Appendix II

COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY

CURRICULUM & SYLLABUS

M.Sc. (COMPUTER SCIENCE) WITH SPECIALIZATION IN DATA SCIENCE

(2022 Admission onwards)

DEPARTMENT OF COMPUTER APPLICATIONS
COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY
KOCHI - 682022

VISION

To become a centre of excellence in Computer Applications and impart innovation-oriented education for building globally competent and socially committed professionals.

MISSION

M1: To develop technically competent professionals and equip them for research, innovations, higher studies, and entrepreneurship.

M2: To mould software professionals with ethical values for developing technologies emphasizing on societal and industrial needs.

M3: To provide a globally recognized academic environment through industry – academia collaborations, digital learning and state of the art skill development.

M4: To foster students by enriching universal human values to work in multidisciplinary domains exhibiting leadership qualities and teamwork.

PROGRAM EDUCATIONAL OBJECTIVES (PEO's)

PEO1. Apply principles of mathematics and computing to design, develop and test softwares for quality, security and utility.

PEO2. Work in a multidisciplinary team to understand software requirements and engage in applying technologies for solving complex computing problems.

PEO3. Engage in lifelong learning to keep pace with changing landscape of technologies for professional advancement.

PEO4. Communicate effectively and demonstrate professional ethics with societal responsibilities.

PROGRAMME ARTICULATION MATRIX

	M1	M2	M3	M4
PEO1	**X**	**X**		
PEO2	**X**	**X**		**X**
PEO3				**X**
PEO4		**X**		

PROGRAMME OUTCOMES (PO's)

1.Computational Knowledge: Apply knowledge of computing fundamentals, computing specialisation, mathematics and domain knowledge appropriate for the computing specialization to the abstraction and conceptualisation of computing models from defined problems and requirements.

2.Problem Analysis: Identify, formulate, research literature, and solve complex computing problems reaching substantiated conclusions using fundamental principles of mathematics, computing sciences and relevant domain disciplines.

3.Design/Development of Solutions: Design and evaluate solutions for complex computing problems, and design and evaluate systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

4.Conduct Investigations of Complex Computing Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5.Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern computing tools to complex computing activities, with an understanding of the limitations.

6.Professional Ethics: Understand and commit to professional ethics and cyber regulations responsibilities, and norms of professional computing practice.

7.Life-long learning: Recognise the need and have the ability to engage in independent learning for continual development as a computing professional.

8.Project management and finance: Demonstrate knowledge and understanding of the computing and management principles and apply these to one's own work, as the member and leader in a team to manage projects and in multidisciplinary environments.

9.Communication Efficacy: Communicate effectively with the computing community, and with society at large, about complex computing activities by being able to comprehend and write effective reports, design documentation, make effective presentations and give and understand clear instructions.

10.Societal and Environmental Concern: Understand and assess societal, environmental, health, safety, legal and cultural issues within local and global context, and the consequential responsibilities to professional computing practice.

11.Individual and Teamwork: Function effectively as an individual and as a member or leader in diverse teams and multidisciplinary environments.

12.Innovation and Entrepreneurship: Identify a timely opportunity and using innovation to pursue that opportunity to create value and wealth for the betterment of the individual and the society at large.

PROGRAMME SPECIFIC OUTCOME (PSO's)

PSO-1: Apply the knowledge of mathematics, statistics, and computer science to deliver solutions for emerging problems in the data science domain using specialist software tools for data storage, analysis and visualisation.

PSO-2: Apply research and investigation to solve sustainable problems related to the environment, industry and society with ethics, and manage projects related to other interdisciplinary fields.

Mapping of PSOs with PEOs

PSO	**PEO1**	**PEO2**	**PEO3**	**PEO4**
PSO1	X			
PSO2	X	X	X	X

Mapping of PSOs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
PSO1	**X**	**X**	**X**	**X**	**X**	**X**	**X**			**X**		
PSO2	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**

M.Sc. COMPUTER SCIENCE WITH SPECIALISATION IN DATA SCIENCE
COURSE STRUCTURE

Semester I

Course Code	Paper				Marks		Credit
		L	T	P	Sessional	Final	
22-359-0101	Statistical Foundations for Data Science	3	1	0	50	50	4
22-359-0102	Operating System Concepts	3	1	0	50	50	4
22-359-0103	Data Structures and Algorithms	3	1	0	50	50	4
22-359-0104	Python for Data Analytics	3	1	0	50	50	4
22-359-0105	Mathematics for Machine Learning	3	1	0	50	50	4
22-359-0106	Python Programming LAB			4	50		2
22-359-0107	Data Structure s and Algorithms LAB			4	50		2
TOTAL							**24**

Semester II

Course Code	Paper				Marks		Credit
		L	T	P	Sessional	Final	
22-359-0201	Networks and Data Communications	3	1	0	50	50	4
22-359-0202	Database Management Systems	3	1	0	50	50	4
22-359-0203	R for Data Analytics	3	1	0	50	50	4
22-359-0204	Machine Learning	3	1	0	50	50	4
	Elective I	3	1	0	50	50	4
22-359-0206	Data Analytics LAB (ML and R)			4	50		2
22-359-0207	Mini Project			4	50		2
	TOTAL						**24**

Semester III

Course Code	Paper				Marks		Credit
		L	T	P	Sessional	Final	
22-359-0301	Deep Learning	3	1	2	50	50	4
	Elective II	3	1	0	50	50	4
	Elective III	3	1	0	50	50	4
	Elective IV	3	1	2	50	50	4
	Elective V (IE*)				50	50	3
22-359-306	Seminar			2	50		1
22-359-307	Mini Project			4	50		2
	TOTAL						**22**

***IE - Interdisciplinary Elective**

Semester IV

Course Code	Paper	Marks		Credit
		Sessional	Final	
22-359-0401	Internship/Project Work	200	200	16
TOTAL				**16**

LIST OF ELECTIVES

Elective I

22-359-0211 Blockchain Technologies

22-359-0212 Digital Image Processing

22-359-0213 Natural Language Processing (MOOC)

22-359-0214 Cryptography and Network Security

Elective II

22-359-0311 Explainable Artificial Intelligence

22-359-0312 Software Project Management

22-359-0313 Network Security Essentials

22-359-0314 Cloud Computing (MOOC)

Elective III

22-359-0321 Big Data Analytics

22-359-0322 Cyber Forensics

22-359-0323 Computer Vision

22-359-0324 Social Network Analysis (MOOC)

Elective IV

22-359-0331 Internet of Things

22-359-0332 Android Application Programming

22-359-0333 Virtualization and Containers

22-359-0334 Software Testing (MOOC)

SEMESTER I

22-359-0101 STATISTICAL FOUNDATIONS FOR DATA SCIENCE

22-359-0101	STATISTICAL FOUNDATIONS FOR DATA SCIENCE	CATEGORY	L	T	P	CREDIT
		CORE	3	1	0	4

Prerequisite: Nil

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

CO 1	Apply summary statistics and data visualisation	(Cognitive level: Apply)
CO 2	Solve problems related to EDA and Inferential Statistics	(Cognitive level: Apply)
CO 3	Solve the problems using Bayes Theorem, Poisson Distribution, Normal Distribution and Testing	(Cognitive level: Apply)
CO 4	Explain the concept of Linear Regression and Parameter estimation	(Cognitive level: Understand)
CO 5	Apply PCA for feature selection.	(Cognitive level: Apply)

Mapping of course outcomes with program outcomes - Low=1, Medium=2, High=3

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2	2	2										2	
CO 2	2	3	3										2	
CO 3	2	2	2										2	
CO 4	2	2	2										3	3
CO 5	3	3	3										3	3

Syllabus

UNIT I (8 Hours)

Probability, basics, Conditional Probability, Bayes Theorem, Distributions - Binomial, Poisson, Normal distributions and related problems. Summary Statistics for Pre-processing and Visualisation.
Hacks tips and fix it (use cases)

UNIT II (10 Hours)

Exploratory Data Analysis (EDA), statistical measures, Basic tools (plots, graphs and summary statistics) of EDA

Inference - Statistical Inference for Categorical Data, Statistical Inference for Binomial Parameters, Statistical Inference for Multinomial Parameters, Bayesian Inference for Binomial and Multinomial Parameters.

UNIT III (7 Hours)

Developing Initial Hypotheses, Identifying Potential Data Sources, testing hypotheses on means, proportions and variances. Hypothesis – generation and testing – Chi square test, t-test, Analysis of variance, correlation

UNIT IV (10 Hours)

Regression and Estimation, Covariance and correlations, Covariance matrix, Parameter Estimation, Bayesian Linear Regression, Maximum likelihood as orthogonal projection. eigen decomposition

UNIT V (10 Hours)

Introduction to principal components, Graphing the Principal Components; factor model and estimations; canonical correlation and canonical variables; Cluster analysis; classification of populations.

Textbooks/References

1. "Practical Statistics for Data Scientists", by Peter Bruce, Andrew Bruce, Edition 1, 2017, O'Reilly Media. Inc.
2. "Mining of Massive Datasets", by Jure Leskovec, Anand Rajaraman, Jeff Ullman, Edition 2, 2019, Cambridge University Press.
3. "Applied Multivariate Statistical Analysis", Richard A. Johnson, Dean W. Wichern, Edition 6, 2008, Pearson.
4. "Mathematics for Machine Learning", A. Aldo Faisal, Cheng Soon Ong, and Marc Peter Deisenroth, Edition , 2020, Cambridge University Press.

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1 (20 Marks)	2 (20 Marks)	
Remember	-	-	-
Understand	10	10	20
Apply	10	10	30
Analyse			20

Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	50	50	3 hours

Continuous Internal Evaluation Pattern:

Continuous Assessment Test (2 numbers) : 40 marks
Assignment/Quiz/Course project : 10 marks

End Semester Examination Pattern **:** Sample QP

22-359-0102 OPERATING SYSTEM CONCEPTS

22-359-0102	OPERATING SYSTEM CONCEPTS	CATEGORY	L	T	P	CREDIT
		CORE	3	1	0	4

Prerequisite: Nil

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

CO 1	Solve synchronisation problems in operating systems and issues in distributed systems.	(Cognitive level: Apply)
CO 2	Employ process scheduling algorithms and solve process scheduling problems	(Cognitive level: Apply)
CO 3	Compare various memory management schemes.	(Cognitive level: Analyze)
CO 4	Solve problems using page replacement algorithms.	(Cognitive level: Apply)
CO 5	Compare different access control mechanisms for protection.	(Cognitive level: Apply)

Mapping of course outcomes with program outcomes Low=1, medium=2, High=3

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	3				1							
CO 2	2	2	2				1							
CO 3	2	2					1						3	
CO 4	3	3					1							
CO 5	3	3	3				1							2

Syllabus

UNIT I (10 Hours): Introduction to Operating Systems, Functions of Operating System,Design Approaches and Types of Advanced Operating Systems. Dual-mode operation, concept of multiprogramming, multiprocessing. Synchronization Mechanisms: Concept of Processes and Threads, Process states and processes state transition diagram, Process control block , process context, CPU Scheduling and Process Scheduling–The Critical Section Problem – Other Synchronization Problems:– Process Synchronization using semaphores & Monitors.

UNIT II (8 Hours): Distributed Operating Systems:- Issues in Distributed Operating System, Deadlock prevention, avoidance and detection & recovery - Dead Lock Characterization, Methods for handling Deadlock.

UNIT III (10 Hours): Memory Management - Types of memory, Memory organization, Address binding Memory Partitioning, Dynamic memory Partitioning, buddy system, Paging, Demand Paging, Segmentation, Page replacement algorithms.

UNIT IV (10 Hours): File System - Directory structure - single level, two-level, tree, acyclic graph, general graph; File system mounting, Implementing File System: File system structure - Layered file system, file attributes, File control block; File system implementation Directory Implementation, Allocation Methods

UNIT V (7 Hours): Security and Protection - Goals, Principles in normal OS for security, Access Control models and methods.

Textbooks/References

1. "Operating System Concept", by Abraham Silberschatz, Peter, Baer Galvin, Greg Gagne, Edition 9, 2015, Wiley India.
2. "An Introduction to Operating Systems: Concepts and Practice", Pramod Bhatt , P. Chandra, Edition 5, 2019, PHI Learning Private Limited.
3. "Operating Systems: Internals and Design Principles", William Stallings, Edition 8, 2015, Pearson.
4. "Modern Operating Systems", Andrew S. Tanenbaum, Herbert Bos, Edition 4, 2015, Pearson.
5. "Operating Systems, Dhananjay M. Dhamdhere, Edition 2, 2008Tata McGraw-Hill Pub.

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1 (20 Marks)	2 (20 Marks)	
Remember	-	-	-
Understand	10		20
Apply	10	20	30
Analyse			20
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	50	50	3 hours

Continuous Internal Evaluation Pattern:

Continuous Assessment Test (2 numbers) : 40 marks
Assignment/Quiz/Course project : 10 marks

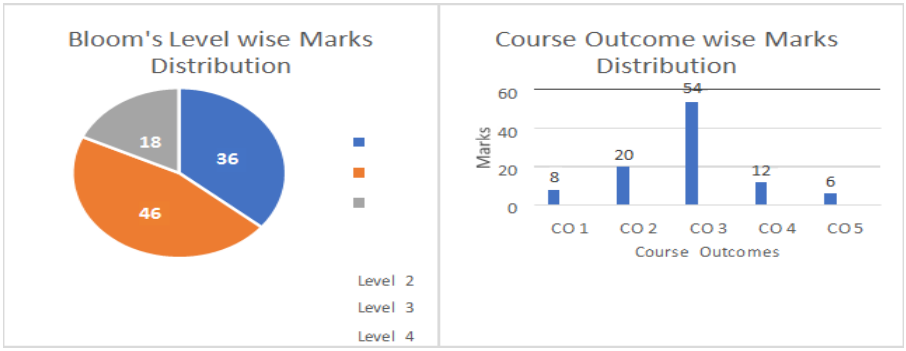
End Semester Examination Pattern **:** Sample QP

Sample Question Paper
Course: Operating System

Maximum Marks: 50 **Time: 03hours**

Answer any 5 questions
Each question carries 10 marks

Q.No	Questions	Marks	CO	BL	PI
1	1. What is an Operating System? Explain the Functions of Operating System?	10	CO1	L2	1.4.1
2	1. Write short note on Critical section problem 2. Explain the concept of semaphore?	10	CO2	L3	1.4.1
3	1. What is Deadlock? What are the four necessary conditions for Deadlock? What is the difference between deadlock prevention and deadlock avoidance?	10	CO3	L3	1.4.1
4	Differentiate between Internal fragmentation and External Fragmentation? Explain the concept of Segmentation?	10	CO4	L4	1.4.1
5	Explain different Directory structures? Different File allocation methods?	10	CO3	L2	1.4.1
6	Explain the working of Access Control Matrix for providing protection.	10	CO5	L2	1.4.1
7	With a neat diagram explain different states of a process	5	CO1	L4	1.4.1



BL - Bloom's Taxonomy Levels : (1- Remembering, 2 - Understanding, 3 - Applying, 4 - Analysing, 5 - Evaluating, 6 - Creating)
CO Course Outcomes
PO Program Outcomes
PI Code Performance Indicator Code

