THE NATIONAL INSTITUTE OF ENGINEERING

MYSURU – 8

(Autonomous Institution under VTU)

Bachelor of Engineering

Scheme & Detailed Syllabus of VII & VIII Semester
2021 Admitted Batch

B.E (Computer Science and Engineering)

Department of Computer Science and Engineering

2024-25

The National Institute of Engineering, Mysuru

Department of Computer Science and Engineering

Vision

The department will offer, through best-in-class faculty and infrastructure, globally acceptable education in Computer Science and produce highly competent and value-based computer engineers.

Mission

1. To evolve into an outstanding department contributing significantly to teaching, research and consultancy in computer science in an integrated manner.
2. To develop state-of-the-art infrastructure and advanced computing facility in tune with requirement of industry and national projects.
3. To promote innovation and entrepreneurship to enhance competence of graduates of computer science.

Program Outcomes (POs)

PO1: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

PO5: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

PO6: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice

PO7: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

PSO1: The ability to understand, analyze and develop software in the emerging areas for efficient use of computer –based systems of varying complexity.

PSO2: The ability to think logically and apply standard practices and strategies in software project development using open-ended programming environments to deliver a quality product.

Program Educational Objectives (PEOs)

PEO1: Acquire the necessary mathematical and scientific knowledge as well as basic managerial and financial procedures to analyze and solve real world problems within their work domain.

PEO2: Acquire the state-of-art knowledge in major areas of computing science like programming, networking, information security and algorithm development as well as technology solutions like cloud, database systems and mobile applications to enable them to succeed in pursuit of higher studies/ Industry/R&D activity.

PEO3: Have the ability and the mindset to continuously update and innovate.

PEO4: Have the necessary communication skills to be able to effectively communicate with technical experts and also non- technical end users.

The National Institute of Engineering, Mysuru

Dept. of CSE – 2021 admitted Scheme of Teaching – Semester 7 and 8 (Academic Year 2024-25)

VII Semester										
Sl. No	**Course Code**	**Course Title**	**Category**	**Teaching Department**	**Teaching Hours / Week**			**Examination**		**Credits**
					Theory Lecture	**Tutorial**	**Practical/ Drawing**			
					L	**T**	**P**	**CIE Marks**	**SEE Marks**	
1	21CS7E1X	Elective-1	PC	CSE	3	0	0	50	100	3
2	21CS7E2X	Elective-2	PC	CSE	3	0	0	50	100	3
3	21CS7E3X	Elective-3	PC	CSE	3	0	0	50	100	3
4	21CS7E4X	Elective-4	PC	CSE	3	0	0	50	100	3
5	21CS7AXX	AEC 6 – MOOC (12 Weeks) *	AEC	CSE	-	-	-	-	100	3
6	21CS7S01	Technical Seminar	PI	CSE	0	0	2	50	-	1
TOTAL								**250**	**500**	**16**

* AEC 6 - MOOC courses shall be identified by the MOOC Coordinator based on the availability of courses in SWAYAM platform before the start of the semester. The courses shall be approved by the Department Council and the same will be communicated to the Office of the Dean.

The National Institute of Engineering, Mysuru

Dept. of CSE – 2021 admitted Scheme of Teaching – Semester 7 and 8 (Academic Year 2024-25)

Elective-1 (21CS7E1X)

Course Code	Course Name	L:T:P
21CS7E11	Game Theory	3:0:0
21CS7E12	Advanced Algorithms	3:0:0
21CS7E13	Parallel Algorithms	3:0:0
21CS7E14	Queuing Theory and Modeling	3:0:0
21CS7E15	Quantum Computing System	3:0:0
21CS7E16	Cryptography and Network security	3:0:0

Elective-2 (21CS7E2X)

Course Code	Course Name	L:T:P
21CS7E21	Advanced Computer Architecture	3:0:0
21CS7E22	Object Oriented Modelling And Design	3:0:0
21CS7E23	Ad-Hoc and Sensor Networks	3:0:0
21CS7E24	Real Time Systems	3:0:0
21CS7E25	Distributed Systems	3:0:0
21CS7E26	Embedded Systems	3:0:0
21CS7E27	Block chain Architecture	3:0:0

Elective-3 (21CS7E3X)

Course Code	Course Name	L:T:P
21CS7E31	Big Data Analytics	3:0:0
21CS7E32	Soft Computing	3:0:0
21CS7E33	Data Mining	3:0:0
21CS7E34	Information Retrieval	3:0:0
21CS7E35	Neural Networks	3:0:0
21CS7E36	Speech and Natural Language Processing	3:0:0
21CS7E37	Deep Learning	3:0:0

Elective-4 (21CS7E4X)

Course Code	Course Name	L:T:P
21CS7E41	Digital Image Processing	3:0:0
21CS7E42	Human Computer Interaction	3:0:0
21CS7E43	Optimization Techniques	3:0:0
21CS7E44	Intelligent System	3:0:0
21CS7E45	Social Networks	3:0:0
21CS7E46	Pervasive Computing	3:0:0

The National Institute of Engineering, Mysuru

Dept. of CSE – 2021 admitted Scheme of Teaching – Semester 7 and 8 (Academic Year 2024-25)

VIII Semester										
Sl. No	**Course Code**	**Course Title**	**Category**	**Teaching Department**	**Teaching Hours / Week**			**Examination**		**Credits**
					Theory Lecture	**Tutorial**	**Practical/ Drawing**			
					L	**T**	**P**	**CIE Marks**	**SEE Marks**	
1	21CS8P01	Project Work (to be completed in VII Semester)	PI	CSE	-	-	-	100	100	8
2	21CS8I01	Research/Industry Internship	PI	CSE	-	-	-	100	100	8
TOTAL								**200**	**200**	**16**

VII SEMESTER

ELECTIVE – 1

Code: 21CS7E11 **Course: Game Theory**
Credits: 3 **L:T:P - 3:0:0**
SEE: 50% **CIE: 50%**
SEE Hours: 3 **Max. Marks: 100**

Prerequisites if any	Strong foundation in mathematics, particularly in areas such as calculus, linear algebra, and probability theory.
Learning objectives	• Interpret the behavior of participants in interactive games. • Apply game theory to solve real world problem involving diverse area. • Discuss the mathematical details of analysis and designing strategic interactions.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Explain basics of game theory, examine and evaluate different situations using game theoretic approach.	Understanding
CO2	Compare applications of deterministic outcome and probabilistic outcome (mixed strategy)	Apply
CO3	Construct sub-games under extensive game with perfect information and illustrates to find sub game perfect equilibrium.	Apply
CO4	Analyze Bayesian games and discuss Nash equilibrium in strictly competitive games Rationalizability	Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	3	-	3	-	-	-	-	-	-	-	-		1	1
CO2	3	3	-	3	-	-	-	-	-	-	-	-		1	1
CO3	3	3	2	3	-	-	-	-	-	-	-	-		1	1
CO4	3	3	2	3	-	-	-	-	-	-	-	-		1	1

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl. No.	Module Name	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
	Module – 1: INTRODUCTION			
1.1	What is game theory? Application of Game Theory.	1	-	-
1.2	The theory of rational choice, Nash Equilibrium: Strategic games, prisoner's dilemma	2	-	-
1.3	Bach or Stravinsky, Stag Hunt	1	-	-
1.4	Nash equilibrium: prisoner's Dilemma, BOS, Stag Hunt	2	-	-
1.5	Strict and non-strict equilibria, Best Response Functions: Using best response functions to define Nash equilibrium	1	-	-
1.6	Synergistic relationship	1	-	-
1.7	Dominated actions: strict and weak domination Equilibrium in single population: symmetric games and symmetric equilibria	1	-	-
	Module – 2: MIXED STRATEGY EQUILIBRIUM			
2.1	stochastic steady states, matching coin	2	-	-
2.2	Strategic games in which players may randomize	1	-	-
2.3	Mixed strategies: definition, equilibrium, best response functions	1	-	-
2.4	Dominated actions	1	-	-
2.5	Pure equilibria when randomization allowed, equilibrium in single population	2	-	-

2.6	The formation of players' beliefs	1	-	-
Module – 3: EXTENSIVE GAMES				
3.1	Extensive games with perfect information	1	-	-
3.2	Strategies and outcomes	1	-	-
3.3	Nash equilibrium	1	-	-
3.4	Subgame perfect equilibrium	1	-	-
3.5	Finding subgame perfect equlilibria of finite horizon games: backward induction	1	-	-
3.6	Allowing for simultaneous moves	1	-	-
3.7	illustration entry into a monopolized industry	1	-	-
3.8	Discussion: subgame perfect equilibrium and backward induction	1	-	-
Module – 4: BAYESIAN GAMES				
4.1	Motivational examples	1	-	-
4.2	General definitions; Two examples concerning information; Illustration: auctions	2	-	-
4.3	Extensive games with imperfect information; Strategies; Nash equilibrium	2	-	-
4.4	Beliefs and sequential equilibrium	1	-	-
4.5	Signaling games	1	-	-
4.6	Illustration: strategic information transmission	1	-	-
Module – 5: STRICTLY COMPETITIVE GAMES, RATIONALIZABILITY				
5.1	Strictly competitive games and maximization	1	-	-
5.2	Maximization and Nash equilibrium; Strictly competitive games	1	-	-
5.3	Maximization and Nash equilibrium in strictly competitive games	1	-	-
5.4	Rationalizability	1	-	-
5.5	Iterated elimination of strictly dominated actions	1	-	-
5.6	Iterated elimination of weakly dominated actions; Dominance solvability	1	-	-
5.7	Problems on Iterated elimination of weakly dominated actions	1	-	-
	Total No. of Lecture Hours	**40**	-	-
	Total No. of Tutorial Hours		**00**	**-**
	Total No. of Practical Hours			**00**

Textbook:

1. **An Introduction to Game Theory –** Martin Osborne, Oxford University Press, Indian Edition, 2004

Reference Book:

1. **Game Theory: Analysis of Conflict** – Roger B. Myerson, Harvard University Press, 1997.
2. **Microeconomic Theory** – Andreu Mas-Colell, Michael D. Whinston, and JerryR. Green, OxfordUniversity Press, New York, 1995.
3. **Game Theory and Strategy** – Philip D. Straffin, Jr., The Mathematical Association of America, January1993

Online Resources:

1. https://nptel.ac.in/courses/110104063
2. https://onlinecourses.nptel.ac.in/noc22_cs77

Code: 21CS7E12 **Course: Advanced Algorithms**
Credits: 3 **L:T:P - 3:0:0**
SEE: 50% **CIE: 50%**
SEE Hours: 3 **Max. Marks:100**

Prerequisites if any	Data Structures and Algorithms**,** Discrete Mathematics, Mathematics Proficiency, Algorithm Design Techniques, Complexity Analysis, Programming Skills
Learning objectives	1. Development of a sound theoretical understanding of advanced algorithms and practical problem solving skills. 2. Describe and apply complex algorithmic paradigms including greedy algorithms and dynamic programming.

Course Outcomes:

On the successful completion of the course, the student will be able to

Cos	Course Outcomes	Bloom's level
CO1	Describe Hashing Technique and Red Black Trees	Understanding
CO2	Design algorithm using Dynamic programming and Greedy	Apply
CO3	Compare different algorithms fusing Amortized Analysis	Apply
CO4	Analyze B trees , Fibonacci heaps, max flow and multi-threaded algorithms.	Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	2	2	3	2	-	-	-	-	-	-	-	-		2	2
CO2	2	2	3	2	-	-	-	-	-	-	-	-		2	2
CO3	2	2	1	2	-	-	-	-	-	-	-	-		2	1
CO4	2	3	3	3	-	-	-	-	-	-	-	-		2	2

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl. No.	Module Name	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
Module – 1: Hash Tables and Red Black Trees				
1.1	Introduction, Direct-address tables	2	-	-
1.2	Hash tables Hash functions	2	-	-
1.3	Open addressing, Perfect hashing	2	-	-
1.4	Red Black Trees: Properties, Rotations	2	-	-
Module – 2 Dynamic Programming				
2.1	Rod Cutting	1	-	-
2.2	Travelling Sales person Problem	1	-	-
2.3	Optimal binary search trees	2	-	-
2.4	Greedy Algorithms: Activity selection problem	2	-	-
2.5	Huffman codes	2	-	-
Module – 3: Amortized Analysis and Single Source Shortest path				
3.1	Aggregate analysis	3	-	-
3.2	The Accounting method, Potential Method	3	-	-
3.3	The Bellman-Ford algorithm	2	-	-

Module – 4: B-trees and Fibonacci Heaps				
4.1	Introduction and Definition of B-trees	1	-	-
4.2	Basic operations of B-trees	2	-	-
4.3	Introduction to Fibonacci heaps	1	-	-
4.4	Structure of Fibonacci heaps	2	-	-
4.5	Mergeable-heap operations	2	-	-
Module – 5: Maximum Flow				
5.1	Introduction, Flow networks	1	-	-
5.2	The Ford-Fulkerson method	1	-	-
5.3	Maximum bipartite matching	2	-	-
5.4	Push reliable algorithms: basic operations, push operation reliable operation,	2	-	-
5.5	The generic algorithm	1	-	-
5.6	The Relabel-to-front algorithm	1	-	-
	Total No. of Lecture Hours	**40**	-	-
	Total No. of Tutorial Hours		**00**	**-**
	Total No. of Practical Hours			**00**

Textbook:

1. Introduction to Algorithms –Thomas H. Cormen, Charles E. Leiserson, Ronald L.Rivest, Clifford Stein PHI, 3rd Edition, 2009

Reference Book:

1. Computer Algorithms - Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, Computer Science Press, 1998
2. The Design and Analysis of Computer Algorithms- Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, Addison Wesley, 1974

Online Resources:

1. https://www.coursera.org/learn/advanced-algorithms-and-complexity
2. https://onlinecourses.nptel.ac.in/noc23_cs63/preview

Code: 21CS7E13 **Course: Parallel Algorithms**
Credits: 3 **L:T:P - 3:0:0**
SEE: 50% **CIE: 50%**
SEE Hours: 3 **Max. Marks: 100**

