Course Title: Software Project Management	***Course Code: CS710***
Credits (L: T: P): 4:0:0	***Contact Hours (L: T: P): 52:0:0***
Type of Course: Lecture	***Category: Professional Core Course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Software Engineering

Course Outcomes: After completing this course, students should be able to:

CO-1	Comprehend the conventional software management Concepts.
CO-2	Assessment of process and project metrics.
CO-3	Understand artifacts of software project estimation.
CO-4	Realize the project scheduling process and its techniques.
CO-5	Analyze the process of risk management, maintenance and reengineering.

Unit No.	Course Content	No. of Hours
1	**Project Management Concepts:** The management spectrum: The People - Stake Holders, Team leaders, Software team, agile teams, Coordination and Communication Issues, The Product- Software Scope, Problem Decomposition, The Process- Melding the Product and the Process**,** Process Decomposition, The Project - The W5HH principle, critical practices.	10
2	**Process and Project Metrics:** Metrics in the process and project domains, Process Metrics and Software Process Improvement, Project Metrics, Software Measurement, Size-Oriented Metrics, Function-Oriented Metrics, Reconciling LOC and FP Metrics, Object-Oriented Metrics- Number of scenario scripts, Number of key classes, Number of support classes, Average number of support classes per key class, Number of subsystems**,** Use Case-Oriented Metrics, Web App Project Metrics, Metrics for Software Quality- Measuring Quality, Defect Removal Efficiency, Integrating metrics within the software process, Arguments for Software Metrics, Establishing a Baseline**,** Metrics Collection, Computation, and Evaluation, Metrics for small organizations, Establishing a software metrics program.	11

3	**Estimation for Software Projects:** Observations on estimation, the project planning process, Software scope and feasibility, Resources - Human Resources, Reusable Software Resources, Environmental Resources, Software Project Estimation, Decomposition techniques- Software sizing, Problem based estimation, An Example of LOC-Based Estimation, An Example of FP-Based Estimation, Process-Based Estimation, An Example of Process-Based Estimation, Estimation with Use Cases, An Example of Estimation Using Use Case Points, Reconciling Estimates, Empirical Estimation Models, The Structure of Estimation Models, The COCOMO-II Model, The Software Equation, Estimation for Object-Oriented Projects, Specialized Estimation Techniques- Estimation for Agile Development, Estimation for WebApp Projects, The Make/Buy Decision, Creating a Decision Tree, Outsourcing.	10
4	**Project Scheduling:** Basic Concepts, Project Scheduling, Basic Principles, The Relationship between People and Effort, Effort Distribution, defining a task for the software project, A Task Set Example, Refinement of Major Tasks, defining a task network, scheduling, Time-Line Charts, Tracking the Schedule, Tracking Progress for an OO Project, Scheduling for Web App and Mobile Projects, Earned Value Analysis.	10
5	**Risk Management, Maintenance and Reengineering:** Reactive versus Proactive Risk Strategies, Software Risks, Risk Identification-Assessing Overall Project Risk, Risk Components and Drivers, Risk Projection-Developing a Risk Table, Assessing Risk Impact, Risk Refinement, Risk Mitigation, Monitoring and Management, The RMMM Plan; Maintenance and Reengineering: Software Maintenance, Software Supportability, Reengineering, Business Process Reengineering-Business Processes, A BPR Model, Software Reengineering- A Software Reengineering Process Model, Software Reengineering Activities, Reverse Engineering, Reverse Engineering to Understand Data, Reverse Engineering User Interfaces, Restructuring- Code Restructuring, Data Restructuring, Forward Reengineering- Forward Engineering for Client-Server Architectures, Forward Engineering for Object-Oriented Architectures, The Economics of Reengineering.	11

Text Book:

Sl. No.	Author/s	Title	Publisher Details
1	Roger S Pressman and Bruce R Maxim	Software Engineering: A Practitioner's Approach	8th edition, McGraw Hill Education,2015 reprint

Reference Books:

Sl. No.	Author/s	Title	Publisher Details
1	Ian Summerville	Software Engineering	10th edition, Pearson Education Publication.

2	Bob Hughes, Mike Cotterell and Rajib Mall	Software Project Management	6th edition, McGraw Hill Education,2017
3	Royce	Software Project Management: A Unified Framework	First Edition Pearson Education,2002
4	Robert K. Wysocki	Effective Software Project Management	John Wiley Publication,2010

Web Resources:

Sl. No.	Web link
1	https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-cs70/
2	https://nptel.ac.in/courses/110/104/110104073/

Course Outcomes	Program Outcomes												PSO's			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	P012	PSO1	PSO2	PSO3	PSO4
CO-1	3	1	1	1	0	1	0	0	2	2	2	1	1	1	1	1
CO-2	2	2	0	2	1	1	1	0	1	0	2	1	3	1	2	1
CO-3	2	3	1	2	2	1	2	1	1	3	3	3	2	1	3	1
CO-4	2	2	2	2	3	1	1	1	3	3	3	2	2	1	3	1
CO-5	3	2	3	2	1	1	2	1	2	2	3	3	2	1	3	3

0 - No association 1--Low association, 2-- Moderate association,3---High association

Course Title: Advanced Computer Architecture	***Course Code: CS720***
Credits (L: T: P): 4:0:0	***Contact Hours (L: T: P): 52:0:0***
Type of Course: Lecture	***Category: Professional Core Course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Computer Organization, Data Structure.

Course Outcomes: After completing this course, students should be able to:

CO-1	Understand the architectural and organizational innovations used in modern computers.
CO-2	Comprehend the importance of memory hierarchy in achieving high performance and apply optimization schemes to improve the memory design.
CO-3	Analyse the ILP design structures in high-performance processors.
CO-4	Investigate the performance of different architectures with respect to ILP and DLP.
CO-5	Design multiprocessor architecture.