Course Contents and Lecture Schedule

No	Topic	No. of Lecture Hours
1	**Unit 1** **10 hours**	
1.1	Introduction to Operating Systems, Functions of Operating System Design Approaches and Types of Advanced Operating Systems.	1 Hour
1.2	Dual-mode operation, concept of multiprogramming, multiprocessing	1 Hour
1.3	Synchronization Mechanisms: Concept of Processes and Threads, Process states and processes state transition diagram, Process control block, process context,	4 Hours
1.4	CPU Scheduling and Process Scheduling	2 Hours
1.5	The Critical Section Problem – Other Synchronization Problems: – Process Synchronization using semaphores & Monitors.	2 Hours
2	**Unit II** **8 hours**	
2.1	Distributed Operating Systems: - Issues in Distributed Operating System	1 Hours
2.2	Deadlock prevention, avoidance and detection & recovery	4 Hours
2.3	Dead Lock Characterization, Methods for handling Deadlock	3 Hours
3	**Unit III** **10 hours**	
3.1	Memory Management - Types of memory,	2 Hours
3.2	Memory organization, Address binding Memory Partitioning,	2 Hours
3.3	Dynamic memory Partitioning, buddy system	2 Hours
3.4	Paging, Demand Paging, Segmentation,	2 Hours
3.5	Page replacement algorithms.	2 Hours
4	**Unit IV** **10 hours**	
4.1	File System	1Hours
4.2	Directory structure - single level, two-level, tree,	2 Hours
4.3	acyclic graph, general graph; File system mounting,	2 Hours
4.4	Implementing File System,File system structure - Layered file system, file attributes,	2 Hours
4.5	File control block; File system implementation Directory Implementation, Allocation Methods	3 Hours
5	**Unit V** **7 hours**	
5.1	Security and Protection	1 Hours
5.2	Goals, Principles in normal OS for security,	2 Hours
5.3	Access Control models and methods.	4 Hours

22-359-0103 DATA STRUCTURES AND ALGORITHMS

22-359-0103	DATA STRUCTURES AND ALGORITHMS	CATEGORY	L	T	P	CREDIT
		CORE	3	1	0	4

Prerequisite: Basic concepts related to data

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

CO 1	Describe complexity analysis of algorithms.	(Cognitive level: Understand)
CO 2	Implement advanced versions of Queue, tree and heap data structures.	(Cognitive level: Apply)
CO 3	Implement data structures for disjoint sets.	(Cognitive level: Apply)
CO 4	Apply the advanced data structures in domain specific application areas.	(Cognitive level: Apply)
CO 5	Implement various algorithm design techniques for specific applications.	(Cognitive level: Apply)

Mapping of course outcomes with program outcomes - Low=1, medium=2, High=3

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO 1	3	3					1						2	
CO 2	3	3	3				1						3	
CO 3	3	3	3										2	
CO 4	3	3	3				1							1
CO 5	3	3	3				1						3	

Syllabus

UNIT I (8 Hours)

Algorithm Analysis - Mathematical Background – Time and Space Complexity of Algorithms – Computational and Asymptotic Complexity, Best average and Worst case Analysis, Asymptotic Notations – Big O, Big and Big ω, Running time calculations – ɵ General Rules, Solutions for the Maximum Subsequence Sum Problem, Logarithms in Running time.

UNIT II (10 Hours)

Queues - Single and Double Ended Priority Queues, Trees - Threaded Binary Trees, Selection Trees, Forests and binary search trees, Counting Binary Trees, Red-Black Trees, Splay Trees, Suffix Trees, Digital Search Trees, Tries- Binary Tries, Multiway Tries, k-d Trees, Point Quadtrees.

UNIT III (10 Hours)

Heaps - Skew Heaps, Binomial Heaps, Fibonacci Heaps, Pairing Heaps, Symmetric MinMax Heaps, Interval Heaps, Data Structures for Disjoint Sets, Disjoint-set operations, Linked-list representation of disjoint sets, Disjoint-set, forests, Analysis of union by rank with path compression, Medians and Order Statistics, Minimum and maximum, Selection in expected linear time, Selection in worst-case linear time.

UNIT IV (8 Hours)

Maximum Flow-Flow Networks, Ford-Fulkerson method-analysis of Ford-Fulkerson, Edmonds-Karp algorithm, Maximum bipartite matching, Bi-connected Components, Finding strong components. Computational Geometry- Line segment properties, Finding the convex hull, Finding the closest pair of points, Skip lists.

UNIT V (9 Hours)

Algorithm Design Techniques - Greedy Algorithm – Scheduling problem, Huffman codes, approximate bin packing, Divide and Conquer – Closest points problem, Selection problem, Dynamic Programming – All pairs shortest path.

Textbooks/References

1. Fundamentals of Data Structures in C", by Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, Edition 2, 2007, Silicon Press.
2. "Introduction to Algorithms", by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, Edition 3, 2009, The MIT Press.
3. "Data Structures and Algorithm Analysis in C", by Mark Allem Weiss, Edition 2, 2002, Pearson.
4. Data Structures using C and C++, by Yedidyah Langsam , Moshe J. Augenstein, Aaron M. Tenenbaum, Edition 2, 2006, Pearson.
5. Introduction to Design and Analysis, by Sara Baase & Allen Van Gelder, Edition 3, 2000, Pearson.

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1 (20 Marks)	2 (20 Marks)	
Remember	-	-	-
Understand	10	10	20
Apply	10		30
Analyse		10	20
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	50	50	3 hours

Continuous Internal Evaluation Pattern:

Continuous Assessment Test (2 numbers) : 40 marks
Assignment/Quiz/Course project : 10 marks

End Semester Examination Pattern : Sample Question Paper

22-359-0104 PYTHON FOR DATA ANALYTICS

22-359-0104	PYTHON FOR DATA ANALYTICS	CATEGORY	L	T	P	CREDIT
		CORE	3	1	0	4

Prerequisite: Basic concepts related to data

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

CO 1	Describe the basics of machine learning and Data Science libraries.	(Cognitive level : understand)
CO 2	Apply sci-kit learn for machine learning	(Cognitive level : Apply)
CO 3	Analyse data using visualisations techniques and python matplotlib.	(Cognitive level : Analyse)
CO 4	Analysis of data with Jupyter notebooks, numpy, pandas etc.	(Cognitive level : Analyse)
CO 5	Evaluate The performance of Supervised learning algorithms in standard datasets.	(Cognitive level : Evaluate)

Mapping of course outcomes with program outcomes - Low=1, medium=2, High=3

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1		1		2		2	2					1	
CO 2	3		1		2		2	2					3	3
CO 3	2	2	2		2		2	2					3	3
CO 4	2		2		3		2	2					3	3
CO 5	3	2	2	3	3		2	2					3	3

Syllabus

UNIT I [8 Hours]

An Introduction to Data Analysis: Knowledge Domains of the Data Analyst, Understanding the Nature of the Data, The Data Analysis Process, Quantitative and Qualitative Data Analysis, Introduction to data analytics using Python - The Interpreter, Python Distributions, IPython, PyPI - The Python Package Index, The IDEs for Python, SciPy.

UNIT II [10 Hours]

The NumPy Library, Ndarray, Basic Operations, Indexing, Slicing and Iterating, Conditions and Boolean Arrays, Shape Manipulation, Array Manipulation, Structured Arrays, Reading and Writing Array Data on Files the Pandas Library - An Introduction, Introduction to Pandas Data Structures, Other Functionalities on Indexes, Operations between Data Structures, Function Application and Mapping, Sorting and Ranking, Correlation and Covariance, "Not a Number" Data, Hierarchical Indexing and Levelling.

UNIT III [7 Hours]

Pandas: Reading and Writing Data, Reading and Writing HTML Files, Reading Data from XML, Reading and Writing Data on Microsoft Excel Files, JSON Data, The Format HDF5, Pickle—Python Object Serialization, Interacting with Databases, Reading and Writing Data with a NoSQL Database: MongoDB pandas in Depth: Data Manipulation - Data Preparation, Concatenating, Data Transformation, Discretization and Binning, Permutation, String Manipulation, Data Aggregation, Group Iteration, Advanced Data Aggregation.

UNIT IV [10 Hours]

Data Visualization with matplotlib - The matplotlib Library, matplotlib Architecture, pyplot, Using the kwargs, Adding Further Elements to the Chart and Saving Charts, Handling Date Values, Line Chart, Histogram, Bar Chart, Pie Charts, Advanced Charts, mplot3d, MultiPanelPlots Machine Learning with scikit-learn: The scikit-learn Library, Machine Learning: Supervised and Unsupervised Learning, Training Set and Testing Set.

UNIT V [10 Hours]

Supervised Learning with scikit-learn, The Iris Flower Dataset - The PCA Decomposition, K-Nearest Neighbors Classifier, Diabetes Dataset, Linear Regression: The Least Square Regression Support Vector Machines (SVMs), Support Vector Classification (SVC), Nonlinear SVC, Plotting Different SVM Classifiers Using the Iris Dataset, Support Vector Regression (SVR) An Example- Recognizing Handwritten Digits- Handwriting Recognition, Recognizing Handwritten Digits with scikit-learn, The Digits Dataset, Learning and Predicting.

Textbooks/References

1. "Python Data Analytics Data Analysis and Science Using Pandas, Matplotlib, and the Python Programming Language", by Fabio Nelli, Edition 1, 2015, Apress.
2. "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Ipython", by William McKinney, Edition 2, 2017, Shroff/O'Reilly.
3. "Data Analysis with Python: A Modern Approach",by David Taieb, Edition 1, 2018, Packt Publishing".

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1 (20 Marks)	2 (20 Marks)	
Remember	-	-	-
Understand	10	10	20
Apply	10		30
Analyse		10	20
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	50	50	3 hours

Continuous Internal Evaluation Pattern:

Continuous Assessment Test (2 numbers) : 40 marks

Assignment/Quiz/Course project : 10 marks

End Semester Examination Pattern ` : Sample QP

22-359-0105 MATHEMATICS FOR MACHINE LEARNING

	CATEGORY	L	T	P	CREDIT
MATHEMATICS FOR MACHINE LEARNING	**CORE**	3	1	0	4

Prerequisite: Nil

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

CO 1	Solve the system of Linear equations using various methods.	(Cognitive level: Apply)
CO 2	Explain the basics of Vectors, Spaces and Affine Spaces	(Cognitive level: Understand)
CO 3	Evaluate similarity between two vectors.	(Cognitive level: analyse)
CO 4	Apply different methods to find the Inverse, Rank of a Matrix and Eigenvalues and Eigenvectors	(Cognitive level: Apply)
CO 5	Apply PCA for Dimensionality reduction and Gaussian Mixture Models for Density estimation	(Cognitive level: Apply)

Mapping of course outcomes with program outcomes - Low=1, Medium=2, High=3

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	3				1						3	
CO 2	3	1	1				1						1	
CO 3	3	3	3										2	
CO 4	3	3	3				1						3	
CO 5	3	3	3				1						3	1

Syllabus

UNIT I [8 Hours]

Linear Algebra – System of Linear equations, Matrices, Solving System of Linear equations, Linear Independence, Vector Spaces , Basis, Rank, Linear mapping, Scalars, Addition, Scalar multiplication, dot product, vector projection, cosine similarity.

UNIT II [10 Hours]

Orthogonal Vectors, Normal and Orthonormal Vectors, Vector Norm, Vector Space, Linear Combination, Basis of Vectors, Affine Spaces.

UNIT III [7 Hours]

Matrices - Determinant, Identity matrix, Inverse of a matrix, Rank of a matrix, Nullity , Trace of a matrix, Eigen values, Eigen vectors, Matrix decompositions. Matrix transformations.

UNIT IV [10 Hours]

Differentiation, Rules of Differentiation, Derivatives, Scalar Derivatives, Partial derivatives, Principal Component analysis – Concepts and properties. Dimensionality reduction with PCA.

UNIT V [10 Hours]

Differentiation of univariate functions, Partial differentiation and gradients, Gradient of vector valued function. Gradient matrices. Optimization using gradient functions, Constrained optimization, and Lagrange multipliers. Convex optimization. Density Estimation with Gaussian Mixture Models.

Textbooks/References

1. “Mathematics for Machine Learning”, by A. Aldo Faisal, Cheng Soon Ong, and Marc Peter Deisenroth, Edition 1, 2020, Cambridge University Press.
2. “Advanced Engineering Mathematics”, by Erwin Kreyszig, Edition 10, 2018, Wiley.
3. Higher Engineering Mathematics, B.S Grewal, 44th Edition, 2018, Khanna Publishers.

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1 (20 Marks)	2 (20 Marks)	
Remember	-	-	-
Understand	10	10	20
Apply	10		30
Analyse		10	20
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	50	50	3 hours

Continuous Internal Evaluation Pattern:

Continuous Assessment Test (2 numbers) : 40 marks

Assignment/Quiz/Course project : 10 marks

End Semester Examination Pattern : Sample QP

22-359-0106 PYTHON PROGRAMMING LAB

22-359-0106	PYTHON PROGRAMMING LAB	CATEGORY	L	T	P	CREDIT
		Lab			4	2

Prerequisite: Basic Programming

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

CO 1	Explain programming basics and program design with functions using Python programming language.	(Cognitive level : Understand)
CO 2	Apply Object Oriented concepts, Database and GUI.	(Cognitive level :Apply)
CO 3	Apply different libraries for Machine Learning.	(Cognitive level :Apply)
CO 4	Analyse different datasets	(Cognitive level :Analyse)
CO 5	Analyse data using visualisation techniques	(Cognitive level :Analyze)

Mapping of course outcomes with program outcomes -Low=1, medium=2, High=3

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PO 1**	**PSO 2**
CO 1	1		1		2		2	2					1	
CO 2	3		1		2		2	2					3	3
CO 3	2	2	2		2		2	2					3	3
CO 4	2		2		3		2	2					3	3
CO 5	3	2	2	3	3		2	2					3	3

Experiment

1. Write a Python program to check the validity of a password given by the user. The Password should satisfy the following criteria: 1. Contains at least one letter between a and z 2. Contains at least one number between 0 and 9 3. Contains at least one letter between A and Z 4. Contains at least one special character from $, #, @ 5. Minimum length of password: 6 **2 Hours**

2. Write a program to demonstrate different number data types in Python. And Write a program to perform different Arithmetic Operations on numbers in Python **2 Hours**

3. Write a Python program to construct the following pattern, using a nested for loop

```
*
* *
* * *
* * * *
* * * * *
* * * * * *
```

2 Hours

4. Write a Python class named Circle constructed by a radius and two methods which will compute the area and the perimeter of a given circle

2 Hours

5. 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 codes using Pandas to

1) Clean and Update the CSV file
2) Print total cars of all companies
3) Find the average mileage of all companies
4) Find the highest priced car of all companies

2 Hours

6. Write a Python program to add two matrices and find the transpose of the resultant matrix.

1 Hour

7. Write a Python program to create a function called list_of_frequency that takes a string and prints the letters in non-increasing order of the frequency of their occurrences. Use dictionaries.

1 Hour

8. Write a Python program to read a list of numbers and sort the list in a nondecreasing order without using any built in functions. Separate function should be written to sort the list wherein the name of the list is passed as the parameter.

2 Hours

9. Given the sales information of a supermarket as a CSV file with the following fields month_number, Soap, facewash, toothpaste, shampoo, moisturiser, total_units, total_profit.

Write Python codes to visualise the data as follows

1) Toothpaste sales data of each month and show it using a scatter plot 2) Soap and face wash product sales data and show it using the bar chart

3) Calculate total sale data for last year for each product and show it using a Pie chart.

2 Hours

10. Write a script named copyfile.py. This script should prompt the user for the names of two text files. The contents of the first file should be input and written to the second file.Write a program that inputs a text file. The program should print all of the unique words in the file in alphabetical order

2 Hours

11. Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample **6 Hours**

12. Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets **4 Hours**

13. Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions. Java/Python ML library classes can be used for this problem. **4 Hours**

Textbooks/References

1. "Python Data Analytics Data Analysis and Science Using Pandas, Matplotlib, and the Python Programming Language", by Fabio Nelli, Edition 1, 2015, Apress.
2. "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Ipython", by William McKinney, Edition 2, 2017, Shroff/O'Reilly.
3. "Data Analysis with Python: A Modern Approach", by David Taieb, Edition 1, 2018, Packt Publishing".
4. "Artificial Intelligence with Python: A Comprehensive Guide to Building Intelligent Apps for Python Beginners and Developers", by Prateek Joshi, Edition 1, 2017, Packt Publishing Limited.