Prerequisites if any	Data Structures, Algorithms, Discrete Mathematics and Linear Algebra
Learning objectives	• To design and implement efficient parallel algorithms using variouscomputational models and architectures. • To apply parallel processing techniques to solve complex problemsin computational geometry, graph theory, and numerical analysis.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Describe and compare different models of computation such as RAM, PRAM, and various interconnection networks.	Understanding
CO2	Explain parallel algorithm optimization for tasks such as parallel prefix, maximum sum subsequence, and array packing.	Understanding
CO3	Applying pointer jumping and divide and conquer techniques to solve problems in a parallel computing environment.	Apply
CO4	Solve computational geometry problems and graph algorithms using parallel processing techniques.	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	3	-	-	2	-	-	-	-	-	-	-		-	-
CO2	3	3	-	3	3	-	-	-	-	-	-	-		-	2
CO3	3	3	-	2	3	-	-	-	-	-	-	-		1	2
CO4	3	3	-	2	3	-	-	-	-	-	-	-		1	2

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl. No.	Module Name	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
Module – 1: Models of Computation				
1.1	Models of Computation: RAM (Random Access Machine), PRAM (Parallel Random-Access Machine)	3	-	-
1.2	Interconnection Networks, Processor Organizations, Coarse-Grained Multiprocessors	5	-	-
Module – 2: Parallel Prefix				
2.1	Parallel Prefix: Parallel Prefix, Maximum Sum Subsequence	4	-	-
2.2	Array Packing, Parallel Prefix on a NOW, Cluster, or Grid	4	-	-
Module – 3: Pointer Jumping and Divide and Conquer				
3.1	Pointer Jumping and divide and Conquer: List Ranking, Linked List Parallel Prefix	4	-	-
3.2	Merge Sort (Revisited) Selection, Quicksort (Partition Sort), Concurrent Read/Write	4	-	-

Module – 4: Computational Geometry				
4.1	Computational Geometry: Convex Hull, Smallest Enclosing Box, Line Intersection Problems	4	-	-
4.2	Computational Geometry on NOW, Clusters, and Grids.	4	-	-
Module – 5: Graph Algorithms and Numerical Problems				
5.1	Graph Algorithms: Connected Component Labeling, Minimum-Cost Spanning Trees, Shortest-Path Problems.	3	-	-
5.2	Numerical Problems: Primality, Greatest Common Divisor, Integral Powers, Approximation by Taylor Series, Trapezoidal Integration, Approximate Solution of an Equation.	5	-	-
	Total No. of Lecture Hours	**40**	-	-
	Total No. of Tutorial Hours		**00**	**-**
	Total No. of Practical Hours			**00**

Textbook:

1. Algorithms Sequential and Parallel: A Unified Approach, Russ Miller; Laurence Boxer, Cengage Learning, Third Edition, 2012.

Reference Book:

1. Introduction to Parallel Algorithms, Joseph JaJa, University of Maryland, AddisonWesley Professional.
2. Parallel Algorithms (Hardcover) by Henri Casanova, Arnaud Legrand, Yves Robert,Taylor & Francis Publication (Jul 2008)

Online Resources:

1. NPTEL Course Link: https://archive.nptel.ac.in/noc/courses/noc19/SEM1/noc19-cs17/
2. MIT OpenCourseWare Link: https://ocw.mit.edu/courses/18-337j-parallel-computing-fall-2011/

Code: 21CS7E14 **Course: Queuing Theory and Modeling**
Credits: 3 **L:T:P - 3:0:0**
SEE: 50% **CIE: 50%**
SEE Hours: 3 **Max. Marks: 100**

Prerequisites if any	Calculus and Matrix Algebra
Learning objectives	• To equip students with the ability to analyze and apply concepts of random variables, distributions, and random processes in solving real-world problems. • To enable students to model and analyze queueing systems using fundamental and advanced queueing theory techniques.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Apply problem-solving techniques for both discrete and continuous random variables, encompassing their functions, moments, and prevalent probability distributions.	Apply
CO2	Develop the ability to comprehend, analyze, and manipulate joint, marginal, and conditional distributions, perform calculations for covariance and correlation, and apply the central limit theorem effectively in statistical analysis.	Apply
CO3	Classify and model different types of random processes and solve related problems using Markov chains.	Apply
CO4	Apply queueing theory to model and analyze various queueing systems and models.	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	3	-	3	2	-	-	-	-	-	-	-		2	3
CO2	3	3	-	3	3	-	-	-	-	-	-	-		2	-
CO3	3	3	-	2	3	-	-	-	-	-	-	-		3	3
CO4	3	3	-	2	3	-	-	-	-	-	-	-		1	-

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl. No.	Module Name	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
	Module – 1: Random Variables and Distributions			
1.1	Discrete and continuous random variables –Functions of a random variable– Moments – Moment generating functions	4	-	-
1.2	Binomial Poisson, Geometric, Uniform, Exponential, and Normal distributions	4	-	-
	Module – 2: Two - Dimensional Random Variables			
2.1	Joint distributions – Marginal and conditional distributions – Covariance – Correlation and Linear regression	5	-	-
2.2	Transformation of random variables –Central limit theorem.	3	-	-
	Module – 3: Random Processes			
3.1	Classification – Stationary process – Ergodic process – Markov process – Poisson process	4	-	-
3.2	Discrete parameter Markov chain – Classification of state of a Markov Chain – Chapman Kolmogorov equations	4	-	-

Module – 4: Queueing Models				
4.1	Markovian queues – Birth and Death processes – Single and multiple server queueing models	4	-	-
4.2	Little's formula - Queues with finite waiting rooms – Queues with impatient customers: Balking and reneging.	4	-	-
Module – 5: Advanced Queueing Models				
5.1	Finite source models - M/G/1 queue – Pollaczek Khinchin formula	4	-	-
5.2	M/D/1 and M/EK/1 as special cases – Series queues	4	-	-
	Total No. of Lecture Hours	**40**	-	-
	Total No. of Tutorial Hours		**00**	**-**
	Total No. of Practical Hours			**00**

Textbook:

1. Fundamentals of Applied Probability and Random Processes, Ibe. O.C., Elsevier, 1stIndian Reprint, 2014.
2. Fundamentals of Queueing Theory, Gross. D. and Harris. C.M, Wiley Student edition,2012

Reference Book:

1. Schaum's Outline of Theory and Problems of Probability, Random Variables andRandom Processes, Hwei Hsu, Tata McGraw Hill Edition, New Delhi, 2014.
2. Computer Networks and Systems: Queueing Theory and Performance Evaluation,Robertazzi, 3rd Edition, Springer, 2012.

Online Resources:

1. NPTEL Course Link: https://onlinecourses.nptel.ac.in/noc23_ma38/preview
2. MIT OpenCourseWare Link: https://ocw.mit.edu/courses/15-072j-queues-theory-and-applications-spring-2006/pages/syllabus/

Code: 21CS7E15 **Course: Quantum Computing Systems**
Credits: 3 **L:T:P 3:0:0**
SEE: 50% **CIE: 50%**
SEE Hours: 3 **Max. Marks: 100**

Prerequisites if any	Physics, Linear Algebra, Probability Theory, Complex Numbers, Computer Science Fundamentals
Learning objectives	1. To introduce the fundamentals of quantum computing 2. To inculcate the ability of problem-solving using quantum algorithms

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Explain the fundamental notions of quantum mechanics	Understanding
CO2	Make use of quantum bit gates to design quantum circuits	Apply
CO3	Use the architecture and algorithms to develop solutions	Apply
CO4	Differentiate between probabilistic and quantum computing	Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	-		1	-
CO2	3	2	-	-	-	-	-	-	-	2	-	3		-	3
CO3	-	3	2	-	3	-	-	-	-	-	3	-		3	-
CO4	2	-	3	2	-	-	-	-	-	2	-	2		2	2

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl. No.	Module Name	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
	Module – 1			
1.1	Introduction to quantum mechanics: Linear algebra	3	-	-
1.2	The postulates of quantum mechanics	3	-	-
1.3	Application: superdense coding	1	-	-
1.4	EPR and the Bell inequality	1	-	-
	Module – 2			
2.1	Quantum bits, Single qubit gates, Multiple qubit gates	3	-	-
2.2	Quantum circuits	3	-	-
2.3	Example: Bell states	1	-	-
2.4	Example: quantum teleportation	1	-	-
	Module – 3			
3.1	Classical computations on a quantum computer	2	-	-
3.2	Quantum parallelism	2	-	-
3.3	Deutsch's Algorithm	2	-	-
3.4	The Deutsch-Jozsa Algorithm	2	-	-

Module – 4				
4.1	The quantum Fourier transform, Phase estimation	2	-	-
4.2	Applications: order-finding and factoring	3	-	-
4.3	The quantum search algorithm	3	-	-
Module – 5				
5.1	Probabilistic and Quantum computations	2	-	-
5.2	Introduction to quantum cryptography and quantum information theory	2	-	-
5.3	Quantum programming languages	4	-	-
	Total No. of Lecture Hours	**40**	-	-
	Total No. of Tutorial Hours		**00**	-
	Total No. of Practical Hours			**00**

Textbook:

1. Quantum computation and quantum information, Michael A. Nielsen and Isaac L. Chuang, CambridgeUniversity Press 2010
2. Quantum computing for computer scientists, Noson S. Yanofsky, Mirco A. Mannucci, CambridgeUniversity Press 2008

Reference Book:

1. Quantum computing explained, David McMahon, Wiley-interscience, John Wiley & Sons, 2008

Online Resources:

1. https://archive.nptel.ac.in/courses/106/106/106106232/
2. https://learn-xpro.mit.edu/quantum-computing

Code: 21CS7E16 **Course: Cryptography and Network Security**
Credits: 3 **L:T:P - 3:0:0**
SEE: 50% **CIE: 50%**
SEE Hours: 3 **Max. Marks: 100**

Prerequisites if any	Modular Arithmetic, Matrices, Linear Congruence, Algebraic structures, GF (2n) Fields.
Learning objectives	• Understand the principles, goals, and techniques of both symmetric-key and asymmetric-key cryptography. • Develop the skills to implement message integrity, authentication methods, and digital signatures for secure communication.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Apply traditional and modern symmetric-key cryptosystems.	Apply
CO2	Apply RSA, El-Gamal, and elliptic curve cryptography.	Apply
CO3	Analyze hash functions, message integrity, and use digital signatures.	Analyze
CO4	Analyze entity authentication and key management concepts.	Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-		2	2
CO2	3	3	-	-	-	-	-	-	-	-	-	2		2	2
CO3	3	3	-	3	-	-	-	-	-	-	-	-		2	2
CO4	3	3	-	2	-	-	-	-	-	-	-	-		2	2

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl. No.	Module Name	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
Module – 1: Introduction to Symmetric-Key Cryptosystems				
1.1	Introduction to Symmetric-Key Encipherment: Security Goals, Cryptographic Attacks, Services and mechanism, Techniques	04	-	-
1.2	Traditional Symmetric-Key Ciphers: Introduction, Substitution Ciphers, Transposition Ciphers.	04	-	-
Module – 2: Modern Symmetric-Key Ciphers				
2.1	Introduction to Modern Symmetric-Key Ciphers: Modern Block Ciphers, Modern Stream Ciphers	02	-	-
2.2	Data Encryption Standard (DES): Introduction, DES Structure (overview only), Security of DES	03	-	-
2.3	Advanced Encryption Standard (AES): Introduction, Transformations, Key expansion, The AES Ciphers	03	-	-
Module – 3: Asymmetric-Key Cryptosystems				
3.1	Asymmetric-Key Cryptography: RSA Cryptosystems	03	-	-
3.2	El-Gamal Cryptosystem	03	-	-
3.3	Elliptic curve crypto systems (overview only).	02	-	-

Module – 4: Hashing and Digital Signatures				
4.1	Message Integrity and Message Authentication: Message Integrity, Random Oracle Model, Message Authentication	04	-	-
4.2	Digital Signature: Comparison, Process, Services, Attacks of Digital Signature, Digital Signature Schemes	04	-	-
Module – 5: Entity Authentication and Key Management				
5.1	Entity Authentication: Introduction, Passwords, Challenge-Response, Biometrics	04	-	-
5.2	Key Management: Symmetric-Key Distribution, Kerberos, Symmetric-key Agreement.	04	-	-
	Total No. of Lecture Hours	**40**	-	-
	Total No. of Tutorial Hours		**00**	**-**
	Total No. of Practical Hours			**00**

Textbook:

1. Cryptography and Network Security, Behrouz Forouzan, SIE, 2nd Edition, McGraw-Hill

Reference Book:

1. Cryptography and Network Security, Principles and Practice; Fifth Edition. By William Stallings, Prentice Hall.
2. Handbook of Applied Cryptography, A. Menezes, P. and S. Vanstone, CRC Press.