Unit No.	Course Content	No. of Hours
1	**Fundamentals of Quantitative design and analysis:** Introduction, Classes of Ccomputers, Defining Computer Architecture, Trends in technology, Trends in Power and Energy in Integrated Circuits, Trends in cost, Dependability. Measuring, Reporting and Ssummarizing Pperformance, Quantitative principles of computer ddesign. Putting It All Together: Performance, Price and Power.	10
2	**Review of memory Hierarchy:** Introduction, Cache Performance, Six Basic Cache Optimizations, Virtual Memory, Protection and Examples of Virtual memory. **Memory Hierarchy Design:** Introduction, Ten Advanced Optimizations of Cache performance, Memory Technology and Optimizations, Protection: Virtual Memory and Virtual Machines, Putting it all together: Memory Hierarchies in ARM Cortex-A8.	12
3	**Pipelining - Basics and Intermediate concepts:** Introduction, The Major Hurdles of Pipelining-Pipeline Hazards. **Instruction-Level Parallelism and Its Exploitation - I:** Instruction-Level Parallelism: Concepts and Challenges, Basic compiler Techniques for Exposing ILP, Reducing Branch Costs with Advanced Branch Prediction, Overcoming Data Hazards with Dynamic Scheduling, Dynamic Scheduling: Examples and the Algorithm, Hardware-Based Speculation.	10

4	**Instruction-Level Parallelism and Its Exploitation – II:** Exploiting ILP Using Multiple Issue and Static Scheduling, Exploiting ILP Using Dynamic Scheduling, Multiple Issue, and Speculation, Advanced Techniques for Instruction Delivery and Speculation, Studies of the Limitations of ILP, Putting it all together: ARM Cortex-A8. **Data-Level Parallelism:** Introduction, Vector Architecture, SIMD Instruction Set Extensions for Multimedia.	10
5	**Thread Level Parallelism:** Introduction, Centralized Shared Mmemory Aarchitectures, Performance of symmetric shared memory multiprocessors, distributed Shared memory and directory-based coherence, synchronization: The Basics.	10

Text Book:

Sl. No.	Author/s	Title	Publisher Details
1	John L. Hennessy and David A. Patterson	Computer Architecture: A Quantitative Approach	5th Edition, Morgan Kauffman Elsevier, 2013

Reference Books:

Sl. No.	Author/s	Title	Publisher Details
1	Kai Hwang	Advanced Computer Architecture - Parallelism, Scalability, Programmability	3rdEdition, Tata McGraw Hill, 2015
2	D. B Kirk and W.W. Hwu	Programming Massively Parallel Processors	2nd Edition, Morgan Kauffmann Publishers, 2012
3	Kai Hwang and Zu	Scalable Parallel Computers Architecture	1st Edition, MGH. 2001
4	M.J Flynn	Computer Architecture, Pipelined and Parallel Processor Design	1st edition, Narosa 2011

Web Resources:

Sl. No	Weblink
1	https://nptel.ac.in/courses/106/103/106103206/
2	https://nptel.ac.in/courses/106/105/106105163/

Course Outcomes	Program Outcomes												PSO's			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	P012	PSO1	PSO2	PSO3	PSO4
CO-1	2	3	2	2	2	1	2	1	2	2	1	2	3	3	2	3
CO-2	2	3	2	2	2	1	2	0	2	1	1	2	3	3	1	3
CO-3	2	3	2	2	2	1	2	1	2	0	1	2	3	3	1	2
CO-4	2	3	2	2	2	1	2	0	2	2	1	2	3	3	1	3
CO-5	2	3	2	2	2	1	2	0	2	0	1	2	3	3	1	3

0 - No association 1--Low association, 2-- Moderate association,3---High association

Course Title: Linux Device Driver	***Course Code: CS731***
Credits (L: T:P): 4:0:0	***Contact Hours (L: T: P): 52:0:0***
Type of Course: Lecture	***Category: Professional Elective Course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Operating System.

Course Outcomes: After completing this course, students should be able to:

CO-1	Understand the Fundamentals of Device Drivers.
CO-2	Design and Develop Character and Block Device Drivers.
CO-3	Apply Debugging Tools and Device Drivers.
CO-4	Analyze and Implement Network Device Drivers.
CO-5	Evaluate PCI Drivers and USB Drivers.

Unit No.	Course Content	No. of Hours
1	**An Introduction to Device Drivers and Char Drivers:** The Role of the Device Driver, Splitting the Kernel, Classes of Devices and Modules, Security Issues, **Building and Running Modules:** Setting Up Your Test System, The Hello World Module, Compiling and Loading, The Kernel Symbol Table, Initialization and Shutdown.	10
2	**Character Device Drivers**: The Design of scull, Major and Minor Numbers, Some Important Data Structures, Char Device Registration, open and release, scull's Memory Usage, read and write. **Debugging Techniques:** Debugging Support in the Kernel, Debugging by Printing.	11
3	**Advanced Char driver operations**: Ioctl, Blocking I/O, poll and select, Asynchronous Notification, Seeking a Device, Access Control on a Device File.	10
4	**Block Drivers:** Registration, The Block Device Operations. Network **Drivers:** How snull Is Designed, connecting to the Kernel, the net device Structure in Detail, Opening and Closing, **Case Study:** Implementation of simple Network Device Driver.	11
5	**PCI Drivers:** The PCI Interface, **USB Drivers:** USB Device Basics, USB and Sysfs, USB Urbs, Writing a USB Driver	10

Text Book:

Sl. No.	Author/s	Title	Publisher Details
1	Jonathan Corbet, Alessandro Rubini, Greg Kroah-. Hartman	Linux Device Drivers	3rd Edition, O'Reilly Media, U.S.A, Reprint 2019

Reference Books:

Sl. No.	Author/s	Title	Publisher Details
1	Robert Love	Linux Kernel Development	2nd edition, Pearson India, Reprint 2019
2	Mahesh S Jadhav	Easy Linux Device Driver	2nd Edition, High Tech Easy Publishing, 2020
3	John Madieu	Linux Device Drivers Development	2nd Edition, Packt Publishing,2017.
4	Robert Love	Linux Kernel Development	Indian Edition, Pearson Education India,2010

Web Resources:

Sl. No.	Web link
1	https://lwn.net/Kernel/LDD3/
2	https://nptel.ac.in/content/storage2/courses/106108101/pdf/PPTs/Mod_20.pdf

Course Outcomes	Program Outcomes												PSO's			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	P012	PSO1	PSO2	PSO3	PSO4
CO-1	2	1	1	0	1	0	1	0	1	0	0	1	2	2	1	1
CO-2	2	3	3	2	2	0	0	1	0	1	0	0	2	2	1	1
CO-3	2	2	2	2	3	0	1	0	1	0	1	0	2	1	1	1
CO-4	2	3	3	2	1	0	0	1	0	1	0	1	2	1	1	1
CO-5	2	2	2	2	2	0	0	0	1	1	0	1	2	2	1	1

0 - No association 1--Low association, 2-- Moderate association,3---High association

Course Title: Adhoc Networks	***Course Code: CS732***
Credits (L: T:P): 4:0:0	***Contact Hours (L: T: P): 52:0:0***
Type of Course: Lecture	***Category: Professional Elective Course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Data Communication, Computer Networks.

