life database applications **(Apply Level)**
CO3	Develop PL/SQL programs to perform multiple database operations (Cognitive Knowledge Level: **Apply**)
CO4	Explain the fundamental principles of database storage structures and access techniques (Cognitive Knowledge Level: **Understand**)
CO5	Outline the concepts of transaction processing, concurrency, and recovery (Cognitive Knowledge Level: **Understand**)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1									3
CO2	3	3										3
CO3	3	3			3			3				3
CO4	3	1	1									3
CO5	3	3	3									3

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]		Practical [P]	Project [J]			Total Marks
		Assignment	Test-2	Class work	Evaluation 1	Evalaution-2	Report	
2-0-2-2	5	10	10	15	5	10	5	60

Total Marks distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration

100	**60**	**40**	**3 hours**

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Introduction & Entity Relationship (ER) Model (7 hrs.)

Concept & Overview of Database Management Systems (DBMS) - Characteristics of Database system, Database Users, structured, semi-structured and unstructured data. Data Models and Schema - Three Schema architecture. Database Languages, Database architectures, and classification.ER model - Basic concepts, entity set and attributes, notations, Relationships and constraints, cardinality, participation, notations, weak entities, relationships of degree 3.

MODULE II: Relational Model and SQL DDL (8 hrs.)

Structure of Relational Databases - Integrity Constraints, Synthesizing ER diagram to relational schema. Introduction to Relational Algebra - select, project, cartesian product operations, join - Equi-join, natural join. query examples, introduction to Structured Query Language (SQL), SQL data types, Data Definition Language (DDL), Table definitions and operations – CREATE, DROP, ALTER, INSERT, DELETE, UPDATE.

MODULE III: SQL DML and Physical Data Organization (8 hrs.)

SQL DML (Data Manipulation Language) - SQL queries on single and multiple tables, Nested queries (correlated and non-correlated), Aggregation and grouping, Views, and Assertions. Physical Data Organization - Review of terms: physical and logical records, blocking factor, pinned and unpinned organization. Heap files, Indexing, Singe level indices, numerical examples, Multi-level indices, numerical examples, B-Trees & B+-Trees (structure only, algorithms not required), Extendible Hashing.

MODULE IV: Database Normalization (5 hrs.)

Different anomalies in designing a database, The idea of normalization, Functional dependency, Armstrong's Axioms (proofs not required), Closures and their computation, Equivalence of functional Dependencies (FD), and Minimal Cover (proofs not required). First Normal Form (1NF), Second Normal Form (2NF), Third Normal Form (3NF), Boyce Codd Normal Form (BCNF).

MODULE V: Transactions, Concurrency and Recovery(8hrs.)

Transaction Processing Concepts - Overview of concurrency control, Transaction Model, Significance of concurrency control and recovery, Transaction States, System Log, and Desirable Properties of Transactions. Serial schedules, Concurrent and Serializable Schedules, Conflict equivalence and conflict serializability, Recoverable and cascade-less schedules, Locking, Two-phase locking, and its variations. Log-based recovery, Deferred database modification, check-pointing.

Textbooks

1. Elmasri R. and S. Navathe, Database Systems: Models, Languages, Design and Application Programming, Pearson Education, 2013.
2. Sliberschatz A., H. F. Korth and S. Sudarshan, Database System Concepts, 6/e, McGrawHill, 2011.

Reference books

1. Adam Fowler, NoSQL for Dummies, John Wiley & Sons, 2015
2. NoSQL Data Models: Trends and Challenges (Computer Engineering: Databases and BigData), Wiley, 2018
3. Web Resource: https://www.w3resource.com/redis/
4. Web Resource: https://www.w3schools.in/category/mongodb/
5.WebResource:https://www.tutorialspoint.com/cassandra/cassandra_introduction.htm
6. Web Resource: https://www.tutorialspoint.com/arangodb/index.htm

