DELHI TECHNOLOGICAL UNIVERSITY
(Formerly Delhi College of Engineering)
Shahbad Daulatpur, Main Bawana Road, Delhi-42
(Academic-PG)

Scheme for Full Time M. Tech. as per NEP-2020

SEMESTER I						
Code	**Course Name**	**Type**	**Cr**	**L-T-P**	**Total Credits**	**Level**
ITY101	Linear Algebra & Probability	Core	4	3-1-0	24	500-599*
ITY105	Advanced Data Structures	Core	4	3-0-2		
ITY107	Advanced Operating Systems	Core	4	3-1-0		
ITY109	Foundations of Machine Learning	Core	4	3-0-2		
ITY131	Malware Analysis	Departmental Elective 1	4	3-0-2		
ITY125	Research Problem Formulation	Self-Study	2	-		
ITY123	Open-Source Programming	Skill Enhancement Course 1	2	0-0-4		
UEC101	-	Audit Course	0	0-0-2		

SEMESTER II						
Code	**Course Name**	**Type**	**Cr**	**L-T-P**	**Total Credits**	**Level**
ITY102	Advanced Algorithms	Core	4	3-1-0	24	500-599*
ITY104	Information Security	Core	4	3-1-0		
ITY132	Departmental Elective Course-2	Departmental Elective 2	4	3-1-0/3-0-2		
ITY134	Departmental Elective Course-3	Departmental Elective 3	4	3-1-0/3-0-2		
UCC102	Research Methodology and IPR	University Core Course	4	3-1-0		
ITY146/ ITY148	Dev Ops and ML Ops/Industrial Training	Skill Enhancement Course 2/ Industrial Training	4	2-0-4/-		
		NHEQF Level				6.5

SEMESTER III						
Code	**Course Name**	**Type**	**Cr**	**L-T-P**	**Total Credits**	**Level**
ITY201	Distributed and Cloud Computing	Core	4	3-1-0	16	600-699*
UEC 201	University Elective Course	Open Elective 1	4	3-1-0/3-0-2		
ITY203	Minor Project/Research Thesis/Patent	Minor Project/Research Thesis/Patent	8	-		

SEMESTER IV						
Code	**Course Name**	**Type**	**Cr**	**L-T-P**	**Total Credits**	
ITY202	Project/Thesis	Major Project/Research Thesis/Patent	16	-	16	-
		NHEQF Level				7.0

**** Refer draft UGC Curriculum and credit framework for PG Programme***

SEMESTER I

Core Courses:

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY101 Linear Algebra and Probability	**3**	**1**	**0**	**Fundamentals of Mathematics**

Course Objective: To provide students with a solid foundation in linear algebra and probability theory, enabling them to apply mathematical techniques and probabilistic models to solve problems in various fields.

S. NO	Course Outcomes (CO)
CO1	Understand the fundamental concepts of linear algebra and matrices, and their applications in various real-world applications.
CO2	Comprehend the significance of orthogonality, inner product, and orthonormal bases in vector spaces.
CO3	Understand the concept of random variables and random vectors, and their probabilistic interpretation in modelling uncertainty.
CO4	Differentiate between statistical averages and ensemble averages and understand the concept of random processes.
CO5	Learning parameter estimation using moments and maximum likelihood.

S. NO	Contents	Contact Hours
UNIT 1	Introduction to Linear Algebra and Matrices: Matrices and Linear Transformations, Rank, Determinant, trace of a matrix. Solving simultaneous equations using matrices, Gaussian Elimination, Overdetermined and underdetermine systems, Inverse, pseudo inverse. Condition number of a matrix, eigenvalues, eigenvectors, singular values, singular vectors.	**9**
UNIT 2	Orthogonality: Inner Product, Orthogonality, Gram-Schmidt Orthogonalization, Vector and Matrix Norms - Applications to optimization problems and graph theory, machine learning.	**8**
UNIT 3	Introduction to Random Variables and Random Vectors: Discrete and continuous random variables, random vectors. Transformation of continuous random variables and vectors by deterministic functions. Density functions of transformed continuous random variables.	**9**
UNIT 4	Introduction to Random Processes: Statistical averages, ensemble and time averages. Random process, Bernoulli random process, binomial process. Weak and strict sense stationarity of a random process.	**8**
UNIT 5	Estimation of parameters from data: method of moments, method of maximum likelihood. Tests of fit: Chi-Squared, Student-t test. Cramer-Rao bound on estimators. Comparison of two different distributions of the same random variable/vector.	**8**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Gilbert Strang, Linear algebra and its applications-Fourth Edition - Cengage Learning	2006
2	Papoulis and Unnikrishnan Probability, Random Variables, and Stochastic Processes - Fourth Edition	2002
3	W B Davenport, Probabiility and Random Processes - an introduction for application scientists and engineers, Mc Graw Hill	1970
4	Probability and Statistics with Reliability, Queuing, and Computer Science Applications - Kishore S Trivedi, PHI	1964
5	Kenneth Hoffman and Ray Kunze Linear Algebra (Second Edition), Prentice Hall India	2013

6	Cheney and Kincaid Linear Algebra (Second Edition), Jones and Barlett Learning	2014

Course Title	**Course Structure**			**Pre-Requisite**
ITY105: Advanced Data Structures	**L**	**T**	**P**	**C/C++ Programming, Foundations of Algorithms and Data Structures**
	3	**0**	**2**	

Course Objective: To provide in-depth knowledge and understanding of advanced data structures, their design, analysis, implementation, and to prepare students to tackle complex computational problems efficiently.

S. NO	**Course Outcomes (CO)**
CO1	Understand and implement various advanced tree structures
CO2	Utilize skip lists for randomized data structure operations and implement advanced heap structures
CO3	Apply union-find algorithms for disjoint sets and solving problems related to graph representation
CO4	Implement network flow algorithms as well as graph coloring techniques
CO5	Design and analyze approximation algorithms for NP-hard problems and geometric algorithms
CO6	Implement dictionary abstract data types and applying various hashing techniques

S. NO	**Contents**	**Contact Hours**
UNIT 1	Advanced Tree Structures:- : Binary Search Trees, Balanced Multi-way Trees, Segment Tree AVL Trees, Red-Black Trees, 2-3 Trees, B-Trees, Splay Trees: Concept, Properties, Operations	**6**
UNIT 2	Skip Lists and Advanced Heaps Skip Lists: Need for Randomizing Data Structures and Algorithms, Search and Update Operations, Probabilistic Analysis, Deterministic Skip Lists Binomial Heaps: Structure, Basic Operations, Union, Insertion, Deletion Fibonacci Heaps: Structure, Insertion, Union, Decrease Key, Delete Node Pairing Heaps: Structure, Operations, and Analysis	**8**
UNIT 3	Disjoint Sets and Advanced Graph Algorithms I Disjoint Sets: Union-Find Algorithms, Union by Rank, Path Compression, Applications Graph Representation: Types of Graphs, Paths, and Circuits, Euler Graphs: Concept and Properties Hamiltonian Paths & Circuits: Concept and Properties, Cut-sets: Definition and Applications Connectivity and Separability: Definitions and Applications, Planar Graphs: Concept and Properties Isomorphism: Concept and Applications	**8**
UNIT 4	Advanced Graph Algorithms II and Network Flow Algorithms Network Flow Algorithms: Ford-Fulkerson Method, Edmonds-Karp Algorithm, Max-Flow Min-Cut Theorem Graph Coloring: Techniques, Algorithms, and Applications	**7**
UNIT 5	Approximation Algorithms and Geometric Algorithms Approximation Algorithms: Set Cover, Max-SAT, Knapsack, Bin Packing, Scheduling, Traveling Salesman Tour Geometric Algorithms: Convex Hull Algorithms, Lower Bound of Convex Hull, Line Segment Intersection, Closest Pair Points	**7**
UNIT 6	Dictionaries, Hashing Dictionaries: Definition, Dictionary Abstract Data Type, Implementation of Dictionaries. Hashing: Review of Hashing, Hash Function, Collision Resolution Techniques in Hashing, Separate Chaining, Open Addressing, Linear Probing, Quadratic Probing, Double Hashing, Rehashing, Extendible Hashing.	**6**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Introduction to Algorithms" by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein	3rd Edition, 2009
2	Algorithms" by Robert Sedgewick and Kevin Wayne	4th Edition, 2011
3	Data structures and Algorithms in C++, Michael T.Goodrich, R.Tamassia and D.Mount, Seventh Edition Wiley student edition, John Wiley and Sons.	1st Edition, 2008
4	Algorithm Design" by Jon Kleinberg and Éva Tardos	1st Edition, 2005
5	Advanced Data Structures" by Peter Brass	1st Edition, 2008

Course Title	Course Structure			Pre-Requisite
ITY107: Advanced Operating Systems	L	T	P	Operating Systems
	3	1	0	

Course Objective: Develop a comprehensive understanding of process synchronization, distributed operating systems, resource management, scheduling, failure recovery, fault tolerance, and security mechanisms in both centralized and distributed computing environments

S. NO	Course Outcomes (CO)
CO1	Gain proficiency in understanding and resolving synchronization problems in operating systems, including critical section management and deadlock detection, paving the way for advanced system design approaches.
CO2	Analyze and implement distributed mutual exclusion, deadlock detection, and agreement protocols to address challenges inherent in distributed operating systems architecture and resource management.
CO3	Develop expertise in distributed scheduling techniques and load balancing algorithms to optimize system performance and resource utilization in distributed computing environments.
CO4	Acquire knowledge and skills in failure recovery and fault tolerance mechanisms to ensure reliable communication in distributed systems.
CO5	Acquire knowledge and skills in failure recovery and fault tolerance mechanisms to ensure reliable communication in distributed systems.

S. NO	Contents	Contact Hours
UNIT 1	Process Synchronization: Functions of OS, Design Approches, Advanced OS. Concept of Process, Concurrent Process, The Critical Section Problem, Synchronization Problems. Process Deadlock, Models of Deadlocks, Models of Resources, Graph Theoretical model of System state, Condition of deadlock, Single Unit request, Consumable resources, Reusable resources.	8
UNIT 2	Distributed Operating systems: System architechtutre types, Distributed OS, issues in distributed OS, Limitations of Distributed Systems, Lamport's logical clock, Vector clocks, Casual ordering of messages, Global State. Distributed Mutual Exclusion, Distributed deadlock detection, Agreement Protocols.	10
UNIT 3	Distributed Resource management: Distributed File System, mechanism of building Distributed file systems, Design issues, Log structured file systems, Distributed shared memory, Algorithms, Memory Coherence, Coherence Protocols, Design Issues. Dsitributed Scheduling: issues in load balancing, Components of Load Distributing Algorithms, Load Distributing Algorithms.	8
UNIT 4	Failure Recovery and Fault Tolorence: Recovery, checkpointing and recovery, checkpointing for distributed database systems. Atomic actions and Commiting, Commint Protocols, Votoing Protocols, Failure Resilient Processes, Reliable Communication.	8
UNIT 5	Potection and Security: Resource Security and Protection, Acess and control flow, Implementation of Acess control matrix, Safety in acess Matrix Model, Advanced Models of protection, Cryptography, Coventional cryptography, Modern Cryptography, Private Key Cryptography: DES, Public Key Cryptography, Multiple Encryptions, Authentication in distributed Systems. Case study: The Kerberos Security.	8
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Mukesh Singhal , Niranjan Shivaratri, "ADVANCED CONCEPTS IN OPERATING SYSTEMS", McGraw Hill Education.	2017
2	Andrew S. Tanenbaum, Maarten Van Steen ,"Distributed Systems: Principles and Paradigms", Pearson Prantice Hall.	2016

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY109: Foundation of Machine Learning	3	0	2	Basic probability theory and linear algebra

Course Objective: To describe various mathematical concepts like probability, statistics, and overview of different machine learning tasks like classification, clustering, regression.

S. NO	Course Outcomes (CO)
CO1	Describe basic understanding of linear alegebra, probability theory and discriminant function
CO2	Analyse and implement supervised learning algorithms like SVM, decision trees, neural networks for problem solving
CO3	Investigate feature selection methods and mixture models
CO4	Explain and implement reinforcement learning
CO5	Describe Bayesian learning and Bias Variance trade off
CO6	Discuss the recent trends and applications in machine learning

S. NO	Contents	Contact Hours
UNIT 1	Introduction: Linear Algebra, Probability Theory, Introduction to Bayesian Methods, Parametric Methods, Discriminant Functions.	6
UNIT 2	Supervised Learning: Linear Regression models, classification, Linear discriminant analysis, Probably Approximately Correct (PAC) Learning, Learning Multiple Classes, Model Selection and Generalization, Support vector machine, Decision trees, Nearest neighbors, neural networks.	8
UNIT 3	Unsupervised Learning: Clustering, Mixture Models, Latent Variables, Expectation-Maximization, Feature selection, Dimensionality Reduction, Factor/Component Analysis, Linear Discriminant Analysis.	8
UNIT 4	Genetic Algorithms: Motivation, Genetic operators, Fitness function, Models of Evolution and Learning, Fuzzy Logic: Fuzzy sets and operations, Membership function, Classical sets, angular fuzzy sets.	10
UNIT 5	Reinforcement Learning: Introduction, The learning task, Q learning, Non-deterministic rewards and actions, Relationship to dynamic programming, Model-Based Learning. Introduction to Deep Learning: Basics of deep learning, Importance of deep learning, Feature engineering, Overview of deep learning framework.	10
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Alpaydin, E, Introduction to Machine Learning, MIT Press, 2004	2004

2	David Barber, Machine Learning: A probabilistic approach, 2006.	2006
3	Charlie Kaufman, Radia Perlman and Mike Spencer, "Network Security: Private Communication in a Public World", Prentice Hall.	2002
4	Tom Mitchell , Machine Learning, McGraw Hill, 1997	1997

Course Title	**Course Structure**			**Pre-Requisite**
ITY123: Open-Source Programming	**L**	**T**	**P**	**Programming Fundamentals**
	0	**0**	**4**	

Course Objective: To have a thorough understanding of programming with Python language for research and application development purpose.

S. NO	**Course Outcomes (CO)**
CO1	To have a basic understanding of introduction about python.
CO2	To study arrays and control flow operators in python programming langunge.
CO3	To understand functions and loops in python.
CO4	To apply modules, packages andd file handling in python.
CO5	To learn object oriented concepts in python.

S. NO	**Contents**	**Contact Hours**
UNIT 1	Introductory Remark about Python , A Brief History of Python, How Python is different from other languages , Python Version, Installing PythonPython coding Introduction , Python keywords and Identifiers, Python statements, Comments in python, Getting user input, Variables, Data types, Numbers, Strings	**5**
UNIT 2	Arrays : Lists, Tuples, Dictionary & Exercise ; Control flow and Operators, Control flow and syntax, The if statement , Python operators	**4**
UNIT 3	Loop in Python : The while Loop , Break and continue , The for Loop, Pass statement Function in Python : Introduction of Function, Calling a function, Function arguments, Built in function, Scope of variables	**4**
UNIT 4	Modules and Package : Modules and Packages , Importing Modules , Standard Modules- sys , Standard Modules- OS , The dir Function, Packages File Handling : Introduction to File Handling in Python, Files and Directories, Writing Data to a file, Reading data from a file, Additional file methods, Working with files, Working with Directories, The pickle Module	**4**
UNIT 5	Object oriented Concept : Classes & Objects, Introduction of classes and objects, Creating classes, Instance methods, Special class method, Inheritance , Method overriding, Data hiding	**4**
	TOTAL	**21**

REFERENCES

S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Python Crash Course: A Hands-On, Project-Based Introduction to Programming (2nd Edition)	2019
2	Head-First Python: A Brain-Friendly Guide (2nd Edition)	2016
3	Python Programming: An Introduction to Computer Science (3rd Edition)	2016

4	Python Cookbook: Recipes for Mastering Python 3 (3rd Edition)	2013

Departmental Electives -1

Course Title	**Course Structure**			**Pre-Requisite**
	L	**T**	**P**	
Advanced Software Engineering	**3**	**1**	**0**	**Software Engineering**

Course Objective: To understand the foundational concepts, principles, and theories of software engineering and achieve proficiency in modern software development methodologies, tools, and best practices.

S. NO	**Course Outcomes (CO)**
CO1	Demonstrate a deep understanding of software engineering principles and methodologies.
CO2	Apply agile development practices effectively in real-world scenarios.
CO3	Understand UML and use them while making project documents.
CO4	Analyze and interpret software metrics data to make informed decisions in software development.
CO5	Create good quality products that meet user expectations.
CO6	Understand the reasons for software aging.

S. NO	**Contents**	**Contact Hours**
UNIT 1	Introduction to Software Engineering, Software Development Lifecyle and importance of architecture and design in the lifecycle, Software Process Models- Linear Sequential Model, Protyping model, RAD model, Evolutionary software process models: Incremental model and Spiral model, Concurrent development model, Component based development, Model based development.	**6**
UNIT 2	Agile Methods for Development – Characteristics for agile processes, Extreme Programming (XP), Adaptive Software Development, Scrum, Dynamic System Development Model, Feature Driven Development, Crystal.	**6**
UNIT 3	Understanding Unified Modelling Language- Roots of UML, Evolution of UML, Main UML specification documents, Structure and Behavior, Main diagrams- Use case diagram, Class diagram, Sequence diagram, Activity diagram	**8**
UNIT 4	Software Project Management- Time-scale Charts, PERT vs. Time-scale chart, Earned Value Management, Project Scope and Risk, Project Approaches to Remember, Responsibility of project managers, Organization of SPMP Document, Estimation, Project planning, Software Cost Components, Software Pricing Factors, Four Common (subjective) estimation models, Top-down and bottom-up estimation, Software Cost Estimation, Factors affecting Productivity, Software Size Metrics	**8**
UNIT 5	Software Quality Assurance and Testing: Testing fundamentals: types of testing, test-driven development (TDD), Test automation and tools, Quality assurance processes and metrics.	**8**
UNIT 6	Software Aging- The Causes of Software Aging, Cost of Software Failure, Reducing the Cost of SW Aging, Design for Success, Design for Change, Keeping Records (Documentation), Why is Software Aging Inevitable?, Software Geriatrics, Planning Ahead	**6**
	TOTAL	**42**

REFERENCES

S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**

1	Software Engineering - A Practitioner's Approach by Roger S. Pressman and Bruce R. Maxim, Eighth edition, McGraw-Hill Education	2015
2	Software engineering by K.K.Aggarwal and Yogesh Singh, Fourth edition, New Age International Publishers	2022
3	Software Testing: Principles and Practices by Srinivasan Desikan and Gopalaswamy Ramesh, Pearson	2005
4	Schaum's Outlines, Problems of Software Engineering by David Gustafson, McGRAW-HILL	2002

Course Title	**Course Structure**			**Pre-Requisite**
Mobile Application Development	**L**	**T**	**P**	**Programming fundamentals**
	3	**0**	**2**	

Course Objective: Master the fundamentals of Android development, covering native application creation, UI design, data handling, user experience enhancement, multimedia integration, and wireless connectivity, empowering students to build robust and feature-rich Android applications

S. NO	**Course Outcomes (CO)**
CO1	Develop native Android applications utilizing the Android SDK and understanding the Open Handset Alliance framework.
CO2	Design intuitive user interfaces, manage application components, and leverage system permissions effectively.
CO3	Implement file and database handling techniques, ensuring efficient data storage and backup solutions.
CO4	Enhance user experience through multimedia integration, wireless connectivity, and telephony features, enabling you to build comprehensive and functional Android applications.

S. NO	**Contents**	**Contact Hours**
UNIT 1	Introduction to Android: Native Android Application; SDK Features; Introduction to Open Handset Alliance; Development Framework; Application Fundamentals; Device Compatibility; System permissions.	**10**
UNIT 2	User Interface and Application Components: Basic UI Design; Fragments; Widget Toolbox; Creating New View; Introduction to Intents; Intent Filters and broadcast Receivers; Activities; Services; Content Providers; Application Widgets; Processes and Threads.	**10**
UNIT 3	Files and Database Handling: Saving Application Data; Shared Preferences; Preference Framework and Activity; Static File as Resource; File System; Introduction to SQLite Database; Querying SQLite; Storage options; Data backup User Experience Enhancement: Action Bar; Menus and Action Bar Items; Settings; Dialogs; Customizing Toast; Notifications; Search; Drag and Drop Multimedia.	**12**
UNIT 4	Wireless Connectivity and Telephony: Audio and Video Handling; Manipulating Raw Audio; Sound Effects; Camera Programming; Video Recording; Managing Wireless Connectivity: Wi-Fi, Bluetooth, Near Field Communication; Hardware Support for Telephony; Telephony Management; SMS and MMS.	**10**
	TOTAL	**42**

REFERENCES

S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Reto Meier, “Professional Android 4 Application Development”, Wrox	2012
2	Matt Gifford, “PhoneGap Mobile Application Development Cookbook”, PACKT	2012
3	Adrian Kosmaczewski, “Mobile JavaScript Application Development”, O’RELLY	2012

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Sementic Web	3	0	2	Web Technologies

Course Objective: Understand the concept structure of the semantic web technology and how this technology revolutionizes the World Wide Web. Understand the concepts of Web Science, semantics of knowledge and resource, ontology.

S. NO	Course Outcomes (CO)
CO1	To understand fundamentals of sementic web.
CO2	To study Knowledge Representation for the Semantic Web Ontologies.
CO3	To learn Web Ontology Engineering process.
CO4	To learn different application of sementic web.
CO5	To get infrormed with different web resources.