Course Outcomes: After completing this course, students should be able to:

CO-1	Understand the fundamental principles of Ad hoc networks along with MAC protocol.
CO-2	Design routing protocols for ad hoc networks with respect to protocol design issues.
CO-3	Apply various multicast routing protocol in ad hoc networks.
CO-4	Analyze the challenges in designing transport layer protocols for Ad hoc networks.
CO-5	Evaluate energy and QoS related performance measurements of ad hoc networks.

Unit No.	Course Content	No. of Hours
1	**Ad hoc Wireless Networks:** Introduction, Issues in Ad hoc Wireless Networks, Adhoc Wireless Internet; MAC Protocols for Ad hoc Wireless Networks: Introduction, Issues in Designing a MAC Protocol, Design Goals of MAC Protocols, Classification of MAC protocols, Contention-Based Protocols, Contention-Based Protocols with Reservation Mechanisms, Contention-Based Protocols with Scheduling Mechanisms, MAC Protocols that Use Directional Antennas.	10
2	**Routing Protocols for Ad Hoc Wireless Networks:** Introduction, Issues in Designing a Routing Protocol for Ad hoc Wireless Networks; Classification of Routing Protocols; Table Driven Routing Protocols; On-Demand Routing Protocols, Hybrid Routing Protocols, Hierarchical Routing Protocols and Power-Aware Routing Protocols.	11
3	**Multicast Routing in Ad hoc Wireless Networks:** Introduction, Issues in Designing a Multicast Routing Protocol, Operation of Multicast Routing Protocols, An Architecture Reference Model for Multicast Routing Protocols, Classifications of Multicast Routing Protocols, Tree-Based Multicast Routing Protocols and Mesh-Based Multicast Routing Protocols.	10
4	**Transport Layer and Security Protocols for Ad hoc Networks:** Introduction, Issues in Designing a Transport Layer Protocol; Design Goals of a Transport Layer Protocol; Classification of Transport Layer Solutions; TCP over Transport Layer Solutions; Other Transport Layer Protocols for Ad hoc Networks; Security in Ad hoc Wireless Networks, Issues and Challenges in Security Provisioning, Network Security Attacks, Key Management and Secure Touting Ad hoc Wireless Networks.	10

5	**Quality of Service and Energy Management in Ad hoc Wireless Networks:** Introduction, Issues and Challenges in Providing QoS in Ad hoc Wireless Networks, Classification of QoS Solutions, MAC Layer Solutions, Network Layer Solutions; Energy Management in Ad hoc Wireless Networks: Introduction, Need for Energy Management in Ad hoc Wireless Networks, Classification of Energy Management Schemes, Battery Management Schemes, Transmission Management Schemes, System Power Management Schemes.	11

Text Book:

Sl. No.	Author/s	Title	Publisher Details
1	Siva Ram Murthy & B. S. Manoj	Ad hoc Wireless Networks	2nd Edition, Pearson Education, 2011, reprint 2019

Reference Books:

Sl. No.	Author/s	Title	Publisher Details
1	Ozan K. Tonguz and Gianguigi Ferrari	Ad hoc Wireless Networks	John Wiley, reprint 2019.
2	Xiuzhen Cheng, Xiao Hung, Ding-Zhu Du	Ad hoc Wireless Networking	Kluwer Academic Publishers, 2004.
3	C.K. Toh	Ad-hoc Mobile Wireless Networks- Protocols and Systems	Pearson Education, 2002.
4	Zhao and Leonidas	Wireless Sensor Networks	Morgan Kaufman Publishers, 2004

Web Resources:

Sl. No.	Web link
1	http://nptel.ac.in/courses/106105160
2	https://onlinecourses.nptel.ac.in/noc17_cs07/preview

Course Outcomes	Program Outcomes												PSO's			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	P012	PSO1	PSO2	PSO3	PSO4
CO-1	3	2	1	1	0	1	1	0	1	0	0	1	2	2	1	1
CO-2	3	3	3	2	2	0	1	0	0	1	1	1	2	2	1	1
CO-3	2	2	3	2	1	1	0	1	1	1	0	1	1	2	1	1
CO-4	2	2	3	2	1	2	1	1	0	1	0	1	2	1	1	1
CO-5	2	2	2	2	2	1	1	1	0	1	1	0	2	1	1	1

0 -- No association 1---Low association, 2--- Moderate association, 3---High association

Course Title: Advanced Cryptography	***Course Code: CS733***
Credits (L: T:P): 4:0:0	***Contact Hours (L: T: P): 52:0:0***
Type of Course: Lecture	***Category: Professional Elective Course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Computer Networks.

Course Outcomes: After completing this course, students should be able to:

CO-1	Understand and apply different data encryption/decryption techniques.
CO-2	Explore algorithms related to the Public Key Cryptography and hash functions.
CO-3	Appraise the authentication and Key management activities.
CO-4	Address issues related to security in Transport and Application Layer.
CO-5	Understanding the concepts of IP and network security.

Unit No.	Course Content	No. of Hours
1	**Encryption Techniques and Data Encryption Standards** **Introduction:** Computer security concepts, OSI security Architecture, Security attacks and Services, Security mechanism and model for Network Security. **Classical Encryption Techniques:** Symmetric Cipher Model, Substitution Techniques: Caesar Cipher, Mono alphabetic Cipher, Play fair Cipher, Hill Cipher, Polyalphabetic Cipher, Onetime Pad. Transposition Techniques, Steganography. **Traditional Block Cipher**: Feistel structure, Block cipher design Principles. Data Encryption Standard(DES), DES example, The Strength of DES.	11
2	**Public-Key cryptography and Hash Functions function** **Public-Key cryptography:** Principles of Public-Key Cryptosystems, The RSA Algorithm, Diffie-Hellman Key Exchange. **Cryptographic Hash Functions:** Applications of Cryptographic Hash Functions, Two simple hash functions, Requirements and security, secure hash algorithm (SHA).	10
3	**Authentication and Key Management Message Authentication:** Authentication Requirements, Authentication Functions, Message Authentication Codes (MAC), HMAC. Authentication Applications: Digital signature. **User authentication:** Remote user authentication principles, Remote user Authentication using symmetric Encryption, Remote user authentication using Asymmetric Encryption. **Key Distribution:** Symmetric key distribution using symmetric and asymmetric encryption, Distribution of public keys.	11