NPTEL/SWAYAM Courses

1. Data Base Management System, IIT Kharagpur - Prof. Partha Pratim Das, Prof. Samiran Chattopadhyay, Prof. Kausik Datta

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE I (7 hours)		
1.1	Concept & Overview of Database Management Systems (DBMS) - Characteristics of Database system	1
1.2	Database Users, structured, semi-structured, and unstructured data	1
1.3	Data Models and Schema - Three Schema architecture. Database Languages	1
1.4	Database architectures and classification	1
1.5	ER model - Basic concepts, entity set and attributes, notations	1
1.6	Relationships and constraints, cardinality, participation, notations	1

1.7	weak entities, relationships of degree 3	1
MODULE II (8 hours)		
2.1	Structure of Relational Databases - Integrity Constraints	1
2.2	Synthesizing ER diagram to relational schema (Lecture 1)	1
2.3	Synthesizing ER diagram to relational schema (Lecture 2)	1
2.4	Introduction to Relational Algebra - select, project, cartesian product operations (Lecture 1)	1
2.5	Introduction to Relational Algebra - select, project, cartesian product operations (Lecture 2)	1
2.6	Join - Equi-join, natural join. Query examples	1
2.7	Introduction to Structured Query Language (SQL), SQL data types, Data Definition Language (DDL)	1
2.8	Table definitions and operations – CREATE, DROP, ALTER, INSERT, DELETE, UPDATE.	1
MODULE III (8 hours)		
3.1	SQL DML (Data Manipulation Language) - SQL queries on single and multiple tables (Lecture 1)	1
3.2	SQL DML (Data Manipulation Language) - SQL queries on single and multiple tables (Lecture 2)	1
3.3	Nested queries (correlated and non-correlated), Aggregation and grouping	1
3.4	Views, and Assertions.	1
3.5	Review of terms: physical and logical records, blocking factor, pinned and unpinned organization. Heap files	1
3.6	Singe level indices, numerical examples	1
3.7	Multi-level indices, numerical examples	1
3.8	B-Trees & B+-Trees (structure only, algorithms not required), Extendible Hashing	1
MODULE IV (5 hours)		
4.1	Different anomalies in designing a database, The idea of Normalization	1

4.2	Functional Dependencies, Armstrong's Axioms (proofs not required)	1
4.3	Closures and their computation, Equivalence functional Dependencies (FD), Minimal Cover (proofs not required)	1
4.4	First Normal Form (1NF), Second Normal Form (2NF)	1
4.5	Third Normal Form (3NF), Boyce Codd Normal Form (BCNF)	1
	MODULE V (8 hours)	
5.1	Transaction Processing Concepts - Overview of Concurrency Control, Transaction Model	1
5.2	Significance of concurrency Control and Recovery	1
5.3	Transaction States, System Log, Desirable Properties of transactions	1
5.4	Serial Schedules, Concurrent and Serializable Schedules	1
5.5	Conflict Equivalence, and Conflict Serializability	1
5.6	Recoverable and cascade-less schedules	1
5.7	Locking, Two-phase locking and its variations	1
5.8	Log-based recovery, Deferred Database Modification, Check-pointing.	1

CO Assessment Questions	
1	1. Discuss the functionalities that should be provided by a DBMS. 2. Give one example each for logical and physical data independence.
2	1. Assume we have the following application that models soccer teams, the games they play, and the players in each team. In the design, we want to capture the following: • We have a set of teams, each team has an ID (unique identifier), name, main stadium, and to which city this team belongs. • Each team has many players, and each player belongs to one team. Each player has a number (unique identifier), name, DoB, start year, and shirt number that he uses. • Teams play matches, in each match there is a host team and a guest team. The match takes place in the stadium of the host team. • For each match we need to keep track of the following: The date on which the game is played The result of the match