Online Resources:

1. NPTEL Course Link: https://onlinecourses.nptel.ac.in/noc22_cs90/preview
2. MIT OpenCourseWare Link: https://ocw.mit.edu/courses/6-857-network-asnd-computer-security-spring-2014/pages/lecture-notes-and-readings/

ELECTIVE – 2

Code: 21CS7E21 **Course: Advanced Computer Architecture**
Credits: 3 **L:T:P - 3:0:0**
SEE: 50% **CIE: 50%**
SEE Hours: 3 **Max. Marks:100**

Prerequisites if any	Computer Organization and Architecture, Digital Logic Design, Assembly Language Programming**,** Data Structures and Algorithms
Learning objectives	• To design and implement efficient parallel architecture such as linear array, Grid, Torus, binary tree and 2D mesh. • To apply parallel algorithm complexity and various modelsof parallelism algorithms to solve complex problems in semi group computation, routing etc can be solved efficiently onvarious parallel architectures

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Understand pipelining, form of parallelism, popular parallel architectures such as linear array, Grid, Torus, binary tree and 2D mesh.	Understanding
CO2	Discuss parallel algorithm complexity and various models of parallelism algorithms.	Apply
CO3	Discuss how problems such as semi group computation, routing etc. can be solved efficiently on various parallel architectures.	Apply
CO4	Analyze circuit level sorting along with examples of practical significance such as discrete Fourier transform, fast FFT etc. were discussed.	Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	-		2	2
CO2	3	3	-	2	1	-	-	-	-	-	-	-		2	2
CO3	2	3	-	-	-	1	-	-	-	-	-	-		2	2
CO4	3	3	2	1	-	-	-	-	-	-	-	-		2	2

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl. No.	Module Name	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
	Module – 1: Pipeline and Parallel Processing			
1.1	Pipelined Data Paths Pipelining Concepts, Pipeline Stalls or Bubbles,	1	-	-
1.2	Pipelined Data Path Design, Pipelined Control,	1	-	-
1.3	Optimal pipelining, Data Dependencies and Hazards,	1	-	-
1.4	Data Forwarding, Pipeline Branch Hazards	1	-	-

1.5	Branch Prediction, Advanced Pipelining	1	-	-
1.6	Exceptions in a Pipeline, Introduction to Parallelism Why Parallel Processing?	1	-	-
1.7	A Motivating Example, Types of Parallelism: A Taxonomy	1	-	-
1.8	Roadblocks to Parallel Processing, Effectiveness of Parallel Processing	1	-	-
1.9	A Taste of Parallel Algorithms Some Simple Computations, Some Simple architectures,	1	-	-
1.10	Algorithms for a Linear Array, Algorithms for a Binary Tree,	1	-	-
1.11	algorithms for 2D Mesh, Algorithms with Shared Variables	1	-	-
Module – 2: Model of Parallel Processing				
2.1	Parallel Algorithm Complexity: Asymptotic Complexity	1	-	-
2.2	Algorithm Optimality and Efficiency, Complexity classes	1	-	-
2.3	Parallelizable Tasks and the NC Class, Parallel Programming Paradigms	1	-	-
2.4	Solving Recurrences. Models of Parallel Processing: SIMD versus MIMD Architectures	1	-	-
2.5	Global versus Distributed Memory	1	-	-
2.6	the PRAM Shared-Memory model	1	-	-
2.7	Distributed-Memory or Graph Models	1	-	-
2.8	Circuit Model and Physical Realizations.	1	-	-
Module 3: RAM and Basic Algorithms				
3.1	Data Broadcasting	1	-	-
3.2	Semi group or Fan-in Computation	1	-	-
3.3	Parallel Prefix Computation	1	-	-
3.4	Ranking the Elements of a Linked List	1	-	-
3.5	Matrix Multiplication	1	-	-
3.6	Sequential Ranked- Based Selection	1	-	-
3.7	A Parallel Selection Algorithm.	1	-	-
Module – 4:Shared-Memory Algorithms				
4.1	A Selection-Based Sorting Algorithm	1	-	-
4.2	Alternative Sorting Algorithms	1	-	-
4.3	Convex Hull of a 2D Point Set	1	-	-
4.4	Some Implementation Aspects.	1	-	-
4.5	Data Access Problems and Caching	1	-	-
4.6	Coordination and synchronization	1	-	-

Module – 5: Sorting and Selection Networks				
5.1	What is a Sorting Network? , Figures of Merit for Sorting Networks,	1	-	-
5.2	Design of Sorting Networks, Other Classes of Sorting Networks,	1	-	-
5.3	Selection Networks.	1	-	-
5.4	Other Circuit Level Examples : Searching and Dictionary Operations ,	1	-	-
5.5	A Tree- structured Dictionary Machine	1	-	-
5.6	Parallel Prefix Computation	1	-	-
5.7	Parallel Prefix Networks, The Discrete Fourier Transform	1	-	-
5.8	Parallel Architectures for FFT	1	-	-
	Total No. of Lecture Hours	**40**	-	-
	Total No. of Tutorial Hours		**00**	-
	Total No. of Practical Hours			**00**

Text book:

1. B. Parhami, Computer Architecture, From Microprocessors to Supercomputers, Oxford University Press,Indian edition, 2005
2. B. Parhami, Introduction to Parallel Processing, Algorithms and Architectures, Plenum series, KLUWERACADEMIC PUBLISHERS, 2002,Kluwer's eBookstore at: http://www.ebooks.kluweronline.com

Reference Book:

1. Advanced Computer Architecture, Parallelism, Scalability, Programmability– Kai Hwang,TataMc-Grawhill,2003.
2. Computer Architecture, A Quantitative Approach, John L. Hennessey and David A. Patterson: – 4th Edition,Elsevier, 2007
3. Parallel Computer Architecture, A Hardware /Software Approach, David E. Culler, Jaswinder Pal Singh,Anoop Gupta, – Morgan Kaufman, 1999

Course Code: 21CS7E22 **Course: Object Oriented Modelling and Design**
Credits: 3 **L:T:P:S : 3:0:0**
SEE: 50% **CIE: 50%**
SEE Hours: 3 Hrs **Max. Marks: 100**

Prerequisites if any	Object-Oriented Programming (OOP) concepts, Software Engineering.
Learning objectives	• Understand the importance of Classes, Objects and their relationships • Identify proper classification technique and apply suitable modelling notations. Make use of suitable modelling notations to solve problems • Explain the process mechanisms of software development life cycle • Apply object-oriented techniques to solve real-world applications. Classify and use patterns

Course Outcomes:
On the successful completion of the course, the student will be able to

	Course Outcomes	Bloom's level
CO1	Understand the importance of Classes, Objects and their relationships	Understand
CO2	Identify proper classification technique and apply suitable modeling notations. Make use of suitable modeling notations to solve problems.	Apply
CO3	Explain the process mechanisms of software development life cycle	Analyze
CO4	Apply object-oriented techniques to solve real-world applications.Classify and use patterns	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	2	2	2	-	2	2	-	-	-	-	-		3	2
CO2	3	-	3	-	2	-	-	-	-	-	-	-		2	3
CO3	2	3	-	2	-	-	2	-	-	-	-	-		2	1
CO4	3	2	2	-	1	1	-	-	-	-	-	-		2	2

Strong: 3 Medium: 2 Low:1

Course Content

Sl. No.	Module – 1	No. of Lecture Hours	No. of Tutorial Hours	Self Learning Hours
1.1	The Object Model: The Foundations of the Object Model	1	-	-
1.2	Elements of the Object Model,	1	-	-
1.3	Applying the Object Model.	1	-	-
1.4	Classes and Objects: The Nature of an Object, Relationships among Objects	1	-	-
1.5	The Nature of a Class,	1	-	-
1.6	Relationships among Classes	1	-	-
1.7	The Interplay of Classes and Objects	1	-	-
1.8	On Building Quality Classes and Objects.	1	-	-
	Module – 2			
2.1	Classifications: The importance of Proper Classification	2	-	-
2.2	Identifying Classes and Objects.	1	-	-
2.3	Method: Notation - The Unified Modeling Language	1	-	-
2.4	Package Diagrams	1	-	-
2.5	Component Diagrams,	1	-	-

2.6	Deployment Diagrams,	1	-	-
2.7	Use Case Diagrams	1	-	-
2.8	Activity Diagrams.	1	-	-
	Module – 3			
3.1	Sequence Diagrams	1	-	-
3.2	Interaction Overview Diagrams	2	-	-
3.3	Composite Structure Diagrams	2	-	-
3.4	State Machine Diagrams	2	-	-
3.5	Object Diagrams.	2	-	-
	Module –4			
4.1	Process: The Macro Process:	2	-	-
4.2	The MicroProcess: The Software development Lifecycle	1	-	-
4.3	The Analysis and Design Process	1	-	-
4.4	Pragmatics: Management and Planning, Staffing, Release Management, Reuse.	1	-	-
4.5	Applications: Control System - Traffic Management: Inception, Elaboration, Construction, Post Transition.	1	-	-
4.6	Data Acquisition: Weather Monitoring Station: Inception, Elaboration, Construction, Post Transition.	1	-	-
	Module –5			
5.1	Patterns: What is a pattern and what makes a pattern?	1	-	-
5.2	Pattern categories: Relationships between patterns	1	-	-
5.3	Pattern description	1	-	-
5.4	Communication Patterns: Forwarder-Receive	1	-	-
5.5	Client-Dispatcher-Server	1	-	-
5.6	Publisher-Subscriber	1	-	-
5.7	Idioms: Introduction, what can idioms provide? Whereto find idioms?	1	-	-
	Total No. of Lecture Hours	40		
	Total No. of Tutorial Hours		0	
	Total No. of Self learning Hours			0

Text Books:

1. Object-Oriented Analysis and Design with Applications ,Grady Booch, Robert A. Maksimchuk, Michael W. Engle, Bobbi J.Young, Jim Conallen, Kelli A.Houston, 3rd Edition, Pearson, 2007.(Chapters 1,2,3,4,5,6,7,9,11)
2. Pattern-Oriented Software Architecture, A System of Patterns, Frank Buschmann, Regine Meunier, Hans Rohnert, Peter Sommerlad, Michael Stal, Volume 1, John Wiley and Sons, 2006.(Chapters 1, 3.5, 3.6, 4)

Reference Books:

1. Object-Oriented Systems Analysis and Design Using UML, Simon Bennett, Steve McRobband Ray Farmer:, 2nd Edition, Tata McGraw-Hill, 2002.
2. Object-Oriented Modeling and Design with UML, Michael Blaha, James Rumbaugh, 2ndEdition, Pearson Education, 2005.
3. Object-Oriented Analysis, Design, and Implementation,Brahma Dathan, Sarnath Ramnath,Universities Press, 2009.
4. UML 2 Toolkit, Hans-Erik Eriksson, Magnus Penker, Brian Lyons, David Fado, Wiley DreamtechIndia, 2004.
5. Object-Oriented Systems Analysis and Design Using UML, Simon Bennett, Steve McRobband Ray Farmer, 2nd Edition, Tata McGraw-Hill, 2002

Code: 21CS7E23 **Course: Ad-hoc and Sensor Networks**
Credits: 3 **L:T:P - 3:0:0**
SEE: 50% **CIE: 50%**
SEE Hours: 3 **Max. Marks:100**

Prerequisites if any	Computer Networks
Learning objectives	• To understand the basics of Ad-hoc & Sensor Networks. • To learn various fundamental and emerging protocols of all layers. • To study about the issues pertaining to major obstacles in establishment and efficient management of Ad-hoc and sensor networks. • To understand the nature and applications of Ad-hoc and sensor networks. • To understand various security practices and protocols of Ad-hoc and Sensor Networks.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Understand the issues and challenges in the design of wireless ad hoc networks.	Understand Analyze
CO2	Explain the working of MAC and Routing Protocols for ad hoc and sensor networks	Analyze Apply
CO3	Discuss the Transport Layer protocols and their QoS for ad hoc and sensor networks.	Analyze
CO4	Describe various security issues in ad hoc and sensor networks and the corresponding solutions.	Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	2	2	-	-	-	-	-	-	-	-	-	-		1	1
CO2	3	2	-	-	1	-	-	-	-	-	-	-		2	1
CO3	2	2	-	-	1	-	-	-	-	-	-	-		2	1
CO4	2	1	-	-	2	-	-	-	-	-	-	-		3	2

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl. No.	Module Name	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
Module – 1: MAC & ROUTING IN AD HOC NETWORKS				
1.1	Introduction – Issues and challenges in ad hoc	1	-	-
1.2	MAC Layer Protocols for wireless ad hoc networks-Contention-Based MAC protocols	1	-	-
1.3	MAC Protocols Using Directional Antennas	1	-	-
1.4	Multiple-Channel MAC Protocols	1	-	-
1.5	Power-Aware MAC Protocols	1	-	-
1.6	Routing in Ad hoc Networks – Design Issues	1	-	-
1.7	Proactive Routing Protocols	1	-	-
1.8	Reactive Routing Protocols	2	-	-

Module – 2: TRANSPORT & QOS IN AD HOC NETWORKS				
2.1	TCP‟s challenges and Design Issues in Ad Hoc Networks	1	-	-
2.2	Transport protocols for ad hoc networks	1	-	-
2.3	Issues and Challenges in providing QoS s	1	-	-
2.4	MAC Layer QoS solution	1	-	-
2.5	Network Layer QoS solutions	2	-	-
2.6	QoS Model	1	-	-
Module – 3: MAC & ROUTING IN WIRELESS SENSOR NETWORKS				
3.1	Introduction	1	-	-
3.2	Applications	1	-	-
3.3	Challenges	1	-	-
3.4	Sensor network architecture	1	-	-
3.5	MAC Protocols for wireless sensor networks	1	-	-
3.6	Low duty cycle protocols and wakeup concepts	1	-	-
3.7	Contention- Based protocols	1	-	-
3.8	Schedule-Based protocols- IEEE 802.15.4 Zigbee	2	-	-
Module – 4: TRANSPORT & QOS IN WIRELESS SENSOR NETWORKS				
4.1	Data-Centric and Contention-Based Networking	1	-	-
4.2	Transport Layer and QoS in Wireless Sensor Networks	2	-	-
4.3	Congestion Control in network processing	1	-	-
4.4	Operating systems for wireless sensor networks – Examples	2	-	-
Module – 5: SECURITY IN AD HOC AND SENSOR NETWORKS				
5.1	Security Attacks	1	**0**	**0**
5.2	Key Distribution and Management	1	**0**	**0**
5.3	Intrusion Detection	1	**0**	**0**
5.4	Software based Anti-tamper techniques	2	**0**	**0**
5.5	Water marking techniques	1	**0**	**0**
5.6	Defense against routing attacks	1	**0**	**0**
5.7	Secure Ad hoc routing protocols	2	**0**	**0**
	Total No. of Lecture Hours	**40**	-	-
	Total No. of Tutorial Hours		**00**	**-**
	Total No. of Practical Hours			**00**

Textbooks:

1. C.Siva Ram Murthy and B.S.Manoj, ―Ad Hoc Wireless Networks – Architectures and 2 Protocols‖,Pearson Education, 2006.
2. Holger Karl, Andreas Willing, ―Protocols and Architectures for Wireless Sensor Networks‖, JohnWiley & Sons, Inc., 2005.

Reference Books:

1. Subir Kumar Sarkar, T G Basavaraju, C Puttamadappa, ―Ad Hoc Mobile Wireless Networks‖, Auerbach Publications,2008.
2. Carlos De Morais Cordeiro, Dharma Prakash Agrawal, ―Ad Hoc and Sensor Networks: Theory andApplications (2nd Edition)‖, World Scientific Publishing, 2011.