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1 (20 Marks)	2 (20 Marks)	
Remember	-	-	-
Understand			-
Apply	20	20	-
Analyse			-
Evaluate			-
Create			-

Mark distribution

Total Marks	CIE	ESE	ESE Duration
50	50	-	-

Continuous Internal Evaluation Pattern:

Continuous Assessment Test (2 numbers)	: 40 marks
Assignments	: 10 marks

22-359-0107 DATA STRUCTURES AND ALGORITHMS LAB

22-359-0107	DATA STRUCTURES AND ALGORITHMS LAB	CATEGORY	L	T	P	CREDIT
		LAB	0	0	4	2

Prerequisite: Basic programming

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

CO 1	Apply elementary data structures, Nonlinear data structures and binary search tree using C.	(Cognitive level: Apply)
CO 2	Implement Heap and Graph operations using C.	(Cognitive level: Apply)
CO 3	Implement data structures for disjoint sets.	(Cognitive level: Apply)
CO 4	Apply Greedy algorithms.	(Cognitive level: Apply)
CO 5	Apply dynamic programming to find the shortest path.	(Cognitive level: Apply)

Mapping of course outcomes with program outcomes - Low=1, medium=2, High=3

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3					1						1	
CO 2	3	3					1						2	
CO 3	3	3											1	
CO 4	3	3	2				1						2	
CO 5	3	3	2				1						2	

Experiment

1. Implementation of Polynomials and Sparse matrices using arrays **2 Hours**
2. Implementation of Stack , Queues, Priority Queues, DEQUEUE and Circular Queues using arrays **2 Hours**
3. Implementation of various linked list operations. **2 Hours**
4. Implementation of stack, Queue and Trees using linked list **2 Hours**
5. Implementation of binary trees, binary search trees, Heap and Graph using linked lists and arrays. Perform creations, insertion, deletion and traversal. **6 Hours**
6. Implement linear search and binary search algorithms. **2 Hours**
7. Implementation of hash table using your own mapping functions and observe collisions and overflow resolving schemes **4 Hours**
8. The details of students (number, name, total-mark) are to be stored in a linked list. Write functions for the following operations:
    - **a.** 1.Insert
    - **b.** 2.Delete
    - **c.** 3.Search
    - **d.** 4.Sort on the basis of number
    - **e.** 5.Display the resultant list after every operation **2 Hours**
9. Represent any graph and Perform
    - **a.** Depth first search
    - **b.** Breadth first search **2 Hours**
10. Write a program to find the shortest path from a given graph **2 Hours**
11. Write a program to obtain shortest path from a given graph based on Digkstra's algorithm. **2 Hours**
12. Write a program to compute the number of collisions required in a long random sequence of insertions into a hash table (with some suitable hash function) using:
    a. Linear probing,
    b. Quadratic probing,
    c. Double hashing

Textbooks/References

1. Fundamentals of Data Structures in C", by Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, Edition 2, 2007, Silicon Press.
2. "Introduction to Algorithms", by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, Edition 3, 2009, The MIT Press.
3. "Data Structures and Algorithm Analysis in C", by Mark Allem Weiss, Edition 2, 2002, Pearson.
4. Data Structures using C and C++, by Yedidyah Langsam , Moshe J. Augenstein, Aaron M. Tenenbaum, Edition 2, 2006, Pearson.
5. Introduction to Design and Analysis, by Sara Baase & Allen Van Gelder, Edition 3, 2000, Pearson.

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1 (20 Marks)	2 (20 Marks)	
Remember	-	-	-
Understand			-
Apply	20	20	-
Analyse			-
Evaluate			-
Create			-

Mark distribution

Total Marks	CIE	ESE	ESE Duration
50	50	-	-

Continuous Internal Evaluation Pattern:

Continuous Assessment Test (2 numbers) : 40 marks
Assignments : 10 marks

22-359-0201 NETWORKS AND DATA COMMUNICATIONS

22-359-0201	NETWORKS AND DATA COMMUNICATIONS	CATEGORY	L	T	P	CREDIT
		CORE	3	1	0	4

Prerequisite: Nil

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

CO 1	Describe how computer networks are organised with the concept of layered approach.	(Cognitive level : Understand)
CO 2	Analyse topological and routing strategies for an IP based network.	(Cognitive level : Analyze)
CO 3	Compare protocols of computer networks, and how they can be used to assist in network design and implementation.	(Cognitive level : Analyze)
CO 4	Analyze congestion and flow control strategies.	(Cognitive level : Analyze)
CO 5	Implement network communication services for client/server and other application layouts (Create).	(Cognitive level : Analyze)

Mapping of course outcomes with program outcomes - Low=1, medium=2, High=3

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2	2												
CO 2	2	2											2	
CO 3	3	3											2	1
CO 4	2	2											2	1
CO 5	2	2			3								2	2

Syllabus

UNIT I (8 Hours)

Introduction, History And Development Of Computer Networks, Network Topologies. Layering And Protocols. Physical Layer: Different Types of Transmission Media, Errors In Transmission: Attenuation, Noise. Repeaters. Encoding (Nrz, Nrzi, Manchester, 4b/5b, Etc.), Mac Layer: Aloha, Csma, Csma/Cd, Csma/Ca Protocols. Examples: Ethernet, Including Gigabit Ethernet And Wifi (802.11), Token Ring, Bluetooth, Wimax.

UNIT II (10 Hours)

The Services Provided by the Link Layer, Error-Detection And - Correction Techniques -Parity Checks, Checksumming Methods, Cyclic Redundancy Check (Crc), Switched Local Area Networks-Link-Layer Addressing And Arp, Ethernet, Link-Layer Switches, Virtual Local Area Networks (Vlans), Wireless Links And Network Characteristics-Cdma, 802.11 Architecture, 802.11 Mac Protocol, Ieee 802.11 Frame, Mobility In The Same Ip Subnet

UNIT III (10 Hours)

IPv4 and IPv6 Addressing, IP Address – Subnetting / Super Netting, Packet Forwarding with Classfull, Routing Algorithms - The Link-State (LS) Routing Algorithm, Distance-Vector (DV) Routing Algorithm, OSPF, Routing Among the ISPs: BGP-The Role of BGP, Advertising BGP Route Information, Determining the Best Routes, IP-Anycast, SDN Control Plane - SDNController and SDN Control Applications, Open Flow Protocol, Data and Control Plane Interaction, ICMP: The Internet Control Message Protocol, Simple Network Management Protocol (SNMP).

UNIT IV (8 Hours)

Transport-Layer Services, Multiplexing and Demultiplexing, Connectionless Transport-UDP Segment Structure, UDP Checksum, Principles of Reliable Data Transfer, Building a Reliable Data Transfer Protocol, Pipelined Reliable Data Transfer Protocols, Go-Back-N (GBN), Selective Repeat, Connection-Oriented Transport, TCP Connection, TCP Segment Structure, Round-Trip Time Estimation and Timeout, Reliable Data Transfer, Flow Control, TCP Connection Management, Principles of Congestion Control, Causes and the Costs of Congestion, Congestion Control, TCP Congestion Control, Classic TCP Congestion Control, Network - Assisted Explicit Congestion Notification and Delay-based Congestion Control, Fairness.

UNIT V (9 Hours)

Principles of Network Applications - Network Application Architectures, Processes Communicating, Transport Services Available to Applications, Transport Services Provided by the Internet, Application - Layer Protocol, Web and HTTP, Electronic Mail in the Internet-SMTP, DNS - The Internet’s Directory Service, Peer-to-Peer Applications, Video Streaming and Content Distribution Networks, Socket Programming: Creating Network Applications

Textbooks/References

1. "Computer Networking, Global Edition", by James Kurose & Keith Ross, Edition 8, 2021, Pearson.
2. "Computer Networks, Global Edition", by Andrew Tanenbaum, Nick Feamster, David Wetherall, Edition 6, 2021, Pearson.
3. "Data and Computer Communications", by William Stallings, Edition 10, 2017, Pearson.
4. "TCP/IP Illustrated, Volume 3: TCP for Transactions, HTTP, NNTP, and the UNIX Domain Protocols", by W. Richard Stevens, Edition 3, 1996, Addison Wesley.

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1 (20 Marks)	2 (20 Marks)	
Remember	-	-	-
Understand	10	10	20
Apply	10		30
Analyse		10	20
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	50	50	3 hours

Continuous Internal Evaluation Pattern:

Continuous Assessment Test (2 numbers) : 40 marks
Assignment/Quiz/Course project : 10 marks

End Semester Examination Pattern : Sample QP

22-359-0202 DATABASE MANAGEMENT SYSTEMS

22-359-0202	DATABASE MANAGEMENT SYSTEMS	CATEGORY	L	T	P	CREDIT
		CORE	3	1	0	4

Prerequisite: Nil

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

CO 1	Employ ER diagram as a data modelling technique to represent entity framework.	(Cognitive level: Apply)
CO 2	Solve database queries using SQL and various database designs using logical database design principles including functional dependencies and normalisation.	(Cognitive level: Apply)
CO 3	Explain the concepts of a database transaction and related database facilities (concurrency control and deadlock handling).	(Cognitive level: Understand)
CO 4	Describe the primary methods of organising files of records on disk and the indexing techniques for files including B+ tree indexing and hash based indexing.	(Cognitive level: Understand)
CO 5	Compare various types of databases including OODBMS, Distributed database, NOSQL Databases and Blockchain Database.	(Cognitive level: Analyse)

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2	2	1										1	
CO 2	3	2	2										2	1
CO 3	1	2			1								1	
CO 4	3	3											2	1
CO 5	2		2		3								2	2

Syllabus

UNIT I (10 Hours)

Introduction: - Database-System Applications -Purpose of Database Systems- View of Data- Database Languages-Database design -Database Users and Administrators- History of Database Systems. Introduction to the Relational Model: Structure of Relational Databases- Database Schema- Key- Schema Diagrams. The Entity-Relationship Model-Attribute types- Mapping cardinalities- Weak Entity Set- Reducing E-R Diagrams to Relational Schemas.

UNIT II (12 hrs)

Relational Algebra- SQL Data Definition- Basic Structure of SQL Queries- Additional Basic

Operations- Set Operations- Aggregate Functions- Nested Subqueries- Modification of the Database – Views – Integrity and Security – triggers, cursor, functions, procedure – Embedded SQL. Relational Database Design: Features of Good Relational Designs- Decomposition Using Functional Dependencies- Normal Forms(1NF, 2NF, 3NF, BCNF).

UNIT III (8 hrs)

Transaction concept – A Simple Transaction Model- ACID Properties- Serializability – testing Serializability- Concurrency Control – Locks- Two Phase locking – Deadlock handling – Timestamp based protocol, Recovery concepts.

UNIT IV (8 hrs)

Overview of Physical Storage Media- Database Storage Architecture - File Organisation - Organisation of records in files, Indexing - Basic Concepts- Ordered Indices - B + - Tree Index Files - Hash Indices.

UNIT V (7 hrs)

Object-Oriented Databases - Distributed databases - Distributed Data Storage, Introduction to NOSQL Systems, Document-based NOSQL Systems and MongoDB

Textbook/References

1. "Database System Concepts", by Abraham Silberschatz, Henry F. Korth, S. Sudarshan, Edition 6, 2010, McGraw Hill.
2. "Fundamentals of Database Systems", by Elmasri Ramez & Navathe Shamkant, Edition 7, 2017, Pearson.
3. "Database Management Systems", Arun K Majumdar, Pritimoy Bhattacharyya, Edition 1, 2017, McGraw Hill.
4. "Database Management Systems", Raghu Ramakrishnan & Johannes Gehrke, Edition 3, 2002, McGraw Hill.

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1 (20 Marks)	2(20 Marks)	
Remember	-	-	-
Understand	4	4	20
Apply	8	8	30
Analyse	8	8	20
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	50	50	3 hours

Continuous Internal Evaluation Pattern:
Continuous Assessment Test (2 numbers) : 40 marks
Assignment/Quiz/Course project : 10 marks

End Semester Examination Pattern **:** Sample QP

.

22-359-0203 R FOR DATA ANALYTICS

22-359-0203	R FOR DATA ANALYTICS	CATEGORY	L	T	P	CREDIT
		CORE	3	1	0	4

Prerequisite: Basic concepts related to data

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

CO 1	Describe the basics of R language	(Cognitive level: Understand)
CO 2	Solve problems related to classification and clustering using R tool and employ commercially available dataset for clustering, association rule mining, text mining and classification using R language.	(Cognitive level: Apply)
CO 3	Apply association rule mining methods using R language.	(Cognitive level: Apply)
CO 4	Interpret data using visualisation techniques in R	(Cognitive level: Apply)
CO 5	Develop applications for predicting various useful information	(Cognitive level: Create)

Mapping of course outcomes with program outcomes - Low=1, medium=2, High=3

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO 1	2	2											2	2
CO 2	2	2	3	3	3								3	3
CO 3	3	3	3	2	2								2	2
CO 4	2	2	3	3	3								3	3
CO 5	2	2	3	3	3								2	2

Syllabus

UNIT I (8 Hours)

R Introduction: Advantages of R over other programming languages, R studio, Expressions, variables, functions in R, Control structures in R, Data structures in R: Vectors, List, Factors, Matrix, Arrays, Data frames. Data: Different types of data, Quality of data, Methods for reading data into Rstudio: CSV and spreadsheets, reading data from packages, Reading data from Web/API,s, Reading from a JSON document, Reading a XML file, Importing data from SQL databases,. Preprocessing: basic preprocessing methods, Data pre-processing using R: Finding the missing values, Invalid values, and outliers.

UNIT II (10 Hours)

Data Visualization: Data visualization tools in market, box plots, qqplot, histogram, Scatter Plot, Bar & Stack Bar Chart, Box Plot, Area Chart, Heat Map, Correlogram. Plotting with base graphics, Plotting with Lattice graphics, Plotting and coloring in R. Data summary statistics using R: Data Range, Frequencies and Mode, Mean and median, Measuring spread, Variance and Standard deviation. Time series data: Reading time series data, plotting time series data, decomposing time series data, Forecasts using exponential smoothing.

UNIT III (10 Hours)

Classification in R: Nearest Neighbors classifier, Naïve Bayes classifier, Decision tree: terminologies associated with decision tree, decision tree representation in R, appropriate problems for decision tree learning, basic decision tree algorithm, Measuring features, Issues in Decision tree learning. Forecasting Numeric data- Regression methods, neural networks classifiers. Evaluating Model performance: Measuring performance for classification, Estimating future performance. Improving model performance with meta learning

UNIT IV (8 Hours)

Association rules mining in R: Frequent itemset, data structure overview, Apriori algorithm for association rule learning,measuring rule interest- support and confidence,building a set of rules with the Apriori principle, Mining algorithm interfaces in R, Auxiliary functions, Sampling from transactions.

Text mining in R: Definition of text mining, Challenges in text mining, Text mining v/s data mining, Text mining in R, General architecture of text mining systems, Pre-processing of documents in R, Core Text mining operations, Mining frequent patterns, associations and correlations, frequent item sets, closed item sets and association rules, frequent item sets mining methods, Pattern evaluation methods.

UNIT V (9 Hours)

Clustering in R: Basic concepts in clustering, Types of clustering, types of clusters, Hierarchical clustering, K-means clustering, CURE algorithm.