S. NO	Contents	Contact Hours
UNIT 1	Semantic Web Introduction: fundamental of semantic web, Examples of semantic web, Semantic web technologies, layered approach Web Intelligence Thinking and Intelligent Web Applications, The World Wide Web, Limitations of Today's Web.	8
UNIT 2	Structured web documents in XML: The XML language, Structuring, Namespaces, Querying and Addressing XML documents. Knowledge Representation for the Semantic Web Ontologies and their role in the semantic web, Ontologies Languages for the web, UML, XML/XML Schema	9
UNIT 3	Web Ontology Engineering: Introduction, OWL language, Examples, OWL in OWL, Future extensions, Ontology Engineering, Ontology Engineering, Constructing Ontology, Ontology Development Tools, Ontology Methods.	9
UNIT 4	Applications: Semantic Search, e-learning, Semantic Bioinformatics, Knowledge Base, XML Based Web Services, Creating an OWL-S Ontology for Web Services, Semantic Search Technology, Web Search Agents and Semantic Methods.	8
UNIT 5	Describing Web Resources: Introduction, RDF, RDF Schema, RDF: XML-Based Syntax, RDF serialization, syntax and language, Direct Inference System, Querying RQL, A query language for RDF: SPARQL	8
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Berners Lee, Godel and Turing, Thinking on the Web, Wiley inter science, 2008.	2008
2	Grigoris Antoniou and Frank Van Hermelen , A Semantic web Primer, MIT Press.	2002
3	John Davies (Editor), Rudi Studer (Co-Editor), Paul Warren (Co-Editor), Semantic Web Technologies, Trends and Research in Ontology Based Systems.	2006

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Software Testing	3	0	2	Software Engineering

Course Objective: provide students with the essential knowledge and practical skills required to conduct comprehensive software testing, ensuring the delivery of high-quality software products through various testing techniques and methodologies.

S. NO	Course Outcomes (CO)
CO1	Demonstrate a comprehensive understanding of the fundamental concepts of software testing
CO2	Apply functional testing techniques to design and execute test cases effectively.
CO3	Implement structural testing methods to identify and uncover defects in software systems.
CO4	Demonstrate proficiency in regression testing practices to ensure software quality during maintenance and evolution.
CO5	Exhibit competency in various software testing activities and gain knowledge of automated software testing tools.

S. NO	Contents	Contact Hours
UNIT 1	**Introduction**: Software Failures, Testing Process, Some Terminologies, Limitations of Testing, The V-shaped Software Life Cycle Model	8
UNIT 2	**Functional Testing**: Boundary Value Analysis, Equivalence Class Testing, Decision Table Based Testing, Cause Effect Graphing Technique, Essentials of Graph Theory- Graph Introduction, Matrix Representation of Graphs, Paths andIndependent Paths, Generation of a Graph from Program, Identification of Independent Paths.	8
UNIT 3	Structural Testing:Control Flow Testing, Data Flow Testing, Slice Based testing, Mutation Testing. Software Verification: Verification Methods, Software Requirements Specifcation (SRS) Document, Software Design Description (SDD) Document, Source Code Reviews, User Documentaion, Verefication.	8
UNIT 4	Regression Testing: Regression Test Cases selection, Reducing the number of Test Cases, Risk Analysis, Code Coverage, Prioritization Technique.	8
UNIT 5	Software Testing Activities: Levels of Testing, Dubugging, Software Testing Tools- Methodology to evaluate automated testing. Using tools: Load Runner, Win runner and Rational Testing Tools, Java Testing Tools, JMetra, JUNIT Cactus and other recent tools., Software Test Plan. Metrics and Models in Software Testing: Software Metrics, Categories of Metrics, Object- Oriented Metrics Used in Testing, Measures during testing, Software Quality Attributes Prediction Models	10
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Software Testing by Yogesh Singh, First edition, Cambridge University Press	2012
2	Software engineering by K.K.Aggarwal and Yogesh Singh, Fourth edition, New Age International Publishers	2022
3	Software Testing: Principles and Practices by Srinivasan Desikan and Gopalaswamy Ramesh, Pearson	2005
4	Schaum's Outlines, Problems of Software Engineering by David Gustafson, McGRAW-HILL	2002

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Object Oriented Software Engineering	3	0	2	Software Engineering

Course Objective: To understand basic methodology of object oriented software engineering and learn to create UML diagrams at various phases of software development life cycle using real-life case studies.

S. NO	Course Outcomes (CO)

CO1	Understand object-oriented system concepts and development methodologies.
CO2	Use of UML 2.0 for static and dynamic modeling of object-oriented systems.
CO3	Understand the Unified Process (UP) and its applications in software development, including logical architecture design and use case modeling.
CO4	Proficient in applying creational, structural, and behavioral design patterns to solve common software design problems.
CO5	Apply object-oriented testing techniques and metrics to evaluate the quality and reliability of software systems.

S. NO	Contents	Contact Hours
UNIT 1	Introduction: Object Oriented system concepts and Principles, Object Oriented system development, Component reuse, The common process framework for Object Oriented processes, System Development and Methodologies, object oriented software estimation.	**8**
UNIT 2	UML 2.0 – Objects and Classes, Object Relationships, Inheritance and Polymorphism, Aggregation and Composition; Static Modeling Notation- Package Diagrams, Composite Structures, Component Diagrams, Deployment Diagram; Dynamic Modeling Notation- Use Case Diagrams, Activity Diagrams, Interaction Diagrams	**8**
UNIT 3	The Unified Process and its Applications: Introduction to Unified Process, Relationship between UP, UML and OO design, What is a logical architecture?, UML Package Diagrams, Inception- Use cases, System Sequence Diagrams, Domain Model, Operation Contracts	**8**
UNIT 4	Patterns, Uses of Design Patterns, Types- Creational, Structural and Behavioural Design Patterns.	**8**
UNIT 5	Object Oriented Testing and metrics: Path Testing, State based testing, Class Testing, object oriented metrics. Applications & Tools: A complete case study of Software development using above Methodologies, Concepts of Computer-Aided Software Engineering and knowledge about current CASE tools use in the industry.	**10**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Applying UML and Patterns, Craig Larman, Prentice Hall,	2005
2	The Unified Modeling Language User Guide, Second Edition, G. Booch, J. Rumbaugh and I. Jacobson, second edition, Addison Wesley	2005
3	UML2 and the Unified Process, Jim Arlow and Ila Neustadt, Addison Wesley	2005
4	Object Oriented Software Engineering by I. Jacobson, M. Christerson, P. Jonsson, G. Overgaard 2nd Edition, Pearson Education.	2007
5	Object Oriented Software Engineering by Yogesh Singh & Ruchika Malhotra, First Edition, PHI Learning	2012

Course Title	Course Structure			Pre-Requisite
	L	**T**	**P**	
Privacy and Security in Online Social Media	**3**	**0**	**2**	**Basic Programming Skills**

Course Objective: This course aims to provide students with a comprehensive understanding of privacy and security issues in online social media and networks. Through structured units, students will explore topics such as security services, data collection challenges, trust management, cybercrime, and legal considerations.

S. NO	Course Outcomes (CO)
CO1	Understand the concepts of privacy and security in online social media and networks, analyze the importance of security services, and recognize digital friends with associated risks.

CO2	Implement encryption techniques to secure peer-to-peer social networks and develop strategies for enhancing user privacy perceptions.
CO3	Evaluate challenges and opportunities in data collection from online social media using APIs.
CO4	Identify and mitigate risks such as spam, phishing, and identity theft in online social media.
CO5	Analyze the interdisciplinary impact of privacy in social networks.
CO6	Design web portals with credibility scoring mechanisms and understand the social network graph, evaluate security implications of emerging technologies like the Bitcoin system and Android security features.

S. NO	**Contents**	**Contact Hours**
UNIT 1	Privacy and Security in Online Social Media, Online Social Networks, security services(authentication, availability, integrity, confidentiality), Recognizing Your Digital Friends, Encryption for Peer-to-Peer Social Networks, Understanding User Privacy Perceptions, Cybercrime, Privacy Usable security, Trust Management and Issues	**8**
UNIT 2	Data collection from social networks, challenges, opportunities, and pitfalls in online social networks, APIs, Collecting data from Online Social Media.	**8**
UNIT 3	Trust, credibility, and reputations in social systems, Online social Media and Policing, Information privacy disclosure, revelation and its effects in OSM and online social networks.	**8**
UNIT 4	Spam, Phishing and identity theft in OSM & Identifying fraudulent entities in online social networks, Crowdsourcing and Ethics, Interdisciplinary Impact Analysis of Privacy in Social Networks, Legal and policy issues in privacy and security, Anonymity in a networked world, e crime, identity resolution.	**10**
UNIT 5	Web portal, Credibility scoring Social network graph, bitcoin system, android security.	**8**
	TOTAL	**42**

REFERENCES

S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Gavin Bell ,Building Social Web Applications, Publisher: Shroff/O'Reilly; First edition	
2	Toby Segaran ,Programming Collective Intelligence: Building Smart Web 2.0 Applications,(Author), Publisher: O'Reilly Media	
3	Altshuler, Y. and Elovici, Security and Privacy in Social Networks, Publisher: Springer	
4	Privacy and Security in Online Social Media" by Reynaldo Ortiz Moreno	2018

Course Title	**Course Structure**			**Pre-Requisite**
Software Project Management	**L**	**T**	**P**	**Software Engineering**
	3	**0**	**2**	

Course Objective: The course aims to equip students with the knowledge and skills necessary to effectively plan, execute, and control software projects, considering various project management techniques, tools, and methodologies.

S. NO	**Course Outcomes (CO)**
CO1	Understand project management fundamentals, including process frameworks, life cycle models, and project artifacts.
CO2	Use estimation techniques to predict cost, effort, schedule, and productivity for software projects.

CO3	Develop skills in project organization, risk management, tracking, control, and defect tracking for effective project management.
CO4	Understand the importance of project closure analysis
CO5	Explore the evolution of software management, software economics, and modern project management practices.
CO6	Engage in discussions on emerging project management practices and assess modern project profiles and software development processes.

S. NO	**Contents**	**Contact Hours**
UNIT 1	Introduction: Project Management concepts, Process Framework, Project Planning Software Life Cycle Models, Artifacts of the Project Management Process.	**6**
UNIT 2	Cost and Scheduling Estimation Models: Various Levels of COCOMO for Cost ,Effort, Schedule and Productivity Estimation. Approaches to Effort, Cost Estimation, and Schedule Estimation factors through COCOMO II, Putnam Estimation Model, Algorithmic models.	**8**
UNIT 3	Project Management Techniques: Project Organizations and Responsibilities, Establishing Project Environment, Risk Management Process, Project Tracking and Control Defect Tracking Concepts such as Process monitoring and audit, Reviews, Inspections and Walkthroughs.	**8**
UNIT 4	Project Closure: Project Closure Analysis, Role of Closure Analysis in a project, Performing Closure Analysis, Closure Analysis Report.	**6**
UNIT 5	Software Project Management Renaissance: Conventional Software Management, Evolution of Software Economics, Improving Software Economics, The old way and the new way.	**6**
UNIT 6	Advance Topics in Software Project Management: Discussion on future Software Project Management Practices & Modern Project Profiles, Next Generation Software Economics, Modern Process Transitions.	**8**
	TOTAL	**42**

REFERENCES

S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Managing the Software Process by Watts S. Humphrey, Pearson Education.	1989
2	Software Project Management by Bob Hughes, Tata McGraw Hill.	2009
3	Software Project Management by W. Royce, Pearson Education	1998
4	Software Project Management in Practice by P. Jalote, Pearson Education	2002

Course Title	**Course Structure**			**Pre-Requisite**
Mobile Computing	**L**	**T**	**P**	**Computer Networks**
	3	**1**	**-**	

Course Objective: To learn the fundamental concepts of Mobile Computing

S. NO	**Course Outcomes (CO)**
CO1	To understand the fundamentals of mobile computing
CO2	To acquire the knowlwdge of mobile communication systems

CO3	To implement the various protocols realted at network layer and transport layer
CO4	To understand the server management in mobile computing
CO5	To implement the concept of mobile adhoc network for latest applications

S. NO	Contents	Contact Hours
UNIT 1	INTRODUCTION: Mobile Communication-Mobile Computing-Mobile Computing Architecture-Mobile devices-Mobile System Networks – Data dissemination – Mobile management- Security. Mobile Device and Systems	**8**
UNIT 2	GSM AND SIMILAR ARCHITECTURES: GSM – services and architectures – Radio interfaces – Protocols – Localization – Calling – Handover – Security – New data services – General packet radio service- High speed circuit switched data – DECT. WIRELESS MEDIUM ACCESS CONTROL BASED COMMUNICATION-Medium Access Control.	**8**
UNIT 3	MOBILE IP NETWORK LAYER AND MOBILE TRANSPORT LAYER: IP and mobile Network layers – Packet Delivery and Handover Management – Location management – Registration – Tunneling and Encapsulation - Route Optimization - Dynamic Host Configuration Protocol. Conventional TCP/IP Transport Layer Protocols – Indirect TCP – Snooping TCP – Mobile TCP – Other methods of mobile TCP – layer transmission – TCP over 2.5G/3G Mobile networks.	**9**
UNIT 4	SERVER AND MANAGEMENT: Mobile agent – Application server – Gateways – Portals -Service Discovery – Device management – Mobile file systems-Security.	**8**
UNIT 5	MOBILE AD HOC AND WIRELESS SENSOR NETWORKS: Introduction to mobile Ad hoc network – MANET, Wireless Sensor Networks & Applications.	**9**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Raj Kamal, "Mobile Computing", Oxford Higher education, Second Edition, 2007	2007
2	Jochen Schiller, "Mobile Communications", Addison-Wesley, 2nd Edition. 2004	2004
3	Lother Merk, Martin S. Nicklaus and Thomas Stober, "Principle of Mobile Computing", Second Edition, Springer, 2003.	2003
4	William C.Y. Lee, "Mobile Communication Design Fundamentals", John Wiley.	1995

Course Title	Course Structure			Pre-Requisite
	L	**T**	**P**	
Secure Coding	**3**	**1**	**0**	**-**

Course Objective: Equip participants with a comprehensive understanding of cybersecurity fundamentals, proactive security development processes, threat modeling techniques, and secure coding practices to mitigate risks and safeguard systems against a range of threats including malware, access control breaches, and web-specific vulnerabilities.

S. NO	Course Outcomes (CO)
CO1	Demonstrate an understanding of cybersecurity principles, including the CIA Triad and various types of malware, to identify and mitigate security threats effectively.
CO2	Implement proactive security development processes, including threat modeling and threat rating using techniques like Attack Trees and DREAD, to assess and prioritize security risks.

CO3	Apply access control mechanisms and encryption techniques to protect sensitive data and mitigate common software security vulnerabilities such as format string problems and integer overflow.
CO4	Implement secure coding practices, including buffer overrun prevention and handling of socket security issues, to develop robust and resilient software systems.
CO5	Analyze and address database and web-specific security issues, including SQL injection and race conditions, and employ secure coding techniques to defend against attacks such as DoS and ARP spoofing.

S. NO	**Contents**	**Contact Hours**
UNIT 1	Introduction: Security, CIA Triad, Viruses, Trojans, and malware The need for secure system, proactive security development process, Threat modelling process and its benefits, Identifying the Threats by Using Attack Trees and rating threats using DREAD, cross-site scripting.	**8**
UNIT 2	Access control, protecting secret data, Format String Problems, Integer Overflow, and Software Security Fundamentals, Buffer Overrun- Stack overrun, Heap Overrun, Array Indexing Errors.	**8**
UNIT 3	Socket security, Avoiding Server Hijacking, Securing RPC, ActiveX and DCOM, secure .NET code, Command Injection, Failure to Handle Errors, and Security Touchpoints, Java Programming with Crypto API.	**8**
UNIT 4	Proactive Security development process, Secure Software Development Cycle (S-SDLC), Security issues while writing SRS, Design phase security, Development Phase, Test Phase. Database and Web-specific issues: SQL Injection Techniques and Remedies, Race conditions, Time of Check Versus Time of Use and its protection mechanisms.	**10**
UNIT 5	Secure Coding Techniques: Protection against DoS attacks, Application Failure Attacks, CPU Starvation Attacks, Insecure Coding Practices In Java Technology. ARP Spoofing.	**8**
	TOTAL	**42**

REFERENCES

S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Michael Howard and David LeBlanc, Writing Secure Code, Microsoft Press, 2nd Edition	2004
2	Jason Deckar,Syngress , Buffer Overflow Attacks: Detect, Exploit, Prevent,1st Edition.	2005
3	Frank Swiderski and Window Snyder, Threat Modeling, Microsoft Professional, 1st Edition	2004

Course Title	**Course Structure**			**Pre-Requisite**
Multi Agent System	**L**	**T**	**P**	
	3	**1**	**0**	

Course Objective: The course aims to introduce Multi-agent System design principles and applications.

S. NO	**Course Outcomes (CO)**
CO1	To understand the fundamentals of Multi agent systems.
CO2	To be able utilize a variety of principles of agent design and reasoning.
CO3	To get learning of agent oriented methodologies.
CO4	To learn design of coordination Structures. Social Models for Coordination. Trust and Reputation.
CO5	To explore Agent-Oriented Design for real world novel applications.

S. NO	Contents	Contact Hours
UNIT 1	Introduction to intelligent agents. Definition, Architectures interface agents, information agents, heterogeneous Multi-Agent Systems, distributed-intelligent-systems, Communication, Standards, Coordination, Negotiation, Distributed planning. Voting. Auctions. Coalition formation. Application of multi-agent systems to industrial problems.	9
UNIT 2	Agent Design: Reasoning in Agents Definition of Reasoning. Automated Reasoning. Reasoning Paradigms. Symbolic Reasoning Agents. Deductive Reasoning Agents. Agent-Oriented Programming, Practical Reasoning. BDI Agents. BDI Agent Control Loop	9
UNIT 3	Agent-Oriented-Methodologies Current trends in Software engineering. Agent-Oriented Software Engineering. Agent-Oriented Methodologies. The GAIA Methodology. The Prometheus Methodology	8
UNIT 4	Social Design: Coordination and Social Models Coordination in MAS. Coordination Structures. Social Models for Coordination. Trust and Reputation Models. Organizational Models. Institutional Models.	8
UNIT 5	Applications of Agent-Oriented Design. Agent-Oriented Design for 1) Electronic Negotiation Support, 2) Flexible Dynamic Web services, 3) Multi-robotic environments. Case studies for the practical assignments.	8
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	1. Michael Wooldridge (John Wiley and Sons), An Introduction to Multiagent Systems, first edition 2002, or second edition, 2009.	2009
2	Luck, M., McBurney, P., Shehory, O., Willmott, S, Agent Technology: Computing as interaction. A Roadmap to Agent Based Computing, Willmott, S., 2005.	2005

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Data Mining and Warehousing	3	1	0	Basic course on probability and statistics

Course Objective: To familiarize the student with data minining and warehousing fundamentals to enable the student to process, store and analyse large volumes of noisy multi-variate data found in real-world application domains.

S. NO	Course Outcomes (CO)
CO1	To understand the fundamentals of data mining and data warehousing.
CO2	To implement data pre-processing and analyze data with multiple attributes.
CO3	To execute association rule mining and item-set mining.
CO4	To describe the implementation of a data warehouse project and its management.
CO5	To explore case studies for data storage and data warehouse in practical applications.

S. NO	Contents	Contact Hours
UNIT 1	Introduction to data mining and warehousing, types of databases for data mining, functionalities of data mining, classification of data mining systems, task primitives, integration of data mining with database, issues of data mining, Pivot Tables, Relational Database, Database Normalization, normal forms, SQL, Data Warehousing fundamentals.	8
UNIT 2	Data Objects and Attribute Types: Nominal Attributes, Data Cleaning, Data Integration and Transformation, Data Reduction, Data Discretization and Concept Hierarchy Generation.	6

UNIT 3	Data cube computation and data generalization, Associations and correlations- basic concepts, efficient and scalable frequent item sets mining methods, mining various kinds of association rules, constraint-based association mining.	**8**
UNIT 4	Data Warehouses and Data Marts, Overview of the components, Metadata in the Data Warehouse, Planning and Project Management: Planning Your Data Warehouse, The Data Warehouse Project, Architectural Components: Understanding Data Warehouse Architecture, Infrastructure Supporting Architecture, Collection of Tools	**10**
UNIT 5	Data design and data preparation: From Requirements to Data Design, The STAR Schema, STAR Schema Keys, Advantages of the STAR Schema, Data Extraction, Data Transformation, Data Loading . OLAP in the Data Warehouse: Demand for Online Analytical Processing, Major Features and Functions, OLAP Models. Implementation and maintenance: physical design steps, physical design considerations, physical storage, indexing the data warehouse, performance enhancement techniques.	**10**
	TOTAL	**42**

REFERENCES

S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Han, Kamber, "Data Mining Concepts and Techniques", Morgan Kaufmann.	2000
2	M.H. Dunham, "Data Mining Introductory and Advanced Topics", Pearson Education.	2002
3	Ralph Kimball, "The Data Warehouse Lifecycle toolkit", John Wiley.	1996
4	Paulraj Ponniah, "Data Warehousing Fundamentals", John Wiley.	2001

Course Title	**Course Structure**			**Pre-Requisite**
Foundation to Computer Security	**L**	**T**	**P**	**-**
	3	**1**	**0**	

Course Objective: This course provides a comprehensive overview of information security principles, including threat management, cryptographic methods, and program security. Students will learn to secure operating systems, databases, and networks, equipping them with the skills to design and implement effective security measures across various computing environments.