4	**Application and Transport Layer Security** **Application Layer Security:** Pretty Good Privacy (PGP), Multipurpose Internet Mail Extensions (MIME) and secured Multipurpose internet Mail extensions(S/MIME). **Transport Layer Security:** Web security considerations, Secure socket layer (SSL),Transport Layer security (TLS).	10
5	**Network Layer Security** **Authentication applications:** Kerberos, X.509 authentication services, public key infrastructure. **IP Security:** IP Security Overview, IP security architecture, authentication header, Encapsulation Security Payload (ESP).	10

Text Books:

Sl. No.	Author/s	Title	Publisher Details
1	William Stallings	Cryptography and Network Security - Principles and Practices	4th Edition, Prentice Hall, 2016. Reprint 2019

Reference Books:

Sl. No.	Author/s	Title	Publisher Details
1	Behrouz A Forouzan, Debdeep Mukhopadhyay	Cryptography and Network Security	Mc-GrawHill, 3rd Edition, 2015
2	Jonathan Katz, Yehuda Lindell	Introduction to Modern Cryptography"	CRC press publications. 2007
3	Atul Kahate	Cryptography and Network Security	3rd Edition, McGraw Hill Education private Limited, 2013
4	Douglas R. Stinson	Cryptography: Theory and Practice	3rd Edition, Chapman and Hall/CRC, 2006

Web Resources:

Sl. No.	Web link
1	https://onlinecourses.nptel.ac.in/noc21_cs16/preview
2	https://onlinecourses.nptel.ac.in/noc21_cs43/preview

Course Outcomes	Program Outcomes												PSO's			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	P012	PSO1	PSO2	PSO3	PSO4
CO-1	3	2	2	1	2	2	2	2	3	3	1	2	2	3	3	2
CO-2	3	3	3	2	3	2	2	3	2	3	2	3	3	3	2	2
CO-3	3	3	3	2	3	2	2	2	3	2	2	2	3	3	2	3
CO-4	3	2	3	2	3	2	2	2	2	2	1	3	3	3	2	2
CO-5	2	3	3	2	3	2	1	3	2	2	1	3	3	3	2	2

0 -- No association 1---Low association, 2--- Moderate association, 3---High association

Course Title: Advances in AI	***Course Code: CS734***
Credits (L: T:P): 4:0:0	***Contact Hours (L: T: P): 52:0:0***
Type of Course: Lecture	***Category: Professional Elective Course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Artificial Intelligence and Machine Learning

Course Outcomes: After completing this course, students should be able to:

CO-1	Demonstrate the fundamentals of Intelligent Agents
CO-2	Illustrate the reasoning on Uncertain Knowledge
CO-3	Explore forms of learning in solving AI problems
CO-4	Realize natural language processing and robotics aspects through artificial intelligence.

Unit No.	Course Content	No. of Hours
1.	**Intelligent Agents**: Foundations of AI, Agents and Environments, Good Behaviour: The Concept of Rationality, The Nature of Environments, The Structure of Agents. **Problem Solving:** Games, Optimal decisions in Games, Alpha-beta Pruning, Imperfect Real time decisions, stochastic games	12
2.	**Logical Agents:** Knowledge based agents**,** The Wupus world, Logic **Uncertain knowledge and Reasoning:** Quantifying Uncertainty**,** acting under Uncertainty, Basic Probability Notation, Inference Using Full Joint Distributions, Independence, Bayes Rule and Its Use, The Wumpus World Revisited	10
3.	**Learning:** Forms of learning, supervised learning, learning decision trees, evaluating and choosing best hypothesis, Theory of learning, regression and classification with linear models, Artificial Neural networks, non-parametric models, SVM, Ensemble Learning, Practical Machine Learning.	10
4.	**Natural Language Processing:** Language Models, Text Classification, Information Retrieval, Information Extraction. **Perception:** Image formation, Image processing operations, Object Recognition by Appearance, Reconstructing the 3DWorld, Object Recognition from Structural Information, Using Vision	10
5.	**Robotics**: Introduction, Robot Hardware, Robotic perception, Planning to Move, planning uncertain movements, Moving, Robotic software architectures, application domains.	10

Text Book:

Sl. No.	Author/s	Title	Publisher Details
1	Stuart J. Russell and Peter Norvig,	Artificial Intelligence: A Modern Approach	Third Edition, Pearson, 2017.

Reference Books:

Sl. No.	Author/s	Title	Publisher Details
1	Eugene Charnik, Drew McDermott	Introduction to Artificial Intelligence	Pearson EducationIndia, 1st edition, 2016.
2	George F Luger	Artificial Intelligence – Structures and Strategies for Complex Problem Solving	Addison Wesley, Fifth Edition, 2015
3	Dan W.Patterson	Introduction to Artificial Intelligence and Expert Systems	PHI 2014
4	Denis Rothman	Artificial Intelligence by Example	Ingram short title 2018

Web Resources:

Sl. No.	Web link
1	https://nptel.ac.in/courses/106/105/106105077/
2	https://onlinecourses.nptel.ac.in/noc21_cs42/

Course Outcomes	Program Outcomes												PSO's			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	P012	PSO1	PSO2	PSO3	PSO4
CO-1	3	3	3	2	3	0	1	1	1	1	2	3	3	3	3	3
CO-2	3	3	3	2	3	0	1	1	1	1	2	3	3	3	3	3
CO-3	3	3	3	2	3	0	1	1	1	1	2	3	3	3	3	3
CO-4	3	3	3	2	3	0	1	1	1	1	2	3	3	3	3	3

0 -- No association 1---Low association, 2--- Moderate association, 3---High association

Course Title: Distributed Computing Systems	***Course Code: CS735***
Credits (L: T: P): 4:0:0	***Contact Hours (L: T: P): 52:0:0***
Type of Course: Lecture	***Category: Professional Elective Course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Computer Networks, Operating Systems.