Online Resources:

1. https://www.youtube.com/watch?v=GUSrkWJ_Z2g
2. https://www.youtube.com/watch?v=ycaz99NogS4&list=PLSvfr6gMyxinv_WR0qZr-Cwr4YzRopLAd

Code: 21CS7E24 **Course: Real Time systems**
Credits: 3 **L:T:P - 3:0:0**
SEE: 50% **CIE: 50%**
SEE Hours: 3 **Max. Marks:100**

Prerequisites if any	Operating Systems, computer Networks, Problem-Solving Skills
Learning objectives	Develop a comprehensive understanding of real-time constraints, task scheduling algorithms, timing analysis techniques, performance optimization in real-time systems.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Compare Hard and Soft Real-Time Systems, define the temporal parameters associated with real-time workloads, and rephrase the sentence.	Understanding
CO2	Analyze the fundamental problems of Real Time Systems.	Apply
CO3	Demonstrate the use of real time scheduling, to enhance response	Apply
CO4	Compare Fixed priority versus Dynamic priority algorithms	Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	2	2	-	1	1	2	-	-	-	-	-	-		3	1
CO2	-	3	2	-	-	-	-	-	-	-	-	-		2	3
CO3	3	2	3	-	-	2	-	-	-	-	2	-		3	3
CO4	-	2	-	-	-	-	-	-	-	-	-	-		-	-

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl. No.	Module Name	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
Module – 1: Hard Versus Soft Real-Time Systems				
1.1	Jobs and Processors, Release Times, Deadline and Timing Constraints.	3	-	-
1.2	Hard and Soft timing Constraints, Hard Real-Time Systems, Soft Real-Time Systems.	5	-	-
Module – 2: A Reference model of Real-Time systems				
2.1	Processors and Resources, Temporal Parameters of Real- Time Work load,	2	-	-
2.2	Periodic task model, Precedence Constraints and Data dependency, other types dependencies	6	-	-
Module – 3: Approaches to Real-Time Scheduling				
3.1	Clock-Driven approach, Weighted Round-Robin approach, Priority driven approach.	4	-	-
3.2	Dynamic Versus Static Systems, Effective Release times and deadlines, optimality of the EDF and LST algorithms.	4	-	-
Module – 4: Clock-driven Scheduling:				
4.1	Notations and assumptions, static, Timer-Driven Scheduler, General Structure Cyclic Schedulers Cyclic executives	6	-	-
4.2	Improving the average response time of a periodic jobs	2	-	-

Module – 5: Priority-Driven Scheduling of Periodic Tasks:				
5.1	Static assumption, Fixed Priority Versus Dynamic Priority algorithms,	4	-	-
5.2	Maximum Scheduling utilization, Optimality of the RM and DM algorithms	4	-	-
	Total No. of Lecture Hours	**40**	-	-
	Total No. of Tutorial Hours		**00**	**-**
	Total No. of Practical Hours			**00**

Textbook:

1. Real Time Systems – Jane W.S. Liu Pearson Education Asia, First Indian Reprint-2001.

Reference Book:

1. Real Time Systems Design and Analysis: An Engineer_s Hand book Second Edition, Lapante.

Online Resources:

1. Coursera course: Real-Time Embedded Systems Concepts and Practices Course by University of ColoradoBoulder | Coursera

Code: 21CS7E25 **Course: Distributed Systems**
Credits: 3 **L:T:P 3:0:0**
SEE: 50% **CIE: 50%**
SEE Hours: 3 **Max. Marks: 100**

Prerequisites if any	Computer Networks, Operating Systems
Learning objectives	1. Learn the fundamentals of distributed systems through examples 2. Learn to use appropriate remote invocation techniques for communication in DS

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Explain the applications and challenges arising from the construction of distributed systems	Understanding
CO2	Demonstrate suitable remote invocation techniques for communication within distributed systems.	Apply
CO3	Demonstrate applications using CORBA middleware by employing distributed objects and components.	Apply
CO4	Analyze clock synchronization algorithms and choose the optimal concurrency control algorithm for managing transactions	Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	-		1	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-		-	2
CO3	-	-	2	-	2	-	-	-	-	-	-	-		2	-
CO4	-	-	-	2	-	-	-	-	-	-	-	2		2	2

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl. No.	Module Name	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
Module – 1: Characterization of Distributed Systems, System models				
1.1	Introduction to DS, examples	1	-	-
1.2	Trends in distributed system. Focus on resource sharing	2	-	-
1.3	Challenges	1	-	-
1.4	Physical models, Architectural Models, Fundamental Models	3	-	-
1.5	Case study: WWW	1	-	-
Module – 2: Inter Process Communication, Remote Invocation				
2.1	Introduction, API for Internet Protocols	1	-	-
2.2	External data representation and Marshalling	2	-	-
2.3	Client – Server Communication	1	-	-
2.4	RR Protocol, RPC, RMI	3	-	-
2.5	Case study: SUN RPC	1	-	-
Module – 3: OS Support, Distributed Objects, DFS				
3.1	Processes, Threads, OS Architecture	2	-	-
3.2	Introduction to Distributed Objects and components	1	-	-
3.3	Case study: CORBA – architecture, service	2	-	-
3.4	Distributed file systems, File service architecture	2	-	-
3.5	Case study: Sun Network File System	1	-	-

Module – 4: Time and Global State				
4.1	Clocks, Events and process status	2	-	-
4.2	Synchronizing physical clocks	2	-	-
4.3	Logical time and logical clocks, Global states	3	-	-
4.4	Distributed debugging	1	-	-
Module – 5: Transactions and Concurrency Control				
5.1	Introduction to Transactions, Nested Transactions	3	-	-
5.2	Locks, Optimistic Concurrency Control, Timestamp ordering	4	-	-
5.3	Comparison of methods for concurrency control	1	-	-
	Total No. of Lecture Hours	**40**	-	-
	Total No. of Tutorial Hours		**00**	-
	Total No. of Practical Hours			**00**

Textbook:

1. George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair: Distributed Systems – Concepts andDesign, Fifth Edition, Pearson Publications, 2012.

Reference Book:

1. Maarten van Steen. Andrew S. Tanenbaum: Distributed Systems, Third edition, 2017

Online Resources:

1. www.cdk5.net/corba
2. https://www.coursera.org/specializations/pcdp
3. https://onlinecourses.nptel.ac.in/noc21_cs87/

Code: 21CS7E26 **Course: Embedded Systems**
Credits: 3 **L:T:P – 3:0:0**
SEE: 50% **CIE: 50%**
SEE Hours: 3 **Max. Marks:100**

Prerequisites if any	Operating System, Microprocessor, C programming
Learning objectives	• To describe the fundamentals of Embedded Systems • To understand and design an embedded system application. • To identify the challenges of Concurrent Process and its solutions. • To compare the advantages of the software Architectures and design an embedded system. • To analyze the inter-task communication primitives, embedded software development tools, hardware, and the selection of the Real-Time Operating System (RTOS).

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Understand the fundamentals of embedded systems and apply essential skills to comprehend and craft embedded system applications.	Understand/Apply
CO2	Identify the challenges of Concurrent Process and its solutions.	Apply
CO3	Compare the advantages of the software architectures and design an embedded system	Analyze
CO4	Analyze the inter task communication primitives, Embedded Software Development Tools and the hardware along with the choice of the RTOS	Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	-	3	2	-	-	-	-	-	-	-	-		2	-
CO2	3	3		-	-	-	-	-	-	-	-	-		1	-
CO3	3	2	3	-	-	-	-	-	-	-	-	-		1	-
CO4	3	1	-	-	-	2				3	1	-		2	-

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl. No.	Module Name	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
	Module – 1:			
1.1	Custom single-purpose processor design	1	-	-
1.2	RT-level custom single-purpose processor design	1	-	-
1.3	Optimizing custom single-purpose processors	1	-	-
1.4	optimizing the FSMD, Optimizing the data-path,	2	-	-
1.5	optimizing the FSM. Optimizing the original program	2	-	-
1.6	Timers,counters and watchdog timers	1	-	-

Module – 2:				
2.1	An introductory example, A basic state machine model. State machine models: Introduction; finite-state machines (FSM)	2	-	-
2.2	Finite-state machines with data path model (FSMD); Using state machines	2	-	-
2.3	Describing a system as a state machine, Comparing state machine and sequential program models	2	-	-
2.4	Capturing a state machine model in a sequential programming language	1	-	-
2.5	Hierarchical/Concurrent state machine model (HCFSM) andthe State charts language; Program state machine model (PSM)	1	-	-
Module – 3:				
3.1	Concurrent process models: Concurrent processes:	1	-	-
3.2	Process create and terminate, Process suspend and resume, Process join; Communication among processes	1	-	-
3.3	Shared memory, Message passing; Synchronization among processes	2	-	-
3.4	Condition variables, Monitors	2	-	-
3.5	Interrupt Basics. Interrupts: The Shared Data Problem	2	-	-
Module – 4:				
4.1	Survey of Software Architecture: Round Robin. Round Robin with Interrupts,	2	-	-
4.2	Function Queue Scheduling Architecture; Real Time Operating System Architecture, Selecting architecture.	2	-	-
4.3	Introduction to RTOS: Tasks and Task States, Tasks andData,	2	-	-
4.4	Semaphores and shared data.	2	-	-
Module – 5:				
5.1	Basic Design Using an RTOS: Overview, Principles, An Example	2	-	-
5.2	Encapsulating semaphores and Queues, Hard Real-Time Scheduling Considerations.	2	-	-
5.3	Embedded Software Development Tools: Host and Target Machines	2	-	-
5.4	Linker/Locator for Embedded Software, getting embedded software into the Target System, Saving Power	2	-	-
	Total No. of Lecture Hours	**40**	-	-
	Total No. of Tutorial Hours		**00**	**-**
	Total No. of Practical Hours			**00**

Textbook:

1. Textbook 1: Embedded System Design: A Unified Hardware/ Software Introduction - Frank Vahid, Tony Givargis, John Wiley & Sons, Inc.2002
2. Textbook 2 An Embedded Software Primer - David E. Simon: Pearson Education, 1999.

Reference Book:

1. Reference book 1: Embedded C: Michael J. Pont, Pearson Education (2002).
2. Reference book 2: Real-Time Systems and Programming Languages: Alan Burns and Andy Wellings

Online Resources:

1. Online Resource 1: Introduction to Embedded System Design - Course (nptel.ac.in)
2. Online Resource 2: Real-Time Embedded Systems Specialization [4 courses] (CU Boulder) | Coursera

Code: 21CS7E27 **Course: Block chain Architecture**
Credits: 3 **L:T:P 3:0:0**
SEE: 50% **CIE: 50%**
SEE Hours: 3 **Max. Marks:100**

Prerequisites if any	Distributed systems and Networking, Cryptography
Learning objectives	• Impart strong technical understanding of Blockchain technologies. • Develop familiarity of current technologies, tools • Introduce application areas and current practices

Cos	Course Outcomes	Bloom's level
CO1	Describe architecture, characteristics, consensus in trust building exercise and Distributed ledger in Blockchain	understand
CO2	Analyze hashing , characteristics , its types and usage of same in blockchain	analyze
CO3	Compare the consensus algorithm used in Blockchain technology and explain the importance of Asymmetric cryptography in Blockchain	apply
CO4	Discuss Bitcoin, Decentralized applications, Ethereum and SMART Contract	understand

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	1		2	2
CO2	3	3	-	-	-	-	-	-	-	-	-	1		2	2
CO3	3	2	-	-	-	-	-	-	-	-	-	1		2	2
CO4	3	2	1	-	-	-	-	-	-	-	-	1		2	2

Sl. No.	Module Name	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
	Module – 1: Introduction to Blockchain			
1.1	Introduction, Concepts of Blockchain, History, Definition of Blockchain	1	-	-
1.2	Fundamentals of Blockchain, Characteristics of Blockchain, Consensus in Trust-Building Exercise	1	-	-
1.3	Public, Private, and Hybrid Blockchains, DLT, DLT Applications and databases	2	-	-
1.8	Architecture of Blockchain, Transactions	1	-	-
1.9	Blocks, chaining blocks, transactions, Value proposition of Blockchain Technology	2	-	-

Module – 2: Decentralized System &Hash Functions				
2.1	Introduction, Distributed Decentralized Databases, Decentralized Enterprise	1	-	-
2.2	Decentralization	1	-	-
2.3	Disintermediation	1	-	-
2.4	Hash Functions: Hashing	1	-	-
2.5	MAC	1	-	-
2.6	SHA-1, SHA-256	1	-	-
2.7	Distributed Hash Tables	2	-	-
2.8	Hashing and Data Structures, Hashing in Blockchain Mining	1	-	-
Module – 3: Consensus				
3.1	Introduction, Consensus Approach, Consensus Algorithms-POW	1	-	-
3.2	POS, POA, POET	2	-	-
3.3	POB, Byzantine Agreement Methods, PBFT, DBFT	2	-	-
3.4	Symmetric Cryptography, Asymmetric Cryptography	2	-	-
Module – 4: Bitcoins & Decentralized Applications				
4.1	Introduction, Working of Bitcoin, Merkle Trees, Bitcoin Block Structure	1	-	-
4.2	Bitcoin Address	1	-	-
4.3	Bitcoin Transactions	1	-	-
4.4	Bitcoin Network, Bitcoin Wallets, Bitcoin Payments, Bitcoin Clients, Bitcoin Supply	2	-	-
4.5	Decentralized Applications- Introduction, Today's Web Applications Requirement	1	-	-
4.6	Mining in Blockchain Bitcoin, Blocks Validation and identification, Bitcoins Creation	1	-	-
4.7	Mining Hardware, Mining Software, Running Miner Software, Executing several miners Reasons for Bitcoin Mining	2	-	-
Module 5: Ethereum and Smart Contract				
5.1	Introduction , Ethereum, History, Ethereum Virtual Machine	1	-	-
5.2	Working of Ethereum, Ethereum Clients, Ethereum Key Pairs	1	-	-
5.3	Ethereum Address, Ethereum Wallets	1	-	-
5.4	Ethereum Transactions, Ethereum Languages	1	-	-
5.5	Ethereum Development Tools	1	-	-
5.6	Smart Contracts- Introduction, SMART Contract	1	-	-