S. NO	**Course Outcomes (CO)**
CO1	Gain comprehensive understanding of cybersecurity and explore the implementation of security policies and mechanisms to prevent, detect, and deter security breaches.
CO2	Gain comprehensive understanding and proficiency in basic cryptographic principles
CO3	Explore program security focusing on understanding and mitigating malicious code like viruses, Trojan horses, and worms
CO4	Explore the security aspects of database management systems, including database integrity, secrecy, inference control, and the management of multilevel databases.
CO5	Develop a comprehensive understanding of network security techniques, including firewalls and virtual private networks, to effectively safeguard network infrastructure and data transmission.

S. NO	**Contents**	**Contact Hours**
UNIT 1	Introduction: Basic concepts: threats, vulnerabilities, controls; risk; confidentiality, integrity, availability; security policies, security mechanisms; assurance; prevention, detection, deterrence.	**8**

UNIT 2	Basic cryptography: Basic cryptographic terms, Historical background, Symmetric crypto primitives, Modes of operation, Cryptographic hash functions, Asymmetric crypto primitives.	**9**
UNIT 3	Program security: Malicious code: viruses, Trojan horses, worms. Program flaws: buffer overflows, time-of-check to time-of-use flaws, incomplete mediation Software development controls, Testing techniques.	**8**
UNIT 4	Trusted operating systems: Assurance; trust, Design principles, Evaluation criteria, Evaluation process Database management systems security: Database integrity, Database secrecy, Inference control, Multilevel databases.	**9**
UNIT 5	Network security: Network threats: eavesdropping, spoofing, modification, denial of service attacks o Introduction to network security techniques: firewalls, virtual private networks.	**8**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	William Stallings, "Cryptography and Network Security: Principles and Practice", Prentice-Hall.	2023
2	Charles P. Pfleeger, "Security in Computing", Prentice Hall	2023
3	William R. Cheswick and Steven M. Bellovin, "Firewalls and Internet Security: Repelling the Wily Hacker", Addison-Wesley	2003

Course Title	Course Structure			Pre- Requisites
	L	**T**	**P**	
Malware Analysis	**3**	**1**	**0**	

Course Objective: To introduce fundamentals of malware and to set up a protected static and dynamic malware analysis environment. Learn various malware behavior monitoring tools and actionable detection signatures from malware indicators. Learn how to trick malware into exhibiting behaviors that only occur under special conditions.

S. NO	Course Outcomes (CO)
CO1	To list the goals of Malware Analysis and to define Malware Analysis techniques.
CO2	To employ and illustrate static malware analysis techniques.
CO3	To employ and illustrate dynamic malware analysis techniques.
CO4	To classify and describe malware functionalities and behaviors
CO5	To be able to examine malwares with reverse engineering.
CO6	To be able to examine malwares with reverse engineering.

S. NO	Contents	Contact Hours
UNIT 1	Introduction to malware, OS security concepts, malware threats, evolution of malware, malware types viruses, worms, rootkits, Trojans, bots, spyware, adware, logic bombs, malware analysis, static malware analysis, dynamic malware analysis.	**6**

UNIT 2	X86 Architecture- Main Memory, Instructions, Opcodes and Endianness, Operands, Registers, Simple Instructions, The Stack, Conditionals, Branching, Rep Instructions, C Main Method and Offsets. Antivirus Scanning, Fingerprint for Malware, Portable Executable File Format, The PE File Headers and Sections, The Structure of a Virtual Machine, Reverse Engineering- x86 Architecture, recognizing c code constructs in assembly, c++ analysis, Analysing Windows programs, Anti-static analysis techniques-obfuscation, packing, metamorphism, and polymorphism.	**8**
UNIT 3	Live malware analysis, dead malware analysis, analyzing traces of malware- system-calls, api-calls, registries, network activities. Anti-dynamic analysis techniques-anti-vm, runtime-evasion techniques, , Malware Sandbox, Monitoring with Process Monitor, Packet Sniffing with Wire shark, Kernel vs. User-Mode Debugging, OllyDbg, Breakpoints, Tracing, Exception Handling, Patching	**7**
UNIT 4	Downloader, Backdoors, Credential Stealers, Persistence Mechanisms, Privilege Escalation, Covert malware launching- Launchers, Process Injection, Process Replacement, Hook Injection, Detours, APC injection.	**8**
UNIT 5	Signature-based techniques: malware signatures, packed malware signature, metamorphic and polymorphic malware signature Non-signature based techniques: similarity-based techniques, machine-learning methods, invariant inferences	**7**
UNIT 6	Malware Characterization, Case Studies – Plankton, DroidKungFu, AnserverBot, Smartphone (Apps) Security	**6**
	Total	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Practical malware analysis The Hands-On Guide to Dissecting Malicious Software by Michael Sikorski and Andrew Honig ISBN-10: 1-59327-290-1, ISBN-13: 978-1-59327-290-6	2012
2	Android Malware by Xuxian Jiang and Yajin Zhou, Springer ISBN 978-1-4614-7393-0	2005
3	Hacking exposed™ malware & rootkits: malware & rootkits security secrets & Solutions by Michael Davis, Sean Bodmer, Aaron Lemasters, McGraw-Hill, ISBN: 978-0-07-159119-5	2010
4	Windows Malware Analysis Essentials by Victor Marak, Packt Publishing	2015

SEMESTER II

Core Courses:

Course Title	Course Structure			Pre-Requisite
ITY102 Advanced Algorithms	**L**	**T**	**P**	C/C++ Programming, Foundations of Algorithms and Data Structures
	3	**1**	**0**	

Course Objective: The course aims to provide students with a deep understanding of algorithm design techniques, advanced algorithms, and their practical applications.

S. NO	Course Outcomes (CO)
CO1	To implement iterative and recursive algorithms, analysis of advanced tree structures for efficient data manipulation and search.
CO2	To comprehend and apply randomized algorithms, probabilistic analysis, and game theoretic techniques in algorithm design.
CO3	To perform amortized analysis on greedy algorithms, and implement graph algorithms for various problems.
CO4	To analyze sorting algorithms, understand lower bounds, medians, and order statistics, and perform complexity analysis on sorting and searching algorithms.

CO5	To analyze sorting networks and matrix operations for solving problems efficiently.
CO6	To implement and analyze string matching algorithms

S. NO	**Contents**	**Contact Hours**
UNIT 1	Algorithm Design Techniques: Iterative and Recursive techniques: their correctness and analysis. Divide and Conquer: Application to Sorting and Searching (review of binary search), merge sort, quick sort, their correctness and analysis. Recapitulation of order of growth & growth of functions, recurrences, probability distributions, Average case analysis of algorithms	**6**
UNIT 2	Advanced Topics in Algorithms Design Randomized Algorithms: Basic concepts, analysis, applications in sorting and searching. Probabilistic Analysis: Expected running time, Markov chains, and random walks. Game Theoretic Techniques: Zero-sum games, Nash equilibrium, applications in algorithm design.	**8**
UNIT 3	Dynamic Programming and Greedy Algorithms Introduction to Dynamic Programming: Application to various problems (for reference; Weighted Interval Scheduling, Sequence Alignment, Knapsack), their correctness and analysis. Introduction to Greedy Algorithms - Amortized Analysis. Graph Algorithms: Maximum Flow algorithms, Application to various problems, their correctness and analysis.	**8**
UNIT 4	Sorting and Searching: Heapsort, Lower Bounds using decision trees, sorting in Linear Time - Bucket Sort, Radix Sort and Count Sort, Medians & Order Statistics, complexity analysis and their correctness.	**8**
UNIT 5	Sorting Networks: Comparison Networks, Zero-one principle, bitonic Sorting Networks, Merging Network, Sorting Network. Matrix Operations- Strassen's Matrix Multiplication, inverting matrices, Solving system of linear Equations	**8**
UNIT 6	String Matching: Naive String Matching, Rabin-Karp algorithm, matching with finite Automata, Knuth-Morris-Pratt algorithm, Z Algorithm	**4**
	TOTAL	**42**

REFERENCES

S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	"Introduction to Algorithms" by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein	3rd Edition, 2009
2	"Algorithms" by Robert Sedgewick and Kevin Wayne	4th Edition, 2011
3	"Algorithm Design" by Jon Kleinberg and Éva Tardos	1st Edition, 2005
4	"Advanced Data Structures" by Peter Brass	1st Edition, 2008
5	"The Algorithm Design Manual" by Steven S. Skiena,Springer	2nd Edition, 2008

Course Title	**Course Structure**			**Pre-Requisite**
ITY104 Information Security	**L**	**T**	**P**	
	3	1	0	

Course Objective: Learning the concept of Information security and mathematical tools for the implementation of various security

S. NO	**Course Outcomes (CO)**
CO1	To understand the fundamentals of information security and encryption models.

CO2	To be able utilize a variety of modern block ciphers, DES and IDEAfor encryption decryption .
CO3	To learn graphs and ring theory and various algorithms and principles for cryptography.
CO4	To perform Message Authentication using algorithms MAC5 MD5, PKI and the concept of key management.
CO5	To be able to assess system security in IP based and Web networks and assocciated protocols IPSec , SSL , TLS and WAP.

S. NO	**Contents**	**Contact Hours**
UNIT 1	Introduction: Need for security, Introduction to security attacks, services and mechanism, introduction to cryptography, Conventional Encryption: Conventional encryption model, classical encryption techniques substitution ciphers and transposition ciphers, cryptanalysis, stereography, stream and block ciphers, Intruders, Viruses and related threads.	**6**
UNIT 2	Modern Block Ciphers: Block ciphers principals, Shannon's theory of confusion and diffusion, fiestal structure, data encryption standard(DES), strength of DES, crypt analysis of DES, block cipher modes of operations, triple DES,IDEA encryption and decryption, strength of IDEA, key distribution.	**8**
UNIT 3	Introduction to graph, ring and field, prime and relative prime numbers, modular arithmetic, Fermat's and Euler's theorem, primarily testing, Euclid's Algorithm, Chinese Remainder theorem, discrete logarithms, Principals of public key crypto systems, RSA algorithm, security of RSA, key management, Diffle-Hellman key exchange algorithm, introductory idea of Elliptic curve cryptography, Elganel encryption.	**8**
UNIT 4	Message Authentication and Hash Function: Authentication requirements, authentication functions, message authentication code (MAC), hash functions, security of hash functions and MACS, MD5 message digest algorithm, Secure hash algorithm(SHA), Public Key Infrastructure(PKI): Digital Certificate, private key management, Digital Signatures: Digital Signatures, authentication protocols, digital signature standards (DSS), proof of digital signature algorithm. Authentication Applications: Kerberos and X.509, directory authentication service, password, challenge-response, biometric authentication, electronic mail security-pretty good privacy (PGP), S/MIME.	**8**
UNIT 5	IP Security: Architecture, Authentication header, Encapsulating security payloads, combining security associations, key management. Web Security: Secure Socket Layer(SSL) and transport layer security, TSP, Secure Electronic Transaction (SET), Electronic money, WAP security, firewall design principals, Virtual Private Network (VPN) security.	**6**
UNIT 6	Impossible Differential cryptanalysis, Attribute-based signatures from RSA, Security of SSL/TLS enabled applications, ECC for wireless security, Error propagation property and application in DES cryptography, Certificate Legitimation.	**6**
	TOTAL	**42**

REFERENCES

S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	William Stallings, "Cryptography and Network Security: Principals and Practice", Prentice Hall, New Jersy.	1999
2	Atul Kahate, "Cryptography and Network Security", TMH.	2003
3	Behrouz A. Forouzan, "Cryptography and NetworkSecurity", TMH.	2007
4	Johannes A. Buchmann, "Introduction to Cryptography",Springer-Verlag.	1999
5	Bruce Schiener, "Applied Cryptography".	2015

Course Title	**Course Structure**	**Pre-Requisite**

ITY146 Dev Ops and ML Ops	L	T	P	NIL
	2	0	4	

Course Objective: Comprehensive understanding of DevOps principles, practices, and tools to streamline software delivery and enhance collaboration between development and operations teams.

S. NO	Course Outcomes (CO)
CO1	Explain the core principles of DevOps and MLOps, including collaboration, automation, and continuous delivery
CO2	Describe the benefits and challenges of implementing DevOps and MLOps practices.
CO3	Apply version control systems (VCS) like Git and infrastructure as code (IaC) tools like Terraform or Ansible.
CO4	Utilize configuration management tools (e.g., Puppet, Chef) and CI/CD pipelines (e.g., Jenkins, GitLab CI/CD) to automate software deliver
CO5	Employ containerization and orchestration technologies (e.g., Docker, Kubernetes) for efficient deployment and management of applications and ML models

S. NO	Contents	Contact Hours
UNIT 1	What is DevOps and MLOps? Core principles of DevOps and MLOps (collaboration, automation, continuous delivery) Benefits and challenges of implementing DevOps and MLOps The Machine Learning Lifecycle DevOps vs MLOps: Similarities and Differences.	7
UNIT 2	Version Control Systems (VCS) - Git Infrastructure as Code (IaC) - Terraform, Ansible Configuration Management Tools - Puppet, Chef Continuous Integration and Continuous Delivery (CI/CD) Pipelines - Jenkins, GitLab CI/CD Containerization and Orchestration - Docker, Kubernetes	8
UNIT 3	Machine Learning Model Training and Experimentation Data Versioning and Management Model Packaging and Deployment Monitoring, Logging, and Alerting for ML models MLOps Tools - MLflow, Kubeflow	8
UNIT 4	Introduction to Cloud Computing (AWS, Azure, GCP) Cloud-based DevOps and MLOps tools Infrastructure Provisioning and Management on Cloud Platforms	12
UNIT 5	Security Considerations in the Machine Learning Lifecycle Model Explainability and Bias Detection Data Governance and Privacy, A/B Testing and Model Serving Continuous Learning and Model Retraining DevOps for Data Science Teams (DataOps) Case Studies: Implementing MLOps in Real-World Projects	7
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Michael Httermann, DevOps for Developers, Apress	2012
2	Matthew Sacks, Website Development and Operations: Streamlining DevOps for Large-Scale Websites by Matthew Sacks, Apress	2012
3	Gene Kim, Jez Humble, and Patrick Debois, The DevOps Handbook: How to Create World-Class Agility, Reliability, and Security in Technology Organizations	2016
4	Emmanuel Ameisen "Building Machine Learning Powered Applications: Going from Idea to Product", Oreilly	2020

Departmental Elective-2

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Image Analysis	3	0	2	-

Course Objective: The course aims to provide students with comprehensive knowledge and practical skills in image analysis, including techniques for image enhancement, restoration, segmentation, and the application of various algorithms to effectively interpret and process digital images.

S. NO	Course Outcomes (CO)
CO1	Understand the fundamental concepts of a digital image processing system.
CO2	Analyze images in the frequency domain using various transforms.
CO3	Evaluate techniques for image enhancement in the spatial and frequency domain.
CO4	Elucidate the mathematical modelling of image restoration.
CO5	Interpret image segmentation and representation techniques.

S. NO	Contents	Contact Hours
UNIT 1	Fundamental steps in DIP, concept of visual information, image formation model, image sampling and quantization, digital image representation, spatial and gray level resolution, relationship between pixels, application of image processing system.	**8**
UNIT 2	Introduction to Multidimensional signals and systems, 2D-Signals, 2D systems, classification of 2D system, 2D convolution, 2D Z-transform, Image Transform: 2DDFT, discrete cosine, discrete sine, Haar, Walsh, Hadamard, Slant, KL, SVD, Hough,Radon, Ridgelet.	**10**
UNIT 3	Image enhancement; Spatial domain: linear transformation, image negative, grey level shifting, non-linear transformation, logarithmic transformation, exponential transformation, grey level slicing, bit plane slicing, image averaging, mask processing, histogram manipulations.	**8**
UNIT 4	Image Restoration :Image Restoration – degradation model, Properties, Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters – Optimum Notch Filtering – Inverse Filtering – Wiener filtering	**8**
UNIT 5	Image Segmentation :Edge detection, Edge linking via Hough transform – Thresholding – Region based segmentation – Region growing – Region splitting and merging – Morphological processing- erosion and dilation.	**8**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Rafael C. Gonzalez, Richard Eugene Woods “Digital Image Processing” 3rd Edition.	2008
2	Anil K. Jain, Fundamentals of Digital Image Processing Pearson.	2002
3	Kenneth R. Castleman, Digital Image Processing Pearson.	2006
4	Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, Digital Image Processing using MATLAB Pearson Education, Inc.	2011

Course Title	Course Structure			Pre-Requisite
	L	**T**	**P**	
Artificial intelligence	**3**	**1**	**0**	**Basic course on probability and statistics**

Course Objective: To familiarize the student with the foundations of Artificial Intelligence (AI) and to trace the evolution of AI from knowledge and reasoning based techniques to contemporary AI technologies.

S. NO	Course Outcomes (CO)

CO1	To analyze different types of agents and environments.
CO2	To design and analyze various intelligent search techniques.
CO3	To represent knowledge using Predicate logic.
CO4	To solve rule-based systems, Resolution, and semantic nets and frames.
CO5	To implement probabilistic reasoning and inferencing systems.
CO6	To understand the design of real-world intelligent systems and applications.

S. NO	**Contents**	**Contact Hours**
UNIT 1	Introduction: Foundations of AI, AI Problems, Task Domains of AI, Introduction to Intelligent program and Intelligent agents, types of agents and environments. Problem Solving: Basic Problem-solving Method: state space search, problem formulation, uninformed and informed search.	**8**
UNIT 2	Heuristic search Techniques: Hill climbing techniques, Best First search, A* Search, Problem Reduction: AO* Search, Constraint Satisfaction. Evolutionary and metaheuristic algorithms- genetic algorithm, simulated annealing. Game Playing: Game Tree, Searching procedure Minimax, alpha-beta pruning	**10**
UNIT 3	Knowledge Representation: Knowledge Representation issues. Knowledge Representation using Predicate Logic: Unification, resolution. Rule based Systems: Forward versus backward reasoning, conflict resolution. Structured Knowledge Representation: Semantic Nets, Frames, conceptual dependency, scripts.	**10**
UNIT 4	Reasoning: Handling uncertainty Non-Monotonic Reasoning, Probabilistic reasoning, Belief networks, fuzzy logic, neural nets.	**8**
UNIT 5	Applications: Expert Systems: Architecture, Domain Knowledge, Knowledge Acquisition, Case Studies: Computer Vision, Natural language Processing, Speech recognition, Information retrieval, Robotics etc.	**6**
	TOTAL	**42**

REFERENCES

S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	1. S.Russel, P.Norvig, Artificial Intelligence – A Modern Approach. Second Edition, PHI/ Pearson Education.	2011
2	2. E. Rich and K. Knight, Artificial Intelligence, E. Rich and K. Knight, TMH, 2nd ed.(ISBN- 978-0070522633)	2018
3	3. N.J. Nilsson, Principles of AI, Narosa Publ. House, (ISBN: 978-81-85198-29-3).	1980
4	4. E. Charniak, D. McDermott, Introduction to Artificial Intelligence, Addison Wesley (ISBN: 0201119455)	1985
5	5. George F. Luger, Artificial Intelligence: Structures and Strategies for Complex Problem Solving (5th Edition), 2005. Addison-Wesley. (ISBN: 978-8131723272)	1994

Course Title	**Course Structure**			**Pre-Requisite**
	L	**T**	**P**	
Pattern analysis	**3**	**1**	**0**	**Basic course on probability and statistics**

Course Objective: To familiarize the student with the basic concepts and methodologies for pattern analysis and explore applications in

S. NO	**Course Outcomes (CO)**

CO1	To describe Pattern recognition fundamentals.
CO2	To compute object, boundary and regional descriptors.
CO3	To estimate Maximum-likelihood and Bayesian parameter estimation.
CO4	To apply Bayesian decision theory, Minimum-error-rate classification and Discriminant functions.
CO5	To investigate unsupervised classification using different similarity and dissimilarity measures.
CO6	To understand the mechanism behind and evaluate the predicitve performance of an artificial neural network.

S. NO	Contents	Contact Hours
UNIT 1	Introduction to Pattern Analysis, Types of patterns, Feature, feature vectors, feature space and classifiers. Pattern recognition systems and its applications such as web based patterns.	**6**
UNIT 2	Object Representation: Chain codes, Polygon Approximations, Signatures, Boundary segments, skeletons. Boundary Descriptors: Fourier Descriptor and Statistical Moments. Regional Descriptors: Topological descriptor, texture, moments of 2-D functions.	**8**
UNIT 3	Maximum-likelihood and Bayesian parameter estimation: Maximum Likelihood estimation: Gaussian case, Maximum a Posteriori estimation, Bayesian estimation. Bayesian decision theory: Minimum-error-rate classification, Classifiers, Discriminant functions, Decision surfaces, Normal density and Discriminant functions, Discrete features, Missing and noisy features.	**10**
UNIT 4	Clustering, fundamentals of clustering, similarity/ dissimilarity, measures, clustering criteria, different distance functions: Bhattacharya Distance, scatter matrices, minimum cluster distance criteria, K-mean algorithm, K-medoids, DBSCAN, dataset visualization, unique clustering, no existence of clusters.	**10**
UNIT 5	Neural networks as a feature extractor and classifier, single layer perceptron, multi-layer perceptron, training set, test set, generalization, normalization, and evaluation, evaluation Parameters-Accuracy, confusion matrix, Precision, Recall, ROC, F-measure, specificity, sensitivity.	**8**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Richard O. Duda, Peter E. Hart, David G. Stork , "Pattern Classification", IInd edition, Wiley	2007
2	Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer.	2006
3	S.Theodoridis, K. Koutroumbas, "Pattern Recognition", IInd Edition, Elsevier.	2008
4	Rafael C. Gonzalez, Richard Eugene Woods "Digital Image Processing" 3rd Edition, Pearson.	2008

Course Title	Course Structure			Pre-Requisite
	L	**T**	**P**	
Fundamentals of data Science	**3**	**1**	**0**	**Probability, Statistics, Linear Algebra**

Course Objective: 1. To familiarize with different types of data and its visualization.
2. To understand and practice data pre-processing, data modeling and data exploration.
3. To solve real-world analytical problems in data science.

