TKM COLLEGE OF ENGINEERING

(Government Aided and Autonomous)

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COMPUTER SCIENCE AND ENGINEERING

B. Tech Curriculum 2023

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	23MAP301	BSC	Advanced Linear Algebra, Complex Analysis and Partial Differential Equations	3	1	2	0	5	6	5	60	40
2	K	23EST302	ESC	Probability, Statistics and Optimization	2	0	0	0	2	2	2	100	
3	B	23CSJ303	PBC	Advanced Programming	2	0	2	2	5	6	5	60	40
4	C	23CSP304	PCC	Data Structures and Algorithms	2	1	2	0	4	5	4	60	40
5	D	23CSP305	PCC	Computer Organization and Architecture	2	1	2	0	4	5	4	60	40
6	E	23HUT310	HSMC	Life Skills and Professional Ethics	3	0	0	0	3	3	3	40	60
7	I	23EST307	ESC	Engineering Mechanics	2	0	0	0	2	2	2	100	
8	M / R	23CSM3XX	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	23CSM309	Python for Machine Learning	23CSM310	Object Oriented Programming*

23MAP301	Advanced Linear Algebra, Complex Analysis and Partial Differential Equations	L	T	P	J	S	C	Year of Introduction
		3	1	2	0	5	5	2023

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	15	10	10	20		**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)

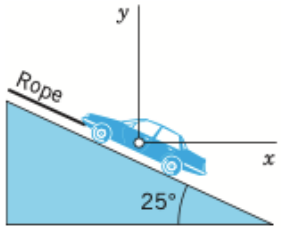
COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. ofHours [45 hours]
MODULE 1 [9 hours]		
1.1	Defining of vector spaces	1
1.2	Vector space examples	1
1.3	Subspaces	1
1.4	Linear dependence and independence	1
1.5	Basis and dimension	1
1.6	Basis and dimension(continued)	1
1.7	Row space, column space	1
1.8	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 $y(x,t)$.

	Date of approval
Board of Studies	
Academic Council	

23EST302	PROBABILITY, STATISTICS AND OPTIMIZATION	L	T	P	J	S	C	Year of Introduction
		2	0	0	0	2	2	2023

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. ofHours [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.

	Date of approval
Board of Studies	
Academic Council	

23CSJ303	Advanced Programming	L	T	P	J	S	C	Year of Introduction
		2	0	2	2	5	5	2023

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**	**10**	**15**	**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
MODULEIV		
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
MODULEV		
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.

5	Access modifiers and Packages Strings- Class and Methods, String Buffer and String Tokenizer. Reading Input from Console Using Scanner class	3	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
6	Inheritance- Super class and Subclass, extends keyword, Types- Single Level, Multilevel, Hierarchical and Multiple. super keyword, calling superclass constructor from child class constructor	2	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

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.

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. 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 (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	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.

	Date of approval
Board of Studies	
Academic Council	

23CSP304	Data Structures and Algorithms	L	T	P	J	S	C	Year of Introduction
		2	1	2	0	4	4	2023

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	10	10	15	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 Searc	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 ⌊n/2⌋ and the last n - ⌊n/2⌋ 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.

	Date of approval
Board of Studies	
Academic Council	

23CSP305	COMPUTER ORGANIZATION AND ARCHITECTURE	L	T	P	J	S	C	Year of Introduction
		2	1	2	0	4	4	2023

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 (23CST105)

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	10	10	15	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. ofHours
	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.

	Date of approval
Board of Studies	
Academic Council	

23HUT310	LIFE SKILLS AND PROFESSIONAL ETHICS	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2023

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				

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: (2×10 =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: (5×8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5×8 = 40 marks]	

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 Civil 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 Civil Engineering disasters	1
4.6	Case study on Civil 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.

23EST307	ENGINEERING MECHANICS	L	T	P	J	S	C	Year of Introduction
		1	1	0	0	2	2	2023

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	
1-1-0-0	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.