	The players participated in the match. For each player, how many goals he scored, whether he took the yellow card, and whether he took the red card. During the match, one player may substitute another player. We want to capture this substitution and the time at which it took place. • Each match has exactly three referees. For each referee, we have an ID (unique identifier), name, DoB, and years of experience. One referee is the main referee and the other two are assistant referees. Design an ER diagram to capture the above requirements.
3	1. Answer each of the following questions briefly. The questions are based on the following relational schema: ***Emp (eid: integer, ename: string, age: integer, salary: real)*** ***Works (eid: integer, did: integer, pct time: integer)*** ***Dept (did: integer, dname: string, budget: real, managerid: integer)*** A. Write the SQL statements required to create the above relations, including appropriate versions of all primary and foreign key integrity constraints. B. Write an SQL statement to add 'John Doe' as an employee with eid = 101, age = 32, and salary = 15, 000. C. Write an SQL statement to give every employee a 10% raise. D. Write an SQL statement to delete the 'Toy' department. Given the referential integrity constraints you chose for this schema, explain what happens when this statement is executed.
4	1. Consider a file with 2,00,000 records stored in a disk with fixed-length blocks of size 256 bytes. Each record is of size 50 bytes. The primary key is 4 bytes and the block pointer is 6 bytes. Compute the following, assuming that a multi-level primary index is used as the access path: (i) Blocking factor for data records (ii) Blocking factor for index records (iii) Number of data blocks (iv) Number of First level index blocks (v) Number of levels of multi-level index
5	1. Determine if the following schedule is recoverable. Is the schedule cascade-less? Justify your answer. r1(X), r2(Z), r1(Z), r3(X), r3(Y), w1(X), c1, w3(Y), c3, r2(Y), w2(Z), w2(Y),c2. (Note: ri(X)/wi(X) means transaction Ti issues read/write on item X; ci means transaction Ti commits.)

	2. Prove that two-phase locking always gives serializable schedules.

24CSO843	Computer Architecture	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble:
The main objective of this course is to offer a comprehensive base that imparts extensive understanding to the learner regarding contemporary and upcoming developments in computer architectures, with a specific focus on performance and the interaction between hardware and software. Topics covered include design and analysis, memory hierarchy, pipelining, the functioning of multiprocessors, thread level parallelism, and data level parallelism. Ultimately, this course facilitates the development of the learner's ability to create software/hardware applications grounded in architectural frameworks.

Prerequisite: Strong Foundation in Computer Organization and Architecture.

Course Outcomes: After the completion of the course the student will be able to

CO1	Familiarize the classes of computers, and new trends and developments in computer architecture. **(Understand Level)**
CO2	Understand and apply performance metrics to find the performance of systems. **(Apply Level)**
CO3	Acquire knowledge about the pipelining concepts and the technologies to overcome the implementation issues. **(Understand Level)**
CO4	Analyze the basic design procedure for different levels of parallelism. **(Analyze Level)**
CO5	Analyze the memory hierarchy design, performance improvement techniques and cache optimization techniques. **(Analyze Level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2									3
CO2	3	3	2									3
CO3	3	3	2									3
CO4	3	3	2									3
CO5	3	3	2									3
CO6	3	3										3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	✓
Evaluate			✓	
Create				

Mark Distribution of CIA						
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

Module I: Fundamentals of Quantitative Design and Analysis (6hours)

Introduction, Classes of computers, Defining Computer Architecture – Trends in Technology – Trends in Power and Energy in Integrated Circuits – Trends in Cost – Dependability – Measuring, Reporting and Summarizing Performance – Quantitative Principles of Computer Design.

Module II: Pipelining: Basic and Intermediate Concepts (8hours)

Basic and Intermediate pipelining Concepts, The Major Hurdle of Pipelining – Pipeline Hazards, Pipelining Implementation, Implementation issues that makes Pipelining hard, The MIPS R4000 Pipeline, Extending the MIPS Pipeline to Handle Multicycle Operations.