Course Outcomes: After completing this course, students should be able to:

CO-1	Describe the fundamental concept of distributed system and desired properties of such systems.
CO-2	Understanding Remote Communication and Interprocess Communication.
CO-3	Design algorithms to handle synchronization and deadlocks in various distributed applications.
CO-4	Develop an Advanced modelling techniques for building distributed computer systems.
CO-5	Design distributed File System and implementing cloud computing.

Unit No.	Course Content	No. of Hours
1.	**Basic Distributed System Concepts:** Introduction, What is a Distributed System?, Architectures for Distributed Systems, Distributed Computing Models, Comparison of the Distributed Computing Models, Advantages of Distributed Systems, Disadvantages of Distributed Systems, Software Concepts, Network Operating System, Distributed Operating System, Multiprocessor Time-Sharing System, Comparison of Different Operating Systems, Design issues in distributed systems: Transparency, Flexibility, Reliability , Performance, Scalability, Security, Fault Tolerance, Client-Server Model, Basic Concepts, Client-Server Addressing, Client-Server Implementation, Client-Server Architecture, Network Communication: LAN and WAN Technologies: Introduction to LAN and WAN , Classification of Networks, Protocols for Network Systems: The ISO/OSI Reference Model, Internet Protocols, Asynchronous Transfer Mode: Introduction to ATM, ATM Protocol Reference Model, Protocols for Distributed Systems: Fast Local Internet Protocol (FLIP), Versatile Message Transfer Protocol	11

2.	**Inter process Communication:** Message Passing: Introduction to Message Passing, Advantages and Features of Message-Passing Systems, IPC Message Format, IPC Synchronization, Message Buffering Strategies, Multi-datagram Messaging, Process Addressing Techniques, Failure Handling Mechanism, Group Communication, Types of Group Communication: Group Management, Group Addressing and Message Delivery, Reliability Mechanism, Message Ordering, API for Internet Protocol: Synchronous and Asynchronous Communications, Sockets, UDP and TCP, Java API for UDP and TCP Protocols, Remote Communication: Introduction to Remote Communication, Middleware, Remote Procedural Call Basics, Basic RPC Operation, Stub Generation in RPC, RPC Implementation, RPC Messages, Parameter Passing Semantics, Server Management, RPC Communication, RPC Call Semantics, RPC Communication Protocols, Client-Server Binding, Other RPC Issues, Exception Handling and Security, RPC in Heterogeneous Environment, Failure Handling, RPC Optimization, Complicated and Special RPCs, Case Study: Sun RPC, Remote Method Invocation Basics, Distributed Object Concepts, RMI Implementation, Design Issues in RMI, RMI Execution, Types of Objects, Binding a Client to an Object, RMI Parameter Passing.	11
3	**Synchronization:** Introduction, Clock synchronization: Physical Clocks, Use of Synchronized Clocks, Logical clocks: Event Ordering, Implementation of logical clock, Lamport's Timestamps, Vector Timestamps, Global state, Mutual exclusion: Centralized Algorithm, Distributed Algorithm, Token Ring Algorithm, Comparison of Various Algorithms, Election algorithms: Bully algorithm, Ring algorithm, Election in wireless networks, Deadlocks in Distributed systems: Modelling, Handling Deadlock, Prevention, Detection, Recovery, Issues in Recovery from Deadlocks.	10
4.	**Distributed System Management:** Introduction, Resource Management: Desirable Features of a Global Scheduling Algorithm, Resource Management, Task Assignment Approach, Load Balancing Approach, Load Sharing Approach, Process Management and Migration, Threads, Fault Tolerance	10
5.	**Distributed Shared Memory:** DSM Concepts, Hardware DSM, Design Issues in DSM Systems, Implementing Issues in DSM Systems, Heterogeneous and other DSM systems, Distributed File System: Introduction DFS, File Models, DFS Design, Semantics File Sharing, DFS Implementation, File Caching in DFS, Replication in DFS, Sun Network File System, Google File System, Emerging Trends in Distributed Systems, Emerging Trends in Distributed Computing: Introduction, Grid Computing, Service Oriented Architecture, Cloud Computing, The Future of Emerging Trends.	10

Text Book:

Sl. No.	Author/s	Title	Publisher Details
1	Sunita Mahajan	Distributed Computing	Oxford, second edition

Reference Books:

Sl. No.	Author/s	Title	Publisher Details
1	Andrew S Tanenbaum and Maarten van Steen	Distributed systems: principles and paradigms	2007 Pearson Education. Inc, second edition.
2	Coulouris, Dollimore, Kindberg& Blair	Distributed systems: concepts and design	Pearson, 5th Edition January 2016
3	Ajay D. Kshemkalyani , Mukesh Singhal	Distributed Computing Principles, Algorithms, and Systems	Cambridge, 2010
4	Huiwei Wang, Huaqing Li	Distributed Optimization, Game and Learning Algorithms	Springer publication, 2021

Web Resources:

Sl. No.	Web link
1	https://www.youtube.com/watch?v=ylbDPIUlNQQ
2	https://www.youtube.com/watch?v=RZy1JOBpFJI

Course Outcomes	Program Outcomes												PSO's			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	P012	PSO1	PSO2	PSO3	PSO4
CO-1	3	3	2	3	1	1	0	0	1	0	0	2	3	3	2	3
CO-2	2	2	3	3	3	0	0	0	1	0	1	2	3	3	2	3
CO-3	3	3	2	3	3	1	0	0	0	0	1	2	3	3	2	3
CO-4	2	3	3	3	3	1	0	0	0	0	1	2	3	3	2	3
CO-5	2	3	3	3	3	1	0	0	0	0	1	2	3	3	2	3

0 -- No association 1---Low association, 2--- Moderate association, 3---High association

Course Title: Wireless Sensor Networks	***Course Code: CS741***
Credits (L: T: P): 4:0:0	***Contact Hours (L: T: P): 52:0:0***
Type of Course: Lecture	***Category: Professional Elective Course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Data Communication and Computer Networks**.**

Course Outcomes: After completing this course, students should be able to:

CO-1	Understand the fundamental concepts of WSN and its applications.
CO-2	Assess basic technologies and systems of WSN.
CO-3	Explore suitable MAC and routing algorithm and for wireless sensor actuator network.
CO-4	Implement the elements of distributed computing and network protocol for an application
CO-5	Suggest suitable hardware and software platforms for a application to setup sensor networks.