5.7	Benefits of SMART CONTRACT, Absolute and immutable, Contractual Confidentiality , Law Implementation & settlement, characteristics, Hyperledger fabric Architecture	1	-	-
5.22	Supply Chain Management	1	-	-
	Total No. of Lecture Hours	**40**	-	-
	Total No. of Tutorial Hours		**00**	-
	Total No. of Practical Hours			**00**

Textbook:

1. Mastering Blockchain- Distributed Ledger Technology, Decentralization, and Smart Contracts Explained, 2nd Edition by Imran Bashir · 2018
2. Blockchain Technology: Concepts and Applications, by Kumar Saurabh & Ashutosh Saxena, WILEY Emerging Technology Series, First Edition, 2020

Reference Book:

1. Blockchain from concepts to execution, Debajani Mohanty, Second revised edition, BPB Publication, 2021
2. A Practical Guide To Blockchain And Its Applications , PARIKSHIT JAIN , BloomsBury,Edition 2019

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc22_cs44/ - Blockchain and its Applications
2. https://www.youtube.com/watch?v=qOVAbKKSH10, Blockchain Technology Explained (2 Hour Course)

ELECTIVE – 3

Code: 21CS7E31 **Course: Big Data Analytics**
Credits: 3 **L:T:P - 3:0:0**
SEE: 50% **CIE: 50%**
SEE Hours: 03 **Max. Marks: 100**

Prerequisites if any	Programming skills in languages commonly used in data analytics, such as Python, SQL, or Java, as well as familiarity with data manipulation libraries and frameworks.
Learning objectives	• To understand and apply the concepts of Big data analytics,Hadoop eco-system • To enable students to develop applications using databases and built in functionsof Hive

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Understand Big Data concepts and associated technologies for managing large datasets, including the Hadoop ecosystem.	Understand
CO2	Analyze the basics of MapReduce and HBase.	Apply/Analyze
CO3	Analyze the process of virtualizing and processing data through MapReduce.	Apply/Analyze
CO4	Analyze YARN, Mahout, and Hive functionalities.	Apply/Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	1		2	-
CO2	3	2	-	-	3	-	-	-	-	-	-	1		2	1
CO3	3	2	-	3	2	-	-	-	-	-	-	1		2	1
CO4	3	2	-	3	2	-	-	-	-	-	-	1		2	1

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl. No.	Module Name	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
	Module – 1: Getting an Overview of Big Data:			
1.1	**Getting an Overview of Big Data**:What is Big Data?, History of Data Management – Evolution of Big Data, Structuring Big Data, Types of Data,	1		
1.2	Elements of Big Data:Volume, Velocity, Variety ,Veracity, Big Data Analytics, Advantages of Big Data Analytics	2		
1.3	**Exploring the concept of Big Data in Business context**:Use of Big Data in Social Networking, Use of Big Data in Preventing Fraudulent Activities,	2		
1.4	Use of Big Data in Retail Industry, Future of Big Data in Automation Industry	1		

Module – 2: Introducing Technologies for Handling Big Dataand Hadoop Ecosystem				
2.1	**Introducing Technologies for Handling Big Dataand Hadoop Ecosystem**: Distributed and Parallel Computing for Big Data, Introducing Hadoop, How does Hadoop Function?	2		
2.2	Cloud Computing and Big Data, Features of Cloud Computing, Cloud Deployment Models, Cloud Delivery Models,	1		
2.3	Cloud Services for Big Data, Cloud Providers in Big Data Market, In-Memory Computing Technology for Big Data	1		
2.4	Hadoop Ecosystem, Hadoop Distributed File System, HDFS Architecture, Featuresof HDFS,	2		
2.5	MapReduce, Features of MapReduce, HadoopYARN,	1		
2.6	IntroducingHBase,CombiningHBase and HDFS,Sqoop, Flume	1		
Module – 3: Understanding MapReduce Fundamentals and HBase				
3.1	**Understanding MapReduce Fundamentals and HBase**: The MapReduce Framework	1		
3.2	Exploring the Features of MapReduce	1		
3.3	Working of MapReduce,,Exploring Map and Reduce Functions	1		
3.4	Techniques to Optimize MapReduceJobs,Hardware/Network Topology,	1		
3.5	Synchronization, File System, Uses of MapReduce,	1		
3.6	Role of HBase in Big Data Processing,	1		
3.7	Characteristics of HBase	1		
3.8	Installation of HBase	1		
Module – 4: Big Data Technology Foundations and MapReduce,Hadoop YARN and Mahout				
4.1	**Understanding Big Data Technology**: Exploring the Big Data Stack,Virtualization and Big Data,	1		
4.2	Virtualization Approaches.	1		
4.3	Developing a Simple MapReduce Application	1		
4.4	Points to Consider while designing MapReduce	1		
4.5	**Understanding Hadoop YARN Architecture and Mahout:** Background of YARN, YARN Architecture, Working of YARN	1		
4.6	YARN Schedulers, Backward Compatibility with YARN	1		
4.7	YARN Configurations, YARN Commands,Yarn Containers	1		
4.8	What is Mahout?, Machine Learning, Collaborative Filtering	1		
4.9	Clustering, Classification	1		
4.10	Mahout Algorithms, Environment for Mahout.	1		
Module – 5:Exploring Hive				
5.1	**Exploring Hive**: Introducing Hive,	1		
5.2	Hive Services	2		

5.3	Data Types in Hive	1		
5.4	Built-In Functions in Hive	1		
5.6	Hive DDL, Data Manipulation in Hive	1		
5.7	Data Retrieval in Hive, Using Joins in Hive	1		
5.8	Getting Started with Hive Installation	1		
	Total No. of Lecture Hours	**40**	**-**	**-**
	Total No. of Tutorial Hours		**00**	**-**
	Total No. of Practical Hours			**00**

Textbook:

1. Big Data: Black Book, DT Editorial Services, Wiley India Pvt Ltd, 2015 Edition

Reference Book:

1. Big Data Analytics with R and Hadoop, VigneshPrajapati, -Packt Publishing, 2013
2. Michael Minelli, Michehe Chambers, ―Big Data, Big Analytics: Emerging Business Intelligence and AnalyticTrends for Today‘s Business‖, 1st Edition, AmbigaDhiraj,Wiley CIO Series, 2013.
3. Bill Franks, ―Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with AdvancedAnalytics‖, 1st Edition, Wiley and SAS Business Series, 2012.
4. Tom White, ―Hadoop: The Definitive Guide‖, 3rd Edition, O‘reilly, 2012.
5. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data EMCEducation Services, Wiley India Pvt Ltd, 2013

Online Resources:

1. https://nptel.ac.in/courses/106104189

Code: 21CS7E32 **Course: Soft Computing**
Credits: 3 **L:T:P - 3:0:0**
SEE: 50% **CIE: 50%**
SEE Hours: 3 **Max. Marks:100**

Prerequisites if any	Mathematics**,** Machine Learning and Artificial Intelligence
Learning objectives	• To understand various key technologies, fuzzy sets and fuzzy logic used in Soft Computing • To acquire the knowledge on usage of Soft Computing systems in real world • To obtain knowledge on neural network architectures and pattern classifiers

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Discuss key technologies of Soft Computing	Understand
CO2	Analyze the diverse applications of Soft Computing systems across real-world scenarios.	Analyze
CO3	Apply the concepts of fuzzy logic, sets and inference systems	Apply
CO4	Illustrate the neural network architectures and pattern classifiers	Understand

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	1		1	-
CO2	3	3	3	2	-	-	-	-	-	-	-	1		2	2
CO3	3	2	-	-	-	-	-	-	-	-	-	1		2	2
CO4	3	2	3	2	-	-	-	-	-	-	-	1		2	2

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl. No.	Module Name	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
Module – 1: Introduction				
1.1	Introduction to soft computing	2	-	-
1.2	Fuzzy systems and Rough sets	2	-	-
1.3	Artificial Neural Networks	2	-	-
1.4	Search strategies	2	-	-
Module – 2: Fuzzy Sets and Fuzzy Logic				
2.1	Introduction to fuzzy sets, membership functions	2	-	-
2.2	Operations on fuzzy sets, relations	2	-	-
2.3	Crisp Logic, logic basics, fuzzy truth	2	-	-
2.4	Fuzzy rules and reasoning	2	-	-
Module – 3: Fuzzy Inference				
3.1	Fuzzy inference systems, fuzzification of input variables	2	-	-
3.2	Applications of fuzzy operators	2	-	-
3.3	Evaluation of rules, Aggregation, defuzzification	2	-	-
3.4	Controllers	2	-	-

Module – 4: Artificial Neural Networks				
4.1	Introduction, Computation in terms of patterns	2	-	-
4.2	The Mc CULLOCH–PITTS Neural Model	2	-	-
4.3	The perceptron, Neural network architectures	2	-	-
4.4	Activation functions , Learning	2	-	-
Module – 5: Pattern Classifiers				
5.1	Introduction and Hebb nets	2	-	-
5.2	Perceptrons	2	-	-
5.3	ADALINE	2	-	-
5.4	MADALINE	2	-	-
	Total No. of Lecture Hours	**40**	-	-
	Total No. of Tutorial Hours		**00**	**-**
	Total No. of Practical Hours			**00**

Textbook:

1. Introduction to Soft Computing, Neuro Fuzzy and Genetic Algorithms , Samir Chakraborty and UditRoy, Wiley, Publications, 2013 Edition.

Reference Book:

1. Modern Adaptive Fuzzy Control Systems, Ardashir Mohammadzadeh, Mohammad Hosein Sabzalian, Chunwei Zhang, Oscar Castillo, Rathinasamy Sakthivel, Fayez F. M. El-Sousy, Springer Publications,2023 Edition.
2. Studies in Fuzziness and Soft Computing, Publisher Book Series,Germany,Springer Verlag.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc20_cs17/preview
2. https://www.classcentral.com/course/swayam-introduction-to-soft-computing-10053

Code: 21CS7E33 **Course: Data Mining**
Credits: 3 **L:T:P - 3:0:0**
SEE: 50% **CIE: 50%**
SEE Hours: 3 hrs **Max. Marks:100**

Prerequisites if any	DBMS, Machine learning
Learning objectives	• Understand the concepts of Data Mining and Applications • Analysis of various Data Preprocessing Techniques and Data WarehouseImplementation. • Mining Frequent Patterns, Associations, Correlations ,Classification and Prediction

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Understand Data Mining concepts and applications	Understand
CO2	Analyse different Data Preprocessing techniques.	Analyze
CO3	Discuss Data Warehouse Implementation.	Understand
CO4	Analyze Data Cube Computation , Data Generalization, Mining Frequent Patterns, Associations, Correlations , Classification and prediction	Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	2	-	2	1	-	-	-	-	-	-	-		2	-
CO2	3	2	-	2	-	-	-	-	-	-	-	1		2	2
CO3	3	1	2	1	-	-	-	-	-	-	-	1		2	1
CO4	3	2	2	2	1	-	-	-	-	-	-	1		2	2

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl. No.	Module	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
	Module – 1: Data Mining Concepts and Applications			
1.1	Motivation and importance, What is Data Mining, Relational Databases	2	-	-
1.2	Data Warehouses, Transactional Databases, Advanced Database Systems and Advanced Database Applications	3	-	-
1.3	Data Mining Functionalities	2	-	-
1.4	Interestingness of a pattern Classification of Data Mining Systems.	1	-	-
	Module – 2: Data Preprocessing Techniques			
2.1	Data Preprocessing Why Pre-process the Data?	1	-	-
2.2	Data Cleaning	2	-	-
2.3	Data Integration and Transformation	2	-	-
2.4	Data Reduction	2	-	-
2.5	Data Discretization.	1	-	-
	Module – 3: Data Warehouse Implementation			
3.1	Data Warehouse and OLAP Technology for Data Mining	1	-	-
3.2	What is a Data Warehouse? Multi-Dimensional Data Model	2	-	-
3.3	Data Warehouse Architecture	2	-	-
3.4	Data Warehouse Implementation	2	-	-
3.5	Development of Data Cube Technology	1	-	-

Module – 4: Data Cube Computation and Data Generalization				
4.1	Data Cube Computation and Data Generalization: Efficient Methods for Data Cube Computation	4	-	-
4.2	Further Development of Data Cube and OLAP Technology	2	-	-
4.3	Attribute-Oriented Induction—An Alternative Method for Data Generalization and Concept Description	4	-	-
Module – 5: Association and Classification				
5.1	Mining Frequent Patterns, Associations, and Correlations: Basic Concepts and a Road Map	1	-	-
5.2	Efficient and Scalable Frequent Itemset Mining Methods	2	-	-
5.3	Mining Various Kinds of Association Rules	2	-	-
5.4	Classification and Prediction: What Is Classification? What Is Prediction?	2	-	-
5.5	Issues Regarding Classification and Prediction	1	-	-
	Total No. of Lecture Hours	**40**	-	-
	Total No. of Tutorial Hours		**00**	**-**
	Total No. of Practical Hours			**00**

Textbook:

1. Data Mining Concepts and Techniques, Jiawei Han and Micheline Kamber, Morgan Kaufman Publications. 3rd Edition, July 2011.