Module III: Instruction-Level Parallelism and Its Exploitation(8hours)
Instruction-Level Parallelism: Concepts and Challenges – Basic Compiler Techniques for Exposing ILP – Reducing Branch Costs with Prediction – Overcoming Data Hazards with Dynamic Scheduling – Dynamic Scheduling – Hardware-Based Speculation – Exploiting ILP Using Multiple Issue and Static Scheduling, Advanced Techniques for Instruction Delivery and Speculation, Studies of the Limitations of ILP
Module IV: Data and Thread-Level Parallelism (7hours)
Vector Architecture – SIMD Instruction Set Extensions for Multimedia – Graphics Processing Units – Centralized Shared-Memory Architectures – Performance of Shared-Memory Multiprocessors – Distributed Shared Memory, Models of Memory Consistency, Multicore Processors and Their Performance.
Module V: Memory Hierarchy Design (7hours)
Review of Memory Hierarchy Design, Cache Performance, Basic Cache Optimizations, Virtual Memory, Protection: Virtual Memory and Virtual Machines, Advanced Optimizations of Cache Performance, Crosscutting Issues: The Design of Memory Hierarchies.
Text books 1. David. A. Patterson and John L. Hennessy, "Computer Architecture: A Quantitative approach", Elsevier, 5th Edition, 2012.
Reference books 1. K. Hwang and Naresh Jotwani, “Advanced Computer Architecture, Parallelism, Scalability, Programmability”, Tata McGraw Hill, 2nd Edition, 2010 2. John Paul Shen, Mikko Lipasti. Modern Processor Design – Fundamentals of Superscalar Processors. McGraw Hill International Edition, 2005. 3. Dezso Sima, Terence Fountain, Peter Kacsuk. Advanced Computer Architecture – A Design Space Approach, Addison Wesley, 2000.

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. ofHours
MODULE 1		
1.1	Introduction, Classes of computers, Defining Computer Architecture	1
1.2	Trends in Technology, Trends in Power and Energy in Integrated Circuits	1
1.3	Trends in Cost, Dependability	1
1.4	Measuring, Reporting and Summarizing Performance.	1
1.5	Quantitative Principles of Computer Design.	2
MODULE II		
2.1	Basic and Intermediate pipelining Concepts.	1

2.2	The Major Hurdle of Pipelining – Pipeline Hazards	2
2.3	Pipelining Implementation	1
2.4	Implementation issues that makes Pipelining hard- Exceptions.	2
2.5	A Basic Pipeline for MIPS R4000	1
2.6	Extending the MIPS Pipeline to Handle Multicycle Operations	1
	MODULE III	
3.1	Techniques for Exposing ILP	1
3.2	Reducing Branch Costs with Prediction	1
3.3	Overcoming Data Hazards with Dynamic Scheduling – Tomasulo's Approach	2
3.4	Hardware-Based Speculation	1
3.5	Exploiting ILP Using Multiple Issue and Static Scheduling	1
3.6	Advanced Techniques for Instruction Delivery and Speculation	1
3.7	Limitations of ILP	1
	MODULE IV	
4.1	Vector Architecture	1
4.2	SIMD Instruction Set Extensions for Multimedia	1
4.3	Graphics Processing Units- Architecture	1
4.4	Centralized Shared Memory Architectures, Performance of Shared Memory Multiprocessors	1
4.5	Distributed Shared Memory	1
4.6	Models of Memory Consistency	1
4.7	Multicore Processors and their Performance.	1
	MODULE V	
5.1	Review of Memory Hierarchy Design	1
5.2	Cache Performance**.**	1
5.3	Basic Cache Optimizations	1
5.4	Virtual Memory, Protection, Virtual Memory and Virtual Machines	1
5.5	Advanced Optimizations of Cache Performance	2
5.6	Crosscutting Issues: The Design of Memory Hierarchies.	1