S. NO	Course Outcomes (CO)
CO1	Ability to identify different types of data and data distributions.
CO2	Ability to understand and apply different data cleaning and data transformation techniques.
CO3	Ability to understand and implement different data visualization techniques.
CO4	Ability to understand and execute different data exploration techniques.
CO5	Ability to implement different real-world applications of data science.

S. NO	Contents	Contact Hours
UNIT 1	**Introduction to data science:** Basics of Probability & Statistics (Random Variables, Bayes's Theorem, Normal distribution, Central Limit Theorem). Defining data science, Recognizing different types of data, Data distributions. Data acquisition and data storage.	**10**
UNIT 2	**Data pre-processing:** Missing data problem, Outlier definition. Data cleaning, Data transformation or data wrangling procedures such as merging, ordering and aggregating.	**10**
UNIT 3	**Data visualization**: Introduction to data visualization, Challenges of data visualization. Definition of Dashboard, Dashboard design and principles. Basic charts and plots, Box plots, Histogram, Graphs, Networks, Hierarchies, Reports.	**10**
UNIT 4	**Exploratory Data Analysis**: Data exploration for univariate data. Outlier detection techniques. Descriptive statistics (mean, standard deviation etc.) for data exploration. Correlation statistics for data exploration. Data exploration for multivariate data. Use of multivariate visualization tools such as bar charts, bar plots, heat maps, bubble charts, run charts, and scatter plots.	**12**
	TOTAL	

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Data Mining: Concepts and Techniques, Jiawei Han, Micheline Kamber and Jian Pei, 3rd ed., *Morgan Kaufmann*	2022
2	Data science from scratch, Joel Grus, 2nd ed., *O'Reilly Media.*	2019
3	Python data science handbook, Jake VanderPlas, 2nd ed., O'Reilly Media.	2016
4	Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, Aurélien Géron, 2nd ed., O'Reilly Media.	2019
5	The data science handbook, Field Cady, John Wiley & sons.	2017

Course Title	Course Structure			Pre-Requisite
	L	**T**	**P**	
Deep Learning	**3**	**1**	**0**	

Course Objective: To provide students with an in-depth understanding of deep learning concepts and architectures, including neural networks, convolutional networks, recurrent networks, and their applications.

S. NO	Course Outcomes (CO)
CO1	Understand the foundation and scope of Deep Neural networks

CO2	To Explore predicate logic and its applications to understand knowledge representation.
CO3	To solve rule-based systems, Resolution, and semantic nets and frames
CO4	To implement probabilistic reasoning and inferencing systems
CO5	To Study AI-based expert systems, including architecture, domain knowledge, and knowledge acquisition.

S. NO	**Contents**	**Contact Hours**
UNIT 1	Introduction: Basics of deep learning, Importance of deep learning, Feature engineering, Overview of deep learning framework.	**6**
UNIT 2	Machine Learning Basics: Supervised learning algorithms, Hyper parameters and validation sets, overfitting, under fitting, Unsupervised learning algorithms, Stochastic Gradient Descent, Challenges motivating Deep Learning.	**9**
UNIT 3	Deep feed forward network: Artificial Neural Network, activation function, multi-layer neural network, Training Neural Network: Risk minimization, loss function, backpropagation, regularization, model selection, and optimization, Data Augmentation, Dropout.	**9**
UNIT 4	Convolutional Networks (CNN): Motivation, The Convolution Operation, Pooling, Structured outputs, Kernels. Recurrent and Recursive Nets: Recurrent Neural Networks (RNN), Bidirectional RNNs, Deep Recurrent Networks, Recursive Neural Networks, Long-Term Dependencies, Long-Short Term Memory, Gated RNNs.	**9**
UNIT 5	Applications: Large scale deep learning, Computer vision, Speech Recognition, Natural Language Processing, Other applications, Deep Learning Tools and Libraries: Caffe, Theano, Keras.	**9**
	TOTAL	**42**

REFERENCES

S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press.	2006
2	Python Deep Learning, by Valentino Zocca, GianmarioSpacagna, Daniel Slater, and Peter Roelants, Packt Publishing Ltd.	2017
3	Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education.	2004

Course Title	**Course Structure**			**Pre-Requisite**
Natural Language Processing	**L**	**T**	**P**	**Basic course on probability and statistics**
	3	**1**	**0**	

Course Objective: To explore and design computer systems that are able to process and understand spoken or written text in natural languages like English, and generate their outputs in a natural language.

S. NO	**Course Outcomes (CO)**
CO1	To understand and implement text pre-processing techniques and pattern matching using regular expressions.
CO2	To execute syntactic parsing of sentences for a given grammar and probabilistic inferencing.
CO3	To implement Bag-of-Words models for feature extraction and machine learning for text classification.
CO4	To analyze the use of word embeddings and sequence learning using LSTM or transformer.

CO5	To examine text generation models using Language modelling and encoder-decoder models.
CO6	To explore real-world applications of Natural Language Processing and Natural Language Generation.

S. NO	**Contents**	**Contact Hours**
UNIT 1	The study of Language, Introduction to NLP and various terms related to NLP- morphology, syntax, semantics, pragmatics, discourse, ambiguity. Regular Expression, Finite State Automata.	**6**
UNIT 2	Pre-processing: Tokenization, Lemmatization, Stemming. Frequency Based Methods: Count Vectorizer, Bag of Words, 1-hot encoding, TF, TF-IDF, Machine learning classifiers. Prediction Based Methods: Word Embeddings, LSTM/Transformer.	**10**
UNIT 3	Word Senses, WordNet, Synsets, Hypernyms, Hyponyms, Meronyms, Holonyms, Word Sense Disambiguation, Word Similarity, Semantic Role Labelling.	**8**
UNIT 4	Probabilistic Context-Free Grammars, Syntactic Parsing, Part-of-speech-tagging, Probabilistic Language Processing, N-gram language modelling. Encoder-decoder model for sequence-to-sequence learning, Attention mechanism.	**10**
UNIT 5	Intelligent Work Processors, Machine Translation, User Interfaces, Man-Machine Interfaces, Natural language Question-Answering Systems, Speech Recognition, Commercial use of NLP, Semantic Interpretation, Information Retrieval.	**8**
	TOTAL	**42**

REFERENCES

S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	D. Jurafsky, J. H. Martin, Speech and Language Processing, Pearson Education,(ISBN-13: 978-8131716724)	2008
2	James Allen, Natural Language Understanding, 2/e, Pearson Education (ISBN 13: 9788131708958)	2003
3	Manning and Schutze, Foundation of Statistical Natural Language Processing, (ISBN-13: 978-0262133609)	1998
4	Bharati, Chaitanya and Sangal: Natural Language Processing- a Paninian perspective(ISBN-13: 978-8120309210)	1995
5	Leonard Bolc. (Ed.): Natural Language Parsing Systems, Springer Verlag, (ISBN-13: 978-0387175379)	1986

Course Title	**Course Structure**			**Pre-Requisite**
Embedded Systems	**L**	**T**	**P**	
	3	0	1	

Course Objective: The objective of the course is to introduce students to the Embedded systems algorithm concepts and their implementation, focusing on programming.

S. NO	**Course Outcomes (CO)**
CO1	To learn the design issues, Goals and Applications of embedded systems.
CO2	To differentiate and compare various microcontollers and assembly languages.
CO3	To learn fundamentals of programming in C.
CO4	To learn assembly level programming.

CO5	To perform coding of I/O controller and necessary peripheral devices.

S. NO	**Contents**	**Contact Hours**
UNIT 1	Introduction: fundamentals of embedded systems, embedded system architecture, classifications of embedded systems, fundamentals of embedded processor and microcontrollers, embedded software in a system, examples of embedded systems. CISC vs. RISC.	**6**
UNIT 2	The 8051 Architecture: 8051 microcontrollers, I/O Ports and Circuits, Timers Counters, Serial Interface, Interrupts. 8051 Assembly Language Programming: Registers in the 8051, 8051 Assembly Assembling and Running an 8051 Programs.	**7**
UNIT 3	Programming in C: Fundamental concepts of C programming, Examples on different concepts, Control structure, Functions, Storage classes, Pointers, structure, union, object-oriented programming, Assembly language intro, memory organization.	**5**
UNIT 4	Assembly language programming: Instruction set and Programming, Immediate Addressing, Register Addressing Direct Addressing, Indirect Addressing, Indexed Addressing.	**7**
UNIT 5	I/O Programming: PIC I/O ports, I/O bit manipulation programming, timers/counters, programming to generate delay and waveform generation, I/O programming.	**6**
UNIT 6	PIC Microcontrollers: Introduction PIC Microcontroller, PIC16F877A Architecture and Instruction Set, I/O Ports and SFRs, Interrupts, Timers.Serial Communication Protocols, Introduction to Timers & Counters, Difference between Timer and Counter.	**5**
UNIT 7	Serial Communication Protocols, Introduction to Timers & Counters, Difference between Timer and Counter.	**6**
	TOTAL	**42**

REFERENCES

S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	1. Shibu K. V. (TMH),Introduction to Embedded Systems, McGraw Hill Education (15 June 2009)	2009
2	2. F. Vahid (John Wiley), Embedded System Design – A unified hardware and software introduction, John Wiley & Sons; ISBN: 0471386782. Copyright (c) 2002.	2002
3	3. Chuck helebuyck, Programming PIC microcontrollers with PIC basic; 1st Edition (later printing) edition (December 6, 2002).	2002

Course Title	**Course Structure**			**Pre-Requisite**
GPU Computing	**L**	**T**	**P**	
	3	1	0	

Course Objective: The course aims to provide students with a comprehensive understanding of GPU architecture and parallel computing

S. NO	**Course Outcomes (CO)**
CO1	To import basic knowledge of GPU architecture and usage, features and security aspects.
CO2	To learn the languages, compilers, and data management required for GPU computing.
CO3	To learn how to preserve a data's availability, integrity, and confidentiality.
CO4	To recognize various network security procedures in order to defend against threats in networks.
CO5	To be able to assess system security in relation to the proper application of security services and methods.

S. NO	**Contents**	**Contact Hours**

UNIT 1	Introduction: History, GPU Architecture, Clock speeds, CPU / GPU comparisons, Heterogeneity, Accelerators, Parallel Programming, CUDA OpenCL / OpenACC, Kernels Launch parameters, Thread hierarchy, Warps/Wavefronts, Threadblocks/Workgroups, Streaming multiprocessors, 1D/2D/3D thread mapping, Device properties, Simple Programs	**8**
UNIT 2	Memory: Memory hierarchy, DRAM / global, local / shared, private / local, textures, Constant Memory, Pointers, Parameter Passing, Arrays and dynamic Memory, Multi-dimensional Arrays, Memory Allocation, Memory copying across devices, Programs with matrices, Performance evaluation with different memories	**9**
UNIT 3	Synchronization: Memory Consistency, Barriers (local versus global), Atomics, Memory fence. Prefix sum, Reduction. Programs for concurrent Data Structures such as Worklists, Linked-lists. Synchronization across CPU and GPU Functions: Device functions, Host functions, Kernels functions, Using libraries (such as Thrust), and developing libraries.	**9**
UNIT 4	Support: Debugging GPU Programs. Profiling, Profile tools, Performance aspects Streams: Asynchronous processing, tasks, Task-dependence, Overlapped data transfers, Default Stream, Synchronization with streams. Events, Event-based- Synchronization - Overlapping data transfer and kernel execution, pitfalls.	**8**
UNIT 5	Advanced topics: Dynamic parallelism, Unified Virtual Memory, Multi-GPU processing, Peer access, Heterogeneous processing	**8**
	TOTAL	**42**

REFERENCES

S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	K R. Fernando and M. Kilgard, "The Cg Tutorial: The Definitive Guide to Programmable Real-Time.	2003
2	E. Kandrot and J. Sanders, Cuda by Example: an Introduction to General-Purpose Gpu Programming, Addison	2010
3	David B. Kirk, Wen-mei W. Hwu, Morgan Kaufmann, Programming Massively Parallel Processors: A Hands	2010
4	Wen-Mei w. Hwu, Morgan Kaufmann, GPU Computing GEMS Emerald Edition.	2011

Course Title	**Course Structure**			**Pre-Requisite**
Computer Vision	**L**	**T**	**P**	**Image Processing**
	3	**0**	**2**	

Course Objective: To learn fundamental computer vision algorithms and basic machine learning frameworks necessary for the automated understanding of images and videos. This include object recognition from images, activity/event recognition from videos, scene segmentation and clustering, motion and tracking, and deep learning for images and videos.

S. NO	**Course Outcomes (CO)**
CO1	To describe Image Formation Models, Monocular imaging system, Orthographic & Perspective projections
CO2	To evaluate applications of 2D/3D Vision Filters, Binary Images, Features and Edge Detection
CO3	To describe Image Processing and Feature Extraction concepts
CO4	To analyze motion Estimation, Regularization theory, Optical computation, Stereo Vision
CO5	To investigate Shape Representation Segmentation, Deformable curves and surfaces
CO6	To explain about Object recognition, describe Hough transforms and other simple object recognition methods

S. NO	**Contents**	**Contact Hours**

UNIT 1	Image Formation Models: Monocular imaging system, Orthographic & Perspective Projection, Camera models and Camera calibration, Sources, shadows and shading.	**6**
UNIT 2	Image Processing: Image representation, feature extraction and matching, Image filters, Edge detection, Image texture analysis, Clustering, Model Fitting	**6**
UNIT 3	Motion Estimation: Regularization theory, Optical computation, Multi-view scene processing, depth recovery from Stereo Vision, Motion estimation, Structure from motion.	**8**
UNIT 4	Shape Representation and Segmentation: Deformable curves and surfaces, Snakes and active contours, Level set representations, Fourier and wavelet descriptors, Medial representations, Multi-resolution analysis.	**8**
UNIT 5	Object recognition: Hough transforms and other simple object recognition methods, Shape correspondence and shape matching, Principal component analysis, Tracking with linear dynamical models.	**8**
UNIT 6	Object detection and tracking: Tracking with linear dynamical models, Optical flow estimation, Object tracking using deep neural networks.	**6**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	D. Forsyth and J. Ponce ,Computer Vision - A modern approach, Prentice Hall	2013
2	Linda Shapiro and George Stockman, Computer Vision, Prentice-Hall, 2001.	2001
3	Szeliski, Richard. Computer vision: algorithms and applications. Springer Science & Business Media, 2010.	2010
4	E. Trucco and A. Verri, Introductory Techniques for 3D Computer Vision, Publisher: PHI COMPUTER SECURITY.	1994

Course Title	Course Structure			Pre-Requisite
Smart Sensing for Internet of Things	**L**	**T**	**P**	
	3	1	0	

Course Objective: Deepen the understanding of IoT network models and applications for novel system design.

S. NO	Course Outcomes (CO)
CO1	To understand the various models, designs and applications of IoT.
CO2	To discuss similarities and differences between IoT, M2M, and SDN. To understand IoT platform and design Methodology.
CO3	To be able to program using Python packages for system design of IoT.
CO4	To perform data analytics on IoT data using Hadoop, Apache and Map reduce techniques.
CO5	To explore ethical aspects of implementation and application of IoT.

S. NO	Contents	Contact Hours
UNIT 1	Introduction to Internet of Things, Definitions and Characteristics of IoT, Physical Design of IoT, Things in IoT, IoT Protocols, Logical Design of IoT, IoT Functional Blocks, IoT Communication Models, IoT Communication APIs, IoT Enabling Technologies, Wireless Sensor Networks, Cloud Computing, Big Data Analytics, Communication Protocols.	**8**

UNIT 2	IoT and M2M, Introduction, M2M, Difference between IoT and M2M, SDN and NFV for IoT, Software Defined Networking, Network Function Virtualization, IoT Platform Design Methodology, Introduction, IoT Design Methodology.	**8**
UNIT 3	IoT System Logocal Design Using Python, Introduction, Installing Python, Python Data Types and Data Structures, Control Flow, Functions, Modules, Packages, File Handling, Date Time applications, Classes, Python Packages of Interest for IoT.IoT Physical Devices and End Points.	**9**
UNIT 4	Data Analytics for IoT; Introduction AppacheHadoop, using HadoopMapReduce for Batch Data Analysis, Apache oozie, Apache Spark, Apache Storm, using Apache Storm for Real-time Data Analysis.	**9**
UNIT 5	Ethics: Characterizing the IoT, Privacy, Control, Distributing Control and Crowd Sourcing.	**8**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	1. Raj Kamal ,"INTERNET OF THINGS" , McGraw-Hill(June7,2022)	2022
2	2. Timothy Chou, "Precision - Internet of Things", McGraw-Hill.(May 29,2017)	2017
3	3.Rajkumar Buyya, Amir Vahid Dastjerdi **,** "Internet of Things Principles and Paradigms", Morgan Kaufmann	2016

Course Title	Course Structure			Pre-Requisite
	L	**T**	**P**	
Financial Data Analytics	**3**	**0**	**2**	**Python, Excel**

Course Objective: Equip students with the knowledge and skills to analyze financial data using statistical and computational techniques, enabling them to make informed decisions, detect patterns, and predict trends in financial markets.

S. NO	Course Outcomes (CO)
CO1	Use spreadsheets to perform Extracting, Transforming and Loading (ETL) from different financial data sources
CO2	Understand financial analytics major tools and techniques
CO3	Understand data modeling and create relational database
CO4	Understand data visualization theories and techniques and use visualization techniques to visualize real-time and off-line financial data
CO5	Learn how to create written reports and present analysis results to different financial and non-financial audiences

S. NO	Contents	Contact Hours
UNIT 1	**Useful Excel Functions in Finance** Essential Excel Functions for Analyzing Financial Data • Basic data manipulation - searching, sorting, filtering, and basic statistics. • Descriptive analytics • Data aggregation techniques for single and multiple financial data • Advanced functions	**8**

UNIT 2	**ETL and Power Queries** Connecting Excel to Financial & Non-Financial Data Sources, and ETL (Extracting, Transforming and Loading) (3 week) • ETL techniques • Connecting Excel to popular financial data sources using vendor provided Excel Add-ins (such as Bloomberg Excel Add-in) • Connecting Excel to cloud and web data sources • Using Power Query to perform ETL in Excel • Creating and editing queries in Power Query	**8**
UNIT 3	**Relational Database, Data Models and Power Pivots** Databases, Data Model and Power Pivots (2 week) • Introduction to Relational Databases • Excel's data models and how they can empower financial data analysis • Representation of financial data in data models, data relationships and joins • Basing pivot tables on a data model • Calculated columns, measures, and the DAX language	**8**
UNIT 4	**Big Data, Cloud-based Analytics and Analytics Automation** Cloud-based and Automated Analytics (1 week) • Cloud storage for financial data and analytics findings • Financial analytics in the cloud • Automated analytics • Crowd analytics (or wisdom of the crowd)	**10**
UNIT 5	**Introduction to predictive analytics** • Types of analytics • Supervised versus unsupervised learning for financial and non-financial data • Model performance evaluation • Case studies on business problems, analytical techniques and tools (e.g., Excel macros & VBA, machine learning/data mining, and artificial intelligence)	**8**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Data Analytics Made Easy: Analyze and present data to make informed decisions without writing any code By Andrea De Mauro Publication date :Aug 30, 2021 1st Edition ISBN-13 :9781801074155	2021
2	Financial Data Analytics with Machine Learning, Optimization and Statistics (Wiley Finance) 1st Edition by Yongzhao Chen, Ka Chun Cheung, Kaiser Fan, Phillip Yam	
3	Financial Data Analytics: Theory and Application by Sinem Derindere Köseoğlu Springer Nature, 25 Apr 2022	2022
4	Machine Learning in Finance: From Theory to Practice 1st ed. 2020 Edition by Matthew F. Dixon (Author), Igor Halperin (Author), Paul Bilokon (Author) Format: Kindle Edition	2020

Course Title	Course Structure			Pre-Requisite
	L	T	P	
FoG and Edge Computing	**3**	**1**	**-**	**Computer Networks**

Course Objective: 1. To introduce Fog and Edge enabling technologies and its opportunities.
2. To review underlying technologies, limitations, and challenges along with performance metrics and discuss generic conceptual framework in Edgecomputing.
3. To impart the knowledge to log the sensor data and to perform further data analytics.

S. NO	Course Outcomes (CO)
CO1	Explore technologies behind the communication and management of edge resources.
CO2	Learn the techniques for storage and computation in fog, edges, 5G and clouds.

CO3	Implement Internet of Everything (IoE) applications through Fog and edge computing architecture, and use optimization techniques for the same.
CO4	Analyze the performance and issues of the applications developed using Fog and edge architecture.