Reference Book:

1. Introduction to Data Mining, Adriaan, Addison Wesley Publication
2. Data Mining Techniques, A.K.Pujari, University Press

Online Resources:

1. https://hanj.cs.illinois.edu/bk3/bk3_slidesindex.htm
2. https://www.ibm.com/topics/data-mining

Code: 21CS7E34 **Course: Information Retrieval**
Credits: 3 **L:T:P - 3:0:0**
SEE: 50% **CIE: 50%**
SEE Hours: 3 **Max. Marks:100**

Prerequisites if any	Data structures and algorithms, DBMS, Machine Learning and Artificial Intelligence
Learning objectives	• Understand the information retrieval models and pre-processing of web pages. • To acquire the knowledge on Structured Text, Multimedia Information & Web retrieval and web crawling • To gain the knowledge on various Architecture of Enterprise Search Systems

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Discuss the information retrieval models	Understand
CO2	Acquire the knowledge on pre-processing of web page	Apply
CO3	Discuss the structured text, multimedia information retrieval, web retrieval, and web crawling	Apply
CO4	Analyze various Architecture of Enterprise Search Systems	Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	2	-	3	-	-	-	-	-	1	-	2		2	1
CO2	2	2	1	3	-	-	-	-	-	1	-	2		2	2
CO3	2	2	1	3	-	-	-	-	-	1	-	2		2	2
CO4	2	2	2	3	-	-	-	-	-	1	-	2		2	2

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl. No	Module Name	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
Module – 1: Information Retrieval				
1.1	Information Vs Data Retrieval , Information Retrieval Models: Boolean Model	2	-	-
1.2	Vector Space Model, Language Model,	2	-	-
1.3	Multimedia Retrieval , Probabilistic Model,	2	-	-
1.4	Neural Network Model, Precision and Recall	2	-	-
Module – 2: Text and webpage pre-processing				
2.1	Pre-processing Technique, Inverted index	2	-	-
2.2	Latent Semantic Indexing, Web Search	2	-	-
2.3	Simple Ranking Functions, Web Spamming,	2	-	-
2.4	Managing Web Data	2	-	-
Module – 3: Structured Text Retrieval and Multimedia Information Retrieval				
3.1	Structuring Power, Explicit vs. Implicit Structure, Static vs. Dynamic Structure, Single Hierarchy vs. Multiple Hierarchies	2	-	-
3.2	Early Text Retrieval Models, Model Based on Non-Overlapping Lists, Model Based on Proximal Nodes, Ranking Structured Text Results	2	-	-
3.3	What is Multimedia? , Multimedia IR ,Text IR versus	2	-	-

	Multimedia IR ,The Challenges ,The Semantic Gap ,Feature Ambiguity ,Machine-generated Data			
3.4	Content-based Image Retrieval, Color-Based Retrieval, Texture ,Salient Points	2	-	-
Module – 4: Web retrieval and web crawling				
4.1	Search Engine Architectures: Cluster based Architecture, Distributed Architectures	2	-	-
4.2	Search Engine Ranking: Link based Ranking, Simple Ranking Functions, Learning to Rank	2	-	-
4.3	Search Engine User Interaction	2	-	-
4.4	Browsing, Applications of a Web Crawler	2	-	-
Module – 5: Enterprise Search				
5.1	Characteristics and Applications of Enterprise Search, Enterprise Search Software, Workplace Search	2	-	-
5.2	Enterprise Search Tasks, Examples of Search-Supported Tasks, Search Types, Studying Enterprise Search	2	-	-
5.3	Architecture of Enterprise Search Systems, Gathering	2	-	-
5.4	Extracting, Indexing	2	-	-
	Total No. of Lecture Hours	**40**	-	-
		Total No. of Tutorial Hours	**00**	**-**
			Total No. of Practical Hours	**00**

Textbook:

1. Ricardo Baeza-Yates and Berthier Ribeiro-Neto, ―Modern Information Retrieval: The Concepts and Technology behind Search, Second Edition, ACM Press Books.
2. Ricci, F, Rokach, L. Shapira, B.Kantor, ―Recommender Systems Handbook, First Edition.

Reference Book:

1. C. Manning, P. Raghavan, and H. Schütze, ―Introduction to Information Retrieval, Cambridge University Press.
2. Stefan Buettcher, Charles L. A. Clarke and Gordon V. Cormack, ―Information Retrieval: Implementing and Evaluating Search Engines, The MIT Press.

Online Resources:

1. https://www.coursera.org/learn/text-retrieval
2. https://www.youtube.com/watch?v=Q72hzU1Z6aQ

Code: 21CS7E35 **Course: Neural Networks**
Credits: 3 **L:T:P - 3:0:0**
SEE: 50% **CIE: 50%**
SEE Hours: 3 **Max. Marks:100**

Prerequisites if any	Basic understanding of mathematics, including calculus and linear algebra, familiarity with programming concepts, AI & ML
Learning objectives	• Comprehend the principles and elements of neural networks, encompassing neuron models and network architectures. • Implement and evaluate single-layer, multilayer perceptron models for solvingpattern recognition tasks. • Apply advanced neural network techniques.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Understand the fundamentals of neural network	Understand
CO2	Apply perceptron models for pattern recognition.	Apply
CO3	Apply advanced neural network techniques for real-world problems.	Apply
CO4	Analyze neural network performance and limitations.	Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	3	-	2	3	-	-	-	-	-	-	1		3	2
CO2	3	3	-	2	2	-	-	-	-	-	-	2		3	2
CO3	3	2	-	2	2	-	-	-	-	1	-	3		3	3
CO4	3	3	-	2	2	-	-	-	-	-	1	2		2	2

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl. No.	Module Name	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
Module – 1: Introduction				
1.1	**Introduction:** A Neural Network, Human Brain, Models of a Neuron	2	-	-
1.2	Neural Network as Graphs, Network Architectures, Knowledge Representation	1	-	-
1.3	Artificial Intelligence and Neural Networks.	1	-	-
1.4	**Learning Process:** Error Correction Learning, Memory Based Learning, Hebbian Learning,	2	-	-
1.5	Competitive, Boltzmann Learning, Credit Assignment Problem	1	-	-
1.6	Memory, Adaption, Statistical Nature of the Learning Process.	1	-	-
Module – 2: Perceptron				
2.1	**Single Layer Perceptron:** Adaptive Filtering Problem, Unconstrained Optimization Techniques, Linear Least Square Filters	3	-	-

2.2	Least Mean Square Algorithm, Learning Curves, Learning Rate Annealing Techniques, Perceptron –Convergence Theorem.	3	-	-
2.3	**Multilayer Perceptron:** Introduction and preliminaries, XOR Problem, Output Representation and Decision Rule.	2	-	-
Module – 3: Back Propagation				
3.1	Back Propagation Algorithm, Heuristics, Back Propagation and Differentiation	2	-	-
3.2	Back Propagation and Differentiation, Hessian Matrix, Generalization	3	-	-
3.3	Cross Validation, Network Pruning Techniques, Virtues and Limitations of Back Propagation Learning, Accelerated Convergence,	2	-	-
3.4	Supervised Learning	1	-	-
Module – 4: Radial-Basis Function Networks				
4.1	Cover's Theorem, Interpolation Problem, Posed Hypersurface Reconstruction problem, Regularization Theory	2	-	-
4.2	Generalized Radial-Basis Function Networks, Approximation properties of Radial-Basis Function Networks,	3	-	-
4.3	Comparison of RBF Networks and Multi-layer Perceptron's, Learning Strategies.	3	-	-
Module – 5: Self-Organization Maps (SOM)				
5.1	Two Basic Feature-Mapping Models, Self-Organization Map, Two Basic Feature-Mapping Models, Self-Organization Map, SOM Algorithm, Properties of Feature Map,	4	-	-
5.2	Computer Simulations, Learning Vector Quantization, Adaptive Patter Classification, Hierarchical Vector Quantization, Contextual Maps.	4	-	-
	Total No. of Lecture Hours	**40**	-	-
	Total No. of Tutorial Hours		**00**	**-**
	Total No. of Practical Hours			**00**

Textbook:

1. *Neural Networks a Comprehensive Foundations*, Simon Haykin, PHI, 2nd Edition.

Reference Book:

1. *Neural Networks and Learning Machines*, Simon Haykin, PHI, 3rd Edition.
2. *Neural Networks - A Classroom Approach,* Sathish Kumar, McGraw Hill Education 2nd Edition.
3. *Introduction to Artificial Neural Systems*, Jacek M. Zurada, JAICO Publishing House Ed. 2006.

Online Resources:

1. https://nptel.ac.in/courses/117105084
2. https://www.coursera.org/programs/faculty-learning-program-iqr5x/learn/introduction-to-deep-learning- with-keras?source=search

Code: 21CS7E36 **Course: Speech and Natural Language Processing**
Credits: 3 **L: T:P - 3:0:0**
SEE: 50% **CIE: 50%**
SEE Hours: 3 **Max. Marks:100**

Prerequisites if any	Familiarity with fundamental problem-solving abilities, logical reasoning, discrete mathematics, Python programming, finite automata, formal languages, as well as foundational concepts in machine learning and artificial intelligence.
Learning objectives	This course aims to help students: • Gain knowledge of natural language concepts and different models. • Apply various NLP techniques in language modeling. • Explore language modeling principles including parsing, tagging, tokenizing, extraction, regular expression, and information retrieval.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Comprehend the principles of text mining.	Understand
CO2	Implement a range of NLP techniques for language processing.	Apply
CO3	Implement suitable Natural Language Processing methods to solve specified problems.	Apply
CO4	Evaluate the NLP concepts employed in both language modeling and processing.	Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	1	-	-	-	-	-	-	-	-	-	1		2	1
CO2	3	2	-	2	2	-	-	-	-	-	-	2		2	2
CO3	3	2	-	2	2	-	-	-	-	1	-	2		2	2
CO4	3	2	-	3	2	-	-	-	-	-	-	2		2	2

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl. No.	Module Name	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
Module – 1: Overview and language modelling				
1.1	Overview: Origins and challenges of NLP-Language and Grammar-Processing Indian Languages	4	-	-
1.2	NLP Applications-Information Retrieval. Language Modelling: Various Grammar- based Language Models.	4	-	-
Module – 2: Word level and syntactic analysis				
2.1	Word Level Analysis: Regular Expressions-Finite-State Automata-Morphological Parsing	3	-	-
2.2	Spelling Error Detection and correction-Words and Word classes-Part-of Speech Tagging	3	-	-
2.3	Syntactic Analysis: Context-free Grammar Constituency-Parsing.	2	-	-
Module – 3: Text Processing				
3.1	Processing Raw Text: Accessing Text from the Web and from Disk, Strings: Text Processing at the Lowest Level, Text Processing with Unicode	3	-	-
3.2	Regular Expressions for Detecting Word Patterns, Useful	3	-	-

	Applications of Regular Expressions,			
3.3	Normalizing Text, Regular Expressions for Tokenizing Text, Segmentation.	2	-	-
Module – 4: Extracting Relations from Text				
4.1	From Word Sequences to Dependency Paths: Introduction, Subsequence Kernels for Relation Extraction, A Dependency-Path Kernel for Relation Extraction and Experimental Evaluation	4	-	-
4.2	Mining Diagnostic Text Reports by Learning to Annotate Knowledge Roles: Introduction, Domain Knowledge and Knowledge Roles, Frame Semantics and Semantic Role Labelling	4	-	-
Module – 5: Information retrieval and lexical resources				
5.1	Information Retrieval: Design features of Information Retrieval Systems-Classical, nonclassical	4	-	-
5.2	Alternative Models of Information Retrieval – valuation Lexical Resources: World Net-Frame Net Stemmers-POS Tagger	4	-	-
	Total No. of Lecture Hours	**40**	-	-
	Total No. of Tutorial Hours		**00**	**-**
	Total No. of Practical Hours			**00**

Textbook:

1. Tanveer Siddiqui, U.S. Tiwary, "Natural Language Processing and Information Retrieval", Oxford University Press, 2008. **(Module 1, Module 2, Module 5)**
2. Anne Kao and Stephen R. Poteet (Eds), "Natural Language Processing and Text Mining", SpringerVerlag London Limited 2007 **(Module 4)**
3. Steven Bird, Ewan Klein, and Edward Loper, "Natural Language Processing with Python" First Edition, O'Reilly Media, Inc., 2019 **(Module 3)**

Reference Book:

1. Daniel Juraf sky and James H Martin, "Speech and Language Processing: An introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", 2nd Edition, Prentice Hall, 2008.
2. James Allen, "Natural Language Understanding", 2nd edition, Benjamin/Cummings publishing company, 1995.

Online Resources:

1. https://nptel.ac.in/courses/106105158

Code: 21CS7E37 **Course: Deep Learning**
Credits: 3 **L:T:P - 3:0:0**
SEE: 50% **CIE: 50%**
SEE Hours: 3 **Max. Marks:100**

Prerequisites if any	Basic understanding of calculus, linear algebra, and programming concepts in Python, AI & ML
Learning objectives	• Implement diverse deep learning architectures effectively for various data modalities and tasks. • Critically evaluate and apply regularization and optimization techniques in deep learning models. • Demonstrate proficiency in deploying and fine-tuning deep learning models for real-world applications.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Understand the fundamentals of deep learning, including network architectures and backpropagation algorithms.	Understand
CO2	Apply recurrent and convolutional neural networks for modeling sequential and image data, respectively.	Apply
CO3	Apply various deep learning techniques with regularization methods and ensemble methods to address real-world challenges in data analysis.	Apply
CO4	Analyze and evaluate different deep generative models for tasks such as data generation and representation learning.	Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	2	-	-	-	-	-	1	-	-	-	1		2	2
CO2	3	2	3	3	-	2	-	-	1	-	-	1		2	2
CO3	3	2	2	3	2	1	-	-	-	-	1	2		2	3
CO4	3	3	1	3	1	1	-	-	-	-	-	-		2	3

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

		No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
Module – 1: Neural Networks				
1.1	**Neural Networks:** What is a neural network, Models of a Neuron, Activation functions, Network Architectures, Knowledge representation, Learning Process.	4	-	-
1.2	**Deep Feedforward Networks:** Multilayer Perceptron, Example: Learning XOR, Gradient-Based Learning, Hidden Units, Architecture Design, Back-Propagation Algorithm	4	-	-
Module – 2: Convolutional Networks				
2.1	**Convolutional Networks:** Convolution Operation, Motivation, Pooling, Convolution and Pooling as an Infinitely Strong Prior, Variants of the basic convolution function, Structured Outputs	4	-	-
2.2	Data types, Efficient Convolution Algorithms, Random or	4	-	-

	Unsupervised features, The Neuroscientific basis for convolutional networks.			
Module – 3: Sequence Modelling				
3.1	Recurrent and Recursive Nets: Unfolding Computational Graphs, Recurrent Neural Networks, Bidirectional RNNs,	3	-	-
3.2	Encoder-Decoder Sequence-to-Sequence Architectures, Deep Recurrent Networks, Recursive Neural Networks	2	-	-
3.3	Echo State Networks, The Long Short-Term Memory and Other Gated RNNs	3	-	-
Module – 4: Autoencoders				
4.1	Undercomplete Autoencoders, Regularized Autoencoders, Representational Power	2	-	-
4.2	Layer Size and Depth, Stochastic Encoders and Decoders, Denoising Autoencoders	3	-	-
4.3	Contractive Autoencoders, Applications of Autoencoders, Variational Autoencoders	3	-	-
Module – 5: Pretrained models				
5.1	**Pretrained models:** Lenet, AlexNet, VGGNet, Densenet, Resnet, Transfer Learning,	3	-	-
5.2	Neural Networks- Hyperparameter Tuning, Regularization and Optimization. Data Augmentation techniques.	3	-	-
5.3	**Other Architectures:** Generative Adversarial Networks, Reinforcement Learning.	2	-	-
	Total No. of Lecture Hours	**40**	-	-
	Total No. of Tutorial Hours		**00**	**-**
	Total No. of Practical Hours			**00**

Textbook:

1. *Deep Learning*, Ian Goodfellow, Yoshua Bengio, Aaron Courville, MIT press, 2016.
2. *Neural Networks and Deep Learning*, Charu C Agarwal, 1st Edition, Springer, 2016.