<table>
<tr><th colspan="2">CO Assessment Questions</th></tr>
<tr><td>CO1</td><td>1. Explain Flynn’s classification of computer architecture with diagrams.
2. Explain briefly the quantitative principles of computer design.</td></tr>
<tr><td>CO2</td><td>1. Define Amdahl’s law. How it defines the speed-up gained by using a particular feature?
2. Your company has just bought a new dual Pentium processor, and you have been asked to optimize (doubling the performance) your software for this processor. You will run two applications on this dual Pentium, but the resource requirements are not equal. The first application needs 80% of the resources, and the other only 20% of the resources.
(i) Given that 40% of the first application is parallelizable, how much speedup would you achieve with that application if run in isolation?
(ii) Given that 40% of the first application is parallelizable, how much overall system speedup would you observe if you parallelized it?</td></tr>
<tr><td>CO3</td><td>Identify the types of dependencies among the instructions in the following MIPS code.
DIV.D F0,F2,F4
ADD.D F6,F0,F8
S.D F6,0(R1)
SUB.D F8,F10,F14
MUL.D F6,F10,F8</td></tr>
<tr><td>CO4</td><td>Assume a hypothetical GPU with the following characteristics:
(a) Clock rate 1.5 GHz
(b) Contains 16 SIMD processors, each containing 16 single-precision floating-point units
(c) Has 100 GB/sec off-chip memory bandwidth
Without considering memory bandwidth, what is the peak single-precision floating-point throughput for this GPU in GLFOP/sec, assuming that all memory latencies can be hidden? Is this throughput sustainable given the memory bandwidth limitation?</td></tr>
<tr><td>CO5</td><td>Assume the following average miss rates for 32 KB data caches in a particular architecture: 5.2% for floating-point programs with a direct-mapped cache, 4.9% for these programs with a two-way set associative cache, 3.5% for integer programs with a direct-mapped cache, and 3.2% for integer programs with a two-way set associative cache. Assume the miss penalty to L2 is 10 cycles, and the L2 misses and penalties are the same. Find out which of the following is more important for floating-point programs and integer programs:
(a) Two-way set associativity or
(b) Hit under one miss for the primary data caches</td></tr>
</table>

	(Given that one hit under miss reduces the miss penalty by 9% for the integer benchmarks and 12.5% for the floating point.).

24CSO853	Big Data Analytics	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Prerequisite: Computational Fundamentals for Machine Learning

Preamble: This course delves into the foundations of big data, analytics best practices, real-world use cases, and the tools and techniques that empower data-driven decision-making. It explores the dynamic and transformative field of harnessing big data for insightful decision-making and innovation. This course is designed to equip the student with the knowledge in big data related classification, clustering, rule mining, stream data management and No-SQL databases.

Course Outcomes: After the completion of the course the student will be able to

CO1	Identify significance, characteristics, and practices of Bigdata. **(Cognitive Knowledge Level: Understand)**
CO2	Use advanced clustering and classification algorithms with large datasets **(Cognitive Knowledge Level: Apply)**
CO3	Distinguish between content-based and knowledge-based recommendation systems and identify the use of rule based systems **(Cognitive Knowledge Level: Understand)**
CO4	Understand the principles of graph analytics and apply them to big data scenarios. (**Cognitive Knowledge Level: Understand)**
CO5	Apply NoSQL databases to analyze big data in real-world scenarios, such as E-Commerce, blogs, and Twitter data, understanding their implications in different domains. **(Cognitive Knowledge Level: Understand)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3									3
CO2	2	1	3									3
CO3	2	1	3									3
CO4	2	1	3									3
CO5	2	1	3									3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test 1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate			✓	

Create			✓	

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : INTRODUCTION TO BIG DATA

Evolution of Big data - Best Practices for Big data Analytics - Big data characteristics - Validating - The Promotion of the Value of Big Data - Big Data Use Cases- Characteristics of Big Data Applications - Perception and Quantification of Value -Understanding Big Data Storage - A General Overview of High-Performance Architecture - HDFS - MapReduce and YARN - Map Reduce Programming Mode

MODULE II : CLUSTERING AND CLASSIFICATION

Advanced Analytical Theory and Methods: Overview of Clustering - K-means - Use Cases - Overview of the Method - Determining the Number of Clusters - Diagnostics - Reasons to Choose and Cautions.- Classification: Decision Trees - Overview of a Decision Tree - The General Algorithm - Decision Tree Algorithms - Evaluating a

Decision Tree - Decision Trees in R - Naïve Bayes - Bayes' Theorem - Naïve Bayes Classifier

MODULE III : ASSOCIATION AND RECOMMENDATION SYSTEM

Advanced Analytical Theory and Methods: Association Rules - Overview - Apriori Algorithm - Evaluation of Candidate Rules - Applications of Association Rules - Finding Association& finding similarity - Recommendation System: Collaborative Recommendation- Content Based Recommendation - Knowledge Based Recommendation- Hybrid Recommendation Approaches.