Unit No.	Course Content	Hours
1.	**Overview of Wireless Sensor Networks:** The vision of Ambient Intelligence, Application examples, Types of applications, Challenges for WSNs, why are sensor networks different? Enabling technologies for wireless sensor networks Challenges for Wireless Sensor Networks, Enabling Technologies for Wireless Sensor Networks. Architectures: Single-Node Architecture - Hardware Components, Energy Consumption of Sensor Nodes, Operating Systems and Execution Environments, Some examples of sensor nodes	10
2.	**Network Architecture:** Sensor Network Scenarios, optimization Goals and Figures of Merit, Design principles for WSNs, Service interfaces of WSNs, Gateway Concepts. Physical Layer - Wireless channel and communication fundamentals, Physical layer and transceiver design considerations in WSNs	10
3	**MAC protocols** - Fundamentals of (wireless) MAC protocols, Low duty cycle protocols and wakeup concepts, Contention-based protocols, Schedule-based protocols, The IEEE 802.15.4 MAC protocol, how about IEEE 802.11 and Bluetooth? Link-layer protocols - tasks and requirements, Error control, Framing, Link management.	10

4.	**Routing protocols:** The many faces of forwarding and routing, Gossiping and agent-based unicast forwarding, Energy-efficient unicast, Broadcast and multicast, Geographic routing, Mobile nodes, Data aggregation	10
5.	**Localization and positioning:** Properties of localization and positioning procedures, Possible approaches: Proximity , Trilateration and triangulation, Scene analysis, Single-hop localization - Overlapping connectivity, Approximate point in triangle, Positioning in multi-hop environments, Impact of anchor placement, Topology control: Motivation and basic ideas, Controlling topology in flat networks – Power control: Some example constructions Processing, XML Processing in JavaScript, XML Processing in PHP, JSON, Using JSON in JavaScript, Using JSON in PHP and protocols - The relative neighborhood graph, Spanning tree–based construction, Hierarchical networks : Some ideas from centralized algorithms, Some distributed approximations.	12

Text Book:

Sl. No.	Author/s	Title	Publisher Details
1	Holger Karl & Andreas Willig	Protocols and Architectures for Wireless Sensor Networks	1st edition, John Wiley, 2011.

Reference Books:

Sl. No.	Author/s	Title	Publisher Details
1	Ian F. Akyildiz, Mehmet Can Vuran	Wireless Sensor Networks	1st Edition Wiley 2010
2	Feng Zhao & Leonidas J. Guibas	Wireless Sensor Networks- An Information Processing Approach	Elsevier, 2007
3	Kazem sohraby, Daniel minoli, Taieb znati	Wireless Sensor Networks: Technology, Protocols and Applications	Second Edition (Indian), WILEY, 2014
4	Anna Ha´c	Wireless Sensor Network Designs	1st edition John Wiley & Sons Ltd,2012

Web Resources:

Sl. No.	Web link
1	https://nptel.ac.in/courses/106/105/106105160
2	https://nptel.ac.in/noc/courses/noc18/SEM1/noc18-cs09

Course Outcomes	Program Outcomes												PSO's			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	P012	PSO1	PSO2	PSO3	PSO4
CO-1	3	3	2	3	2	3	2	0	2	1	1	1	3	2	1	3
CO-2	2	2	3	2	2	3	1	1	1	2	1	2	2	2	1	2
CO-3	2	2	2	2	2	3	1	0	2	2	1	2	2	2	1	2
CO-4	2	3	2	2	2	3	1	0	1	1	2	2	2	2	1	3

0 -- No association 1---Low association, 2--- Moderate association, 3---High association

Course Title: Speech Processing	***Course Code: CS742***
Credits (L: T:P): 4:0:0	***Contact Hours (L: T: P): 52:0:0***
Type of Course: Lecture	***Category: Professional Elective Course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Basic mathematics.

Course Outcomes: After completing this course, students should be able to:

CO-1	Understand and classify the various sounds based on their characteristics.
CO-2	Represent the speech signals in Time domain by applying various techniques.
CO-3	Analyze the speech signals in frequency domain using various filtering techniques.
CO-4	Apply and evaluate the various models to analyze and process the homomorphic speech signals.
CO-5	Apply the concepts on simple speech processing applications using simple models.

Unit No.	Course Content	No. of Hours
1	**Fundamentals of Human Speech Production and sounds classification:** The Process of Speech Production, Short-Time Fourier Representation of Speech, The Acoustic Theory of Speech Production, Lossless Tube Models of the Vocal Tract, Digital Models for Sampled Speech Signals	10
2	**Time-Domain Methods for Speech Processing:** Introduction to Short-Time Analysis of Speech, Short-Time Energy and Short-Time Magnitude, Short-Time Zero-Crossing Rate, The Short-Time Autocorrelation Function, The Modified Short-Time Autocorrelation Function, The Short-Time Average Magnitude Difference Function.	10
3	**Frequency Domain Representations:** Discrete-Time Fourier Analysis, Short-Time Fourier Analysis, Spectrographic Displays, Overlap Addition (OLA), Method of Synthesis, Filter Bank Summation (FBS) Method of Synthesis, Time-Decimated Filter Banks, Two-Channel Filter Banks, Implementation of the FBS Method Using the FFT, OLA Revisited, Modifications of the STFT.	10
4	**The Cepstrum and Homomorphic Speech Processing:** Homomorphic Systems for Convolution, Homomorphic Analysis of the Speech Model, Computing the Short-Time Cepstrum and Complex Cepstrum of Speech, Homomorphic Filtering of Natural Speech, Cepstrum Distance Measures, **Linear Predictive and Mel frequency Analysis of Speech Signals:** Basic Principles of Linear Predictive and MFCC Analysis methods.	12
5	Applications of Speech Processing: Brief applications of speech processing in voice response systems, speech and speaker recognition system.	10

Text Books:

Sl. No.	Author/s	Title	Publisher Details
1	Lawrence Rabiner and Biing-Hwang Juang	Fundamentals of Speech Recognition	Pearson Education, 2009.
2	Daniel Jurafsky and James H Martin	Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition Pearson Education	Pearson Education

Reference Books:

Sl. No.	Author/s	Title	Publisher Details
1	Steven W. Smith	The Scientist and Engineer's Guide to Digital Signal Processing	California Technical Publishing.2006
2	Thomas F Quatieri	Discrete-Time Speech Signal Processing – Principles and Practice	Pearson - Education,2005
3	Ben gold and Nelson Morgan	Speech and audio signal processing, processing and perception of speech and music	Wiley- India Edition, 2006 Edition.
4	JacobBenstty,yiteng Huang et.al	Hand book of speech processing	Springer,2007

Web Resources:

Sl. No.	Web link
1	https://nptel.ac.in/courses/PLvv3PyiCcNrFuT7CEIvIr4a4g4orascx3.
2	https://nptel.ac.in/courses/jqsWOJze3ac.