Textbooks/References

1. "Data Analytics using R", by Seema Acharya, Edition 1, 2018, McGrawHill.
2. "Machine Learning with R: Expert techniques for Predictive Modelling", by Brett Lantz, Edition 3, 2019, Packt Publishing Limited.
3. "Data Analytics with R", by Bharti Motwani, Edition 1, 2019, Wiley.
4. "R Programming for Data Science", by Roger D. Peng, Edition 1, 2012, Lulu.com
5. "R Programming for Dummies", Andrei de Vries, Joris Meys, Edition 2, 2016, Wiley.
6. "R Programming for Beginners", Sandip Rakshit, Edition 1, 2017, McGrawHill

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1 (20 Marks)	2(20 Marks)	
Remember	-	-	-
Understand	10	10	20
Apply	10		30
Analyse		10	20
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	50	50	3 hours

Continuous Internal Evaluation Pattern:
Continuous Assessment Test (2 numbers) : 40 marks
Assignment/Quiz/Course project : 10 marks

End Semester Examination Pattern : Sample QP

22-359-0204 MACHINE LEARNING

22-359-0204	MACHINE LEARNING	CATEGORY	L	T	P	CREDIT
		CORE	3	1	0	4

Prerequisite: Nil

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

CO 1	Describe various Data Reduction and transformation methods.	(Cognitive level : Understand)
CO 2	Apply association rule mining algorithms for frequent pattern mining.	(Cognitive level : Apply)
CO 3	Apply various Regression,classification and clustering algorithms.	(Cognitive level : Apply)
CO 4	Compare the performance of various Machine Learning algorithms.	(Cognitive level : Analyze)
CO 5	Solve problems related to Neural Networks and Deep Neural Networks.	(Cognitive level : Apply)

Mapping of course outcomes with program outcomes - Low=1, medium=2, High=3

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO 1	2	2											2	2
CO 2	2	2	3	3	3								3	3
CO 3	3	3	3	2	2								2	2
CO 4	2	2	3	3	3								3	3
CO 5	2	2	3	3	3								2	2

Syllabus

UNIT I (10 Hours)

Foundations of Learning - Components of learning - learning versus design - Introduction to

Machine Learning characteristics of machine learning – learning models - types of learning– training versus testing; Exploratory Data Analysis – mean, median, mode, quartile deviation, visualizing numeric variables – boxplots histograms, understanding categorical data – binomial and multinomial distributions, understanding numeric data – uniform, normal and chi-square distributions, Data Pre-processing - Data Cleaning, Missing Values, outliers, Noisy Data; Data Transformation and Discretization - Data Transformation Strategies, Data transformation by Normalization, various methods of Discretization.

UNIT II (8 Hours)

Association rule mining - Associations, and correlations, Market Basket Analysis, Frequent Itemsets and Association Rules, Mining Methods – The Apriori Algorithm, Generating Association Rules from Frequent Itemsets, Finding Frequent Itemsets without Candidate Generation, FP-Growth, FP-Tree.

UNIT III (10 Hours)

Regression and Classification - Regression – Simple Linear Regression, Multiple Regression, Assessing Performance, bias variance dichotomy, overfitting and underfitting, regularization. Classification- Decision tree induction, Bayes Classification, Rule Based Classification, Model evaluation and selection, Advanced Classification methods – Bayesian classification, Support Vector Machines. Ensemble methods of classification, gradient boosting.

UNIT IV (8 Hours)

Cluster Analysis - Overview of Clustering Methods, Distance Measures, Partitioning methods - k-Means, k-Medoids; Hierarchical methods - Agglomerative versus Divisive Clustering, BIRCH, Chameleon, Density based methods.

UNIT V (9 Hours)

Neural Networks - Biological neuron, idea of computational units, McCulloch–Pitts unit and Threshold logic, Linear Perceptron, Multilayer Perceptron, Perceptron Learning Algorithm, Linear separability; loss functions – various types, hyper parameter tuning, Feed Forward Neural Networks, Forward propagation, activation functions and its derivatives, backpropagation and optimization functions, batch normalization, implementation.

Textbooks/References

1. "Machine Learning with R", by Brett Lantz**,** Edition 3, 2019, Packt Publishing Limited
2. "Introduction to Machine Learning", by Ethem Alpaydin, Edition 3, 2020, MIT Press.

3. "Data Mining Concepts and Techniques", by Jiawei Han, Micheline Kamber, Jian Pei Professor, Edition 3, 2000,
4. "Hands-On Machine Learning with Scikit-Learn, Keras", and TensorFlow", by Aurélien Géron, Edition 2, 2019, O'Reilly Media, Inc.
5. "Machine Learning Algorithms", by Giuseppe Bonaccorso, Edition 2, 2020, Packt Publishing Limited.
6. "Machine Learning, An Algorithmic Perspective", by Stephen Marsland, Edition 2, Taylor & Francis.

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1 (20 Marks)	2 (20 Marks)	
Remember	-	-	-
Understand	10	10	20
Apply	10		30
Analyse		10	20
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	50	50	3 hours

Continuous Internal Evaluation Pattern:

Continuous Assessment Test (2 numbers) : 40 marks
Assignment/Quiz/Course project : 10 marks

End Semester Examination Pattern : Sample QP

22-359-0206 DATA ANALYTICS LAB (ML AND R)

22-359-0206	DATA ANALYTICS LAB (ML and R)	CATEGORY	L	T	P	CREDIT
		LAB	0	0	4	2

Prerequisite: Basic concepts related to data

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

CO 1	Describe the basics of R language.	(Cognitive level: Understand)
CO 2	Solve problems related to classification and clustering using R tool and employ commercially available dataset for clustering, association rule mining, text mining and classification using R language.	(Cognitive level: Apply)
CO 3	Apply association rule mining methods using R language.	(Cognitive level: Apply)
CO 4	Interpret data using visualization techniques in R.	(Cognitive level: Apply)
CO 5	Develop applications for predicting various useful information.	(Cognitive level: Create)

Mapping of course outcomes with program outcomes - Low=1, medium=2, High=3

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO 1	1	1	1				1						1	
CO 2	3	3	3	3	3		1						3	3
CO 3	2	2	2	3	3		1						2	2
CO 4	2	2	2	3	3		1						2	2
CO 5	3	3	3	3	3		1						3	3

Experiment

1. Write a program to check whether a year (integer) entered by the user is a leap year or not? **1 Hour**

2. Write an R program to find the sum of natural numbers without formula using the if–else statement and the while loop. **1 Hour**
3. Write an R program to make a simple calculator that can add, subtract, multiply and divide using switch cases and functions. **2 Hours**
4. Write an R program to create a list containing strings, numbers, vectors and logical values and do the following manipulations over the list.
    a. Access the first element in the list
    b. Give the names to the elements in the list
    c. Add element at some position in the list
    d. Remove the element
    e. Print the fourth element
    f. Update the third element **2 Hours**
5. For any available dataset create a histogram by using appropriate arguments for the following statements.
    a. Assigning names
    b. Change colors of the Histogram
    c. Remove Axis and Add labels to Histogram
    d. Change Axis limits of a Histogram **4 Hours**
    e. Create a Histogram with density and Add Density curve to the histogram

6. Design a data frame in R for storing about 20 employee details. Create a CSV file named "input.csv" that defines all the required information about the employee such as id, name, salary, start_date, dept. Import into R and do the following analysis.
    a. Find the total number rows & columns
    b. Find the maximum salary
    c. Retrieve the details of the employee with maximum salary
    d. Retrieve all the employees working in the IT Department **2 Hours**

7. Create a dataset or table ['Smart Phone"] in an excel sheet that stores the mobile information [price, company name, model, SalePercent] of five different companies. Store at least 20 rows. Write the scripts and find out the output for the following information.
    a. Maximum price of the mobile of each company
    b. Minimum price of mobile of each company
    c. Average price of mobile of each company
    d. Total Price of mobile of each company **2 Hours**
8. For any available dataset, apply all clustering algorithms. **6 Hours**
9. Apply various classification algorithms. **10Hours**

Textbooks/References

1. "Introduction to Data Science: Data Analysis and Prediction Algorithms with R", by

Rafael A. Irizarry, Edition 1, 2019, Chapman and Hall/CRC

2. "Data Analytics using R", by Seema Acharya, Edition 1, 2018, McGraw Hill.
3. "Machine Learning with R", by Brett Lantz, Edition 3, 2019, Packt.
4. "Data Analytics with R", by Bharti Motwani, Edition 1, 2019, Wiley.
5. "R programming for Data Science", by Roger D. Peng, Edition 1, 2008, Lulu.com.
6. "R for Dummies", by Andrie de Vries, Joris Meys, Edition 2, 2015, Wiley.
7. "R Programming for Beginners", Sandhya Arora and Latesh Malik, Edition 1, 2020, Universities Press.

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1 (20 Marks)	2 (20 Marks)	
Remember	-	-	
Understand			
Apply	20	20	
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
50	50		3 hours

Continuous Internal Evaluation Pattern:
Continuous Assessment Test (2 numbers) : 40 marks
Assignment/Quiz/Course project : 10 marks

22-359-0207 MINI PROJECT

Course Outcomes

After completion of the mini project students will be able to

CO 1	Analyse the requirements and existing systems/literature for the identified problem.	(Cognitive Level: Analyse)
CO 2	Design a solution for the identified problem	(Cognitive level: Apply)
CO 3	Develop the solution using appropriate software tools	(Cognitive level: Create)
CO 4	Test and validate the solution	(Cognitive level: Evaluate)
CO 5	Deploy the developed product and document the project	(Cognitive level: Apply)

Mapping of course outcomes with program outcomes - Low=1, medium=2, High=3

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO 1	3	3	3										3	
CO 2	3	3	3	3	3	3	3						3	3
CO 3	3	3	3	3	3	3		3					2	2
CO 4	3	3	3	3	3	3	3	3		3	3		3	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Mark Division

Continuous Assessment by Guide	20
Internal Evaluation	20
Final Panel Evaluation	10

22-359-0301 DEEP LEARNING

22-359-0301	Deep Learning	CATEGORY	L	T	P	CREDIT
		CORE	3	1	0	4

Prerequisite: Basic knowledge in Machine learning

Course Outcomes

After completion of this course, students will be able to

CO1	Discuss the basics concepts of neural networks.	(Cognitive level : Understand)
CO2	Compare the computational Performance of Parallel Computation on CPUs and GPUs	(Cognitive level : Analyze)
CO3	Examine the working of different types of Autoencoders and Generative Adversarial Networks	(Cognitive level : Analyze)
CO4	Employ various RNN cell variants	(Cognitive level : Apply)
CO5	Describe the basic concepts in Reinforcement Learning and Unsupervised learning.	(Cognitive level : Understand)

Mapping of course outcomes with programme outcomes - Low=1, medium=2, High=3

	PO 1	PO2	PO3	PO4	PO5	PO 6	PO7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	2	1	1	2	1			2					2	
CO2	2	2	2	2	2			2					3	2
CO3	2	1	1	2	1			2					3	2
CO4	2	1	1	2	2			2					3	1
CO5	2	1	1	2	1			2					2	

Syllabus

Unit I (8 hours):

Introduction to Neural Networks: Perceptron, Multi-layer perceptron, Regularization, Hyperparameter tuning, GPUs,TPUs. Regression: Linear Regression, Multiple linear regression, Multivariate linear regression, Logistic regression.

Unit II(8 hours):
Convolution Neural Networks: Convolution operations, DCNN, VGG16. Advanced Convolution Neural Networks: AlexNet, Residual networks, DenseNets, Xception.

Unit III (9 hours):

Autoencoders: Introduction, Vanilla autoencoders, Sparse encoders, Denoising autoencoders, Stacked autoencoders,Variational Autoencoders. Generative Adversarial Networks: DCGAN, SRGAN, Cycle GAN, Info GAN.

Unit IV (10 hours):

Recurrent Neural Network: RNN cell, RNN cell variants, RNN variants, RNN topologies, Encoder-Decoder architecture, Attention mechanism, Transformer architecture.

Unit V (10 hours):

Unsupervised Learning: Principal Component analysis, Self-organizing maps, Restricted Boltzmann Machines.

Reinforcement Learning: Deep reinforcement learning agents,Deep Q-Networks, Deep deterministic policy gradient.

TEXTBOOK/ References:

1. Deep learning with Tensor flow 2 and Keras,Antonio Gulli,Amita Kapoor, Sujith Pal,2019

2. Dive into Deep Learning, Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola,2020

3. Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT Press, 2016.

4. Yuxi (Hayden), Liu and Savansh Mehta, “Hands -on Deep Learning Architectures with Python”, Packt, 2019

5. Josh Patterson & Adam Gibson, “Deep Learning: A Practitioners Approach”, published by O’Reilly Media.,2017

6. Nikhil Ketkar, “Deep Learning with Python”, published by Apress Media,2017

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1 (20 Marks)	2 (20 Marks)	
Remember	-	-	-
Understand			20
Apply	10	10	30
Analyse	10	10	20
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	50	50	3 hours

Continuous Internal Evaluation Pattern :
Continuous Assessment Test (2 numbers) : 40 marks
Assignment/Quiz/Course project : 10 marks

End Semester Examination Pattern : Sample QP

22-359-0306 SEMINAR

22-359-0306	SEMINAR	CATEGORY	L	T	P	CREDIT
		CORE			2	1

Course Outcomes

After completion of the Seminar students will be able to

CO 1	Describe the ideas presented in Literature.	(Cognitive Level: Understand)
CO 2	Interpret technical documents	(Cognitive level: Apply)
CO 3	Examine various technical documents	(Cognitive level: Analyze)
CO 4	Present the technical topics before audience	(Cognitive level: Apply)
CO 5	Write the report	(Cognitive level: Apply)

Mapping of course outcomes with program outcomes -Low=1, Medium=2, High=3

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2
CO1	3												1	1
CO2	3	3	3			2			2				2	2
CO3	3	3	3	3	3		1							1
CO4	3	3	3	3	3		3		3					
CO5	3					3	3							1

Mark Division

Continuous Assessment by Guide	**25**
Final Panel Evaluation	**25**

22-359-0307 MINI PROJECT

		CATEGORY	L	T	P	CREDIT
22-359-0307	Mini Project	CORE			4	2

Course Outcomes

After completion of the mini project students will be able to

CO 1	Analyse the requirements and existing systems/literature for the identified problem.	(Cognitive Level: Analyse)
CO 2	Design a solution for the identified problem	(Cognitive level: Apply)
CO 3	Develop the solution using appropriate software tools	(Cognitive level: Create)
CO 4	Test and validate the solution	(Cognitive level: Evaluate)
CO 5	Deploy the developed product and document the project	(Cognitive level: Apply)

Mapping of course outcomes with program outcomes - Low=1, medium=2, High=3

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	3										3	
CO 2	3	3	3	3	3	3	3						3	3
CO 3	3	3	3	3	3	3		3					2	2
CO 4	3	3	3	3	3	3	3	3		3	3		3	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Mark Division

Continuous Assessment by Guide	20
Internal Evaluation	20
Final Panel Evaluation	10

22-359-0401 Internship/Project Work

22-359-0401	Internship/Project Work	CATEGORY	L	T	P	CREDIT
		CORE		3	24	16

Course Outcomes

After completion of the project work students will be able to

CO 1	Analyse the requirements and existing systems/literature considering realistic constraints.	(Cognitive Level: Analyse)
CO 2	Examine the literature and describe solution for the identified problem	(Cognitive level: Analyse)
CO 3	Develop the solution using appropriate software tools	(Cognitive level: Create)
CO 4	Test and validate the solution	(Cognitive level: Evaluate)
CO 5	Deploy the developed product and document the project	(Cognitive level: Apply)

Mapping of course outcomes with program outcomes - Low=1, medium=2, High=3

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	3										3	
CO 2	3	3	3	3	3	3	3						3	3
CO 3	3	3	3	3	3	3		3					2	2
CO 4	3	3	3	3	3	3	3	3		3	3		3	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Mark Division

Continuous Assessment by Guide	100
Internal Evaluation by Guide	100
Final Panel Evaluation	100
Demonstration and report submission	100

ELECTIVE I

22-359-0211	BLOCKCHAIN TECHNOLOGIES	CATEGORY	L	T	P	CREDIT
		ELECTIVE	3	1	0	4

Prerequisite: Nil

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

CO 1	To classify different types of blockchain platforms and consensus protocols	Cognitive Level:Understand
CO 2	To examine a Smart Contract with Solidity	Cognitive Level:Analyze
CO 3	To solve real world problems using Code chain	Cognitive Level:Apply
CO 4	To differentiate the various security and performance tools in blockchain	Cognitive Level:Analyze
CO 5	To discuss different types of use-case of blockchain network	Cognitive Level:Understand

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO2**
CO1	2	2											3	
CO2	2	2	2	1	2								3	2
CO3	2	2		1	2									3
CO4	2	2	2	1	2								2	
CO5	2	2											1	

Syllabus

UNIT I (8 Hours)

Introduction to Blockchain, Bitcoin Blockchain: Structure, Operations, Features, Consensus Model, Incentive Model. The Double-Spend Problem, Byzantine Generals' Computing Problems, Public-Key Cryptography, Hashing, Distributed Systems, Distributed Consensus, Proof of Work, Proof of Stake, Delegated Proof of Stake, Proof of Elapsed Time, Deposit based consensus, Proof of importance, Federated consensus or federated Byzantine consensus, Reputation-based mechanisms, Practical Byzantine Fault Tolerance.