MODULE IV : STREAM MEMORY

Introduction to Streams Concepts – Stream Data Model and Architecture - Stream Computing, Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating moments – Counting oneness in a Window – Decaying Window – Real time Analytics Platform(RTAP) applications - Case Studies - Real Time Sentiment Analysis, Stock Market. Using Graph Analytics for Big Data: Graph Analytics.

MODULE V : NoSQL DATABASES

NoSQL Databases : Schema-less Models‖: Increasing Flexibility for Data Manipulation-Key Value Stores- Document Stores - Tabular Stores - Object Data Stores - Graph Databases Hive - Sharding –- Hbase – Analyzing big data with twitter - Big data for E-Commerce Big data for blogs - Review of Basic Data Analytic Methods

Text books

1. Viktor Mayer-Schönberger and Kenneth Cukie, Big Data: A Revolution That Will Transform How We Live, Work, and Think

Reference books

1. S. Anand and J. S. Sarma, Big Data Analytics: A Practical Guide for Managers
2. Tom White, Hadoop: The Definitive Guide
3. Thomas H. Davenport, Big Data at Work: Dispelling the Myths, Uncovering the Opportunities

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Evolution of Big data and Best Practices for Big data Analytics	1
1.2	Big data characteristics, Validating big data, The Promotion of the Value of Big Data	1
1.4	Big Data Use Cases, Characteristics of Big Data Applications - Perception and Quantification of Value	1
1.5	A General Overview of High-Performance Architecture - HDFS	1
1.6	MapReduce and YARN	2
1.7	Map Reduce Programming Mode	1
	MODULE II	

2.1	Overview of Clustering - K-means	1
2.2	Use Cases - Overview of the Method - Determining the Number of Clusters	1
2.3	Diagnostics - Reasons to Choose and Cautions	1
2.4	Classification: Decision Trees - Overview of a Decision Tree	1
2.5	The General Algorithm - Decision Tree Algorithms - Evaluating a Decision Tree	1
2.6	Decision Trees in R	1
2.7	Naïve Bayes - Bayes‘ Theorem, Naïve Bayes Classifier	1
MODULE III		
3.1	Advanced Analytical Theory and Methods: Association Rules - Overview	1
3.2	Apriori Algorithm - Evaluation of Candidate Rules	1
3.3	Applications of Association Rules - Finding Association& finding similarity -	1
3.4	Recommendation System: Collaborative Recommendation	1
3.5	Content Based Recommendation	1
3.6	Knowledge Based Recommendation	1
3.7	Hybrid Recommendation Approaches	1
MODULE IV		
4.1	Introduction to Streams Concepts – Stream Data Model and Architecture	1
4.2	Stream Computing, Sampling Data in a Stream – Filtering Streams	1
4.3	Counting Distinct Elements in a Stream – Estimating moments	1
4.4	Counting oneness in a Window – Decaying Window	1
4.5	Real time Analytics Platform(RTAP) applications	1
4.6	Case Studies - Real Time Sentiment Analysis, Stock Market.	1

4.7	sing Graph Analytics for Big Data: Graph Analytics.	1
MODULE V		
5.1	Introduction to NoSQL Databases	1
5.2	Schema-less Models‖: Increasing Flexibility for Data Manipulation-Key Value Stores- Document Stores - Tabular Stores - Object Data Stores	1
5.3	Graph Databases Hive - Sharding –- Hbase	1
5.4	Analyzing big data with twitter	1
5.5	Big data for E-Commerce Big data for blogs	1
5.6	Review of Basic Data Analytic Methods	2