Course Outcomes	Program Outcomes												PSO's			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	P012	PSO1	PSO2	PSO3	PSO4
CO-1	1	2	2	1	2	1	3	1	2	1	2	1	1	2	1	3
CO-2	1	1	2	1	3	1	2	1	2	3	2	3	2	1	2	1
CO-3	1	2	1	2	1	2	1	2	3	2	3	2	1	2	1	3
CO-4	2	1	3	1	2	3	1	3	2	1	2	1	3	2	1	2
CO-5	1	1	1	2	1	2	1	2	3	2	1	2	1	3	2	1

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Course Title: Robotics	***Course Code:CS743***
Credits (L: T:P): 4:0:0	***Lecture Hours (L: T: P): 52:0:0***
Type of Course: Lecture	***Category: Professional Elective Course***
CIE Marks: 50	***SEE Marks: 100***

Prerequisite: **NIL**

Course Outcomes: After completing this course, students should be able to:

CO-1	Understand the basic principle of Robots.
CO-2	Comprehend the working principles of wheeled mobile robots.
CO-3	Understand how robot perceives its environment with the help of various sensors.
CO-4	Understand the principles of actuators
CO-5	Programming robots for specific applications.

Unit No.	Course Content	No. of Hours
1	Introduction - What is a robot? Classification of Robots, what is Robotics? History of Robotics, Advantages and Disadvantages, Robots, Robot Components, Robot Degrees of Freedom, Robot Joints, Robot Coordinates, Robot Reference Frames, Programming Modes, Robot Characteristics, Robot Workspace, Robot Languages, Robot Applications.	10
2.	Kinematics of Wheeled mobile robots – Differential Drive Kinematics, Forward Kinematics for Differential Drive Robots, Mapping Angular Wheel Velocity to Linear Velocity. Driving algorithms - Random drive, driving to a target, turn and drive straight, circle, dog curve and splines.	10
3.	Distance - Measure Distance with Ultrasonic Sound, Ultrasonic Sensor, Detect Obstacles with Infrared (IR Distance Sensor), How to See Infrared, Test Project: Posture Alarm. Smoke and Gas - Detect Smoke (Analog Gas Sensor), Burglar Alarm (Passive Infrared Sensor), Pressure and vibration sensing, Accelerometer and Gyro and Tilt sensing.	10
4.	Introduction to Electric Motors - Preliminary Concepts, DC Motors, Stepper Motors, Servomotors, AC Motors, Gears and Gearmotors, Linear Motors, DC and Servo Motor	10
5	Line following, Cliff detection and avoidance, Obstacle avoidance, Wall following algorithms, maze, recursive maze exploration and shortest path and case studies.	12

Text Books:

Sl. No.	Author/s	Title	Publisher Details
1	Saeed Benjamin Niku	Introduction in Robotics Analysis, Control and Application	Wiley, 2nd Edition
2	Tero Karvinen, Kimmo Karvinen, Ville Valtokari	Make: Sensors	--
3	Que Publishing	Motors for Makers: A Guide to Steppers, Servos, and Other Electrical Machines	Matthew Scarpino

Reference Books:

Sl. No.	Author/s	Title	Publisher Details
1	Nikolaus Correll	Introduction to Autonomous Robots	1st edition, 2016
2	Thomas Bräunl	Robot Adventures in Python and C	Springer, 2020.
3	Gregor Klancar, Andrej Zdesar, Saso Blazic, Igor Skrjanc	Wheeled mobile robotics from fundamentals towards autonomous systems	Elesevier 2017
4	Gregory Dudek and Michael Jenkin	Computational Principles of Mobile Robotics	Cambridge University Press, 2010

Web Resources:

Sl. No.	Web link
1	https://nptel.ac.in/courses/112/105/112105249/
2	https://nptel.ac.in/courses/107/106/107106090/

Course Outcomes	Program Outcomes												PSO's			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	P012	PSO1	PSO2	PSO3	PSO4
CO-1	3	3	3	2	3	2	1	1	0	0	2	3	3	3	3	3
CO-2	3	3	3	2	3	2	1	1	0	0	2	3	3	3	3	3
CO-3	3	3	3	2	3	2	1	1	0	0	2	3	3	3	3	3
CO-4	3	3	3	2	3	2	1	1	0	0	2	3	3	3	3	3
CO-5	3	3	3	2	3	2	1	1	0	0	2	3	3	3	3	3

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Course Title: High Performance Computing	***Course Code: CS744***
Credits (L: T: P): 4:0:0	***Contact Hours (L: T: P): 52:0:0***
Type of Course: Lecture	***Category: Professional Elective Course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Computer Organization and Architecture.

Course Outcomes: After completing this course, students should be able to: authenticity

CO-1	Design, analyze and implement high performance computational science and engineering applications.
CO-2	Illustrate mapping of applications to high-performance computing systems.
CO-3	Apply hardware/software co-design for achieving performance on real-world applications.

Unit No.	Course Content	No. of Hours
1	**Introduction to Parallel Computing:** Motivating Parallelism, Scope of Parallel Computing. **Parallel Programming Platforms:** Implicit Parallelism: Trends in Microprocessor Architectures, Limitations of Memory System Performance, Dichotomy of Parallel Computing Platforms, Physical Organization of Parallel Platforms, Communication Costs in Parallel Machines, Routing Mechanisms for Interconnection Networks, Impact of Process-Processor Mapping and Mapping Techniques	10
2	**Principles of Parallel Algorithm Design:** Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads, Parallel Algorithm Models. **Basic Communication Operations:** One-to-All Broadcast and All-to-One Reduction, All-to-All Broadcast and Reduction, All-Reduce and Prefix-Sum Operations, Scatter and Gather, All-to-All Personalized Communication, Circular Shift, Improving the Speed of Some Communication Operations	12