S. NO	**Contents**	**Contact Hours**
UNIT 1	**Introduction**: Relevant Technologies - Fog and Edge Computing Completing the Cloud - Hierarchy of Fog and Edge Computing - Business Models – Edge Computing Platforms -Opportunities and Challenges	**8**
UNIT 2	**Challenges in Federating Edge Resources**: Introduction - Methodology - Integrated C2F2T Literature by Modeling Technique -Integrated C2F2T Literature by Use - Case Scenarios - Integrated C2F2T Literature by Metrics – Threads - Standards	**8**
UNIT 3	**Orchestration of Network Slices in Fog, Edge, and Clouds**: Introduction – Background - Network Slicing - Network Slicing in Software-Defined CloudsNetwork Slicing Management in Edge and Fog - Internet of Vehicles (IoV): Architecture, Protocols and Seven-layer security model architecture for Internet of Vehicles - IoV: Network Models, Challenges and future aspects	**9**
UNIT 4	**Optimization Problems in Fog and Edge Computing**: Preliminaries - The Case for Optimization in Fog Computing-Formal Modeling Framework for Fog Computing – Metrics - Further Quality Attributes - Optimization Opportunities along the Fog Architecture - Optimization Opportunities along the Service Life Cycle - Toward a Taxonomy of Optimization Problems in Fog Computing	**9**
UNIT 5	**Applications of Fog and Edge Computing:** Exploiting Fog Computing in Health Monitoring-Smart Surveillance Video Stream Processing at the Edge for Real - Time Human Objects Tracking-Fog Computing Model for Evolving Smart Transportation Applications - Testing Perspectives of Fog - Based IoT Applications - Legal Aspects of Operating IoT Applications in the Fog	**8**
	TOTAL	**42**

REFERENCES

S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	2019, 1st edition, John Wiley & Sons, USA.	2019
2	Assad Abbas, Samee U. Khan, Albert Y. Zomaya, “Fog Computing”, Wiley.	2020
3	Perry Lea, “IoT and Edge Computing for Architects - Second Edition”, Packt Publishing	2020
4	Wei Chang (Editor), Jie Wu (Editor), "Fog/Edge Computing For Security, Privacy, and Applications", Springer-Verlag Berlin and Heidelberg Gmb	2021

Course Title	**Course Structure**			**Pre-Requisite**
Big Data Analytics	**L**	**T**	**P**	**Database Management system**
	3	**0**	**2**	

Course Objective: Mastering the process of mapping and knowlegde extraction from huge volumes of data.

S. NO	**Course Outcomes (CO)**
CO1	To learn about distributed file system.
CO2	To understand the working of Apache Hadoop ecosystem.
CO3	To underatand working and commands of Hdoop.
CO4	To study usgaes and design og Hbase concepts.

CO5	To apply big data analytics in real life problem solving .

S. NO	**Contents**	**Contact Hours**
UNIT 1	Introduction – distributed file system – Big Data and its importance, Four Vs, Drivers for Big data, Big data analytics, Big data applications. Algorithms using map reduce.	**8**
UNIT 2	Big Data – Apache Hadoop & Hadoop EcoSystem – Moving Data in and out of Hadoop – Understanding inputs and outputs of MapReduce - Data Serialization.	**8**
UNIT 3	Hadoop Architecture, Hadoop Storage: HDFS, Common Hadoop Shell commands , Anatomy of File Write and Read., NameNode, Secondary NameNode, and DataNode, Hadoop MapReduce paradigm, Map and Reduce tasks, Job, Task trackers - Cluster Setup – SSH & Hadoop Configuration – HDFS Administering – Monitoring & Maintenance.	**9**
UNIT 4	HBase concepts- Advanced Usage, Schema Design, Advance Indexing - PIG, Zookeeper - how it helps in monitoring a cluster, HBase uses Zookeeper	**9**
UNIT 5	Data Analytics with R: Machine Learning: Introduction, Supervised Learning, Unsupervised Learning, Collaborative Filtering. Big Data Analytics with BigR.	**8**
	TOTAL	**42**

REFERENCES

S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	C. J. Date Addison-Wesley, Introduction to Database Systems . 8th Ed. Publisher: Addison-Wesley; 8 edition (August 1, 2003) ISBN-10: 0321197844/ ISBN-13: 978-0321197849.	2003
2	R. A. Mata-Toledo and P. Cushman, Fundamentals of SQL Programming. Schaum's Outline Series. McGraw-Hill (2000).	2000
3	H. Garcia-Molina and et al. Prentice Hall, Database Systems the Complete Book; 2ndEdition (June 15, 2008). ISBN-10: 0131873253 / ISBN-13: 978- 013187325	2008
4	R. Elmasri and S. Navathe . Addison-Wesley, Fundamentals of Database Systems Addison-Wesley; 6 edition (April 9, 2010) ISBN-10: 0136086209 / ISBN-13: 978-0136086208	2010

Course Title	**Course Structure**			**Pre-Requisite**
Biometric Systems	**L**	**T**	**P**	**Image Processing**
	3	**0**	**2**	

Course Objective: Objectives of this course include scientific foundations needed for the design, implementation, and evaluation of large scale biometric identification systems.

S. NO	**Course Outcomes (CO)**
CO1	To learn about biometric systems and design authentication mechanisms.
CO2	To study fingerprint capture, sensor types, and latent fingerprint recognition issues.
CO3	To study iris recognition investigate eye and iris formation and genetic penetrance.
CO4	To identify essential qualities and detect faces in still photographs and sequences.
CO5	To study handwritten signature recognition will examine signature capture, including scanned photos and tablet-captured signatures.
CO6	To learn secure biometric data transfer methods to protect sensitive data while researching biometric system security.

S. NO	**Contents**	**Contact Hours**

UNIT 1	Introduction to Bio-Metric System: Development of biometric authentication. Basic terms, biometric data, biometric characteristics, biometric features, biometric templates and references. Expected properties of biometric identifiers.	**6**
UNIT 2	Fingerprint recognition: Fingerprint capture, sensor types, latent fingerprints. Fingerprint image pre-processing, segmentation, binary and skeletal images. Fingerprint singularities	**7**
UNIT 3	Iris recognition: Eye and iris morphogenesis, genetic penetrance. Principles of iris image capture, iris sensors. Iris image preprocessing, segmentation, formatting and filtering.	**7**
UNIT 4	Face recognition: Face detection in still images and sequences. Face features. Face space, principal component analysis and its application, Eigen faces, linear discriminant analysis and its application, Fisher faces. Face recognition methods.	**8**
UNIT 5	Recognition of handwritten signatures: Signature capture, off-line (scanned) and on-line (captured by tablets) signatures. Signature as a multidimensional curve, two- and multi-dimensional analyses. Signature features, hidden and visible features.	**8**
UNIT 6	Security of biometrics system: Secure transfer of biometric data. Merging biometrics and cryptography, template protection. Merging biometrics and steganography.	**6**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Jain, A.K., Ross, A., Nandakumar, K. Introduction to Biometrics.	2011
2	Maltoni, D., Maio, D., Jain, A.K., Prabhakar, S., Handbook of Fingerprint Recognition. Second edition	2009
3	Marcel, S., Nixon, M.S., Li, S.Z., Handbook of Biometric Anti-Spoofing: Trusted Biometrics under Spoofing Attacks (Advances in Computer Vision and Pattern Recognition).	2014

Course Title	Course Structure			Pre-Requisite
	L	**T**	**P**	
Network and Internet of Things	**3**	**1**	**0**	**Computer Networks**

Course Objective: To learn the fundamental concepts of IoT Networks with its application in various domain

S. NO	Course Outcomes (CO)
CO1	To understand the fundamentals of Internet of Things
CO2	To acquire the knowledge of various technologies which can integrate with IoT
CO3	To implement various IoT system using python modules nad packages
CO4	To understand the data analytics for IoT applications
CO5	To implement the security system for latest IoT applications

S. NO	Contents	Contact Hours
UNIT 1	Introduction to Internet of Things: Definitions and Characteristics of IoT, Physical Design of IoT, Things in IoT, IoT Protocols, Logical Design of IoT, IoT Functional Blocks, IoT Communication Models, IoT Communication APIs, IoT Enabling Technologies, Wireless Sensor Networks, Cloud Computing, Big Data Analytics, Communication Protocols.	**9**

UNIT 2	IoT and M2M: Introduction, M2M, Difference between IoT and M2M, SDN and NFV for IoT, Software Defined Networking, Network Function Virtualization, IoT Platform Design Methodology, Introduction, IoT Design Methodology.	**9**
UNIT 3	IoT System Logocal Design Using Python, Introduction, Installing Python, Python Data Types and Data Structures, Control Flow, Functions, Modules, Packages, File Handling, Date Time applications, Classes, Python Packages of Interest for IoT.IoT Physical Devices and End Points.	**8**
UNIT 4	Data Analytics for IoT; Introduction AppacheHadoop, using HadoopMapReduce for Batch Data Analysis, Apache oozie, Apache Spark, Apache Storm, using Apache Storm for Real-time Data Analysis.	**8**
UNIT 5	Security: Characterizing the IoT security, Privacy, Control, Distributing Control and Crowd Sourcing.	**8**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Raj Kamal ,"INTERNET OF THINGS" , McGraw-Hill	2022
2	JTimothy Chou, "Precision - Internet of Things", McGraw-Hill.	2011
3	Rajkumar Buyya, Amir Vahid Dastjerdi , "Internet of Things Principles and Paradigms", Morgan Kaufmann	2016
4	Dr Kamlesh Lakhwani, Dr Hemant Kumar Gianey, Joseph Kofi Wireko, Kamal Kant Hiran, "Internet of Things, Principles, Paradigms and Applications in IoT", BPB Publications	2020
5	Raj Kamal, INTERNET OF THINGS (IOT): Architecture and Design Principles, McGraw-Hill	2022

Course Title	Course Structure			Pre-Requisite
	L	**T**	**P**	
Data engineering and analytics	**3**	**0**	**2**	Probability, Statistics, Linear Algebra

Course Objective: 1. To familiarize with the concepts of data mining, data storage, data pipeline and data integration.
2. To analyze data using classification, clustering, feature selection, association rule mining and itemset mining.
3. To understand and explore data warehousing architectures and data lakes.

S. NO.	Course Outcomes (CO)
CO1	Ability to understand and describe data mining, data storage, data pipeline and data integration concepts.
CO2	Ability to understand and implement classification and clustering algorithms for analyzing linearly and non-linearly separable data.
CO3	Ability to understand and implement feature selection algorithms for data reduction.
CO4	Ability to understand and explore patterns and dependencies in data using association-rule mining and itemset-mining.
CO5	Ability to understand, explore and describe data warehousing architectures and data lakes.

S. NO.	Contents	Contact Hours
UNIT 1	**Introduction to data engineering:** Storing data, Data loading, Data transformation, Data structures, SQL and NoSQL databases, Database normalization, Data cubes, Snowflake scheme, Data warehouses, Data lakes, Data Marts, Metadata in Data Warehouse, Data pipeline, Data integration- Extract, Transform, and Load (ETL) processes for integrating data from multiple sources.	**10**

UNIT 2	**Advanced data analytics and machine learning:** Cluster Analysis, Types of Data in Cluster Analysis, Partitioning methods, Hierarchical Methods. Classification techniques for linearly separable and non-linearly separable data- Linear Discriminant Analysis and Support Vector Machine. Feature Ranking and Feature Selection Algorithms. Associations and correlations- basic concepts, efficient and scalable frequent item sets mining methods, mining various kinds of association rules, constraint-based association mining.	**12**
UNIT 3	**Data warehousing**: Planning Your Data Warehouse, The Data Warehouse Project, Architectural Components: Understanding Data Warehouse Architecture, Infrastructure Supporting Architecture, Collection of Tools. Indexing the data warehouse, performance enhancement techniques.	**10**
UNIT 4	**Data design and data preparation**: From Requirements to Data Design, The STAR Schema, STAR Schema Keys, Advantages of the STAR Schema. Data modeling for data warehouses. Scalable data engineering solutions - handling massive datasets. Online Analytical Processing models, Online Transaction Processing models. .	**10**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Data Mining: Concepts and Techniques, Jiawei Han, Micheline Kamber and Jian Pei, 3rd ed., *Morgan Kaufmann*	2022
2	Mining Introductory and Advanced Topics, M.H. Dunham, Pearson Education.	2002
3	Data mining, Pieter Adriaans, Pearson Education.	1996
4	Data warehousing in the real world for building decision support systems, Sam Anahory, Pearson Education.	1997
5	The Data Warehouse Lifecycle toolkit, Ralph Kimball, John Wiley.	1996
6	Fundamentals of database systems, Ramez Elmasri, Pearson Education.	2000
7	Oracle8 data warehousing, Michael Corey, Tata McGraw Hill.	1998
8	Data Warehousing Fundamentals, Paulraj Ponniah, John Wiley.	2001

Departmental Electives-3

Course Title	Course Structure			Pre-Requisites
Digital and Cyber Forensics	**L**	**T**	**P**	
	3	**0**	**2**	

Course Objective: Upon completion, students will understand digital forensics principles and real-world crime examples, address challenging aspects like encryption and jurisdiction, and apply investigation processes using various forensic tools in Windows and UNIX environments.

S. NO	Course Outcomes (CO)
CO1	To employ various forensic tools and technologies in practical scenarios, ensuring the integrity and admissibility of digital evidence in legal proceedings.
CO2	To develop an understanding of various types of computer forensics enabling them to effectively analyze digital evidence from diverse sources
CO3	Students will be proficient in conducting live data collection and analysis in Windows environments.
CO4	Students will be proficient in conducting live data collection and analysis in Unix environments.
CO5	To demonstrate proficiency in conducting ethical hacking activities, including port scanning and vulnerability assessments using tools.

S. NO	Contents	Contact Hours
UNIT 1	Introduction to Digital forensics, Digital evidence and investigations, Real life examples of digital crime, Challenging aspects of digital forensics. Introduction to intellectual property rights and professional ethics.	8
UNIT 2	Computer crime investigation process: The Investigation process, preparing a computer investigation. Overview of Types of computer forensics i.e. Media Forensics, Network forensics (internet forensics), Machine forensic, Email forensic (e-mail tracing and investigations). Digital forensics of image, audio etc files.	9
UNIT 3	Live Data collection and investigating windows environment: windows Registry analysis, Gathering Tools to create a response toolkit (Built in tools like netstat , cmd.exe , nbtstat , arp , md5sum ,regdmpetc and tools available as freeware like Fport , Pslistetc) ,	9
UNIT 4	Live Data collection and investigating UNIX environment Forensic tools and report generation: Recovery of Deleted files in windows, Analyzing network traffic, sniffers	8
UNIT 5	Ethical Hacking, Hardware forensic tools like Port scanning and vulnerability assessment tools like Nmap ,Netscanetc .Password recovery, Mobile forensic tools.	8
	TOTAL	

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Mandia, Kevin, Prosise, Chris, and Pepe, Matt," Incident Response &Computer Forensics", McGraw-Hill.	2003
2	Beebe, Nicole Lang, and Jan Guynes Clark, "A Hierarchical, Objectives-Based Framework for the Digital Investigations Process	2005
3	Nelson, Bill, Amelia Phillips, Frank Enfinger, and Christopher Steuart," Guide to Computer Forensics and Investigations", Thompson Course Technology, Boston	2006

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Privacy in location based services	3	1	0	Basics of internet and mobile networks

Course Objective: This course aims to provide students with a comprehensive understanding of Location-Based Services (LBS), covering their evolution, application areas, privacy concerns, and market dynamics. By the end of the course, students will be proficient in vehicle tracking, navigation systems, and mobile device ecosystems. They will also learn to design and implement private LBS solutions and apply location privacy protection techniques. Through a practical case study, students will develop a real-time LBS application, integrating theoretical concepts into practical solutions.

S. NO	Course Outcomes (CO)
CO1	Understand LBS evolution, applications, taxonomy, privacy concerns, markets, and customer segments.
CO2	Learn vehicle tracking concepts, navigation for different modes, distress call management.
CO3	Explore mobile app ecosystem, business models, privacy, threats, legal protections, and user attitudes towards LBS.
CO4	Analyse private LBS including Geo-Social Networks, Friend-Nearby Notification, POI Finder, and Traffic Monitoring.
CO5	Learn methods for quantifying location privacy and obfuscation-based protection schemes.
CO6	Develop a real-time LBS case study and submit a working application demonstrating concepts learned.

S. NO	Contents	Contact Hours

UNIT 1	Introduction – Evolution of Location Based Services – Application Areas of Location Based Services (LBS) – Application Taxonomy – LBS Privacy – LBS Markets and Customer Segments.	**6**
UNIT 2	Vehicle Tracking: Tracking Concepts, Components of Vehicle Tracking, Online and Offline Tracking. Alarms Used In Vehicle Tracking, Fleet Management – Vehicle Navigation: Navigation Concepts For Road, Waterways And Airways – Components Of Vehicle Navigation, File Formats Used For Navigation – Distress Call Management.	**10**
UNIT 3	Mobile Device Eco-System: Mobile Applications, Business Model, and Privacy, Threats, Legal Protection of Location Data, user Perception of LBS: Overview on User Studies, User Attitude Towards LBS, Privacy Preferences of Users.	**8**
UNIT 4	Design of Private Location-Based Services, Geo-Social Networks, Friend-Nearby Notification, POI Finder, Traffic Monitoring. Quantification of Location Privacy, Obfuscation-based Protection Schemes: Hiding Events, Reducing Precision, Perturbation, Dummies.	**8**
UNIT 5	Case Study: Develop A Real Time Case Study on Location Based Services Using the Above Concepts Learned and Submit A Working Application Along With the Presentation.	**10**
	TOTAL	**42**

REFERENCES

S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Jochen Schiller & Agnes Voisard, "Location – Based Services" Morgan Kaufmann Publishers, 2004.	2004
2	Syed A. Ahson& Mohammad Ilyas, "Location-Based Services Handbook: Applications, Technologies, And Security – CRC Press, 2010	2010

Course Title	**Course Structure**			**Pre-Requisite**
Theory of Modern Cryptography	**L**	**T**	**P**	**Introduction to Computer Networks and Operating Systems**
	3	**1**	**0**	

Course Objective: This course aims to provide an in-depth understanding of various cryptographic techniques, security mechanisms, and protocols essential for securing information and communication systems.

S. NO	**Course Outcomes (CO)**
CO1	Understand the need for security and basics of cryptography and classical encryption techniques.
CO2	Learn principles of modern block ciphers, DES, and block cipher modes of operation.
CO3	Apply mathematical concepts and algorithms in cryptography, including RSA and Diffie-Hellman.
CO4	Understand message authentication, hash functions, and Public Key Infrastructure (PKI).
CO5	Analyze authentication applications, email security protocols, and IP/web security mechanisms.

S. NO	**Contents**	**Contact Hours**
UNIT 1	Introduction: Need for security, Introduction to security attacks, services and mechanism, introduction to cryptography, Conventional Encryption: Conventional encryption model, classical encryption techniques.	**7**
UNIT 2	Modern Block Ciphers: Block ciphers principals, Shannon's theory of confusion and diffusion, Fiestal structure, data encryption standard(DES), strength of DES, crypt analysis of DES, block cipher modes of operations, triple DES, IDEA encryption and decryption, strength of IDEA, key distribution.	**9**

UNIT 3	Introduction to graph, ring and field, prime and relative prime numbers, modular arithmetic, Fermat's and Euler's theorem, primarily testing, Euclid's Algorithm, Chinese Remainder theorem, RSA algorithm, key management, Diffle-Hellman key exchange algorithm.	**8**
UNIT 4	Message Authentication and Hash Function: Authentication requirements, authentication functions, message authentication code (MAC), hash functions, security of hash functions message digest algorithm, Public Key Infrastructure (PKI).	**8**
UNIT 5	Authentication Applications: Kerberos and X.509, biometric authentication, electronic mail security-pretty good privacy (PGP), S/MIME. IP Security: Architecture, Authentication header, Encapsulating security payloads, combining security associations, key management. Web Security: Secure Socket Layer (SSL) and transport layer security.	**10**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Cryptography and Network Security: Principles and Practice" by William Stallings, 7th Edition	2016
2	Network Security Essentials: Applications and Standards" by William Stallings, 6th Edition.	2016
3	Applied Cryptography: Protocols, Algorithms, and Source Code in C" by Bruce Schneier, 20th Anniversary Edition.	2015
4	Introduction to Modern Cryptography: Principles and Protocols" by Jonathan Katz and Yehuda Lindell, 2nd Edition.	2014
5	Cryptography and Network Security" by Behrouz A. Forouzan and Debdeep Mukhopadhyay, 3rd Edition	2015

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Internet Security and Privacy	**3**	**1**	**0**	**cryptography principles and algorithms**

Course Objective: This course offers a comprehensive understanding of computer security principles, including cryptographic techniques, security mechanisms, and technologies. It covers securing operating systems, databases, and network infrastructures, legal and ethical considerations, and practical exercises.

S. NO	Course Outcomes (CO)
CO1	Understand the foundational concepts of network security ensuring the confidentiality, integrity, and availability of data.
CO2	Gain knowledge of basic cryptography principles in securing data and communications.
CO3	Develop an understanding of program security to enhance security.
CO4	Explore trusted operating systems and database management systems security in multilevel databases.
CO5	Identify network threats and understand network security techniques and other malicious activities in network communication.