UNIT II (10 Hours)

Smart Contracts: Definition and Need, Features of Smart Contracts, Life Cycle of a Smart Contract, Introduction to Ethereum Higher-Level Languages.Building A Simple Smart Contract with Solidity, Ethereum Contract ABI, Remix-IDE for Smart Contract Development. Introduction to Solidity: Contracts, Constructors & Functions, Variables, Getters & Setters, Arrays, Memory v/s Storage, Mappings in Solidity, Structs, Error Handling & Restrictions, Libraries, Global Variables in Solidity, Abstract Contracts, Inheritance, And Interfaces, Events Truffle Framework & Ganache: Environment Setup for Truffle & Ganache, Truffle Project Creation, Truffle Compile, Migrate and Create Commands.

UNIT III (10 Hours)

Permissioned Blockchains: Hyperledger Fabric Services, Model and Functions, Hyperledger Composer, Microsoft Azure Blockchain Platform and Services, Other Platforms: IOTA, TRON, Zilliqa, Cosmos, Ripple.Go languages: Native data types, Native data structures, Functions, and methods, Object-Oriented Programming, Error handling, Interfaces. Design and Implementation of Chaincode

UNIT IV (9 Hours)

Security Issues: Blockchain Related Issues, Higher-Level Language (Solidity) Related Issues, EVM Bytecode Related Issues, Real-Life Attacks on Blockchain Applications Smart Contracts, Trusted Execution Environments.Security Tools for Smart Contracts: Working, Advantages, And Disadvantages of Tools- Oyente, Security, Maian, SmartCheck.

UNIT V (8 Hours)

Alternative Decentralized Solutions: Interplanetary File System (IPFS), Blockchain Use Cases: Financial Services Related Use Cases, Revolutionization of Global Trade, Digital Identity, Auditing Services, Supply Chain Management, Healthcare Related Services, Blockchain and IOT, Blockchain and AI.

Text Books/References

1. Tiana Laurence, Blockchain for Dummies, 2 nd Edition 2019, John Wiley & Sons.
2. Building Blockchain Projects, Narayan Prusty, Packt Publishing.
3. Mastering Ethereum: Building Smart Contracts and Dapps Book by Andreas
4. Antonopoulos and Gavin Wood, Shroff Publisher/O′Reilly Publisher.
5. Mastering Blockchain: Deeper insights into decentralization, cryptography, Bitcoin, and popular Blockchain frameworks by Imran Bashir, Packt Publishing (March 17, 2017).
6. Blockchain: Blueprint for a New Economy by Melanie Swan, Shroff Publisher publisher/O'Reilly Publisher Media; 1 st edition (2015).
7. Andreas M. Antonopoulos, Mastering Bitcoin - Programming the Open Blockchain, O'Reilly Media, Inc., 2017
8. Melanie Swan, Blockchain - Blueprint for a new economy, O'Reilly Media, Inc., 2015.
9. Abhijit Das and VeniMadhavan C. E., Public-Key Cryptography: Theory and Practice: Theory and Practice, Pearson Education India, 2009.
10. Joseph J. Bambara and Paul R. Allen, Blockchain – A practical guide to developing business, law, and technology solutions, McGraw Hill, 2018.

Web Resources

1. https://www.coursera.org/learn/smarter-contracts
2. Introduction to Blockchain Technology and Applications,
3. https://swayam.gov.in/nd1_noc20_cs01/preview
4. https://nptel.ac.in/courses/106105184/
5. https://www.coursera.org/learn/blockchain-platforms
6. https://www.edx.org/course/blockchain-and-fintech-basics-applications-and-imitations
7. https://www.accenture.com/in-en/insight-blockchain-technology-how-banks-buildingreal-time
8. https://medium.com/search?q=decentralized%20exchange
9. Emerging Technology Projection: The Total Economic Impact TM Of IBM Blockchain https://www.ibm.com/downloads/cas/QJ4XA0MD
10. https://www.globallegalinsights.com/practice-areas/blockchain-laws-and-regulations/india#chaptercontent1
11. https://www.eduonix.com/blockchain-and-cryptoc

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1 (20 Marks)	2 (20 Marks)	
Remember	-	-	-
Understand			20
Apply	10	10	30
Analyse	10	10	20
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	50	50	3 hours

Continuous Internal Evaluation Pattern :
Continuous Assessment Test (2 numbers) : 40 marks
Assignment/Quiz/Course project : 10 marks

End Semester Examination Pattern : Sample QP

22-359-0212 - DIGITAL IMAGE PROCESSING

22-359-0212	DIGITAL IMAGE PROCESSING	CATEGORY	L	T	P	CREDIT
		ELECTIVE	2	1	0	3

Prerequisite: Basic knowledge on Signals and Systems

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

CO 1	Explain the basics and fundamentals of Digital Image Processing and to manipulate images based on spatial domain techniques.	Cognitive Level: Understand
CO 2	Apply image transforms.	Cognitive Level: Analyze
CO 3	Employ Image Restoration and Denoising.	Cognitive Level: Apply
CO 4	Compare various methods of Image Segmentation and Morphological Image Processing.	Cognitive Level: Analyze
CO 5	Apply image compression and video processing techniques.	Cognitive Level: Apply

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3				2	3						1	1	
CO 2	3	2	2		2	3						1	2	2
CO 3	3		2		2	3						1	2	3
CO 4	3	2	1		2	3						1	3	
CO 5	3	2	1		2	3						1	3	2

Syllabus

UNIT I (7 Hours)

Introduction- Fundamental steps in image processing; Components of image processing system; Pixels; coordinate conventions; Imaging Geometry; sampling and quantization; Basic relationship between pixels; Spatial Domain; Frequency Domain;Colour Models.Image Enhancement in spatial domain-Intensity transformations; contrast stretching; histogram equalization; Correlation and convolution; Smoothing filters; sharpening filters; gradient and Laplacian; Unsharp Masking and High Boost Filtering

UNIT II (10 Hours)

Image transforms and its properties – Unitary transform; Fourier Transforms and properties;

Frequency domain filtering- Smoothing Frequency Domain Filters; Sharpening Frequency Domain Filters; Homomorphic Filtering Wavelet-based Image Processing: Wavelet, Wavelet Transform Discrete and Continuous,Wavelet- Examples, Multiresolution Analysis. Contourlet Transform, Image Pyramid.

UNIT III (8 Hours)

Image Restoration and Denoising : Image Degradation, Image Blur-Types, Image Restoration Techniques Classification, Image Restoration Model, Linear and Nonlinear Image Restoration Techniques.Image Denoising, Noises in Image-Classification, Mean Filtering,Order Statistics-Adaptive Filters-Band reject filters,Band Pass filters,Notch Filters, Weiner filtering- Applications of Digital Image Restoration.

UNIT IV (10 Hours)

Image segmentation: Point, Line and Edge segmentation. Edge linking and Boundary

detection. Segmentation using thresholding, Region based segmentation.Morphological Image Processing-Structuring Element,Dilation,Erosion,opening and Closing, Hit or Miss transformation,Basic Morphological Algorithms

UNIT V (10 Hours)

Image Compression: Fundamentals, Some Basic Compression Methods - Run Length Coding,Huffman Coding, Arithmetic Coding, Bit Plane Coding, Block Truncation Coding. JPEG Compression.Basic Steps of Video Processing:Analog Video, Digital Video. Time-Varying Image Formation models:Three-Dimensional Motion Models, Geometric Image Formation, Photometric Image Formation,Sampling of Videosignals, Filtering operations.

Textbooks/References

1. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing (English) 3rd Edition,Pearson India, 2013.

2. A K. Jain, Fundamentals of digital image processing, Prentice Hall of India, 1989.

3. Video Processing and Communication – Yao Wang, Joem Ostermann and Ya–quin Zhang.1st Ed., PH Int

4. S Jayaraman, S Esakkirajan and T Veerakumar, Digital Image Procesing, McGraw Hill Education , 2009.

5.Digital Video Processing – M. Tekalp, Prentice Hall International.

Web Resources

NPTEL

- Digital Image Processing - (Course from IIT Kharagpur)
- NPTEL Lecture Videos by Prof. P K Biswas from IIT Kharagpur https://nptel.ac.in/courses/117105079

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1 (20 Marks)	2 (20 Marks)	
Remember	-	-	-
Understand			20
Apply	10	10	30
Analyse	10	10	20
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	50	50	3 hours

Continuous Internal Evaluation Pattern :
Continuous Assessment Test (2 numbers) : 40 marks
Assignment/Quiz/Course project : 10 marks
End Semester Examination Pattern : Sample QP

22-359-0213 - NATURAL LANGUAGE PROCESSING

22-359-0213	NATURAL LANGUAGE PROCESSING	CATEGORY	L	T	P	CREDIT
		ELECTIVE	3	1	0	4

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to(include cognitive levels, include higher cognitive levels)

CO 1	Describe language models in NLP	Cognitive Level: Understand

CO 2	Explain pre-processing steps in NLP and describe grammars and how a language is built based on grammar	Cognitive Level: Understand
CO 3	Discuss various vectorization techniques and apply them in various datasets	Cognitive Level: Apply
CO 4	Explain Neural Language Models and apply supervised ML techniques to various datasets	Cognitive Level: analyse
CO 5	Describe various DL techniques that are used with NLP	Cognitive Level: Apply

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO 1	2	1											1	
CO 2	2	2											1	
CO 3	2		3		3								1	
CO 4	2	2	3		3								1	
CO 5	2	1											1	

Syllabus

UNIT I (7 Hours)

Regular Expressions, Text Normalization, Edit Distance, Regular Expressions, Words, Corpora, Text Normalization, Minimum Edit Distance, N-gram Language Models, N-Grams, Evaluating Language Models

UNIT II (10 Hours)

Pre-processing: Handling corpus-raw text - Stemming and Lemmatization for raw text, Stop word removal, Feature Engineering: Understanding feature engineering, a Basic feature of NLP - Parsers and parsing, Types of grammar, POS tagging and POS taggers, n-grams, Bag of words, TF-IDF, Encoders, and decoders, Probabilistic models,NLTK

UNIT III (5Hours)

Advanced Feature Engineering: Word embedding, Understanding the basics of word2vec, Understanding the components of the word2vec model, Main processing algorithms - CBOW, Skip-gram, Applications of word2vec, and simple examples

UNIT IV (6 Hours)

Understanding ML algorithms for NLP: Supervised ML algorithms: Decision tree, Random forest, Naive Bayes, Support vector machines,UnSupervised ML algorithms:-K means clustering,DBSCAN

UNIT V (7Hours)

Neural Networks and Neural Language Models: Training Neural Nets, Neural Language Models, Deep Learning Architectures for Sequence Processing: Recurrent Neural Networks, Managing Context in RNNs: LSTMs and GRUs, Self-Attention Networks: Transformers Case studies: Word sense disambiguation system, Automatic Question Answering system

Textbooks/ References

1. Jurafsky, Dan. Speech & language processing. Pearson Education India, 2020.

2. Thanaki, Jalaj. Python natural language processing. Packt Publishing Ltd, 2017.

3. Goldberg, Yoav. "Neural network methods for natural language processing." Synthesis lectures on human language technologies 10.1 (2017): 1-309.

4. Manning, Christopher, and Hinrich Schutze. Foundations of statistical natural language processing. MIT Press, 1999.

5. Kulkarni, Akshay, and Adarsha Shivananda. Natural language processing recipes: Unlocking text data with machine learning and deep learning using python. Apress, 2019.

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1 (20 Marks)	**2 (20 Marks)**	
Remember	-	-	-
Understand			20
Apply	10	10	3

			0
Analyse	10	10	20
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	50	50	3 hours

Continuous Internal Evaluation Pattern :
Continuous Assessment Test (2 numbers) : 40 marks
Assignment/Quiz/Course project : 10 marks

End Semester Examination Pattern : Sample QP

22-359-0214 - CRYPTOGRAPHY AND NETWORK SECURITY

22-359-0214	CRYPTOGRAPHY AND NETWORK SECURITY	CATEGORY	L	T	P	CREDIT
		CORE	3	1	0	4

Prerequisite: Basic Mathematics

Course Outcomes

After completion of this course, students will be able to

CO1	Solve the problems using Classical Cryptography.	(Cognitive level: Apply)
CO2	Compare Feistel and Non Feistel ciphers and Describe Block Cipher modes of operation.	(Cognitive level: Analyze)
CO3	Apply public key cryptosystems – RSA, Elgamal and ECC for confidentiality.	(Cognitive level: Apply)
CO4	Describe the use of hash functions and explain hash algorithms MD5 and SHA.	(Cognitive level: Understand)
CO5	Discuss Digital Signature Schemes and Various Protocols.	(Cognitive level: Understand)

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	3	3	2	2	1	2		2					1	1
CO2	3	3											1	1
CO3	3	3	2	2	1	2		2					1	
CO4	3	3											1	
CO5	3	3											1	

Syllabus

UNIT I (9 Hours)

Classical cryptography: Shift cipher, Substitution cipher, Affine cipher, Vigenere cipher, Hill cipher, Permutation cipher, Stream ciphers, Product Ciphers: Playfair Cipher. LFSR, Cryptanalysis on Classical Ciphers.

UNIT II (10 Hours)

Block ciphers: Substitution Permutation Networks, Feistel cipher, Data Encryption Standard, Cryptanalysis: Differential Cryptanalysis and Linear Cryptanalysis, Multiple encryption: 3-DES, Advanced Encryption Standard, Analysis of AES, Block Cipher Modes of operation.

UNIT III (13 Hours)

Public Key Cryptosystems: Integer factorization problem, Discrete logarithm problem, RSA cryptosystem, Attacks on RSA, Diffie-Hellman Key agreement Protocol, ElGamal cryptosystem, Elliptic curve cryptography, Homomorphic Encryption, Secret Sharing Schemes

UNIT IV (6 Hours)

Pseudo Random Number Generators (PRNG): LCRNG, RSA, BBS. Cryptographic Hashes for Integrity, Hash functions: MD5, Secure Hash Algorithm (SHA1, SHA512, SHA1024), Message Authentication Code(MAC),Signature schemes: RSA signature, ElGamal signature, ECDSA.