3	**Analytical Modeling of Parallel Programs:** Sources of Overhead in Parallel Programs, Performance Metrics for Parallel Systems, The Effect of Granularity on Performance, Scalability of Parallel Systems. Minimum Execution Time and Minimum Cost-Optimal Execution Time, Asymptotic Analysis of Parallel Programs. **Programming Using the Message-Passing Paradigm:** Principles of Message-Passing Programming, The Building Blocks: Send and Receive Operations, MPI: the Message Passing Interface, Topologies and Embedding, Overlapping Communication with Computation, Collective Communication and Computation Operations, Groups and Communicators	10
4	**Programming Shared Address Space Platforms:** Thread Basics, Why Threads? The POSIX Thread API, Thread Basics: Creation and Termination, Synchronization Primitives in Pthreads, Controlling Thread and Synchronization Attributes, Thread Cancellation, Composite Synchronization Constructs, Tips for Designing Asynchronous Programs, OpenMP: a Standard for Directive Based Parallel Programming. **Dense Matrix Algorithms:** Matrix-Vector Multiplication, Matrix-Matrix Multiplication, Solving a System of Linear Equations. **Sorting:** Issues in Sorting on Parallel Computers, Sorting Networks, Bubble Sort and its Variants, Quicksort, Bucket and Sample Sort.	10
5	**Graph Algorithms:** Definitions and Representation, Minimum Spanning Tree: Prim's Algorithm, Single-Source Shortest Paths: Dijkstra's Algorithm, All-Pairs Shortest Paths, Transitive Closure, Connected Components, Algorithms for Sparse Graphs. **Search Algorithms for Discrete Optimization Problems:** Definitions and Examples, Sequential Search Algorithms, Search Overhead Factor, Parallel Depth-First Search, Parallel Best-First Search, Speedup, Anomalies in Parallel Search Algorithms.	10

Text Book:

Sl. No.	Author/s	Title	Publisher Details
1	Ananth Grama, Anshul Gupta, George Karypis, and Vipin Kumar	Introduction to Parallel Computing	2nd Edition, Addison-Welsey, 2003

Reference Books:

Sl. No.	Author/s	Title	Publisher Details
1	G.E. Karniadakis, R.M. Kirby	Parallel Scientific Computing in C++ and MPI: A Seamless Approach to Parallel Algorithms and their Implementation	Cambridge University Press, 2003

2	M.J. Quinn	Parallel Programming in C with MPI and OpenMP	McGraw-Hill, 2004
3	Shameem Akhter and Jason Roberts	Multicore Programming, Increased Performance through Software Multi-threading	Intel Press, 2006
4	David E. Culler	Parallel Computer Architecture: A Hardware/Software Approach	Elsevier, 2006

Web Resources:

Sl. No.	Web link
1	https://developer.nvidia.com/udacity-cs344-intro-parallel-programming
2	https://nptel.ac.in/courses/106/108/106108055/#

Course Outcomes	Program Outcomes												PSO's			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	P012	PSO1	PSO2	PSO3	PSO4
CO-1	3	3	2	2	2	1	0	0	2	0	0	2	3	3	1	1
CO-2	3	3	2	2	2	1	0	0	2	1	0	2	3	3	1	1
CO-3	3	3	2	2	2	1	1	0	2	1	0	2	3	3	1	1

0 -- No association 1---Low association, 2--- Moderate association, 3---High association

Course Title: Pattern Recognition	***Course Code: CS745***
Credits (L: T: P): 4:0:0	***Contact Hours (L: T: P): 52:0:0***
Type of Course: Lecture	***Category: Professional Elective Course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Data Structures, Analysis and Design of Algorithms

Course Outcomes: After completing this course, students should be able to:

CO-1	Estimating Parameters from Samples.
CO-2	Classify Patterns using Parametric and Non-Parametric Techniques.
CO-3	Clustering of Samples using different Clustering Algorithms.
CO-4	Apply various Dimensionality Reduction Techniques to reduce the Dimension.

Unit No.	Course Content	No. of Hours
1.	**Introduction:** Applications of Pattern Recognition, Statistical Decision Theory and Analysis. Probability: Introduction to probability, Probabilities of Events, Random Variables, Joint Distributions and Densities, Moments of Random Variables, Estimation of Parameters from samples	11
2.	**Statistical Decision Making:** Introduction, Bayes' Theorem, Conditionally Independent Features, Decision Boundaries.	10
3	**Nonparametric Decision Making:** Introduction, Histograms, kernel and Window Estimators, Nearest Neighbor Classification Techniques: K-Nearest neighbor algorithm, Adaptive Decision Boundaries, Minimum Squared Error Discriminant Functions, Choosing a decision-making technique.	11
4.	**Clustering:** Introduction, Hierarchical Clustering, Agglomerative clustering algorithm, The single linkage algorithm, The complete linkage algorithm, Partitional Clustering: Forgy's algorithm, The K-Means algorithm.	10
5.	**Dimensionality Reduction:** Singular Value Decomposition, Principal Component Analysis, Linear Discriminated Analysis.	10

Text Books:

Sl. No.	Author/s	Title	Publisher Details
1	Earl Gose, Richard Johnsonbaugh, Steve Jost,	Pattern recognition and Image analysis	Pearson

Reference Books:

Sl. No.	Author/s	Title	Publisher Details
1	Richard O.Duda, Peter E.Hart, David G. Stork	Pattern Classification	John Wiley publication, 2nd edition, 2001.
2	A.K.Jain, R.Bolle, S.Pankanti	Biometric: Personal Identification in network society	Kluwer academic publishers, 1999.
3	Robert Schalkoff	Pattern Recognition: Statistical, Structural and Neural Approaches	John Wiley & Sons, Inc.1992.
4	Christopher M. Bishop	Pattern Recognition and Machine Learning	Springer publication, 2006

Web Resources:

Sl. No.	Web link
1	https://nptel.ac.in/courses/106/108/106108057/
2	https://nptel.ac.in/courses/106/106/106106046/

Course Outcomes	Program Outcomes												PSO's			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	P012	PSO1	PSO2	PSO3	PSO4
CO-1	3	3	2	3	1	0	0	0	1	0	0	2	3	3	2	3
CO-2	3	3	3	3	3	0	0	0	1	0	1	2	3	3	2	3
CO-3	3	3	3	3	3	1	0	0	0	0	1	2	3	3	2	3
CO-4	3	3	3	3	3	1	0	0	0	0	1	2	3	3	2	3

0 -- No association 1---Low association, 2--- Moderate association, 3---High association