S. NO	Contents	Contact Hours
UNIT 1	Introduction: Basic concepts: threats, vulnerabilities, controls; risk; confidentiality, integrity, availability; security policies, security mechanisms; assurance; prevention, detection, deterrence.	**8**
UNIT 2	Basic cryptography: Basic cryptographic terms, Historical background, Symmetric crypto primitives, Modes of operation, Cryptographic hash functions, Asymmetric crypto primitives.	**8**
UNIT 3	Program security: Malicious code: viruses, Trojan horses, worms. Program flaws: buffer overflows, time-of-check to time-of-use flaws, incomplete mediation, Software development controls , Testing techniques	**9**

UNIT 4	Trusted operating systems: Assurance; trust, Design principles, Evaluation criteria, Evaluation process. Database management systems security: Database integrity, Database secrecy, Inference control, Multilevel databases.	**9**
UNIT 5	Network security: Network threats: eavesdropping, spoofing, modification, denial of service attacks Introduction to network security techniques: firewalls, virtual private networks, intrusion detection.	**8**
	TOTAL	**42**

REFERENCES

S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	"Computer Security: Principles and Practice" by William Stallings and Lawrie Brown.	2017
2	"Introduction to Computer Security" by Michael T. Goodrich and Roberto Tamassia	2011
3	"Security Engineering: A Guide to Building Dependable Distributed Systems" by Ross J. Anderson	2020
4	"Network Security Essentials: Applications and Standards" by William Stallings	2017
5	"Cryptography and Network Security: Principles and Practice" by William Stallings	2019

Course Title	**Course Structure**			**Pre-Requisite**
Applied Cryptography	**L**	**T**	**P**	**Linear Algebra**
	3	**1**	**0**	

Course Objective: This course provides students with a comprehensive understanding of cryptographic concepts, including number theory, block ciphers, public key cryptography, hash functions, and message authentication codes, enabling them to design secure cryptographic systems and apply them effectively.

S. NO	**Course Outcomes (CO)**
CO1	Understand number theory basics and block ciphers, including DES and AES, and their modes of operation.
CO2	Gain proficiency in public key cryptography algorithms like RSA, ElGamal, Diffie-Hellman as well as elliptic curve cryptography (ECC).
CO3	Learn about hash functions, including their properties and real-world applications in cryptography
CO4	Understand message authentication codes (MAC) generated from hash functions and block ciphers for ensuring data integrity and authenticity.
CO5	Explore side-channel analysis techniques and applications of cryptographic protocols in key establishment, blockchains, and secure communication

S. NO	**Contents**	**Contact Hours**
UNIT 1	Number Theory Basics: Modular arithmetic, primes, GCD and Chinese reminder theorems. Block Ciphers: DES, AES; ECB, CBC, OFB, CFB, CTR and GCM modes, Double and triple encryptions.	**10**
UNIT 2	Public Key Cryptography: RSA, ElGamal, Diffe-Hellman Key exchange, practical digital signatures. ECC.	**8**
UNIT 3	Hash Functions: oneway, collision resistant, preimage resistant HASH functions, Real-world examples.	**8**
UNIT 4	Message Authentication Codes: MAC from Hash functions, MAC from block ciphers.	**8**
UNIT 5	Side Channel Analysis: Power / timing analysis of crypto-implementations Applications: Key Establishment Protocols, Blockchains, etc.	**8**
	TOTAL	**42**

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Cryptography and Network Security: Principles and Practice, William Stallings	
2	Menezes, van Oorschot, and Vanstone, HAC: "The Handbook of Applied Cryptography".	
3	IdCrypto: C. Youngblood, "An Introduction to Identity-Based Cryptography," CSEP 590TU	2005
4	AnCom: Ren J and Wu J. Survey on Anonymous Communications in Computer Networks. Computer Communications. 2010, 33(4): 420–431	2010

Course Title	**Course Structure**			**Pre-Requisite**
Cyber Security & Law	**L**	**T**	**P**	
	3	**2**	**0**	

Course Objective: The purpose is to understand the basics of cyber security, laws, and related issues. To explain the information on cyber security and understand the issues that are specific to amendment rights. Further, I have knowledge of the correct issues of software and understand the ethical laws of computers for digital countries.

S. NO	**Course Outcomes (CO)**
CO1	Identify and analyze intervention strategies for cyber security issues, including redundancy, diversity, autarchy, and global regulation.
CO2	Examine the risks and legal implications of copyright issues, internet infringement, privacy rights, and related constitutional and federal statutes.
CO3	Understand duty of care, criminal liability, procedural issues, and the legal framework surrounding electronic contracts, digital signatures, and civil rights.
CO4	Assess the ethical implications and societal impacts of cyber security, with a focus on legal developments, case studies, and the evolution of cyber law from the late 1990s to 2000.

S. NO	**Contents**	**Contact Hours**
UNIT 1	The World Wide Web, Web Centric Business, E Business Architecture, Models of E Business, E Commerce, Threats to virtual world. Cyber Crimes& social media, Cyber Squatting, Cyber Espionage, Cyber Warfare, Cyber Terrorism	**7**
UNIT 2	Computer ethics, moral and legal issues, descriptive and normative claims, Professional Ethics, code of ethics and professional conduct. Privacy, Computers and privacy issue.	**6**
UNIT 3	Web Servers and Browsers, HTTP, Cookies, Caching, Plug-in, ActiveX, Java, JavaScript, Secure Socket Layer (SSL), Secure Electronic Transaction (SET). E-mail Risks, Spam, E-mail Protocols, Simple Mail Transfer Protocol (SMTP), Post office Protocol (POP), Internet Access Message protocol (ICMP). Secured Mail Protocols	**10**
UNIT 4	Copyrights, Jurisdiction Issues and Copyright Infringement, Multimedia and Copyright issues, WIPO, Intellectual Property Rights, Understanding Patents, Understanding Trademarks, Trademarks in Internet, Domain name registration, Software Piracy, Legal Issues in Cyber Contracts, Authorship, Document Forgery.	**8**
UNIT 5	Indian IT ACT, Adjudication under Indian IT ACT, IT Service Management Concept, IT Audit standards, System audit, Information security audit, ISMS, SoA (Statement of Applicability), BCP (Business Continuity Plan), DR (Disaster Recovery), RA (Risk Analysis/Assessment).	**11**
	Total	**42**

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Jonathan Rosenoer. "Cyber Law: The law of the Internet", Springer-Verlag.	1997

2	Mark F Grady. FransescoParisi, "The Law and Economics of Cyber Security", Cambridge University Press, 2006	2006

Course Title	**Course Structure**			**Pre-Requisite**
Digital Watermarking and Steganalysis	**L**	**T**	**P**	**Digital Signal Processing**
	3	**0**	**2**	

Course Objective: To equip students with a comprehensive understanding of digital watermarking, steganography, and steganalysis, including theoretical foundations, practical applications, security considerations, and the evaluation and development of robust information hiding systems.

S. NO	**Course Outcomes (CO)**
CO1	Understand the fundamentals of information hiding, steganography, and digital watermarking
CO2	Apply various models of watermarking, utilize side information for informed embedding, and develop techniques to ensure robustness against volumetric, temporal, and geometric distortions.
CO3	Understand security requirements for watermarking, analyze significant known attacks, and implement methods for exact and selective content authentication, localization, and restoration.
CO4	Conduct steganalysis using significant algorithms, evaluate the effectiveness of steganographic systems

S. NO	**Contents**	**Contact Hours**
UNIT 1	Introduction: Information Hiding, Steganography, and Watermarking, Importance of Digital Watermarking, Theoretic Foundations of Steganography Applications and Properties: Applications of Watermarking, Applications of Steganography, Properties of Watermarking Systems, Evaluating Watermarking Systems, Properties of Steganographic and Steganalysis Systems, Evaluating and Testing Steganographic Systems.	**12**
UNIT 2	Models of Watermarking: Communication-Based Models of Watermarking, Geometric Models of Watermarking, Modeling Watermark Detection by Correlation, Basic Message Coding: Mapping Messages into Message Vectors, Error Correction Coding, Detecting Multi-symbol Watermarks. Watermarking with Side Information: Informed Embedding, Watermarking Using Side Information, Dirty-Paper Codes, Robust Watermarking: Approaches, Robustness to Volumetric Distortions, and Robustness to Temporal and Geometric Distortions.	**12**
UNIT 3	Watermark Security: Security Requirements, Watermark Security and Cryptography, Some Significant Known Attacks, Content Authentication: Exact Authentication, Selective Authentication, Localization, Restoration.	**9**
UNIT 4	Steganalysis: Steganalysis Scenarios, Some Significant Steganalysis Algorithms, Case studies.	**9**
	TOTAL	**42**

REFERENCES

S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Ingemar Cox Matthew Miller Jeffrey Bloom Jessica Fridrich Ton Kalker, "Digital Watermarking and Steganography	2007
2	Ingemar J. Cox, Matthew L. Miller, Jeffrey A. Bloom, Digital Watermarking principles, Morgan Kaufmann	2011

Course Title	**Course Structure**			**Pre-Requisite**
Network Anonymity and Privacy	**L**	**T**	**P**	**-**
	3	**1**	**-**	

Course Objective: 1. To introduceAnonymity and Privacy and its opportunities.
2. To understand the VPN concepts.
3. To impart the knowledge of network anonymity and privacy protocols.

S. NO	Course Outcomes (CO)
CO1	Explore technologies behind anonymity and privacy in networks
CO2	Learn the concept of VPN
CO3	Implement network anonymity and privacy protocols.
CO4	Analyze the performance and security analysis of VoIP communications.

S. NO	Contents	Contact Hours
UNIT 1	**Introduction**: Anonymity and Privacy, and why it matters, Networking basics, various network challenges, cryptography, firewalls, web authentication, user tracking Corporate Network Security Policies, threats and controls, Firewall: Technologies, Stateful and stateless firewall, Transparent Proxy and Protocol or application Gateway, Linux-based Firewall: ip chains&ip tables, Internet Services against firewall.	**8**
UNIT 2	**Virtual Private Network (VPN):** Concepts and technologies, IPSec and Free S/WAN, VPN with Firewall, Intrusion Detection System(IDS): Concepts, Network-based and Host based IDS, tripwire or Snort or Port Sentry setup and management, onion routing, anonymous browsing, P3P	**12**
UNIT 3	**Historical :** dash; MIXes and MIXnets, various theoretical and practical attack strategies against high and low-latency anonymity networks, practical traffic analysis against modern anonymity systems like Tor, Freenet, GNUnet, JAP.	**12**
UNIT 4	Side-channel attacks, covert channel communications, pseudonymity and privacy, Anonymous P2P communication systems (e.g. Oneswarm), traffic analysis against anonymous VoIP communications. Definition and value of privacy, Conceptual frameworks for reasoning about privacy.	**10**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Matthew Bailey, "Complete Guide to Internet Privacy, Anonymity & Security"	2015
2	Kun Peng , “Anonymous Communication Networks: Protecting Privacy on the Web", Auerbach Publications	2014
3	William Stallings, "Cryptography and Network Security: Principles and Practice”, Pearson Education.	2017

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Computer Security	**3**	**1**	**0**	**Computer Networking Fundamentals, Security Fundamentals**

Course Objective: This course aims to provide a comprehensive understanding of network security principles, techniques, and protocols, covering topics such as authentication, encryption, intrusion detection, and wireless network security, enabling students to analyze, design, and implement effective security measures to protect network infrastructure from various threats and attacks.

S. NO	Course Outcomes (CO)
CO1	Understand network security principles and mitigate risks in TCP/IP networks.
CO2	Proficient in authentication mechanisms for secure communication and access control.

CO3	Implement security protocols and technologies to defend against intruders and attacks.
CO4	Identify and address risks in wireless networks using appropriate security measures.
CO5	Analyze and respond to network threats, employing security techniques to protect network resources.

S. NO	**Contents**	**Contact Hours**
UNIT 1	Overview of Network Security, Security services, attacks, Security Issues in TCP/IP suite- Sniffing, spoofing, buffer overflow, ARP poisoning, ICMP Exploits, IP address spoofing, IP fragment attack, routing exploits, UDP exploits, TCP exploits.	**8**
UNIT 2	Authentication requirements, Authentication functions - Message Authentication Codes - Hash Functions - Security of Hash Functions and MACs - MD5 message Digest algorithm - Secure Hash Algorithm - RIPEMD - HMAC Digital Signatures, Authentication Protocols-Kerberos, X.509.	**9**
UNIT 3	IP Security-AH and ESP, SSL/TLS, SSH, Web Security-HTTPS, DNS Security, Electronic Mail Security (PGP, S/MIME). Intruders, Viruses, Worms, Trojan horses, Distributed Denial-Of-Service (DDoS), Firewalls, IDS, Honey nets, Honey pots.	**9**
UNIT 4	Introduction to wireless network security, Risks and Threats of Wireless networks, Wireless LAN Security (WEP, WPA).	**7**
UNIT 5	Network security: Network threats: eavesdropping, spoofing, modification, denial of service attacks o Introduction to network security techniques: firewalls, virtual private networks.	**9**
	TOTAL	**42**

REFERENCES

S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Computer Networking: A Top-Down Approach" by James F. Kurose and Keith W. Ross	2020
2	Network Security Essentials: Applications and Standards" by William Stallings,	2017
3	Network Security: Private Communication in a Public World" by Charlie Kaufman, Radia Perlman, and Mike Speciner	2002
4	Cryptography and Network Security: Principles and Practice" by William Stallings,	2019
5	"Firewalls and Internet Security: Repelling the Wily Hacker" by William R. Cheswick, Steven M. Bellovin, and Aviel D. Rubin	2003

Course Title	**Course Structure**			**Pre-Requisite**
Network Security	**L**	**T**	**P**	
	3	1	0	

Course Objective: To understand the principles of network security and associated threats and cryptographic mechanism.

S. NO	**Course Outcomes (CO)**
CO1	To be able to understand the importance of Security and the concept of network security.
CO2	To understand the basic cryptography principles and classical crypto primitives.
CO3	To understand the different ways of intrusion and threats , testing and software development to prevent them.
CO4	To study Trusted operating system and database design principles and evaluation criteria.

CO5	To be able to familiarize with vulnerabilities in netwrok applications and various attacks on them.

S. NO	Contents	Contact Hours
UNIT 1	Introduction: Basic concepts: threats, vulnerabilities, controls; risk; confidentiality, integrity, availability; security policies, security mechanisms; assurance; prevention, detection, deterrence.	8
UNIT 2	Basic cryptography: Basic cryptographic terms, Historical background, Symmetric crypto primitives, Modes of operation, Cryptographic hash functions, Asymmetric crypto primitives.	8
UNIT 3	Program security: Malicious code: viruses, Trojan horses, worms. Program flaws: buffer overflows, time-of-check to time-of-use flaws, incomplete mediation Software development controls, Testing techniques	9
UNIT 4	Trusted operating systems: Assurance; trust, Design principles, Evaluation criteria, Evaluation process. Database management systems security: Database integrity, Database secrecy, Inference control, Multilevel databases.	9
UNIT 5	Network security: Network threats: eavesdropping, spoofing, modification, denial of service attacks. Introduction to network security techniques: firewalls, virtual private networks, intrusion detection.	8
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Bruce Schneier, "Applied Cryptography: Protocols, algorithms and source code in C", John Wiley & Sons Inc.	2015
2	William Stallings, "Cryptography and Network Security", Prentice Hall	1999
3	Behrouz A. Forouzan, "Cryptography & Network Security", McGraw-Hill.	2007

Course Title	Course Structure			Pre-Requisite
	L	**T**	**P**	
Ethical Hacking	**3**	**0**	**2**	

Course Objective: This course provides a comprehensive understanding of security principles, ethical hacking concepts, and essential terminologies such as threats, attacks, vulnerabilities, and exploits.

S. NO	Course Outcomes (CO)
CO1	To comprehend the significance of security, ethical hacking concepts, and key terminologies such as threats, attacks, and vulnerabilities.
CO2	To gain proficiency in various hacking phases including foot printing, scanning, system hacking, and session hijacking.
CO3	To develop skills to identify buffer overflow vulnerabilities, understand why programs are susceptible, and implement methods to trap and prevent buffer overflow attacks.
CO4	To acquire expertise in securing web applications, including defense mechanisms against SQL injection, cross-site scripting (XSS), and other common threats, along with knowledge of web application technologies and best practices.

S. NO	Contents	Contact Hours
UNIT 1	Introduction: Understanding the importance of security, Concept of ethical hacking and essential. Terminologies-Threat, Attack, Vulnerabilities, Target of Evaluation, Exploit. Phases involved in hacking, Foot printing, Scanning, System Hacking, Session Hijacking. Buffer Overflows: Significance of Buffer Overflow Vulnerability, Why Programs/Applications are vulnerable. Reasons for Buffer Overflow Attacks. Methods of ensuring that buffer overflows are trapped, Sinffing	**10**

UNIT 2	SQL Injection: Attacking SQL Servers, Sniffing, Brute Forcing and finding Application, Configuration Files, Input validation attacks. Preventive Measures. Web Application Threats,	**10**
UNIT 3	Web Application Hacking, Cross Site Scripting / XSS Flaws / Countermeasures Correct Web Application Set-up. Web Application Security: Core Defence Mechanisms. Handling User Access, Authentication, Session Management, Access Control. Web Application Technologies: HTTP Protocol, Requests, Responses and Methods.	**12**
UNIT 4	Attacking Authentication: Attacking Session Management, Design Flaws in Authentication, Mechanisms Attacking Forgotten Password Functionality, attacking Password change functions. Attacking other users: Reflected XSS Vulnerabilities, Stored XSS Vulnerabilities, DOM-Based, XSS Vulnerabilities, HTTP Header Injection. Countermeasures to XSS.	**10**
	TOTAL	**42**

REFERENCES

S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Introduction to Computer Networks and Cybersecurity -- C-H. Wu and J. D. Irwin	2013
2	Cryptography and Network Security: Principles and Practice -- W. Stallings	1998

Course Title	**Course Structure**			**Pre-Requisite**
Intrusion Detection and Prevention	**L**	**T**	**P**	
	3	**1**	**0**	

Course Objective: This course aims to provide a comprehensive understanding of intrusion detection and prevention techniques, including rule-based and profile-based detection, as well as analysis of stealth probes and heuristics, alongside an exploration of the OSI reference model and common network protocols.

S. NO	**Course Outcomes (CO)**
CO1	To develop proficiency in various intrusion detection and prevention techniques, including rule-based and profile-based detection, as well as analysis of stealth probes and heuristics.
CO2	To gain a comprehensive understanding of network protocols such as IP, TCP, UDP, and DNS, along with common abuses associated with these protocols, empowering them to recognize and respond to network attacks more effectively.
CO3	To acquire expertise in advanced threat analysis techniques, including memory buffer overflow, format string overflow, and encrypted communication, as well as the use of tools such as TCPSplice, TCPFlow, and TCPJoin for packet analysis.
CO4	Capacility of deploying and managing IDS/IPS solutions effectively, including configuring Real Secure, creating event filters, and reporting signatures, as well as understanding SNORT modes, NER Sentivist Sensor Signatures, and utilizing statistical correlation for threat response and risk analysis within established policies and procedures.

S. NO	**Contents**	**Contact Hours**
UNIT 1	Intrusion detection, Intrusion Prevention Analysis, Rule based detection, Profile based detection, Stealth Probes Heuristics. OSI reference model – seven layers IP, TCP, UDP, ICMP, ARP, DNS. ARP abuses, IP abuses, TCP abuses, UDP abuses.	**10**
UNIT 2	Memory buffer overflow, Format string overflow, Encrypted communication. TCPSplice, TCPFlow, TCPJoin Command line options, expressions, bulk capture. Tiered architecture, Sensors, agents	**10**
UNIT 3	Packet capture, filtering, packet decoding Storage, fragment reassembly, stream reassembly Stateful inspection. Configuring Real Secure Creating and Implementing Event Filters Reporting Signatures. Collecting requirements Defense Event Viewer Network IDS Assigning packet capture to signatures. SNORT Modes, sniffer Packet capture, detection File Order Filters, Alerts	**12**

UNIT 4	NER Sentivist Sensor Signatures Alerts and forensics. Data correlation definitions Data fusion, alert fusion Using statistical correlation Correlation Coefficient Statistical inference. Response types Response Process Risk Analysis Response methodology UDS and IPS incident response phases. IDS/IPS policy Standard, Baselines and procedures.	**10**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	William Stallings, "Cryptography and Network Security: Principles and Practice", Prentice-Hall.	2006
2	Charles P. Pfleeger, "Security in Computing", Prentice Hall	2003
3	Hansmann, “Principles of Mobile Computing”, Wiley Dreamtech	2004

Course Title	Course Structure			Pre-Requisite
	L	**T**	**P**	
Generative AI	**3**	**0**	**2**	

Course Objective: To learn the fundamental concepts of Blockchain technologies for various applications.

S. NO	Course Outcomes (CO)
CO1	Understand the fundamental concepts of transformers, diffusion models, and their applications in vision and language tasks.
CO2	Analyze and differentiate between various transformer architectures used in language and vision, including GPT, BERT, ViT, and CLIP.
CO3	Implement and fine-tune multi-modal and generative foundation models using efficient training and inference techniques.
CO4	Evaluate foundation models using standard benchmarks and address issues related to hallucinations, bias, fairness, privacy, and prompt engineering.