UNIT V (7 Hours)

Network Security protocols: SSL, TLS, IPSec. Application Layer Security Protocols: PGP,S/MIME,SET.

Textbooks/References:

1. Behrouz A Forouzan, Cryptography and Network Security, Tata Mc Graw Hill, 2005.
2. Cryptography: Theory and Practice, (Third Edition), Douglas R. Stinson.
3. William Stalings, Cryptography and Network Security, Principles and Practices. 6th EdPearson Education, 2014.
4. Handbook of Applied Cryptography, (Second Edition), Alfred J. Menezes, Paul C. van Oorschot, Scott A. Vanstone.
5. Introduction to Modern Cryptography, (Second Edition), Jonathan Katz, Yehuda Lindell.
6. Understanding Cryptography: A Textbook for Students and Practitioners, (2010 Edition),Christof Paar, Jan Pelzl.

7. Introduction to Cryptography with Coding Theory, (Second Edition),Wade Trappe, Lawrence C. Washington.
8. Network Security and Cryptography, Bernard Menezes.

Web Resource:

1. https://nptel.ac.in/courses/106/105/106105162/
2. https://nptel.ac.in/courses/106/105/106105183/
3. https://nptel.ac.in/courses/106/107/106107155/
4. https://www.coursera.org/learn/crypto

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1 (20 Marks)	2 (20 Marks)	
Remember	-	-	-
Understand			20
Apply	10	10	30
Analyse	10	10	20
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	50	50	3 hours

Continuous Internal Evaluation Pattern :
Continuous Assessment Test (2 numbers) : 40 marks
Assignment/Quiz/Course project : 10 marks
End Semester Examination Pattern : Sample QP

ELECTIVE II

22-359-0311 EXPLAINABLE AI

22-359-0311	EXPLAINABLE AI	CATEGORY	L	T	P	CREDIT
		ELECTIVE	3	1	0	3

Course Outcomes

After completion of this course, the students will be able to

CO1	Explain the need of Explainable AI in the context of machine learning	(Cognitive level : Understand)
CO2	Analyze Global and local explanations using SHAP and LIME	(Cognitive level : (Analyze)
CO3	Develop interpretable CNN, use unsupervised learning to perform exploratory analysis on a model	(Cognitive level : Analyze)
CO4	Analyze counterfactual, contrastive XAI and interpret methods for multivariate forecasting and sensitivity analysis	(Cognitive level : Analyze)
CO5	Evaluate adversarial (evasion and poisoning) attacks on machine learning models	(Cognitive Level:Understand)

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	2		1		2	2				1			1	
CO2	2	3	2	2	3					1			3	2
CO3	2	3	2	2	3					1			3	2
CO4	2	3	2	2	3					1			3	3
CO5	2	3	2	2	3	2				1			3	3

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1 (20 Marks)	2 (20 Marks)	
Remember	-	-	-
Understand			20
Apply	10	10	30
Analyse	10	10	20
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	50	50	3 hours

Continuous Internal Evaluation Pattern :
Continuous Assessment Test (2 numbers) : 40 marks
Assignment/Quiz/Course project : 10 marks
End Semester Examination Pattern : Sample QP

Syllabus

UNIT I (7 Hours)

Machine Learning and Explainable AI, Need for XAI, Explainability and Interpretability, XAI Flow, Making ML Models Explainable: Intrinsic Explanations, Post Hoc Explanations, Global or Local Explainability, Properties of Explanations.

UNIT II (8 Hours)

Intrinsic Explainable Models: Loss Function, Linear Regression, Logistic Regression, Decision Trees, KNN. Model Agnostic Methods For XAI: Global Explanations, Local Explanations, Shap.Kernel Explainer, Local Linear Surrogate Models (LIME): Mathematical Representation, Creating agnostic AutoML template, Bagging Classifier, Boosting Classifier, Decision Tree, Extra Trees, Creating Lime Explainer, SHAP for Boosted Trees.

UNIT III (10 Hours)

Explaining Deep Learning Models: Agnostic Approach - Adversarial Features, Augmentations, Occlusions as Augmentations, Occlusion as an Agnostic XAI Method. Opening Deep Networks: Layer Explanation, CAM and Grad-CAM, Deep Shap/ DeepLift. A critic of saliency method - Explainability Batch Normalisation Layer by Layer, Unsupervised methods.

UNIT IV (10 Hours)

Counterfactual Explanations Method: Visualising Data Point using What - If-Tool, Exploring data points, The logic of counterfactual explanations, Contrastive Explanations Method (CEM), CEM Applied to example dataset using CNN, Autoencoders, Interpretation Methods for Multivariate Forecasting and Sensitivity Analysis: Accessing Time Series ,odels with traditional interpretation, Generating LSTM attribution with integrated gradients, Compute Local and Global Attribution.

UNIT V (10 hours)

Understanding the Effect of Irrelevant Features, Feature Engineering, Detecting and Mitigating Bias, Adversarial Attacks, Evasion Attacks, Defending against targeted attacks with preprocessing, Shielding against evasion attacks via adversarial training, Evaluating and certifying adversarial robustness.

Textbooks/References

1. "Explainable AI with Python", by Leonida Gianfagna, Antonio Di Cecco, Edition 2, 2021, Springer.
2. "Hands-On Explainable AI (XAI) with Python: Interpret, visualize, explain, and integrate reliable AI for fair, secure, and trustworthy AI apps", by Denis Rothman, Edition 1, 2020, Packt Publishing Limited.
3. "Interpretable Machine Learning", by Christoph Molnar, Edition 2, 2020, Lulu.com.
4. "Interpretable Machine Learning with Python: Learn to build interpretable high-performance models with hands-on real-world examples", by Serg Masís, Edition 1, 2021, Packt Publishing Limited.

22-359-0312 - SOFTWARE PROJECT MANAGEMENT

22-359-0312	SOFTWARE PROJECT MANAGEMENT	CATEGORY	L	T	P	CREDIT
		ELECTIVE	2	1	0	3

Prerequisite: Software Engineering

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

CO 1	Show suitable life cycle models to be used based on the requirement.	(Cognitive level: Apply)
CO 2	Describe the concepts of managing software projects.	(Cognitive level: Understand)
CO 3	Apply software estimation approaches for effort and cost estimation.	(Cognitive level: Apply)
CO 4	Describe the concepts of risk management and resource allocation.	(Cognitive level: Understand)

CO 5	Describe project monitoring and control, organise people and teams.	(Cognitive level: Understand)

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO 1	2	1		1			2	1					1	
CO 2	2	2	2	1	2		2	1					1	
CO 3	2	2	2	1			2	1						
CO 4	2	1	2				2	1						
CO 5	2	1	2				2							

Syllabus

UNIT I (10 hrs)

Introduction to software engineering: - Software engineering a layered technology – processes, methods, and tools. Software process models. Introduction to Software project management:- software project vs other types of projects. Types of software projects. Factors in Designing a Project Structure, Types of Project Organization Structures, Definition of management- management principles- management control. Functions and activities of management- planning, organizing, staffing, directing, and controlling. Importance of software project management- major issues of software project management, Activities in software project management.

UNIT II (7 hrs)

Project Planning- Planning Objectives, Project Plan, Types of project plan, Elements of a Project Plan. Stepwise project planning activities, Work Breakdown Structure (WBS), Types of WBS, Functions, Activities and Tasks, Methods of representing WBS, Application of the WBS. Structure of a Software Project Management Plan.

UNIT III (8 hrs)

Project Evaluation: - Evaluation of individual projects- technical Assessment, Cost-benefit analysis, cash flow forecasting, cost-benefit evaluation techniques, Risk evaluation. Selection of an appropriate project approach. Choosing Technologies, technical plan contents list, choice of process models, structure versus speed of delivery. Software effort Estimation: Basis for software estimation- Software effort estimation techniques Bottom-up and Top-down estimation- Function Point Analysis- COCOMO II. Cost Estimation- Staffing Pattern- Schedule compression.

UNIT IV (10 hrs)

Activity Planning and Risk Management : Objectives- Project Schedules- Projects and Activities- Sequencing and Scheduling Activities- Network Planning Models- Forward Pass- Backward pass- Identif-ying Critical Path and Critical Activities- Activity-on-arrow networks. Risk Management: Risk- Categories of Risk- Risk Identification- Risk Assessment- Risk Planning- Risk management- Risk Evaluation- PERT, Monte Carlo Simulation, Critical Chain. Resource Allocation: Nature of Resources- Identifying and Scheduling Resources- Creating

Critical Paths- Cost Schedule- Scheduling sequence.

UNIT V (10 hrs)

Monitoring and Control: Creating the framework, collecting data, Visualizing Progress- Gantt Chart, Slip Chart, Timeline. Cost Monitoring- Earned Value Analysis-prioritizing monitoring. Getting the project back to target- Change control. Software Configuration Management- Managing Contracts-Types of contracts, Stages in contract placement, terms of a contract, Contract Management, Acceptance. Managing people and organizing teams- Organizational Behavior, Selecting the right person- Motivation, The Oldham – Hackman job characteristic model – Stress – Health and Safety – Ethical and Professional concerns, working in teams – Decision making Organization and Team Structures- Dispersed and Virtual teams, Leadership.

Textbooks/References

1. Bob Hughes and Mike Cotterell, "Software Project Management", Tata McGraw-Hill, Edition 2004.
2.Robert K. Wysocki, Effective Software Project Management – Wiley Publication, 2011
3. E. M. Bennatan, Software project management: a practitioner's approach (2nd ed.), McGraw Hill, (1995)
4.Royce, Software Project Management, Pearson Education (1999)

Web Resources

[1] NPTEL: Software Project Management, IIT Kharagpur (Prof.RAJIB MALL): https://nptel.ac.in/courses/106105218

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1 (20 Marks)	**2(20 Marks)**	
Remember	-	-	-
Understand	20	20	20
Apply			30
Analyse			20
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	50	50	3 hours

Continuous Internal Evaluation Pattern:
Continuous Assessment Test (2 numbers) : 40 marks
Assignment/Quiz/Course project : 10 marks

End Semester Examination Pattern: - Sample QP

.

22-359-0313 NETWORK SECURITY ESSENTIALS

22-359-0313	NETWORK SECURITY ESSENTIALS	CATEGORY	L	T	P	CREDIT
		ELECTIVE	3	1	0	3

Course Outcomes

After completion of this course, the students will be able to

CO1	Give examples for Vulnerability, Threat, Attacks, Countermeasures and Malicious Softwares.	(Cognitive level: Understand)
CO2	Examine Vulnerabilities leads to different attacks and Discuss Authentication Protocols and Network Layer Protocols for Security.	(Cognitive level: Analyze)
CO3	Differentiate PGP and S/MIME and compare SSL and SET.	(Cognitive level: Analyze)
CO4	Compare different wireless security protocols.	(Cognitive level: Analyze)
CO5	Describe cyber threat intelligence for security.	(Cognitive Level: Understand)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2
CO1	3	3	3		2	2	2			2				1
CO2	3	3	3	2	2	2	2			2				2
CO3	3	3			2	2	2							1
CO4	3	3	3		2	2	2							
CO5	2	2		3	3	2	2	3		2				2

Syllabus

UNIT I (9 hrs)

Vulnerability, Threat, Attacks and Countermeasures (Cryptography, Controls, Firewalls, IDS, Digital Signatures) Introduction to network security - Security requirements, Challenges of security, Network security models.

UNIT II (8 hrs)

Malicious programs – Worms, Viruses, Trojans, Spyware, Adware. Attacks, Side channel Attacks, ARP poisoning, Spoofing, DoS, DDos, Tor, Session Hijacking, Buffer overflow.

Network Security Protocols

Authentication Protocols - Challenge Response Protocol, Zero Knowledge protocol, Kerberos, Onion Layer protocol. HTTPS Transport Layer protocols - SSL, TLS IP Layer Protocol -IPSec - Authentication Header (AH), Encapsulating Security Payload (ESP), Internet Key Exchange (IKE) phases, VPN.

UNIT III (10 hrs)

Application Layer Protocols , PEM,PGP, S/MIME, Digital Certificates, SET.
Wireless Network Security - IEEE 802.11 Wireless LAN - components, Types, Services. Wireless LAN Security - Services.

UNIT IV (8 hrs)

Wireless Security Protocols - RC4, 4 way handshaking, Wired Equivalent Privacy (WEP), Wi-Fi Protected Access (WPA), WPA2 , WPA3.

UNIT V (10 hrs)

Threat Modelling, Cyber Threat Intelligence and Its Role, Sources to collect adversary data and how to exploit and pivot off, Indicators of Compromise (IOC), Collecting Indicators, Storing threat data, Analysis

Textbooks/References

1. “Cryptography and Network Security (SIE), by Behrouz A Forouzan, Debdeep Mukhopadhyay”, Edition 3, 2010, TataMcGraw Hill.
2. “Wireless Network Security A Beginner’s Guide” by Tyler Wrightson, Edition 1, 2012, McGraw Hill.

3. "Network Security Essentials: Applications and Standards", by William Stallings, Edition 6, 2018, Pearson Education.

Web Resources

https://www.coursera.org/learn/ibm-cyber-threat-intelligence

https://www.cse.iitk.ac.in/pages/CS698M.html

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1 (20 Marks)	2 (20 Marks)	
Remember	-	-	-
Understand	10		20
Apply			30
Analyse	10	20	20
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	50	50	3 hours

Continuous Internal Evaluation Pattern :
Continuous Assessment Test (2 numbers) : 40 marks
Assignment/Quiz/Course project : 10 marks

End Semester Examination Pattern : Sample QP

22-382-0314 - CLOUD COMPUTING

22-382-0314	CLOUD COMPUTING	CATEGORY	L	T	P	CREDIT
		ELECTIVE	3	1	0	4

Prerequisite: Nil

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

CO1	Describe the features of cloud computing architecture and different computing models.	Cognitive level : Understand
CO2	Explain various public cloud platforms and software environments.	Cognitive level : Understand
CO3	Apply virtualization techniques such as VMM and Hypervisor.	Cognitive level : Apply
CO4	Analyse different aspects of cloud security including security defence strategies.	Cognitive level : Analyze
CO5	Discuss advanced cloud computing concepts.	Cognitive level : Understand

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	2											
CO2	2			2								
CO3		3										
CO4	2		2	3								
CO5	2											

22-382-0314 CLOUD COMPUTING

UNIT I (8 Hours)

Introduction-Evolution of new computing models: Parallel computing, Edge computing, Grid Computing, Cloud computing. Cloud computing Basics: Architecture, Storage, Services, Applications. Significance of Cloud computing in modern era: Example-Server crashes/Failures-Preventing server Failures-Solution.

UNIT II (8 Hours)

Cloud deployment models: Public, Private, Hybrid, Community -Cloud Service models: software as a Service (SaaS), Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Service Oriented Architecture (SoA)- Public Cloud Platforms: GAE – AWS – Azure, Emerging Cloud

UNIT III (10 Hours)

Virtualization: Introduction to virtualization-Need of Virtualization in Cloud Computing-Hypervisors-Categories of Virtualization: Full Virtualization- Paravirtualization, Levels of implementing virtualization: Hardware, Operating System, Application- Advantages and disadvantages of virtualization- Case studies: VMware, Eucalyptus.

UNIT IV (10 Hours)

Cloud security: Cloud security risks- Security aspects: privacy, trust-Securing the Cloud Infrastructure: Access control, Key Management - Secure Cloud Architecture- Operating System and Network Security, Data Security in cloud, Virtual Machine Security- Advanced Cloud Computing Security : Advanced Security Architectures for Cloud Computing- Side-Channel Attacks and Defenses on Cloud Traffic.