Reference Book:

1. *Pattern Recognition and Machine Learning*, Christopher M. Bishop, Springer, 2006
2. *Neural Networks: A Systematic Introduction*, Raul Rojas, Springer, 1996.
   Machine Learning: A Probabilistic Perspective, Kevin P. Murphy, MIT Press, 2012

Online Resources:

1. https://nptel.ac.in/courses/106106184

ELECTIVE – 4

Code: 21CS7E41 **Course: Digital Image Processing**
Credits: 3 **L:T:P - 3:0:0**
SEE: 50% **CIE: 50%**
SEE Hours: 3 **Max. Marks:100**

Prerequisites if any	Linear Algebra, Calculus, Probability and statistics, AI & ML
Learning objectives	• Analyze digital images by applying techniques in image enhancement, restoration, and segmentation. • Develop proficiency in utilizing image processing software and implementing algorithms to address practical challenges across diverse application domains.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Explain the basics of digital image acquisition and processing.	Understand
CO2	Apply the different image filters and various noise removal and edge detection techniques for digital images.	Apply
CO3	Discuss segmentation and morphology operations on images.	Apply
CO4	Analyze the various machine learning approaches for image processing	Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	2	2	2	-	-	2	-	-	-	-	1		2	3
CO2	3	3	3	2	3	-	2	-	-	-	-	1		3	3
CO3	3	2	3	2	2	-	2	-	-	-	-	1		3	2
CO4	3	3	3	3	2	2	2	-	-	-	3	3		3	3

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

		No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
MODULE -1: Introduction to Image Processing:				
1.1	What is image processing, Image Acquisition and Sampling, Images and Digital Images, Applications, Image Processing Operations.	4	-	-
1.2	Types of Digital Images, Image File Sizes. Point Processing: Introduction, Arithmetic Operations, Histograms.	4	-	-
MODULE -2: Neighborhood Processing				
2.1	Introduction, Notation, Image Filtering, Low and High Pass Filters, Gaussian Filters.	4	-	-
2.2	Edge Sharpening, Non-linear Filters, Edge-Preserving Blurring Filters.	4	-	-
MODULE -3 Image Restoration				
3.1	A Model of Image Degradation, Image Noise, Salt and Pepper Noise, Gaussian Noise, Noise removal,	6	-	-
3.2	Edge detection: Derivatives and Edges, Second Derivatives.	2	-	-
MODULE -4: Image Segmentation				
4.1	Thresholding, Applications of Thresholding, Choosing an Appropriate Threshold Value, Adaptive Thresholding.	5	-	-
4.2	Mathematical Morphology: Dilation and Erosion, Opening and Closing	3	-	-

MODULE -5: Image Processing with Machine Learning-Case studies				
5.1	Feature Mapping Using the SIFT Algorithm, Image Classification Using Artificial Neural Networks, Image Classification Using CNNs,	6	-	-
5.2	Image Classification using- SVM, Decision Trees, & Logistic regression.	2		
	Total No. of Lecture Hours	**40**	-	-
	Total No. of Tutorial Hours		**00**	**-**
	Total No. of Practical Hours			**00**

Textbook:

1. A Computational Introduction to Digital Image Processing, Alasdair McAndrew, Second Edition, CRCPress, ISBN: 978-1-4822-4732-9-5 November 2015,2nd Edition.
2. Practical Machine Learning and Image Processing, Himanshu Singh, ISBN-13: 978-1484241486, Apress-2019

Reference Book:

1. Digital Image Processing, Rafael C. Gonzalez, Richard E. Woods, Third edition, Pearson Prentice Hall
2. The Essential Guide to Image Processing, Alan Bovik, Academic Press, ISBN 13: 978-0123744579

Online Resources:

1. Course era course link: Introduction to Computer Vision and Image Processing Course by IBM | Coursera
2. Nptel course link: Digital Image Processing - Course (nptel.ac.in)

Code: 21CS7E42 **Course: Human Computer Interaction**
Credits: 3 **L:T:P - 3:0:0**
SEE: 50% **CIE: 50%**
SEE Hours: 3 **Max. Marks:100**

Prerequisites if any	Programming Skills, Web development, software engineering
Learning objectives	• To learn the foundations of Human Computer Interaction. • To become familiar with the design technologies for individuals and persons withdisabilities. • To be aware of mobile HCI. • To learn the guidelines for user interface

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Understand the concepts of effective dialog for HCI	Understand
CO2	Discuss design and software process of HCI for individuals and persons with disabilities.	Apply
CO3	Apply principles of cognitive psychology to interface design.	Apply
CO4	Analyze the HCI implications for designing multimedia/ ecommerce/ e-learning Web sites.	Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	-	2	-	2	1	-	-	-	-	-	2		2	2
CO2	2	3	3	-	2	2	-	-	-	-	-	2		2	2
CO3	2	3	3	-	2	2	-	-	-	-	-	2		1	2
CO4	2	3	3	-	2	2	-	-	-	-	-	2		2	2

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl. No	Module Name	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
	Module – 1: FOUNDATIONS OF HCI			
1.1	The Human: I/O channels – Memory – Reasoning and problem solving;	2	-	-
1.2	The Computer: Devices – Memory – processing and networks;	3	-	-
1.3	Interaction: Models – frameworks – Ergonomics – styles – elements – interactivity- Paradigms. - Case Studies	3	-	-
	Module – 2:DESIGN & SOFTWARE PROCESS			
2.1	Interactive Design: Basics – process – scenarios – navigation – screen design – Iteration and prototyping.	2	-	-
2.2	HCI in software process: Software life cycle – usability engineering – Prototyping in practice – design rationale.	3	-	-
2.3	Design rules: principles, standards, guidelines, rules. Evaluation Techniques – Universal Design	3	-	-
	Module – 3:MODELS AND THEORIES			
3.1	HCI Models: Cognitive models:	3	-	-
3.2	Socio-Organizational issues and stakeholder requirements – Communication and collaboration models-Hypertext	3	-	-
3.3	Multimedia and WWW.	2	-	-

Module – 4: MOBILE HCI				
4.1	Mobile Ecosystem: Platforms, Application frameworks	2	-	-
4.2	Types of Mobile Applications: Widgets, Applications, Games- Mobile Information Architecture, Mobile 2.0	3	-	-
4.3	Mobile Design: Elements of Mobile Design, Tools. - Case Studies	3	-	-
Module – 5: WEB INTERFACE DESIGN				
5.1	Designing Web Interfaces – Drag & Drop	2	-	-
5.2	Direct Selection, Contextual Tools, Overlays, Inlays and Virtual Pages	3	-	-
5.3	Process Flow - Case Studies	3	-	-
	Total No. of Lecture Hours	**40**	-	-
	Total No. of Tutorial Hours		**00**	-
	Total No. of Practical Hours			**00**

Textbook:

1. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, ―Human Computer Interaction‖,3rd Edition, Pearson Education, 2004
2. Brian Fling, ―Mobile Design and Development‖, First Edition, O'Reilly Media Inc.,2009
3. Bill Scott and Theresa Neil, ―Designing Web Interfaces‖, First Edition, O'Reilly, 2009.

Reference Book:

1. Designing the User Interface: Strategies for Effective Human-Computer Interaction (5th Edition) Authors: Shneiderman, Plaisant, Cohen, and Jacobs Publisher: Addison Wesley; 5th edition (2009) ISBN: 978-0321537
2. Introduction to Human Factors Engineering (2nd Edition) Authors: Wickens, Lee, Liu, and Gordon-Becker Publisher: Pearson, 2004 ISBN-10: 0131837362

Online Resources:

1. https://archive.nptel.ac.in/courses/106/103/106103115/

Code: 21CS7E43 **Course: Optimization Technique**
Credits: 3 **L:T:P - 3:0:0**
SEE: 50% **CIE: 50%**
SEE Hours: 03 **Max. Marks: 100**

Prerequisites if any	Fundamentals of Mathematics
Learning objectives	• Learn to represent real world problems in the form of mathematical equations andthen apply LPP method • To analyse and apply appropriate simplex technique to solve problems. • To solve dual simplex problems by understanding the relationship between primaland dual forms. • To apply transportation and assignment problems to solve real world problems. • To solve varied problems using game theory.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Understand the importance of Operations Research for problem-solving and apply it to develop and solve linear programming models.	Understand/ Apply
CO2	Analyze and apply Simplex Method for problem solving	Apply/ Analyze
CO3	Apply the Simplex Method to various model forms and convert between primal and dual formulations to solve optimization problems.	Apply
CO4	Analyze the assignment, transportation and game theory methods to solve real world application.	Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	2	3	-	-	-	-	-	-	-	-	1		2	2
CO2	3	3	2	-	-	-	-	-	-	-	-	-		2	1
CO3	3	2	2	-	2	-	-	-	-	-	-	1		1	2
CO4	3	2	2	2	1	2	3	-	-	-	-	2		2	2

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl. No.	Module Name	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
	Module – 1: Introduction			
1.1	The origin, nature and impact of OR	1	-	-
1.2	Defining the problem and gathering data	1	-	-
1.3	Formulating a mathematical model	1	-	-
1.4	Deriving solutions from the model, Testing the model	1	-	-
1.5	Preparing to apply the model	1	-	-
1.6	Implementation	1	-	-
1.7	Introduction to Linear Programming, Prototype example & The linear programming (LP) model.	2	-	-

Module – 2: Introduction to Simplex method				
2.1	**Simplex Method - I:** The essence of the simplex method	1	-	-
2.2	The essence of the simplex method	1	-	-
2.3	Setting up the simplex method	1	-	-
2.4	Algebra of the simplex method	1	-	-
2.6	the simplex method in tabular form	3	-	-
Module – 3: Simplex Method – I and II				
3.1	Adapting to other model forms	1	-	-
3.2	Adapting to other model forms ,Big-M method, Tow phase method	3	-	-
3.3	**Simplex Method – II:** Foundation of simplex method	1	-	-
3.4	The revised simplex method	2	-	-
3.5	A fundamental insight	1	-	-
Module – 4: Duality Theory				
4.1	The essence of duality theory	1	-	-
4.2	Economic interpretation of duality	1	-	-
4.3	Primal dual relationship	2	-	-
4.5	Adapting to other primal forms	1	-	-
4.6	Dual Simplex Method	3	-	-
Module – 5: Transportation and Assignment Problems, Game Theory				
5.1	The transportation Problem	2	-	-
5.2	The assignment problem.	2	-	-
5.3	The formulation of two persons	1	-	-
5.4	zero sum games	1	-	-
5.5	Solving simple games- a prototype example	1	-	-
5.6	Games with mixed strategies	1	-	-
	Total No. of Lecture Hours	**40**	-	-
	Total No. of Tutorial Hours		**00**	**-**
	Total No. of Practical Hours			**00**

Textbook:

1. Frederick S. Hiller and Gerald J. Lieberman: Introduction to Operations Research: Concepts and Cases, 9th Edition, Tata McGraw Hill, 2010
2. Operation Reserch Paperback – 1 January 1976 by PK Gupta (Author), D.S Hira (Author)

Reference Book:

1. Wayne L. Winston: Operations Research Applications and Algorithms, 4th Edition, Cengage Learning, 2003
2. Hamdy A.Taha : Operations Research An Introduction, 10th Edition, Pearson

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc22_ma48/preview
2. https://www.classcentral.com/course/swayam-operations-research-14219

Code: 21CS7E44 **Course: Intelligent Systems**
Credits: 3 **L:T:P - 3:0:0**
SEE: 50% **CIE: 50%**
SEE Hours: 3 **Max. Marks: 100**

Prerequisites if any	Programming skills, Data structure, AI & ML, DBMS
Learning objectives	• To understand basic concepts of RPA • To describe RPA, its application and implementation • To describe the different types of variables, Control Flow and data manipulation techniques • To understand Image, Text and Data Tables Automation • To describe various types of Exceptions and strategies to handle

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Describe the basic concepts and platforms of RPA	Understand
CO2	Explain various control techniques and OCR in RPA	Understand
CO3	Implement different types of variables, control flow and data manipulation techniques	Apply
CO4	Analyze various types and strategies to handle exceptions	Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	1	-	1	-	-	-	-	-	-	-	1		1	1
CO2	3	1	-	-	2	-	-	-	-	-	-	1		2	1
CO3	2	3	3	2	3	-	-	-	-	-	-	1		2	1
CO4	2	3	3	-	3	-	-	-	-	1	-	1		2	1