S. NO	Contents	Contact Hours
UNIT 1	**Introduction to Foundation Models:** Transformers & Attention : Introduction to Transformers, Self-Attention, Cross-Attention, Perceiver: Arbitrary IO with transformers, Self Attention & Non-Parametric Transformers Diffusion : Sampling, Diffusion Models, Latent Diffusion Models (LDM) Applications : LLMs, LVMs and Applications in Vision	**14**
UNIT 2	**Foundation Model Architectures:** Foundation Model Architectures: Transformers in Language including GPT, BERT, RetNet, State Space Models Transformers in Vision: ViT, MLP-Mixer, Conformer, Vision-Language(VL) models, CLIP Architectures: Dual-Encoder, Fusion, Encoder-Decoder, Adapted LLM, Unified Architectures	**14**
UNIT 3	**Multi-Modal & Generative Foundation Models:** Training & Inference : Training Objectives , Contrastive Learning, Efficient Inference Techniques, Pre-training, Fine-tuning & Parameter Efficient Fine-tuning (LoRA, QLoRa), Flash Attention, Retrieval Augmented Generation (RAG)	**8**
UNIT 4	**Evaluation & Benchmarking:** Evaluation Protocols and Standard Benchmarks, Hallucinations, Bias & Fairness, Privacy, Memorization, Machine Unlearning, Prompt Engineering	**6**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of

1	"Generative AI with Python and TensorFlow 2: Create images, text, and music with VAEs, GANs, LSTMs, Transformer models" Joseph Babcock and Raghav Bali, packt Publishing	2021
2	"Learn Python Generative AI: Journey from autoencoders to transformers to large language models", Zonunfeli Ralte and Indrajit Kar, Bpb Publication.	2024
3	"Generative Deep Learning" By David Foster & Karl Friston, O'Reilly.	2023

Course Title	**Course Structure**			**Pre-Requisite**
Blockchain Technology	**L**	**T**	**P**	Cryptography, Basic Mathematics
	3	**0**	**2**	

Course Objective: To learn the fundamental concepts of Blockchain technologies for various applications.

S. NO	**Course Outcomes (CO)**
CO1	To understand the fundamentals of blockchain technology.
CO2	To acquire the knowlwdge on various blockchain platforms.
CO3	To study the Cryptographic Solution in Blockchain and understand their security and privacy issues.
CO4	To study the various consensus protocols used in the blockchain technology.
CO5	To iunderstand the scalability, interoperability issues and their proposed solutions in current scenarios.

S. NO	**Contents**	**Contact Hours**
UNIT 1	**Introduction: Decentralised System:** Difference between centralised, decentralised and distributed system, Introduction and need of decentralised ledger system, Benefits and drawback of centralised third party, security, privacy and integrity issue in decentralised system. **Blockchain Technology:** Introduction of blockchain, Architecture of Blockchain, detailed knowledge on Block Structure, Working of Blockchain, main barrier to blockchain adoption, use-case of blockchain in various field, Bitcoin: UTXO, mining, Merkle tree.	**8**
UNIT 2	**Blockchain Platform:** Introduction of Public/permissionless, Private/Permissioned and Hybrid/Consortiom platfrom, Brief introduction of Avalanche, Cardano, Ethereum, Hyperledger Fabric, Hyperledger Sawtooth, IBM Blockchain, Polkadot,Ripple ,Solana, Near Blockchain, **Ethereum:** Basics, Ethereum clients, Wallets, Tokens, Oracles, Ethereum Virtual Machine, Smart Contract, Introduction to Solidity, Vyper, Introduction to Consensus, **Hyperledger Fabric:** Component of Hypeledger Fabric, chaincode, ledger, ordering services, CouchDB, LevelDB	**8**
UNIT 3	**Cryptography:** Public key cryptography, Digital Signature, Hashing, SHA256, AES, RSA, Elliptic curve crytography, Zero-knowledge proof, Blind Signature, **Security and privacy:** Issues in blockchain, Pseudo-anonymity vs. anonymity, Zcash and Zk-SNARKS for anonymity preservation, attacks on Blockchains – such as Sybil attacks, selfish mining, 51% attacks - -advent of algorand, and Sharding based consensus algorithms to prevent these, Smart Contract Vulnerability(Re-entracy Attack, Transaction order dependence attack, Timestamp dependece, Integer Overflow and underflow), Hard fork/ soft Fork, Mitigatation Techniques.	**9**
UNIT 4	**Consensus:** Foundation od Consensus, Classical Consensus, Nakamoto Consensus, Ethereum Merge, Blockchain Selfish Mining, Security proof for nakamoto consensus, Proof based consensus: PoW, Pos, PoA, PoET, Voting Based Consensus: Paxos, RAFT, PBFT, HotStuff, Tendermint.	**8**
UNIT 5	**Scalability and Interoperability:** Addressing the Issue of Scalability and Interoperability, Blockchain scalability solutions: Layer 1(Sharding, DAG), Layer 2 (Channels, SideChain, Cross Chain), Various Off-chain Storage	**9**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of
1	Mastering Blockchain: Inner workings of blockchain, from cryptography and decentralized identities, to DeFi, NFTs and Web3, 4th Edition "imran bashir", Packt Publishing	2023
2	Mastering Bitcoin: Programming the Open Blockchain (Second Edition) "Andreas Antonopoulos", O'Reilly Media	2017
3	Blockchain Revolution: How the Technology Behind Bitcoin and Other Cryptocurrencies Is Changing the World by Dan and Alex Tapscott, Portfolio Penguin	2016
4	Mastering Ethereum: Building Smart Contracts and DApps by Andreas M. Antonopoulos and Gavin Wood, Shroff/O'Reilly	2018

SEMESTER III

Core Course:

Course Title	Course Structure			Pre-Requisite
	L	T	P	
ITY201 Distributed and Cloud Computing	3	1	0	-

Course Objective: Provide students with a comprehensive understanding of the principles and practices of distributed computing within

S. NO	Course Outcomes (CO)
CO1	Describe system models for distributed and cloud computing.
CO2	Describe the design principles of computer clusters and data centers.
CO3	Describe and distinguish different virtualization techniques.
CO4	Explain cloud enabling technologies, cloud mechanisms, and cloud architectures.

S. NO	Contents	Contact Hours
UNIT 1	Introduction to Clouds, Virtualization and Virtual Machine: Introduction to Cloud Computing:,Cloud computing vs. Distributed computing, Utility computing, Features of today's Clouds: Massive scale, AAS Classification: HaaS, IaaS, PaaS, SaaS, Data-intensive Computing, New Cloud Paradigms, Categories of Clouds: Private clouds, Public clouds 2. Virtualization: What's virtualization, Benefits of Virtualization, Virtualization Models: Bare metal, Hosted hypervisor 3. Types of Virtualization: Processor virtualization, Memory virtualization, Full virtualization, Para virtualization, Device virtualization 4. Hotspot Mitigation for Virtual Machine Migration: Enterprise Data Centers, Data Center Workloads, Provisioning methods, Sandipiper Architecture, Resource provisioning, Black-box approach, Gray-box approach, Live VM Migration Stages, Hotspot Mitigation	10
UNIT 2	Network Virtualization and Geo-distributed Clouds 1. Server Virtualization: Methods of virtualization: Using Docker,Using Linux containers, Approaches for Networking of VMs: Hardware approach: Single-root I/O virtualization (SR-IOV), Software approach: Open vSwitch, Mininet and its applications 2. Software Defined Network: Key ideas of SDN, Evolution of SDN,SDN challenges, Multi-tenant Data Centers: The challenges, Network virtualization, Case Study: VL2, NVP 3. Geo-distributed Cloud Data Centers: Inter-Data Center Networking, Data center interconnection techniques: MPLS, Google's B4 and Microsoft's Swan	12

UNIT 3	Classical Distributed Algorithms and the Industry Systems 1. Time and Clock Synchronization in Cloud Data Centers: Synchronization in the cloud, Key challenges, Clock Skew, Clock Drift, External and Internal clock synchronization, Christians algorithm, Error bounds, Network time protocol (NTP), Berkley's algorithm, Datacenter time protocol (DTP), Logical (or Lamport) ordering, Lamport timestamps, Vector timestamps 2. Global State and Snapshot Recording Algorithms: Global state, Issues in Recording a Global State, Model of Communication, Snapshot algorithm: Chandy-Lamport Algorithm 3. Distributed Mutual Exclusion: Mutual Exclusion in Cloud, Central algorithm, Ring-based Mutual Exclusion, Lamport's algorithm, Ricart-Agrawala's algorithm, Quorum-based Mutual Exclusion, Maekawa's algorithm, Problem of Deadlocks, Handling Deadlocks, Industry Mutual Exclusion : Chubby Failures & Recovery Approaches in Distributed Systems: Local checkpoint, Consistent states, Interaction with outside world, Messages, Domino effect, Problem of Livelock, Rollback recovery schemes, Checkpointing and Recovery Algorithms: Koo-Toueg Coordinated Checkpointing Algorithm	**12**
UNIT 4	Cloud Storage: Key-value stores/NoSQL 1. Design of Key-Value Stores: Key-value Abstraction, Key-value/NoSQL Data Model, Design of Apache Cassandra, Data Placement Strategies, Snitches, Writes, Bloom Filter, Compaction, Deletes, Read, Membership, CAP Theorem, Eventual Consistency, Consistency levels in Cassandra, Consistency Solutions 2. Design of HBase: What is HBase, HBase Architecture, Components, Data model, Storage Hierarchy, Cross-Datacenter Replication, Auto Sharding and Distribution, Bloom Filter, Fold, Store, and Shift	**6**
UNIT 5	Cloud Applications: MapReduce, Spark and Apache Kafka 1. MapReduce: Paradigm, Programming Model, Applications, Scheduling, Fault-Tolerance, Implementation Overview, Examples 2. Introduction to Spark: Resilient Distributed Datasets (RDDs), RDD Operations, Spark applications: Page Rank Algorithm, GraphX, GraphX API, GraphX working 3. Introduction to Kafka: What is Kafka, Use cases for Kafka, Data model, Architecture, Types of messaging systems, Importance of brokers	**4**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Distributed and Cloud Computing by Kai Hwang, Jack Dongarra, Geoffrey C. Fox Released December 2013 Publisher(s): Morgan Kaufmann ISBN: 9780128002049	2013
2	Scalable Parallel Computing: Technology, Architecture, Programming Hardcover – Import, 16 September 1997 by Kai Hwang, Zhiwei Xu. Publisher : McGraw-Hill Education	1997
3	CLOUD COMPUTING A PRACTICAL APPROACH Paperback – 1 July 2017 by Toby Velte , Anthony Velte, Robert Elsenpeter.	2017

Open Elective -1

Course Title	Course Structure			Pre-Requisite
	L	**T**	**P**	
Statistical Machine Learning	**3**	**0**	**2**	**Basic probability theory and linear algebra**

Course Objective: To understand fundamental of stastical machine learning, various regression algorithm, various classification algorithm along with their implementation. Explain the basic principles and theory of stastical machine learning, which may guide students to invent their own algorithms in future**.**

S. NO	Course Outcomes (CO)
CO1	Describe stastical learning, trade-off between prediction accuracy and model interpretabiltiy
CO2	Understand the linear regression

CO3	Investigate and implement various classification problem
CO4	Understand and analyse the various resampling methods
CO5	Investigate and implement unsupervised learning
CO6	Investigate and implement ensemble learning

S. NO	**Contents**	**Contact Hours**
UNIT 1	Introduction: Overview of Statistical Learning, The Trade-Off Between Prediction Accuracy and Model Interpretability, Supervised versus Unsupervised Learning, Regression Versus Classification Problems.	**6**
UNIT 2	Linear Regression: Estimating the Coefficients in simple Linear Regression, Estimating the Regression Coefficients in Multiple Linear Regression, Comparison of Linear Regression with K-Nearest Neighbors.	**6**
UNIT 3	Classification: An Overview of Classification, Estimating the Regression Coefficients for Logistic Regression, Multiple Logistic Regression, Linear Discriminant Analysis, A Comparison of Classification Methods.	**8**
UNIT 4	Resampling Methods: Cross-Validation, The Validation Set Approach, k-Fold Cross-Validation, Bias-Variance Trade-Off for k-Fold Cross-Validation, Cross-Validation on Classification Problems.	**8**
UNIT 5	Unsupervised Learning: The Challenge of Unsupervised Learning, Principal Components Analysis, K-Means Clustering, Hierarchical Clustering, Practical Issues in Clustering.	**8**
UNIT 6	Ensemble Learning: Introduction, Boosting and Regularization Paths, The "Bet on Sparsity" Principle, Regularization Paths, Over-fitting and Margins, Learning a Good Ensemble, Rule Ensembles.	**6**
	TOTAL	**42**

REFERENCES

S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani , An introduction to statistical learning with applications in R, New York, Springer, 2013.	2013
2	T. Hastie, R. Tibshirani, and J. Friedman, The Elements of Statistical Learning: Data Mining, Inference, and Prediction, 2nd Edition, Springer, 2009.	2009
3	David Barber, Machine Learning: A probabilistic approach, 2006.	2006
4	Bishop, C., M., Pattern Recognition and Machine Learning, Springer, 2006.	2006

Course Title	**Course Structure**			**Pre-Requisite**
Soft and Evolutionary Computing	**L**	**T**	**P**	**Artificial Intelligence**
	3	**0**	**2**	

Course Objective: To provide students exposure to soft computing techniques and optimization background and terminology, genetic operators with various evolutionary strategy for real life problem solving.

S. NO	**Course Outcomes (CO)**
CO1	To construct a neural network architecture and describe its working, and to distinguish between supervised, unsupervised and reinforcement learning
CO2	To execute operations on fuzzy sets
CO3	To construct fuzzy rules and fuzzy inferencing systems
CO4	To solve problems involving fuzzy arithmetic and fuzzy numbers

CO5	To learn gradient optimization, sampling, linear programming, and combinatorial optimization vocabulary.
CO6	To study Genetic Algorithms (GAs) representation, operators, and standard algorithm implementation.

S. NO	**Contents**	**Contact Hours**
UNIT 1	Neural Networks: History, overview of biological Neuro-system, Mathematical Models of Neurons, ANN architecture, Learning rules, Learning Paradigms-Supervised, Unsupervised and reinforcement Learning, ANN training Algorithms- Perceptrons, Training rules, Delta, Back Propagation Algorithm, Multilayer Perceptron Model, Applications of Artificial Neural Networks, Radial Basis Function networks	**7**
UNIT 2	Fuzzy Logic: Introduction to Fuzzy Logic, Classical and Fuzzy Sets, Membership Functions, Fuzzy rule generation and solving, Mamdani, Sugeno and Tsukamoto fuzzy rule systems, Graphical fuzzy inferencing. Operations on Fuzzy Sets: Complement, Intersection, Union, Combinations of Operations, Aggregation Operations, Nonspecificity of Fuzzy Sets, Fuzziness of Fuzzy Sets	**8**
UNIT 3	Fuzzy Arithmetic: Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on Intervals & Numbers, Lattice of Fuzzy Numbers, Fuzzy Equations. Introduction of Neuro-Fuzzy Systems: Architecture of Neuro Fuzzy Networks-ANFIS, MANFIS, CANFIS and other neuro-fuzzy network architectures, Learning mechanisms.	**8**
UNIT 4	Optimization background and terminology: Gradient optimization methods, sampling methods, linear programming, combinatorial optimization. Evolutionary Biology background and terminology: Genotype and phenotype, unit of selection, genes and traits, chromosomes, alleles, diploid and haploid, fitness, mutation and recombination.	**9**
UNIT 5	Genetic Algorithms: Representation, operators, and standard algorithm. The building block hypothesis and the schema theorem. Evolutionary strategies: Evolution in continuous variables. Evolutionary algorithms as models: Modeling sexual selection, modeling ecosystems, artificial life. Modularity and regularity in evolution. The scaling problem and the curse of dimensionality. Evolvability. Module acquisition. Developmental models. Compositional and hierarchical approaches.	**8**
	TOTAL	**42**

REFERENCES

S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Jang, Jyh-Shing Roger, Chuen-Tsai Sun, and EijiMizutani. "Neuro-fuzzy and soft computing; a computational approach to learning and machine intelligence." PHI, 1997.	1997
2	"An Introduction to Neural Networks", Anderson J.A., PHI, 1995.	1995
3	Neural Networks, Fuzzy Logic and Genetic Algorithms", by S. Rajasekaran& G. A. Vijayalakshmi Pai,: Synthesis & Applications, PHI, 2003.	2003
4	"An Introduction to Genetic Algorithm", Melanie Mitchell, PHI, 1997.	1997
5	Eiben, A.E., Smith, James E, Introduction to Evolutionary Computing, Springer.	2015
6	Naruya Saitou, Introduction to Evolutionary Genomics, Springer	2018
7	Ashish M. Gujarathi, Evolutionary Computation: Techniques and Applications, CRC Press	2016

Course Title	**Course Structure**			**Pre-Requisite**
	L	**T**	**P**	
Linear Optimization & Optimization Tools	**3**	**1**	**0**	**Basic Mathematics**

Course Objective: To apply linear optimization techniques and design optimization algorithms for real-world problems.

S. NO	Course Outcomes (CO)
CO1	To have a basic understanding of linear programming models.
CO2	To understanf salient features and characterstics of linear programming.
CO3	To study Duality theorem and its applications.
CO4	To Understand sensitivity analysis.
CO5	To apply optimization in real life problem solving.

S. NO	Contents	Contact Hours
UNIT 1	Introduction and Modeling with Linear Programming: Variants of the linear programming problem, Examples of linear programming problems, Piecewise linear convex objective functions, Graphical representation and solution, Linear algebra background and notation, Algorithms and operation counts.	**6**
UNIT 2	Geometry of linear programming: Polyhedra and convex sets, Extreme points, vertices, and basic feasible solutions, Polyhedra in standard form, Degeneracy, Existence of extreme points, Optimality of extreme points, Representation of bounded polyhedral, Projections of polyhedral: Fourier-Motzkin elimination.	**8**
UNIT 3	The Simplex Method: Optimality conditions, Development of the simplex method, Implementations of the simplex method, Anti-cycling: lexicography and Bland's rule, Finding an initial basic feasible solution, Column geometry and the simplex method, Computational efficiency of the simplex method. Duality theory: The dual problem, The duality theorem, Optimal dual variables as marginal costs, Standard form problems and the dual simplex method, Farkas' lemma and linear inequalities, From separating hyperplanes to duality, Cones and extreme rays, Representation of polyhedral, General linear programming duality.	**8**
UNIT 4	Sensitivity Analysis: Local sensitivity analysis, Global dependence on the right-hand side vector, The set of all dual optimal solutions, Global dependence on the cost vector, Parametric programming. The art in linear optimization: Modelling languages for linear optimization, Linear optimization libraries and general observations, The fleet assignment problem, The air traffic flow management problem, The job shop scheduling problem.	**8**
UNIT 5	Nonlinear Programming and Sample Applications, Graphical Illustration of Nonlinear Programming Problems, Types of Nonlinear Programming Problems, One-Variable Unconstrained Optimization, Multivariable Unconstrained Optimization, Introduction to evolutionary and Meta-heuristic optimization.	**8**
UNIT 6	Application to real world optimization problems- Optimization examples from Machine Learning, Robotics, Image Processing and Computer Vision, Web and data mining, network traffic routing.	**4**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Dimitris Bertsimas and John N. Tsitsiklis,"Introduction to Linear Optimization", Athena Scientific (1 February 1997).	1997
2	R. Fletcher, Practical Methods of Optimization, 2nd Edn., John Wiley, 1987.	1987
3	D. G. Luenberger, Linear and Nonlinear Programming, 2nd Edn., Kluwer, 2003.	2003
4	N. S. Kambo, Mathematical Programming Techniques, East West Press, 1997.	1997
5	M. S. Bazarra, J.J. Jarvis, and H.D. Sherali, Linear Programming and Network Flows, 2nd Edn., John Wiley, 1990.	1990
6	A.E Eiben and J.E. Smith, Introduction to Evolutionary Computing, Springer, second edition.	2007

7	David Goldberg, Genetic Algorithms in Search, Optimization, and Machine Learning. Addison-Wesley.	1989

Course Title	**Course Structure**			**Pre-Requisite**
Information Integration and Data Analytics	**L**	**T**	**P**	**Artificial Intelligence, Statistics**
	3	**0**	**2**	

Course Objective: To have an expertise in analysing big data volumes using statistical methods for decision making.

S. NO	**Course Outcomes (CO)**
CO1	To learn basic statistical models for data anlysis.
CO2	To learn supervised learning methods.
CO3	To implement unsupervised learning models.
CO4	To experiment with different information integration and dat models.
CO5	To implement data analytics in real life applications.