CO Assessment Questions	
1	1. What are the key milestones in the evolution of big data, and how have they shaped the current landscape of data management? 2. Can you identify and explain some best practices in big data analytics, and how have these practices contributed to successful implementations? 3. How do the characteristics of big data (Volume, Velocity, Variety, Veracity, and Value) impact the way data is processed and analyzed in big data systems? 4. What techniques can be employed to validate the value derived from big data initiatives, and why is validation crucial for the success of these initiatives?
2	1. Explain the fundamental concepts of clustering and how clustering techniques can be applied in data analysis. 2. What is the K-means clustering algorithm, and how does it work? Provide a real-world use case illustrating the application of K-means. 3. Share examples of industries or scenarios where clustering techniques are particularly beneficial. Why would one choose clustering in these situations? 4. Describe the general algorithm of decision trees and discuss reasons for choosing or cautioning against the use of decision trees in certain situations.
3	1. Explain how saliency maps and gradient-based methods Association Rules 2. Discuss techniques for finding associations and similarities in data. How can these techniques be valuable in different domains?

	3. Compare and contrast collaborative, content-based, and knowledge-based recommendation systems. Why might a hybrid approach be beneficial? 4. Provide examples of successful collaborative recommendation systems and discuss their impact on user experiences. 5. What are the advantages of using hybrid recommendation approaches, and how can organizations implement and benefit from them?
4	1. Explain the basics of stream data, its model, and architecture. How does stream processing differ from traditional batch processing? 2. Discuss techniques for counting distinct elements in a streaming context. Why is this operation important in real-time analytics? 3. How can graph analytics be applied to big data, and what are the benefits of analyzing large-scale graphs in real-time scenarios? 4. Explain the concept of a decaying window in stream processing. In what situations is it useful, and how does it impact real-time analytics?
5	1. How do schema-less models in NoSQL databases increase flexibility for data manipulation? What are the advantages and challenges associated with this approach? 2. Provide examples of scenarios where key-value stores are particularly well-suited. What are the key characteristics of key-value data models? 3. Discuss the applications and benefits of graph databases in the context of big data. How do graph databases enhance data analysis? 4. Share insights on how Twitter data can be analyzed in big data scenarios. What are the challenges and opportunities in using Twitter data for analysis?

24CSD804/ 24CSN804	PROJECT/INTERNSHIP	L	T	P	J	S	C	Year of Introduction
		0	0	14	0	14	7	2024

Preamble: This course is mainly intended to evoke the innovation and invention skills in a student and industrial exposure through internships. The course will provide an opportunity to synthesize and apply the knowledge and analytical skills learned, to be developed as a prototype or simulation. The research-based project in the seventh semester shall be continued as the project in the eighth semester. Internships provide a great opportunity for students to gain exposure to the industry and prepare for their future work environment.

Prerequisite: Major Project Phase I

Course Outcomes: After the completion of the course the student will be able to

CO 1	Model and solve real world problems by applying knowledge across domains. **(Apply level)**
CO 2	Develop products, processes or technologies for sustainable applications. **(Apply level)**
CO 3	Function effectively as an individual and as a leader in diverse teams and to comprehend and execute designated tasks. **(Apply level)**
CO 4	Plan and execute tasks utilizing available resources within timelines, following ethical and professional norms. **(Apply level)**
CO 5	Identify technology/research gaps and propose innovative/creative solutions to real world problems. **(Analyze level)**
CO 6	Organize and communicate technical and scientific findings effectively in written and oral forms. **(Apply level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	3	2	3	3	3	3	3	3	2	3
CO 2	3	3	3	2	3	3	3	3	3	3		3
CO 3						3		3	3	3		3
CO 4						3		3	3	3	2	3
CO 5	3	3	3	2		3	3	3	3	3		3
CO 6					3	3		3	3	3		3

Project Guidelines

- **a.** The progress of the project is evaluated based on three reviews, two interim reviews and a final review.
- **b.** A report is required at the end of the semester.
- **c.** All students doing a project in the eighth semester, shall prepare a Poster as part of their project highlighting their work.
- **d.** The poster carries 5% weightage of the total marks of the project course and to be prepared based on the guidelines issued time to time.