UNIT V (9Hours)

Cloud Programming and Software Environments: (Hadoop, GFS, Map Reduce, NoSQL systems) -Fog computing- Green cloud-Sensor cloud computing- ubiquitous computing Containers: Docker, IOT cloud.

References:

1. RajkumarBuyya, Christian Vecchiola and ThamaraiSelvi S, "Mastering Cloud Computing", Tata McGraw Hill Education Private Limited,New Delhi,2013.
2. Dan C. Marinescu , Cloud computing: Theory and Practice, Morgan Kaufmann, 2013.
3. David S Linthicium, "Cloud computing and SOA convergence in your enterprise", Pearson, USA,2010.
4. Diane Barrett and Gregory Kipper, "Virtualization and Forensics: A Digital Forensic Investigators Guide to Virtual Environment", Elsevier, USA,2010.
5. John R. Vacca, "Cloud Computing Security"/O′Reilly Publisher.
6. Toby Velte, Anthony Velte, Robert Elsenpete. "Cloud Computing, A Practical Approach"/O′Reilly Publisher.

Web Resources:

1.*NPTEL :: Computer Science and Engineering - NOC:Cloud computing*

2. Introduction to Cloud Computing | Coursera

3. Cloud Computing Basics (Cloud 101) | Coursera

22-359-0321 BIG DATA ANALYTICS

22-359-0321	BIG DATA ANALYTICS	CATEGORY	L	T	P	CREDIT
		ELECTIVE	3	1	0	4

Prerequisite: Data Mining

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

CO1	Solve the problems using MapReduce programming paradigm.	(Cognitive level : Apply)
CO2	Apply spark libraries for solving distributed applications.	(Cognitive level : Apply)
CO3	Analyze streaming data using Spark Streaming libraries	(Cognitive level : Analyze)
CO4	Demonstrate the usage of MongoDB, Hbase and Hive	(Cognitive level : Apply)
CO5	Explain the concepts of Spark MLlib libraries and Visualization tools	(Cognitive level : Understand)

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	2	2	3		3	2	2			1		
CO 2	2	2	3		3	2	2					
CO 3	2	2	3	3	3	2	2					
CO 4			3		2	2	2					
CO 5	1											

22-359-0321 BIG DATA ANALYTICS

UNIT I (7 Hours)

Introduction to Big Data: Big Data – Introduction, data life cycle, Structuring Big Data, Characteristics of Big Data, Big data applications, Technologies for handling big data – Distributed and Parallel Computing for Big Data, Introducing Hadoop – Hadoop multi node cluster architecture, Introduction to data lake, data cleansing and transformations, Data lake reference architecture, HDFS and MapReduce. HDFS Concepts– MapReduce Execution, Algorithms using MapReduce, Limitations of Hadoop, Overcoming the limitations of Hadoop

UNIT II (8 Hours)

Apache Spark: Eco system, Components of the Spark unified stack-Spark SQL, Spark Streaming, Spark GraphX, Spark MLLib. Spark context, spark stage, spark executor.Spark Architecture, RDD and RDD Operations-RDD Features and limitations, RDD- Persistence and Cashing mechanism, DAG, spark cluster management, performance tuning, DataFrames and Dataset – In-memory distributed processing using Apache Spark. Spark shell commands.

UNIT III (10 Hours)

Streaming Data: Streaming Architectures - Lambda architecture, Kappa architecture, Spark Streaming- Streaming system components, Discretized stream processing, Spark streaming architecture, Transformations on Dstreams, Window operations, Join and output operations, Caching, Checkpointing, Structured Streaming, Managing Distributed Data Flow with Apache Kafka-Kafka Fundamentals, Use case and applications, Architecture, Kafka Topics, Producer and consumer-Producer and consumer configuration and execution, In-Sync Replicas, Kafka Consumer groups

UNIT IV (10 Hours)

NoSQL Databases: Types NoSQL Databases, Introduction to MongoDB, Data model design, CRUD operations on MongoDB, Projection, limiting and sorting records, indexing, Aggregation, replication and sharding, Analyzing queries, Introduction to HBase, HBase data model, regions, HBase Architecture, zookeeper,Dataflow, WAL and Memstore, HFile, CRUD operations, Meta table, Merge and compaction, Introduction to Hive – Hive data types, Hive file formats,Hive database and table operations, partitioning, Built in operators and functions, Views and indexes, Spark on Hive.

UNIT V (10 Hours)

Analytics and Visualization: Spark MLLib for Machine Learning, ML Pipeline, Feature extraction and Transformations, Classification and Regression-Binary classification-SVM, logistic regression and linear regression, Multiclass classification – DT, Naive Bayes, Clustering- K Means, Hyperparameter Tuning and Cross-validation, Optimization. Building visualizations on Big Data- Power BI, Tableau, and Case Studies on applications of Big Data Analytics

Text books

1. Bill Chambers And Matei Zaharia, “Spark: The Definitive Guide: Big Data Processing Made Simple”, O'Reilly Media, 2018
2. Tathagata Das, Jules S. Damji, Brooke Wenig, Denny Lee, “Learning Spark: Lightning-Fast Data Analytics,” Second Edition, O’Reilly Media, 2020

Reference books

1. DT Editorial Services, “Big Data, Black Book : Covers Hadoop 2, MapReduce, Hive, YARN, Pig, R and Data Visualization”, DreamTech Press, 2016
2. Natraj Dasgupta, “Practical Big Data Analytics”, Packt, 2018
3. Gerard Maas, Francois Garillot “Stream Processing with Apache Spark”, O'Reilly Media, 2019
4. Bart Baesens, “Analytics in Big Data World," Wiley, 2014
5. Tom White, “HADOOP: The definitive Guide”, O Reilly 2012.
6. Kristina Chodorow and Michael Dirolf, “MongoDB: The Definitive Guide”,O'Reilly Media, 2019
7. Andy Konwinski, Holden Karau, Matei Zaharia, and Patrick Wendell, “Learning Spark: LightningFast Big Data Analysis," O Reilly, 2015.

Web Resources

1. Coursera - Introduction to Big Data with Spark and Hadoop Introduction to Big Data with Spark and Hadoop.

Assessment Pattern

Bloom’s Category	Continuous Assessment Tests		End Semester Examination
	1 (20 Marks)	2 (20 Marks)	
Remember	-	-	-
Understand	10		20
Apply			30
Analyse	10	20	20
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	50	50	3 hours

Continuous Internal Evaluation Pattern
Continuous Assessment Test (2 numbers) : 40 marks
Assignment/Quiz/Course project : 10 marks

End Semester Examination Pattern **:** Sample QP

22-359-0322 CYBER FORENSICS

22-359-0322	CYBER FORENSICS	CATEGORY	L	T	P	CREDIT
		ELECTIVE	2	1	0	3

Prerequisite: Nil

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

CO1	Explain systematic approach to computer investigations.	(Cognitive level: Understand)
CO2	Apply forensic procedure to collect and recover digital evidence using tools.	(Cognitive level: Apply)
CO3	Judge the validity of digital evidence before presenting using cryptographic hashes.	(Cognitive level: Analyze)
CO4	Create forensic duplicates for investigation using tools and commands for capturing digital evidence.	(Cognitive level: Create)
CO5	Describe steps to follow for network, email and mobile forensics.	(Cognitive level: Understand)

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2	2				2	2			2				
CO 2	2	2	2	1	2	2	2			2			2	2
CO 3	2	2				2	2			2				1
CO 4	2	2	2	1	2	2	2			2			2	
CO 5	2	2				2	2			2				1

Syllabus

UNIT I (8 Hours)

Computer Forensics Fundamentals: Computer Crime, challenges with computer crime, different types of computer crime-Identity Theft, Identity fraud, Email and internet Fraud, Theft of financial data, Corporate Data Theft, Cyber extortion-Ransomware attack, Phishing, Hacking, Spoofing, Harassment, Intellectual property Theft , Ethical Hacking, Windows Hacking . Computer Forensics Fundamentals- Type of Computer Forensics Technology, Computer forensics specialist approaches - Scientific method in forensic analysis, Computer Forensics Services.

UNIT II (10 Hours)

Computer Forensics Evidence and Capture, Data Recovery-Evidence collection - archiving, artifacts , systematic collections steps, controlling contamination , reconstructing the attacks . Data Seizure - Duplication and preservation of Digital Evidence, Computer image verification and Authentication-Cryptographic Hashes. Data Acquisition. Investigating Cybercrime, Duties Support Functions and Competencies.

UNIT III (10 Hours)

Types of Evidence: The Rules of Evidence, Volatile Evidence, order of volatility- Why Collect Evidence in the first place, Collection Options Obstacles. Computer forensics and network forensics, systematic procedure for network forensics analysis. Incident - Incident Response Methodology - Steps, Activities in Initial Response Phase after detection of an incident, Creating response toolkit.

UNIT IV (9 Hours)

Initial Response & Volatile Data Collection from Windows system - Initial Response & Volatile Data Collection from Unix system, Forensic Duplication, Qualified Duplication, Forensic Duplicates as Admissible Evidence, Forensic Duplication using Linux commands, creating windows Forensic Duplicate using tool, Forensic Duplicate of a Hard Disc.

UNIT V (8 Hours)

Collecting Network-Based Evidence - Investigating Routers - Network Protocols - Email Tracing - Internet Fraud. Hackers Tools. Cell phone and mobile device forensics. Forensics hardware and software, Information Security Investigations, Corporate Cyber Forensics, investigating large scale Data breach cases, Analyzing Malicious software.

Textbooks

1. "Computer Forensics: Computer Crime Scene Investigation" by John Vacca, Edition 1, 2015, Laxmi Publications.
2. "A Practical Guide to Computer Forensics Investigation", by Darren Hayes, 2014, Edition 1, Pearson IT Certification.
3. "Hacking Exposed Computer Forensics", by Aaron Philipp, Chris Davis, and David Cowen, Edition 2, 2009, McGraw Hill.
4. "Insider Computer Fraud: An In-depth Framework for Detecting and Defending Against Insider IT Attacks" by Kenneth Brancik, Edition 1, 2019, Auerbach Publications.
5. "Guide to Computer Forensics and Investigations", by Bill Nelson, Amelia Phillips, Christopher Steuart, Edition 6, 2020, Cengage Learning India Pvt. Ltd.
6. "Cyber Forensics", by Dejey, Murugan, Edition 1, 2018, Oxford University Press.

Web Resources

1. https://www.coursera.org/learn/smarter-contracts

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1 (20 Marks)	2(20 Marks)	
Remember			
Understand	10	5	20
Apply	10	5	30
Analyse		10	20
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	50	50	3 hours

Continuous Internal Evaluation Pattern:
Continuous Assessment Test (2 numbers): 40 marks
Assignment/Quiz/Course project: 10 marks

End Semester Examination Pattern **:** Sample QP

22-359-0323 COMPUTER VISION

22-359-0323	COMPUTER VISION	CATEGORY	L	T	P	CREDIT
		ELECTIVE	3	1	0	4

Prerequisite: Nil

Course Outcomes

After completion of this course, the students will be able to

CO1	Describe digital image formation and representation to perform low level image processing	(Cognitive level: Understand)
CO2	Compare Feature detection and image transformation techniques	(Cognitive level: Analyze)
CO3	Apply segmentation and Feature-based alignment	(Cognitive level: Apply)
CO4	Apply structure from motion and perform dense motion estimation.	(Cognitive level: Apply)
CO5	Apply depth estimation, Object Detection, Face recognition, Instance recognition and understand multi-camera views.	(Cognitive level: Apply)

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	2					2						1	
CO2	3	2	1	1	2		2						2	
CO3	3	2	1	1	2		2						3	1
CO4	3	2	1	1	2		2						3	1
CO5	3	2	1	1	2		2						3	1

Syllabus

UNIT I (9 Hours)

Digital Image Formation and Representation: Fundamentals of Image Formation, Geometric Primitives and Transformations: Orthogonal, Euclidean, Affine, Projective; Photometric Image Formation, Digital Camera, Low-level Image processing: Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing.

UNIT II (8 Hours)

Feature Detection: Edges - Canny, Laplacian of Gaussian (LoG), Difference of Gaussian (DoG); Lines - Hough Transform, Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.

UNIT III (8 Hours)

Image Segmentation: Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, Markov Random Field Segmentation, Texture Segmentation; Feature-based Alignment: 2D and 3D Feature-based alignment, Pose estimation, Geometric intrinsic calibration.

UNIT IV (10 Hours)

Structure from motion: Triangulation, Two-frame structure from motion, Factorization, Bundle adjustment, constrained structure and motion; Dense motion estimation – Translational alignment, Parametric motion, Spline-based motion, Optical flow, Layered motion.

UNIT V (10 Hours)

Depth estimation and multi-camera views: Perspective, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, 3-D reconstruction framework; Autocalibration. Stereo; Recognition - Object Detection, Face recognition, Instance recognition

Textbooks and References

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.

2. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003.

3. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.

4. K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990.

5. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992.

6. Christopher M. Bishop; Pattern Recognition and Machine Learning, Springer, 2006

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1 (20 Marks)	2(20 Marks)	
Remember			
Understand	10	5	20
Apply	10	5	30
Analyse		10	20
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	50	50	3 hours

Continuous Internal Evaluation Pattern:
Continuous Assessment Test (2 numbers): 40 marks
Assignment/Quiz/Course project: 10 marks

End Semester Examination Pattern **:** Sample QP

22-359-0324 SOCIAL NETWORK ANALYSIS

22-359-0324	SOCIAL NETWORK ANALYTICS	CATEGORY	L	T	P	CREDIT
		ELECTIVE	3	1	0	4

Prerequisite: Basic Data Structures, Basic Mathematics

Course Outcomes

After completion of this course, the students will be able to

CO1	Interpret social networks.	Cognitive level: Understand
CO2	Explain different terminologies of graph and representation of graphs.	Cognitive level: Understand
CO3	Calculate centrality, betweenness centrality and directional relations.	Cognitive level: Apply
CO4	Explain structural relations	Cognitive level: Understand
CO5	Analyze social networks using UCINET, PAJEK, ETDRAW, StOCNET, SplusR, NodeXL,SIENA and RSIENA.	Cognitive level: Analyse

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3.

	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO1	2	2												
CO2	2	2												
CO3	3	3												
CO4	2	2												
CO5	3	3			3								2	

Syllabus

UNIT I (8 Hours)

Introduction to Social Network Analysis, Mathematical representations of Social Networks: Notations for Social Network data – Graph theoretic, sociometric. Graphs – Subgraphs, Dyads, Triads, Nodal degree, Density, Walks, trails and paths, Connected graphs and components, Geodesics, distance and diameter, Connectivity, Isomorphic graphs and subgraphs.

UNIT II (10 Hours)

Directed graphs – Dyads, Nodal indegree and outdegree, Density, directed walks, paths and semi paths, Reachability and connectivity, Geodesics, distance and diameter. Signed graphs and signed directed graphs Matrices – for graphs, digraphs, valued graphs, two-mode networks, Basic matrix operations, Computing simple network properties.

UNIT III (10 hours)

Centrality: Actor centrality, Nondirectional relationships – degree, closeness, betweenness centrality, Directional relations – centrality.

UNIT IV (7 Hours)

Structural relationships – strong and weak ties, homophily, positive and negative relationships, Link analysis.

UNIT V (10 Hours)

Network dynamics – cascading behaviour, small-world phenomenon, epidemics. Tools for Social Network Analysis - UCINET-PAJEK-ETDRAW-StOCNET- Splus-R-NodeXL-SIENA and RSIENAReal world Social Networks (Facebook-Twitter etc.)