S. NO	**Contents**	**Contact Hours**
UNIT 1	Introduction to data analytics, Probability distributions, Model fitting, Descriptive statistics, Inferential Statistics through hypothesis tests	**8**
UNIT 2	Supervised learning: Linear and logistic Regression, Lasso regression, ANNOVA, Linear and quadratic discriminant analysis, K-nearest neighbors, neural networks, deep learning, support vector machines, decision trees, random forest	**8**
UNIT 3	Unsupervised learning: Introduction to Clustering mechanisms, K-means clustering, Hierarchical clustering, Unsupervised model fitting, Associative rule mining, Anomaly detection	**8**
UNIT 4	Overview of information integration, integrated views and schema mapping, impact of increasing the number of data sources, data compression, record linking, data exchange, data fusion, data cleaning, source modeling, and information extraction	**9**
UNIT 5	Retrieving data from Big data management systems, processing on Hadoop and Spark, Integration for Multi-channel customer analytics, Case studies, Data integration tools-Splunk and Datameer, Semantic web (RDF, OWL, SPARQL), linked data and services, mash-ups	**9**
	TOTAL	**42**

REFERENCES

S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Hastie, Trevor, et al. The elements of statistical learning. Vol. 2. No. 1. New York: springer, 2009.	2009
2	Doan, AnHai, Alon Halevy, and Zachary Ives. Principles of data integration. Elsevier, 2012 Montgomery, Douglas C., and George C. Runger. Applied statistics and probability for engineers. John Wiley & Sons.	2010
3	C. J. Date Addison-Wesley, Introduction to Database Systems . 8th Ed. Publisher: Addison-Wesley; 8 edition (August 1, 2003) ISBN-10: 0321197844/ ISBN-13: 978-0321197849.	2003

Course Title	Course Structure			Pre-Requisite
Advanced Computer Vision	**L**	**T**	**P**	
	3	**0**	**2**	

Course Objective: To gain a profound understanding of the theories, algorithms of the state-of-the-art of computer vision, various mathematical approaches, and the applications to video processing and vision-based modeling and interaction. This is a research-orientated course.

S. NO	Course Outcomes (CO)
CO1	Understand master image representation, feature extraction, and other image processing techniques to tackle real-world issues in many disciplines like.
CO2	Implement and understand the benefits of the advanced Deep learning concept of Fine-tuning on pre-trained models such as YOLO
CO3	Understand and implement the Image Classification using Computer vision and Deep learning techniques like Convolutional Neural Networks
CO4	Perform the domain anomaly detection and adaptation using Transfer learning & the pre-trained models, Fine Tuning of the pre-trained models
CO5	Understand domain adaptation and anomaly detection by fine-tuning pre-trained models like YOLO for enhanced object detection and applying transfer learning algorithms for anomaly detection.

S. NO	Contents	Contact Hours
UNIT 1	Image Processing: Image representation, feature extraction and matching, Image filters, Edge detection, Image texture analysis, Clustering, Model Fitting.	**8**
UNIT 2	Image classification: Implementation of Image Classification using Computer vision and Deep learning techniques like Convolutional Neural Networks and segmentation, Applications: Traffic Flow Analysis, 3D model Building.	**11**
UNIT 3	Object Segmentation and Detection: Object Segmentation and detection using Python deep learning libraries like PyTorch Object detection and tracking: Tracking with linear dynamical models, Optical flow estimation, Object tracking using deep neural networks. Applications: Defect detection, OCR detection, Cancer Detection	**11**
UNIT 4	Introduction to Transfer Learning: What is Transfer Learning, How Transfer Works, and Why Should You Use Transfer Learning? Steps to Use Transfer Learning, Model Building in Transfer Learning, Code Implementation of Transfer Learning	**6**
UNIT 5	Fine-tuning pre-trained models: Implement the advanced Deep learning concept of Fine-tuning on pre-trained models such as YOLO. Domain adaptation & anomaly detection: Perform the anomaly detection using Transfer learning algorithms	**6**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	D. Forsyth and J. Ponce ,Computer Vision - A modern approach, Prentice Hall	2013
2	Linda Shapiro and George Stockman, Computer Vision, Prentice-Hall, 2001.	2001
3	Szeliski, Richard. Computer vision: algorithms and applications. Springer Science & Business Media, 2010.	2010
4	Deep Learning by I. Goodfellow, Y. Bengio, A. Courville, MIT Press 2016.	2016
5	E. Trucco and A. Verri, Introductory Techniques for 3D Computer Vision, Publisher: PHI COMPUTER SECURITY.	1994

Course Title	Course Structure	Pre-Requisite

Management Information System	L	T	P	
	3	1	0	

Course Objective: To understand and asses the importance of information and its role in business. To develop data analysing skills in students to evaluate information and the tools used for information processing. To understand the MIS planning and development, enterprise resource planning.

S. NO	Course Outcomes (CO)
CO1	To study MIS history, influence, role, and importance.
CO2	To understand master management systems, organizational management, planning vs. control information, systems analysis, and systems design.
CO3	To learn strategic and operational MIS planning and development.
CO4	To learn about ERP's progress and integration into major enterprises.
CO5	To Students will study MIS trends like Decision Support Systems (DSS), Artificial Intelligence (AI), and advanced market research.

S. NO	Contents	Contact Hours
UNIT 1	Introduction to Management Information Systems, History of MIS, Impact of MIS, Role and Importance, MIS Categories, Managers and Activities in IS, Types of Computers Used by Organizations in Setting up MIS, Hardware support for MIS, The Decision-Making Process, System Approach to Problem Solving, The Structure of Management Information System	8
UNIT 2	Types of Management Systems, Concepts of Management Organization, Differences between planning and control information, Systems Analysis, Systems Design	8
UNIT 3	MIS Planning and Development, Planning, development, Business Process Re – Engineering, Improving a process in BPR, Object Oriented methodology, Strategic Level Planning, Operational Level Planning, Economic and Behavior Theories.	9
UNIT 4	Enterprise Resource Planning: Basics of ERP, Evolution of ERP, Enterprise Systems in Large Organizations, Benefits and Challenges of Enterprise Systems, Managing the E-enterprise, Organization of Business in an E-enterprise, E-business, E-commerce, E-communication, E-collaboration	9
UNIT 5	Trends in MIS: Introduction, Decision Support Systems (DSS), Artificial Intelligence (AI), Market Research Methods, Ratio Analysis for Financial Assessment, Management Science Models, Procedural Models, Project Planning and Control Models	8
	TOTAL	42

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	D.P. Goyal, “Management information systems”, Macmillan India Ltd	
2	Robert G. Murdick& Joel E. Ross & James R. Claggett, “Information Systems for Modern Management” PHI.	
3	Gordon B. Davis & M.H. Olson, “Management Information Systems: Conceptual Foundation, structure & Development”.	

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Distributed Data Mining	3	1	0	Database management systems

Course Objective: Provide students with an in-depth understanding of distributed data mining principles and techniques, including algorithms, frameworks, and applications, enabling them to effectively analyze large-scale distributed datasets and address associated challenges such as scalability, performance, and data security.

S. NO	Course Outcomes (CO)
CO1	Understand distributed database systems architecture and design
CO2	Be able to apply methods and techniques for distributed query processing and optimisation
CO3	Understand the broad concepts of distributed transaction process
CO4	Understand the basic concepts of Data warehousing and OLAP technology
CO5	Be able to apply methods and techniques for association analysis, data classification and clustering

S. NO	Contents	Contact Hours
UNIT 1	Introduction to data mining (DM): Motivation for Data Mining - Data Mining-Definition and Functionalities – Classification of DM Systems - DM task primitives - Integration of a Data Mining system with a Database or a Data Warehouse - Issues in DM – KDD Process	**8**
UNIT 2	Distribute data mining process, DDM framework(research based), DDM Algorithms: 3 Key Types,Multi-Agent System, meta learning, grid-based	**8**
UNIT 3	Distributed data mining techniques, Distributed classifier learning- Classification vs. prediction, Issues regarding classification and prediction, Statistical-Based Algorithms, Distance-Based Algorithms, Decision TreeBased Algorithms, Neural Network-Based Algorithms, Rule-Based Algorithms, Combining Techniques, accuracy and error measures, evaluation of the accuracy of a classifier or predictor. Neural Network Prediction methods: Linear and nonlinear regression, Logistic Regression Introduction of tools such as DB Miner / WEKA / DTREG DM Tools	**9**
UNIT 4	distributed clustering: Clustering: Problem Definition, Clustering Overview, Evaluation of Clustering Algorithms, Partitioning Clustering -K-Means Algorithm, KMeans Additional issues, PAM Algorithm; Hierarchical Clustering – Agglomerative Methods and divisive methods, Basic Agglomerative Distributed association rule mining	**9**
UNIT 5	Challenges of distributed data mining: Security and Social Challenges, Noisy and Incomplete Data Distributed Data, Complex Data Performance, Scalability and Efficiency of the Algorithms, Improvement of Mining Algorithms, Incorporation of Background Knowledge, Data Visualization, Data Privacy and Security, User Interface, Mining dependent on Level of Abstraction, Integration of Background Knowledge, Mining Methodology Challenges	**8**
	TOTAL	

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	M. T. Oszu and P. Valduriez, Principles of Distributed Database Systems, 2nd ed., Prentice-Hall,Errata	1889
2	J. Han and M. Kamber, Data Mining: Concepts and Techniques, Morgan Kaufmann, Errata	2000
3	M. Dunham, “Data Mining: Introductory and Advanced Topics”, Pearson Education.	

Course Title	Course Structure			Pre-Requisite
	L	**T**	**P**	
Information Retrieval	**3**	**0**	**2**	

Course Objective: Enable students to understand the various aspects of an Information retrieval system and its evaluation and to be able to design. To give students an understanding of the fundamental techniques for hypermedia architectures, design and usability, document management and retrieval, metadata management, and searching the web. Analyze the performance of information retrieval using advanced techniques such as classification, clustering, and filtering over multimedia.

S. NO	Course Outcomes (CO)
CO1	To study Boolean, Vector Space, Relational Database Management Systems (DBMS), Probabilistic, and Language Models for information retrieval.
CO2	To learn advanced web information retrieval techniques like citation network analysis, social cooperation through PageRank and HITS, and Zipf's Law and term weighting.
CO3	To learn hierarchical and non-hierarchical clustering approaches like single pass and reallocation.
CO4	To study search statements, binding, similarity metrics, and ranking algorithms for user search.
CO5	Tostudy information system evaluation, including introduction to evaluation methodology, metrics, and practical examples.

S. NO	Contents	Contact Hours
UNIT 1	Information Retrieval Models: Boolean Model, Vector Space Model, Relational DBMS, Probabilistic Models, Language Models.	**6**
UNIT 2	Web Information Retrieval: citation network analysis, social collaboration (PageRank and HITS algorithms), Term Indexing: Zipf's Law, term weighting. Searching and Data Structures: Inverted files to support Boolean and Vector Models,	**9**
UNIT 3	Clustering: non-hierarchical- single pass and reallocation; hierarchical agglomerative; String Searching trees, binary trees, binary digital trees, suffix trees, etc.Retrieval Effectiveness Evaluation: Recall, Precision, Fallout, comparing systems using average precision.	**9**
UNIT 4	User Search Techniques: Search statements and binding, Similarity measures and ranking, Relevance feedback, Selective dissemination of information search, Weighted searches of Boolean systems, Searching the Internet and hypertext. Information Visualization: Introduction, Cognition and perception, Information visualization technologies.	**10**
UNIT 5	Text Search Algorithms: Introduction, Software text search algorithms, Hardware text search systems. Information System Evaluation: Introduction, Measures used in system evaluation, Measurement example – TREC results.	**8**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Kowalski, Gerald, Mark T Maybury: Information Retrieval Systems: Theory and Implementation, Kluwer Academic Press, 1997	1997
2	Frakes, W.B., Ricardo Baeza-Yates: Information Retrieval Data Structures and Algorithms, Prentice Hall	1992
3	Yates, "Modern Information Retrival", Pearson Education.	
4	Christopher D. Manning, Prabhakar Raghavan and Hinrich Schutze," Introduction to Information Retrieval", Cambridge University Press. 2.	
5	Carlos Quemada, Guillermo Bistue, Inigo Adin; Design Methodology for RF CMOS Phase Locked Loops, Artech House	

Course Title	Course Structure			Pre-Requisite
Information Audit	**L**	**T**	**P**	
	3	**1**	**0**	

Course Objective: This course aims to provide a comprehensive understanding of different types of audits, including general and specific audits, continuous, periodical, and balance sheet audits, along with the concept and objectives of internal audit, qualifications and qualities required for internal auditors, their role in maintaining internal controls on the accounting function, and evaluation techniques for internal control systems, with a focus on information audit in an EDP environment, including audit planning, challenges, and computer-assisted audit techniques (CAATs).

S. NO	Course Outcomes (CO)
CO1	To develop expertise in various types of audits, including general and specific audits, continuous, periodical, and balance sheet audits, along with a clear understanding of the concept and objectives of internal audit, enabling them to conduct audits effectively in diverse organizational contexts.
CO2	To gain proficiency in the qualifications, code of ethics, and qualities required for internal auditors, as well as understanding the need for independent functioning, the relationship with external auditors, and the role of internal auditors as key members of management, ensuring robust internal control mechanisms.
CO3	To master internal control considerations across various accounting functions, including cash management, payroll, procurement, sales, inventory, fixed assets, and investments, facilitating the establishment and maintenance of effective internal control systems within organizations.
CO4	To acquire the ability to evaluate internal control systems, including setting objectives, steps in evaluation, and techniques such as flowcharts, internal control questionnaires, and schemes, enabling them to identify weaknesses and implement improvements for risk mitigation and compliance assurance, particularly in computerized environments.

S. NO	Contents	Contact Hours
UNIT 1	Types of Audit - general audits and specific audits; types of general audits and types of specific audits; continuous, periodical and balance sheet audits, concept and objectives of internal audit.	**8**
UNIT 2	The Internal Auditor - qualifications for an internal auditor; need for independent functioning; relationship with the external auditor; code of ethics; qualities required in internal audit personnel; role of internal auditor as a management member.	**10**
UNIT 3	Internal Controls on the Accounting Function -Internal control considerations, cash functions like Cash and bank; Salaries and employee benefits; Purchases and creditors; Sales and debtors; Inventories; Fixed assets and investments and other accounting activity. Evaluation of Internal Control Systems - objectives of evaluation; steps in evaluation; techniques of evaluation; flowcharts and internal control questionnaires; internal control schemes.	**14**
UNIT 4	Information Audit in an EDP Environment - audit planning in computerized environment; challenges for the auditor in an IT environment, internal audit practices in computerized systems, Computer assisted audit techniques (CAATs).	**10**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Gallegos, F., Manson D. P., Gonzales, C., Senft, S., Information Technology Control and Audit, Auerbach	2004
2	CISA Review Manual, ISACA publications. 2004.Champlain,	2004
3	Hunton, J.E., Bryant, S.M., and Bagranoff, N.A., Core Concepts of Information Technology Auditing, John Wiley & Sons,	
4	Auditing Information Systems, John Wiley	

Course Title	Course Structure			Pre-Requisite
	L	**T**	**P**	
Web Intelligence and Big Data Analytics	**3**	**0**	**2**	**Database Management Systems**

Course Objective: The course is meticulously designed to provide a deep understanding of the symbiotic relationship between data analytics and business intelligence, empowering individuals to navigate the complexities of modern business landscapes.

S. NO	Course Outcomes (CO)
CO1	To learn about distributed file system.
CO2	To understand the working of Apache Hadoop ecosystem.
CO3	To underatand working and commands of Hdoop.
CO4	To study usgaes and design og Hbase concepts.
CO5	To apply big data analytics in real life problem solving .

S. NO	Contents	Contact Hours
UNIT 1	Introduction – distributed file system – Big Data and its importance, Four Vs, Drivers for Big data, Big data analytics, Big data applications. Algorithms using map reduce, Matrix-Vector Multiplication by Map Reduce.	**8**
UNIT 2	Big Data – Apache Hadoop & Hadoop EcoSystem – Moving Data in and out of Hadoop – Understanding inputs and outputs of MapReduce - Data Serialization.	**8**
UNIT 3	Hadoop Architecture, Hadoop Storage: HDFS, Common Hadoop Shell commands, Anatomy of File Write and Read., NameNode, Secondary NameNode, and DataNode, Hadoop MapReduce paradigm, Map and Reduce tasks, Job, Task trackers - Cluster Setup – SSH & Hadoop Configuration – HDFS Administering – Monitoring & Maintenance.	**9**
UNIT 4	Hadoop ecosystem components - Schedulers - Fair and Capacity, Hadoop 2.0 New Features- NameNode High Availability, HDFS Federation, MRv2, YARN, Running MRv1 in YARN.	**8**
UNIT 5	Hive Architecture and Installation, Comparison with Traditional Database, HiveQL - Querying Data - Sorting And Aggregating, Map Reduce Scripts, Joins & Subqueries, HBase concepts- Advanced Usage, Schema Design, Advance Indexing - PIG, Zookeeper - how it helps in monitoring a cluster, HBase uses Zookeeper and how to Build Applications with Zookeeper.	**9**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Boris lublinsky, Kevin t. Smith, Alexey Yakubovich, “Professional Hadoop Solutions”, Wiley, ISBN: 9788126551071, 2015.	2015
2	Chris Eaton, Dirk derooset al., “Understanding Big data”, McGraw Hill, 2012.	2012
3	Tom White, “HADOOP: The definitive Guide”, O Reilly 2012.	2012

Course Title	Course Structure			Pre-Requisite
Bioinformatics	**L**	**T**	**P**	**Database Management Systems**
	3	**1**	**0**	

Course Objective: Understanding and application of biological databases for different applications.

S. NO	Course Outcomes (CO)

CO1	To understand basics of bological databases.
CO2	To learn information retrival from biological databases.
CO3	To experment with different statistical methods on biological databses.
CO4	To study chromosome and genome mapping.
CO5	To apply predictive methods for DNA sequencing and protien mapping.

S. NO	Contents	Contact Hours
UNIT 1	The Biologist & Internet: Internet basics, FTP, World Wide Web, and Introduction to Primary & Secondary database, GenBank, GCG, and ACDEB. Structure Databases: Introduction to structures, PDB, MMDB, Structure file formats, Visualizing structural information, Database structure viewers.	**9**
UNIT 2	Information Retrieval from Biological Databases & submission of DNA Sequences to the Databases: Retrieving database entries, Integrated information retrieval: The ENTREZ system, sequence databases beyond NCBI, Medical Databases.	**8**
UNIT 3	Sequence Alignment and Database Searching: Introduction, Evolutionary basis of sequence alignment, Optimal alignment methods, Substitution scores & gap penalties, Statistical significance of alignments, Database similarity searching.	**8**
UNIT 4	Multiple Sequence Alignment & Genome Mapping: Progressive alignment methods, Motifs and patterns, Probe, Presentation methods, Abscript; Different types of maps: physical, genetical, etc. Synteny, Human genome project, Application of genome mapping, Chromosome maps.	**9**
UNIT 5	Predictive Methods Using Nucleotide & protein Sequences: Framework, marking repetitive DNA, Database search, Codon bias detection, detecting function sites in the DM, Protein identity based on composition.	**8**
	TOTAL	**42**

REFERENCES

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	A.D. Baxevanis and B.F.F. Ouellette, Bioinformatics: A practical guide to the analysis of genes and proteins, John Wiley and Sons. ISBN 0-471-38391-0.	2001
2	Rastogi, S.C., Mendiratta, N. and Rastogi, Bioinformatics: Concepts, Skills &Applications, CBS Publishers &Distributors, New Delhi. ISBN 13: 9788120330627.	2004
3	Dix A., Finlay J.,Abowd G. D. and Beale R. Human Computer Interaction, 3rd edition, Pearson Education.	2005

Course Title	Course Structure			Pre-Requisite
	L	**T**	**P**	
Quantum Computing	**3**	**1**	**0**	**Linear Algebra & Probability**

Course Objective: This module aims to provide a self-contained, comprehensive introduction to quantum computing, focusing on the design and analysis of quantum algorithms, as well as covering topics in quantum information and quantum cryptography, such as: quantum teleportation, quantum money, and post-quantum cryptography.

S. NO	Course Outcomes (CO)
CO1	Understand the quantum computing paradigm.
CO2	State the four postulates of quantum mechanics and their application to computation:- Design and analyse quantum algorithms.- Grasp the notions of quantum states, unitary evolution, measurements, andcomposite systems.
CO3	Understand the implications of quantum computing on cryptography and security.

CO4	Analyse fundamental quantum algorithms:- Shor's algorithm.- Grover's search.- The Berstein-Vazirani algorithm.- Simon's problem.- The Deutsch-Jozsa paradigm.

S. NO	**Contents**	**Contact Hours**
UNIT 1	Introduction to Quantum computing: motivation, foundations, and prominent applications. Review of linear algebra in the context of quantum information, Dirac's bracket notation, limitation of classical algorithms. The four postulates of quantum mechanics, qubits, quantum gates and circuits.	**9**
UNIT 2	Basic quantum algorithms: I — Deutsch's algorithm, analysing quantum algorithms, and implementing quantum circuits via QISKIT.	**6**
UNIT 3	Basic quantum algorithms II — Simon's problem and the Bernstein -V-azirani algorithm. Grover's quantum search algorithm, the BBBV Theorem, and applications of Grover's algorithm. RSA, and Shor's integer factorisation algorithm.	**12**
UNIT 4	Introduction to quantum cryptography (post-quantum security, quantum key distribution).	**7**
UNIT 5	Introduction to quantum information (superdense coding, nocloning theorem, quantum teleportation) Applications (quantum money, the Elitzur-Vaidman bomb).	**8**
	TOTAL	**42**

REFERENCES

S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Nielse ,"Quantum Computation And Quantum Information" , Cambridge University Press	2013
2	Chuck Easttom, "QUANTUM COMPUTING FUNDAMENTALS", Pearson Education.	2022
3	Parag K. Lala, "QUANTUM COMPUTING", McGraw Hill	2020
4	Daniel J. Bernstein (Editor), Erik Dahmen (Editor), Johannes Buchmann (Editor), "Post-Quantum Cryptography", Springer-Verlag Berlin and Heidelberg Gmb	2010
5	Thomas Vidick, StephanieWehner, Thomas, Stephanie Wehner , Thomas Vidick, "Introduction to Quantum Cryptography" Cambridge University Press	2023