Internship Guidelines

a. The internship shall be treated as their project in eighth semester, and shall be evaluated as same as that of the project.
b. Student should contact his /her Guide/Supervisor from college on weekly basis to communicate the progress and each student has to maintain a diary/log book in this regard.
c. Student should attend the interim and final project evaluation, by submitting the internship report.

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	100	--	--

Mark Distribution

a. Work assessed by the project guide – 25%
b. Three-member Continuous Internal Evaluation Committee - 20% (Guide shall be one member in the CIE committee)
c. Final Evaluation by a three-member Committee comprising of the department project coordinator, guide and an external expert. The external expert shall be an academician or from industry. The industry expert is preferred: 30%
d. Draft report – 5 % Final Report - 15%
e. Preparing and presenting poster -5%
f. One third of the project shall be completed in VII semester and two third in VIII semester.

24CSH809	Project in Honors	L	T	P	J	S	C	Year of Introduction
		0	0	4	0	0	4	2024

Preamble: The objective of this course is to apply the fundamental concepts of courses learned in respective Honors Streams. This course helps the learners to get an exposure to the development of application software/hardware solutions/ software simulations in the field of Computer Science and Engineering. It enables the learners to understand the different steps to be followed such as literature review and problem identification, preparation of requirement specification & design document, testing, development and deployment. Mini project enables the students to boost their skills, widen the horizon of thinking and their ability to resolve real life problems.

Prerequisite: A sound knowledge in courses studied in respective honor stream.

Course Outcomes: After the completion of the course the student will be able to

CO1	Identify technically and economically feasible problems. **(Apply level)**
CO2	Identify and survey the relevant literature for getting exposed to related solutions. **(Apply level)**
CO3	Perform requirement analysis, identify design methodologies and develop adaptable & reusable solutions of minimal complexity by using modern tools & advanced programming techniques **(Apply level)**
CO4	Prepare technical report and deliver presentation. **(Apply level)**
CO5	Apply engineering and management principles to achieve the goal of the project. **(Apply level)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	3	3	3	3	3		3
CO2	3	3	3	2	3	3	3	3	3	3		3
CO3	3	3	3	3	3	3	3	3	3	3	3	3
CO4						3		3	3	3		3
CO5	3	3	3	3	3	3	3	3	3	3		3

Project Guidelines

a. Student Groups with 4 or 5 members should identify a topic of interest in consultation with a Faculty Advisor/Project Coordinator/Guide.

b. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives.

c. Carryout the design/fabrication or develop codes/programs to achieve the objectives by strictly following steps specified in the teaching plan.

d. Innovative design concepts, performance, scalability, reliability considerations, aesthetics/ergonomic, user experience and security aspects taken care of in the project shall be given due weight.

e. The progress of the project is evaluated based on three reviews, two interim reviews and a final review.

- **f.** A report is required at the end of the semester.
- **g.** All students doing a project in the eighth semester, shall prepare a Poster as part of their project highlighting their work.
- **h.** The poster carries 5% weightage of the total marks of the project course and to be prepared based on the guidelines issued time to time.

Total Marks distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	100	--	--

Mark Distribution

a. Work assessed by the project guide – 25%
b. Three-member Continuous Internal Evaluation Committee - 20% (Guide shall be one member in the CIE committee)
c. Final Evaluation by a three-member Committee comprising of the department project coordinator, guide and an external expert. The external expert shall be an academician or from industry. The industry expert is preferred: 30%
d. Draft report – 5 % Final Report - 15%
e. Preparing and presenting poster -5%
f. One third of the project shall be completed in VII semester and two third in VIII semester.