Textbooks and references

1. Social Network Analysis: Methods and Applications, Book by Katherine Faust and Stanley Wasserman Cambridge; New York : Cambridge University Press, 8th series.
2. Networks, Crowds, and Markets: Reasoning about a Highly Connected World Book by David Easley and Jon Kleinberg.
3. Social and Economic Networks Book by Matthew O. Jackson, Illustrated, 21 November 2010

Web Resources

1. NPTEL: https://onlinecourses.nptel.ac.in/noc19_cs66/preview

2. Coursera: https://www.coursera.org/learn/social-network-analysis

3. EDX/UPGRAD: https://www.edx.org/course/social-network-analysis-sna

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1 (20 Marks)	2(20 Marks)	
Remember			
Understand	10	5	20
Apply	10	5	30
Analyse		10	20
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	50	50	3 hours

Continuous Internal Evaluation Pattern:
Continuous Assessment Test (2 numbers): 40 marks
Assignment/Quiz/Course project: 10 marks

End Semester Examination Pattern **:** Sample QP

ELECTIVE IV

INTERNET OF THINGS

22-359-0331	INTERNET OF THINGS	CATEGORY	L	T	P	CREDIT
		ELECTIVE	2	1	0	3

Prerequisite: Nil

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

CO 1	Describe general concepts of Internet of Things.	(Cognitive level : Understand)
CO 2	Compare M2M and IoT Architectures.	(Cognitive level : Analyze)
CO 3	Describe about various devices, sensors required for IoT applications	(Cognitive level : Understand)
CO 4	Design IoT Applications using Arduino IDE.	(Cognitive level : Create)
CO 5	Develop various use cases for IoT	(Cognitive level : Create)

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	2	3												
CO2	2	2		3										
CO3	2													
CO4	3	3	3		3	2	2				1			1
CO5	3	3	3		3	2	2			3	1			1

Syllabus

UNIT I (8 hrs)

Internet of Things - Definition and Characteristics of IoT, Sensors, Actuators, Physical Design of IoT – IoT Protocols, IoT communication models, IoT Communication APIs, IoT enabled Technologies – Wireless Sensor Networks, Cloud Computing, Embedded Systems.

UNIT II (9 hrs)

Design of IoT, IoT Application Areas, Domain Specific IoTs – Home, City, Environment, Energy, Agriculture and Industry, IoT Examples, Layered architecture of IoT. Protocols for IoT- IEEE 802.15.4-, Zigbee, Zigbee Architecture, WiFi, LowPAN, LoRaWAN. Machine to Machine communication – Differences and Similarities between M2M and IoT, CoAP.

UNIT III (8 hrs)

IoT Data Management - Device Management Gateways. Data Acquiring and Storage for IoT Services.

UNIT IV (10 hrs)

Embedded Computing Basics, Embedded Hardware Unit. Embedded Platforms for Prototyping - Arduino, Raspberry Pi, Create Designs using Tinkercad. Prototyping and Designing the Software for IoT Applications- Programming using Arduino - Arduino Programs to Blink LED, Arduino Program to control traffic lights, Create Applications using sensors-Ultrasonic Sensor, Temperature Sensor, Moisture Level Sensor.

UNIT V (10 hrs)

Data Analytics for IoT, Web server for IoT, Blockchain and IoT,Cloud computing for data storage, Big data platform for the internet of things, Big Data Management Systems for the Exploitation of Pervasive Environments - Big Data challenges and requirements coming from different IoT based applications. Case studies- Smart Home, Smart Environment, Smart healthcare, Smart agriculture.

Textbooks/References

1. “Raspberry Pi Cookbook: Software and Hardware Problems and Solutions”, by Simon Monk, Edition 3, 2019, O'Reilly.
2. “Internet Of Things: A Hands-On Approach, by Arshdeep Bahga and Vijay Madisetti, Edition 1, 2015, Orient Blackswan Private Limited - New Delhi.

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1 (20 Marks)	2(20 Marks)	
Remember	-	-	-
Understand	**5**	**5**	**20**
Apply	**10**	**10**	**30**
Analyse	**5**	**5**	**20**
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	50	50	3 hours

Continuous Internal Evaluation Pattern:
Continuous Assessment Test (2 numbers) : 40 marks
Assignment/Quiz/Course project : 10 marks

End Semester Examination Pattern **:** Sample QP

22-359-0332 ANDROID APPLICATION PROGRAMMING

22-359-0332	**ANDROID APPLICATION PROGRAMMING**	**CATEGORY**	**L**	**T**	**P**	**CREDIT**
		ELECTIVE	**3**	**1**	**0**	**4**

Prerequisite: Java

Course Outcomes

After completion of this course, the students will be able to

CO1	Explain the fundamentals of Android Programming.	(Cognitive level : Understand)
CO2	Describe Native Capabilities, Messaging, and Location based services.	(Cognitive level : (Understand)
CO3	Create applications that work with databases to store data using Shared preferences and SQLite database.	(Cognitive level : Analyze)
CO4	Apply built in widgets and components in mobile app	(Cognitive level : Apply)
CO5	Create GUI based applications.	(Cognitive level : Create)

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO2**
CO1	2	2			2				2					
CO2		2	2	2	2									
CO3	2	2	2	2									3	2
CO4	3	2	2	2	1									
CO5	3	2	2									1	2	

Syllabus

UNIT I (13 Hours)

Introduction to Android Architecture: Introduction, History, Features and Android Architecture. Application Environment and Tools, Android Studio, Android SDK, AVD. Application Components- Activity, Content providers, Broadcast receivers, Services. Intents- Explicit and Implicit Intents, Intent Filter, Manifest File. Debugging android application.

UNIT II (14 Hours)

User Interface Design: User Interface Design: Views &View Groups, Views : Button, Text Field, Radio Button, Toggle Button, Checkbox, Spinner, Image View, Image switcher, Event

Handling, Listeners, Layouts : Linear, Relative, List View, Grid View, Table View, Web View, Adapters. Creating the user interface programmatically, Managing changes to screen orientation, Displaying notifications- Setting up notifications, Notification manager. Designing for Tablets – Working with tablets: Developing for different android platforms, Fragments, combining fragments into a multilane UI, Specialized Fragments

UNIT III (13 Hours)

Mobile Data Management :Shared Preferences – Saving and Loading User Preferences, Persisting Data to Files, Creating and using Databases, SQLite Databases. Content Providers - Using a Content Provider, Built in Content Provider - Browser, CallLog, Contacts, Media Store and Settings. Creating Your Own Content Providers -Uri, CRUD access

UNIT IV (12 Hours)

Native Capabilities, Messaging, Location based services Camera, Audio, Sensors and Bluetooth: Android Media API: Playing audio/video, Media recording. Sensors - how sensors work, listening to sensor readings. Bluetooth , Messaging – SMS Messaging, Broadcast Receiver, Sending Email . Maps & Location: Maps : Map - Based Activities, How to load maps, To find map API key, GPS, Working with Location Manager, Working with Google Maps extensions, Location based Services. Location Updates, location-based services (LBS), Location Providers, Selecting a Location Provider, Finding Your Location

UNIT V (11 Hours)

Threading, Services, Web services Tasks & Processes: Tasks, Switching between Task, Process, Process lifecycle. Threads, Thread Life cycle, Worker Threads, Thread Handlers, Threads & Loopers and IPC.Services: Services and Notifications – bound/unbound services, Starting and stopping services, Android Interface Definition Language, Handler and Messenger, Passing objects over IPC, Scheduling of services. Web Services – Android Server Communication: communication protocols, interacting with server-side applications, developing clients forwebservices, Exchanging Data over the Internet data parsing using json and xml parsing. Integrating with 3rd party Apps using Web Services.

TEXTBOOK

1. Beginning Android Programming with Android Studio, 4ed, by J. F. DiMarzio, 2016 BookS
2. Android Application Development Cookbook, by Wei-Meng Lee, John Wiley and Sons, 2013 2. Professional Android 4 Development by Reto Meier, John Wiley and Sons, 2012 3. Android in Action, Third Edition, by W. Frank Ableson, RobiSen, Chris King, C. Enrique Ortiz, 2012

Web Resources

[1] https://nptel.ac.in/courses/106/106/106106147/

[2] https://www.coursera.org/learn/androidapps

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1 (20 Marks)	2(20 Marks)	
Remember	-	-	-
Understand	5	5	20
Apply	10	10	30
Analyse	5	5	20
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	50	50	3 hours

Continuous Internal Evaluation Pattern:
Continuous Assessment Test (2 numbers) : 40 marks
Assignment/Quiz/Course project : 10 marks

End Semester Examination Pattern **:** Sample QP

22-359-0333 VIRTUALIZATION AND CONTAINERS

22-359-0333	VIRTUALIZATION AND CONTAINERS	CATEGORY	L	T	P	CREDIT
		ELECTIVE	3	1	0	4

Prerequisite: Operating Systems, Distributed computing.

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

CO 1	Describe virtualization technology, architecture, limitations, and applications.	(Cognitive level : Understand)
CO 2	Apply networking principles to set up virtual machines and connect to the network	(Cognitive level :Apply)
CO 3	Describe VM life cycle, migrations, scheduling, and load balancing	(Cognitive level : Understand)
CO 4	Examine container fundamentals, implement and set up a container	(Cognitive level : Analyze)
CO 5	Building and creating a simple container framework	(Cognitive level :Apply)

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	1										
CO 2	3	2	1	1			1					
CO 3	2	1					1					
CO 4	2	1					1					
CO 5	2	1					1					
CO 6	3	2	1	1			1					

22-359-0333 VIRTUALIZATION AND CONTAINERS

UNIT I (9 hours)

Distributed computing fundamentals, Cloud Computing and its architecture, Virtual Machines, Traditional and virtual computing, Understanding Virtualization - its need, applications, and Limitation, Simulations and Emulation, virtualized environment - its challenges, tools, and technologies. Types of Hypervisor, Architecture of Hypervisor.

UNIT II (7 hours) IP addressing - Private and Public address, Virtual LAN, Memory addressing, Paging, Memory mapping, virtual memory, complexities and solutions of memory virtualization.

UNIT III (14 hours) VM lifecycle, Process, and system level VMs, VM Configuration, VM Migration, migration types and process, VM provisioning, Scaling, VM scheduling, Load balancing: its significance, types, and algorithms. Case Study: KVM - its architecture and commands; Xen - its architecture and commands.

UNIT IV (10 hours) Container fundamentals, Container versus virtual machine, Various container technologies, Configuring a container engine, Container virtual networking, container orchestration, and clustering, Images and Containers. Case Study- Docker.

UNIT V (5 hours) Creating a Simple Container Framework: The UTS Namespace, Golang Installation, Building a Container with a Namespace, Launching a Shell Program Within the Container, Providing Root File System, The Mount Proc File System, Enabling the Network for the Container.

References

1. Kai Hwang, Geoffrey C. Fox and Jack J. Dongarra, *Distributed and Cloud Computing: From Parallel Processing to the Internet of Things* — Morgan Kauffmann, 2011.
2. James E. Smith, Ravi Nair, *Virtual Machines: Versatile Platforms for Systems and Processes*, Elsevier/Morgan Kaufmann, 2005
3. Matthew Portnoy, *Virtualization Essentials*, Wiley; Second edition (2016)
4. Sean P. Kane, Karl Matthias, *Docker: Up & Running - Shipping Reliable Containers in Production*, Second Edition, O'Reilly

Web References/ Courses

1. https://nptel.ac.in/courses/106/105/106105167/
2. https://nptel.ac.in/courses/106/104/106104182/
3. https://docs.docker.com/
4. https://www.linux-kvm.org/

22-359-0334 SOFTWARE TESTING

22-359-0334	SOFTWARE TESTING	CATEGORY	L	T	P	CREDIT
		ELECTIVE	3	1	0	4

Prerequisite: Software Engineering

Course Outcomes:

After completion of this course, students will be able to

CO1	Describe software engineering testing process.	(Cognitive level : Understand)
CO2	Examine different software testing techniques and strategies.	(Cognitive level : Analyze)
CO3	Describe different types of software testing.	(Cognitive level : Understand)
CO4	Compare different testing tools in different scenarios.	(Cognitive level : Analyze)
CO5	Write test cases for a given scenario.	(Cognitive level :Apply)

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	2	1		1			2	1				
CO2	2	2	2	1			2	1				
CO3	2	2	2	1			2	1				
CO4	2	1	2		2		2	1				

CO5	2	1	2		2		2					

Syllabus

UNIT I (8 Hours)

Fundamentals of Software Testing- Definition, Essentials of testing, Misconceptions about testing, test policy, challenges in testing, Cost aspect, test strategy or test approach. STLC. Categories of Defects, Defect, Error or Mistakes in Software. Testing techniques and tools- Levels of testing – Proposal Testing, Requirement Testing, Design Testing, Code Review, Unit Testing, Module Testing, Integration Testing, Big Bang Testing, Sandwich Testing, Critical Path First, Subsystem Testing, System Testing, Testing Stages**.**

UNIT II (7 Hours)

Acceptance testing - Acceptance Testing Criteria, Importance of Acceptance Criteria, Acceptance Criteria, Alpha Testing, Beta Testing, Gamma Testing, Acceptance Testing During Each Phase of Software Development, Consideration of Alpha and Beta Acceptance Testing Process, Developing Acceptance Test Plan, Software Acceptance Plan, User Responsibilities in Acceptance Test Plan, Executing Acceptance Plan.

UNIT III (10 Hours)

Special Tests: Complexity Testing, Graphical User Interface Testing, Compatibility Testing, Security Testing, Performance Testing, Volume Testing and Stress Testing, Recovery Testing, Installation Testing, Requirement Testing (Specification Testing), Regression Testing, Error Handling Testing, Manual Support Testing, Intersystem Testing, Control Testing, Smoke Testing, Sanity Testing, Adhoc Testing(Monkey Testing, Exploratory Testing, Random Testing), Parallel Testing, Execution Testing, Operations Testing, Compliance Testing, Usability Testing, Decision Table Testing(Axiom Testing), Documentation Testing, Training Testing, Rapid Testing, Control Flow Graph, Generating Tests on the Basis of Combinatorial Designs, State Graph.

UNIT IV (10 Hours)

Risk associate with new technologies, Process Maturity Level of Technology, Testing Adequacy of control in New Technology Usage, Object Oriented Application Testing, Testing of Internal Controls, 'COTS' Testing, Client-Server Testing, Web Application Testing, Mobile Application Testing(PDA Devices), e Business / eCommerce Testing, Agile Development Testing, Data Warehousing Testing. Testing tools – Features of Test Tool, Guidelines for Selecting a Tool, Tools and Skills of Tester, Static Testing Tools, Dynamic Testing Tools, Advantages of Using Tools, Disadvantages of Using Tools, When to use Automated Test tools, Testing using Automated tools, Difficulties while introducing new tools, Process of Procurement of COTS (Readily Available Tool from Market), Procurement of Tools from

Contractor, Advantages of Tools Developed By External Organizations, Contracting a Software, Process of Procurement of Tools from Contractor.

UNIT V (10 Hours)

Testing process: Test policy, Test plan, Test cases, Test Scripts. Test metrics and Test reports – Testing Related Data, Defect Data, Efficiency/Productivity Data, and Categories of the Product/Project Test Metrics, Estimated Budgeted, Approved and Actual, Resources Consumed in Testing, Effectiveness of Testing, Defect Density, Defect Leakage Ratio(Defect Life), Residual Defect Density (RDD), Test Team Efficiency, Test Case Efficiency, Rework, MTBF/MTTR, Implementing Measurement Reporting System in an Organization, Test Reports, Project Test Status Report, Integration Test Report, System Test Report, Acceptance Test Report, Guidelines for Writing and Using Report, Final Test Reporting, Test Status Report, Benchmarking.

References:

1. Software Testing- Principles, Techniques and Tools, M G Limaye, Tata Mc Graw Hill, 2009.
2. Software Quality Assurance from theory to implementation, Daniel Galin, Pearson Education Limited.