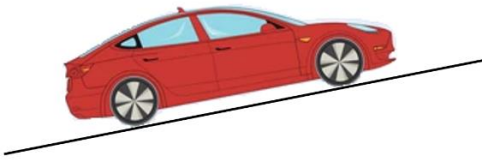
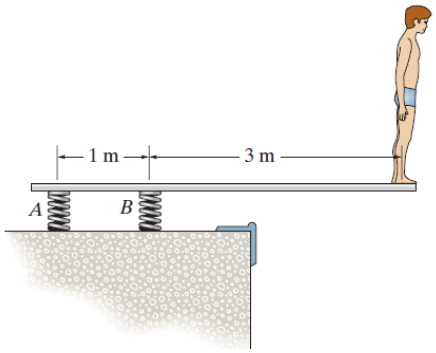
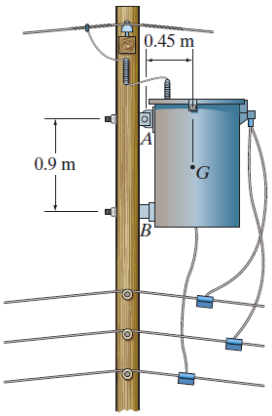
Reference Books:

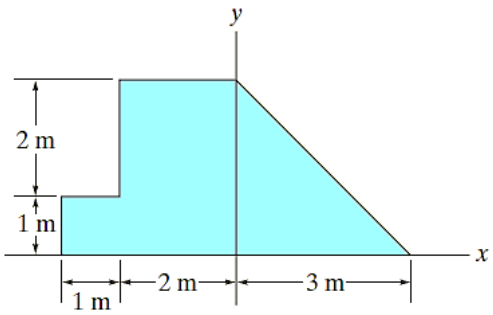
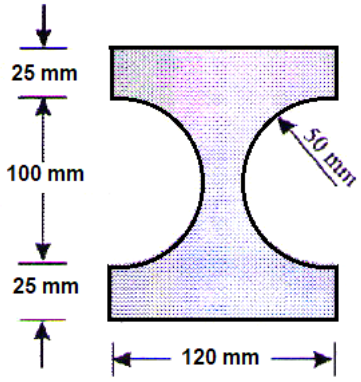
1. Merriam J. L and Kraige L. G., Engineering Mechanics - Vols. 1 and 2, John Wiley.
2. Tayal A K, Engineering Mechanics – Statics and Dynamics, Umesh Publications.
3. Bhavikkatti, S.S., Engineering Mechanics, New Age International Publishers
4. F.P.Beer abd E.R.Johnston (2011), Vector Mechanics for 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. 

	Date of approval
Board of Studies	
Academic Council	


VERIFIED
VERIFIED
CURRICULUM
COMMITTEE
02.06.2023

MINOR – S3

23CSM309	Python for Machine Learning	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	4	4	2023

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.

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23CSM310	Object Oriented Programming	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	4	4	2023

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**	
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 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).

	Date of approval
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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	23CST401	PCC	Discrete Mathematics	2	1	0	0	2	3	3	40	60
2	B	23CSP402	PCC	Computer Networks	2	1	2	0	4	5	4	60	40
3	C	23CSP403	PCC	Operating Systems	2	1	2	0	4	5	4	60	40
4	D	23CSJ404	PBC	Introduction to Database Systems	2	0	2	2	5	6	5	60	40
5	E	23HUT414	HSMC	Management- I (Organizational Behavior)	3	0	0	0	3	3	3	40	60
6	F	23MCT406	MC	Environmental Sciences	3	0	0	0	3	3	0	40	60
7	I	23BYT407	ESC	Biology for Engineers	2	0	0	0	2	2	2	100	
8	M /H /R	23CSM4XX/ 23CSH4XX	MR/ HR/RL	MINOR/HONORS/ REMEDIAL	4	0	0	0			4/ 4/ 0	40	60
TOTAL									**23**	**27**	**21**		

MINOR BUCKETS				
SEMESTER	**BUCKET 1**		**BUCKET 2**	
	Specialization - Machine Learning		**Specialization - Software Engineering***	
	Course Code	**Course Name**	**Course Code**	**Course Name**
S4	23CSM409	Mathematics for Machine Learning	23CSM410	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	23CSH409	Computational Geometry	23CSH410	System Software	23CSH411	Data and Web Mining

23CST401	Discrete Mathematics	L	T	P	J	S	C	Year of Introduction
		2	1	0	0	2	3	2023

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)

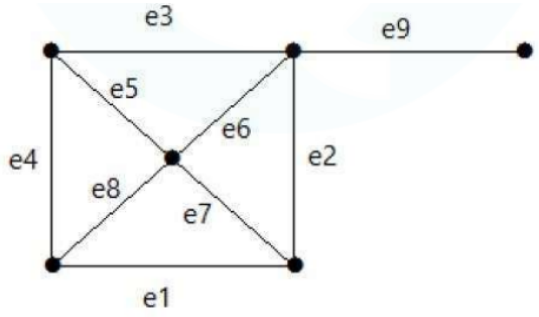
Statements and Notation-Connectives-Negation-Conjunction-Disjunction-Statement Formulas and Truth tables, Conditional and Biconditional-Tautologies-Equivalence of Formulas-Duality Law-Tautological implications- Normal Forms-Theory of inference for statement Calculus-Rules of inference, Predicate Calculus.

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

CO Assessment Questions	
1	1. Show that R∨M , ¬R∨S , ¬M , ¬S cannot exist simultaneously (without using truth table) 2. Represent the following statement in symbolic form “Not every city in Canada is clean”.
2	1. Prove that the group { 1,-1, i, -i } is cyclic with generators i and –i. 2. State and prove Lagrange’s Theorem.
3	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.
4	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.
5	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.

	Date of approval
Board of Studies	
Academic Council	

23CSP402	COMPUTER NETWORKS	L	T	P	J	S	C	Year of Introduction
		2	1	2	0	4	4	2023

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	10	10	15	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

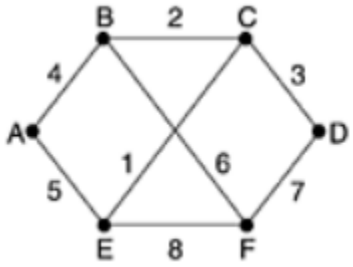
No.	Topic	No. of Hours	Experiment
1	Introduction to the Internet and Service Models	1 1	1. Use Linux tools like ifconfig, dig, ethtool, route, netstat, nslookup, and ip to understand the networking configuration of the computer that the student is working on. 2. Use Wireshark to capture packets when 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.

	Date of approval
Board of Studies	
Academic Council	

23CSP403	OPERATING SYSTEMS	L	T	P	J	S	C	Year of Introduction
		2	1	2	0	4	4	2023

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**	**10**	**10**	**15**	**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

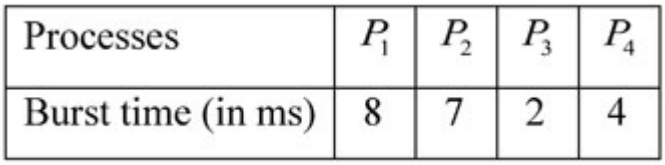
No.	Topic	No. of Hours	Experiment
1	Introduction to Operating Systems	2	1. Understand Linux and practice Linux permissions, special permissions and authentication (various options of chmod, setuid, setgid) 2. Write a shell script to create a file in $USER/class/batch directory and display the list of 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 .  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-

Processes	P_1	P_2	P_3	P_4
Burst time (in ms)	8	7	2	4

	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?

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23CSJ404	INTRODUCTION TO DATABASE SYSTEMS	L	T	P	J	S	C	Year of Introduction
		2	0	2	2	5	5	2023

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	10	15	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.

	Date of approval
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23HUT414	Management – 1 (Organizational Behavior)	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2023

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
MODULEIII		
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?

	Date of approval
Board of Studies	
Academic Council	

23MCT406	Environmental Sciences	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	0	2023

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

	Date of approval
Board of Studies	
Academic Council	

23BYT407	Biology for Engineers	L	T	P	J	S	C	Year of Introduction
		2	0	0	0	2	2	2023

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.

	Date of approval
Board of Studies	
Academic Council	

HONORS – S4

23CSH409	Computational Geometry	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	4	4	2023

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.

	Date of approval
Board of Studies	
Academic Council	

23CSH410	System Software	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	4	4	2023

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

<table>
<tr><td></td><td>efficient as possible</td></tr>
<tr><td>3</td><td>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></td></tr>
<tr><td>4</td><td>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.</td></tr>
<tr><td>5</td><td>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></td></tr>
<tr><td>6</td><td>1. Describe any one commonly used debugging method.
2. Distinguish between character and block device drivers</td></tr>
</table>

	Date of approval
Board of Studies	
Academic Council	

23CSH411	Data and Web Mining	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	4	4	2023

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

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>>

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.

	Date of approval
Board of Studies	
Academic Council	

MINOR – S4

23CSM409	Mathematics for Machine Learning	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	4	4	2023

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
<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 : 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 $x_1 + 2x_2 + 3x_3 + x_4 \leq 5$ $x_1 + x_2 + 2x_3 + 3x_4 \leq 3$ $x_1, x_2, x_3, x_4 \geq 0$

	Date of approval
Board of Studies	
Academic Council	

23CSM410	Software Engineering	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	4	4	2023

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?

	Date of approval
Board of Studies	
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