Mapping Strength: **Strong– 3** **Medium – 2** **Low – 1**

Course Structure

Sl. No.	Module Name	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
	Module – 1: RPA Introduction			
1.1	RPA Foundations, What is RPA –, Flavors of RPA, History of RPA, The Benefits of RPA	1	-	-
1.2	The downsides of RPA, RPA Compared to BPO, BPM and BPA ,Consumer Willingness for Automation	1	-	-
1.3	The Workforce of the Future, RPA Skills On Premise Vs. the Cloud, Web Technology, Programming Languages and Low Code	3	-	-
1.4	OCR-Databases-APIs- AI-Cognitive Automation-Agile, Scrum, Kanban and Waterfall0 DevOps- Flowcharts	3	-	-
	Textbook 1: Ch 1, Ch 2			
	Module – 2: RPA Platforms			
2.1	Components of RPA, RPA Platforms, About Ui Path, About UiPath	2	-	-
2.2	The future of automation , Record and Play	2	-	-

2.3	Record and Play , Downloading and installing UiPath Studio	2	-	-
2.4	Learning Ui Path Studio, Task recorder , Step-by-step examples using the recorder	2	-	-
	Textbook 2: Ch 1, Ch 2			
Module – 3: Sequence, Flow chart and Control flow				
3.1	Sequencing the workflow Activities	1	-	-
3.2	Control flow, various types of loops, and decision making-Step-by-step example using Sequence and Flowchart-Step-by-step example using Sequence and Control flow	3	-	-
3.3	Data Manipulation, Variables and Scope Collections, Arguments -Purpose and Use, Data table usage with examples	2	-	-
3.4	Clipboard management-File operation with step-by-step example-CSV/Excel to data table and vice versa (with a step-by-step example)	2	-	-
	Textbook 2: Ch 3, Ch 4,			
Module – 4: Taking Control of the Controls				
4.1	Finding and attaching windows- Finding the control- Techniques for waiting for a control- Act on controls – mouse and keyboard activities	4	-	-
4.2	Working with UiExplorer- Handling events- Revisit recorder- Screen Scraping- When to use OCR- Types of OCR available- How to use OCR- Avoiding typical failure points	4	-	-
	Text book 2: Ch 5			
Module – 5: Exception Handling				
5.1	Exception Handling, Debugging, and Logging	1	-	-
5.2	Exception handling- Common exceptions and ways to handle them	2	-	-
5.3	Logging and taking screenshots	2	-	-
5.4	Debugging techniques- Collecting crash dumps- Error reporting- Future of RPA	3	-	-
	Text book 2: Ch 8 Text book 1: Ch 13			
	Total No. of Lecture Hours	**40**	-	-
	Total No. of Tutorial Hours		**00**	**-**
	Total No. of Practical Hours			**00**

Textbook:

1. Tom Taulli, The Robotic Process Automation Handbook : A Guide to Implementing RPA Systems,2020, ISBN-13 (electronic): 978-1-4842-5729-6, Publisher : A press
2. Alok Mani Tripathi, Learning Robotic Process Automation, Publisher: Packt Publishing, March 2018 ISBN: 9781788470940

Reference Book:

1. Frank Casale, Rebecca Dilla, Heidi Jaynes ,Lauren Livingston,"Introduction to Robotic Process Automation: a Primer", Institute of Robotic Process Automation
2. Srikanth Merianda, Robotic Process Automation Tools, Process Automation and their benefits: Understanding RPA and Intelligent Automation

Online Resources:

1. https://www.uipath.com/rpa/ro
2. https://www.coursera.org/specializations/roboticprocessautomation

Code: 21CS7E45 **Course: Social Networks**
Credits: 3 **L:T:P – 3:0:0**
SEE: 100 Marks **CIE: 50 Marks**
SEE Hours: 3 **Max. Marks:100**

Prerequisites if any	Graph theory, Statistics, Machine Learning, Data Structures
Learning objectives	• To apply concepts of graph theory • Able to distinguish between strong and weak ties. • To characterize the structure of network and label the link formation. • To analyze the cascading behavior of network

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Interpret the network structure by applying the concepts of graph theory.	Understand
CO2	Analyze the behavioral models in various environments of social networks.	Analyze
CO3	Illustrate link analysis and cascading behavior in social networks.	Apply/ Analyze
CO4	Analyze different interactions in Social networks.	Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	2	3	2	-	-	-	-	-	-	-	1		2	1
CO2	3	1	2	-	-	-	-	-	-	-	-	2		1	2
CO3	3	2	3	-	-	-	-	-	-	-	-	1		1	2
CO4	3	1	3	-	-	-	-	-	-	-	-	1		1	1

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl. No.	Module Name	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
	Module – 1			
1.1	Overview: Aspects of Networks	1	-	-
1.2	Central Themes and Topics	1	-	-
1.3	Graph Theory and Social Networks Graphs Basic Definitions	1	-	-
1.4	Paths and Connectivity	1	-	-
1.5	Datasets: An Overview	1	-	-
1.6	Distance and Breadth-First Search Network	2	-	-
	Module – 2			
2.1	Strong and Weak Ties :Triadic Closure	1	-	-
2.2	The Strength of Weak Ties Tie Strength and Network	1	-	-
2.3	Structure in Large-Scale Data Tie Strength	1	-	-
2.4	Social Media	1	-	-
2.5	Passive Engagement	1	-	-
2.6	Closure, Structural Holes, and SocialCapital	2	-	-
	Module – 3			
3.1	Networks in Their Surrounding Contexts Homophily Mechanisms Underlying Homophily	1	-	-
3.2	Selection and Social Influence Affiliation	1	-	-

3.3	Tracking Link Formation in On-Line Data Positive and Negative	2	-	-
	Relationships Structural Balance			
3.4	Characterizing the Structure of Balanced Networks	2	-	-
3.5	Applications of Structural Balance	2	-	-
3.6	A Weaker Form of Structural Balance	2	-	-
Module – 4				
4.1	Link Analysis and Web Search	1	-	-
4.2	Searching the Web: The Problem of Ranking Link Analysis using Hubs and Authorities	1	-	-
4.3	PageRank, Applying Link Analysis in Modern Web Search	1	-	-
4.4	Applications beyond the Web	1	-	-
4.5	Advanced Material: Spectral Analysis, Random Walks, and Web Search Cascading Behavior in Networks Diffusion in Networks	1	-	-
4.6	Modeling Diffusion through a Network	1	-	-
4.7	Cascades and Clusters, Diffusion, Thresholds, and the Role of Weak Ties	2	-	-
Module – 5				
5.1	Information Cascades: Following the Crowd Simple Herding Experiment Bayes' Rule: A Model of Decision-Making under Uncertainty Bayes' Rule in the Herding Experiment Simple	2	-	-
5.2	General Cascade	1	-	-
5.3	Sequential Decision-Making Power Laws and Rich-Get-Richer Phenomena : Popularity as a Network Phenomenon	1	-	-
5.4	Power Laws , Rich-Get-Richer Models	1	-	-
5.5	The Unpredictability of Rich-Get-Richer Effects	1	-	-
5.6	The Long Tail	1	-	-
5.7	The Effect of Search Tools and Recommendation Systems .	1	-	-
	Total No. of Lecture Hours	**40**	-	-
	Total No. of Tutorial Hours		**00**	**-**
	Total No. of Practical Hours			**00**

Textbook:

1. Networks, Crowds and Markets by David Easley and Jon Kleinberg, Cambridge University Press, 2010
2. Social and Economic Networks by Matthew O.Jackson, Princeton University Press,2010.

Reference Book:

1. Reference book 1 : "Networks: An Introduction by M.E.J.Newman, a college-level textbook about the science of networks."
2. Reference book 2 : M. E. J. Newman Hardback, Oxford University Press,2010

Online Resources:

1. Social Networks - Course (nptel.ac.in)

Code: 21CS7E46 **Course: Pervasive Computing**
Credits: 3 **L:T:P - 3:0:0**
SEE: 100 Marks **CIE: 50 Marks**
SEE Hours: 03 hour **Max. Marks: 100**

Prerequisites if any	Machine learning ,Java, Computer Networks,
Learning objectives	Gain expertise in pervasive computing architectures, protocols, and middleware Acquire skills in deploying and managing pervasive computing systems to enhance userexperience and optimize resource utilization.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Discuss the different applications that use pervasive computing and also compare the different device technology available.	Understanding
CO2	Assess the different device connectivity using the protocols and use the voice technology in the hand held devices	Apply
CO3	Design and demonstrate some applications using the programming languages	Apply
CO4	Create the user interfaces for a given application and apply the concepts to PDA and to compare the connected devices	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	1	-	-	3	-	-	-	-	-	-	2		1	1
CO2	3	1	-	1	3	-	-	-	-	-	-	2		1	2
CO3	3	3	3	3	3	2	-	-	-	-	-	1		3	2
CO4	3	3	3	3	3	2	-	-	-	-	-	3		2	-

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl. No.	Module Name	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
	Module – 1			
1.1	**Past, present, future:** The vine and fig tree dream	1	-	-
1.2	Pervasive computing, the pervasive computing market,	1	-	-
1.3	m-Business Conclusions and challenges	1	-	-
1.4	Email access via WAP and voice.	1	-	-
1.5	**Device technology:** Hardware, Human-machine interfaces	1	-	-
1.6	Biometrics, Operating systems	1	-	-
1.7	Java for pervasive devices	1	-	-
1.8	**Device connectivity:** Protocols, Security	1	-	-
1.9	Device management	1	-	-
	Module – 2			
2.1	**WAP and beyond:** Introduction	1	-	-
2.2	Components of the WAP architecture	2	-	-
2.3	WAP infrastructure	2	-	-
2.4	WAP security issues	1	-	-
2.5	i-Mode SCCCC	1	-	-
2.6	**Voice technology:** Basics of speech recognition	1	-	-
2.7	Voice standards Speech applications	1	-	-
2.8	Speech and pervasive computing, Security	1	-	-

Module – 3				
3.1	**Personal digital assistants:** History	1	-	-
3.2	Device categories	1	-	-
3.3	**Server-side programming in Java:** Java 2 Enterprise Edition: Overview	1	-	-
3.4	Servlets	1	-	-
3.5	Enterprise Java Beans	1	-	-
3.6	Java Server pages	1	-	-
3.7	Web services	1	-	-
3.8	Model-view-controller pattern	1	-	-
Module – 4				
4.1	Example application: Introduction	1	-	-
4.2	Architecture	2	-	-
4.3	Implementation	1	-	-
4.4	**Access from PCs:** Smart-card-based authentication via the Internet	2	-	-
4.5	Access via WAP: WAP functionality	1	-	-
Module – 5				
5.1	Access from personal digital assistants: Extending the example application to personal digital assistant	3	-	-
5.2	Implementation for connected devices	3	-	-
	Total No. of Lecture Hours	**40**	-	-
	Total No. of Tutorial Hours		**00**	**-**
	Total No. of Practical Hours			**00**

Textbook:

1. Pervasive Computing: Technology and Architecture of Mobile Internet Applications, Jochen Burkhardt, Thomas Schaeck, Horst Henn, Stefan Hepper, Klaus Rindtorff, Pearson Education, April 2002.

Reference Book:

1. Pervasive Computing: the mobile world, Uwe Hansmann, springer, 2nd edition, 2003

Online Resources:

1. https://nptel.ac.in/courses/106106147
2. https://www.coursera.org/learn/conduct-ux-research

Code: 21CS7S01 **Course: Technical Seminar**
Credits: 1 **L:T:P - 0:0:2**
CIE: 50% **Max. Marks: 50 Marks**

Prerequisites if any	NIL
1. Learning objectives	1. Students will acquire in-depth knowledge on specific technical topics. 2. To help students develop practical and technical skills relevant to their fieldof study 3. To familiarize students with current trends, challenges, and opportunities inthe industry. 4. To improve students abilities to communicate technical informationeffectively.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Understand current trends in specific area of interest and recognize the relevance of topic chosen.	Understanding
CO2	Illustrate the importance of topic chosen by Performing literature survey .	Apply
CO3	Assess the complexity of the subject matter and Develop technical report and presentations designed to communicate the fundamental aspects of the topic effectively.	Apply
CO4	Provide rationale for the remarks and inquiries made by the audience in the questionnaires.	Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	2	-	3	-	-	-	-	-	-	-	-		2	-
CO2	3	3	-	3	-	-	-	-	-	-	-	-		-	-
CO3	3	2	-	3	-	-	-	-	2	3	-	-		2	-
CO4	2	2	-	3	-	-	-	-	2	3	-	-		3	-

Mapping Strength: Strong– 3 Medium – 2 Low – 1

* A Seminar should be given by an individual student based on topics chosen from the emerging areas and technologies of Computer science &Engineering. References from journals such as IEEE, Springer, Science direct etc., shall be used. A presentation along technical report with 15-20 pages shall also be prepared.

VIII SEMESTER

Code: 21CS8P01 **Course: Project Work**
Credits: 8 **L:T:P - -:-:-**
SEE: 50% **CIE: 50%**
SEE Hours: 3 **Max. Marks: 100**

Prerequisites if any	Knowledge of Computer science and Engineering subjects
Learning objectives	• To effectively utilize oral, written, and visual communication skills. • To demonstrate skill and knowledge of current tools and techniques specific to the professional field of study. • To creatively identify, analyze, and solve real-world problems through critical investigation. • To foster a collaborative environment that enhances teamwork and collective success.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	To develop the ability to identify and articulate a research problem through comprehensive literature review and critical analysis of existing work.	Understand
CO2	Demonstrate competence in designing an effective and innovative solution to the identified problem, integrating theoretical knowledge with practical application.	Apply
CO3	Acquire skills to implement the proposed design using appropriate methodologies and tools. Ensuring functionality, efficiency, accuracy, reliability, and performance of the solution through testing.	Analyze & Evaluate
CO4	Enhance technical writing skills by preparing a detailed report documenting the entire project work, and submit the project for publication in a reputed journal or conference.	Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	3	-	-	-	-	3	-	2	-	-	-		3	3
CO2	3	3	3	3	-	-	3	3	3	-	-	3		3	3
CO3	3	3	3	3	3	-	3	3	3	-	3	3		3	3
CO4	-	-	-	2	-	-	-	3	3	3	3	3		2	3

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Code: 21CS8I01 **Course: Research/Industry Internship**
Credits: 8 **L:T:P - -:-:-**
SEE: 50% **CIE: 50%**
SEE Hours: 3 **Max. Marks: 100**

Prerequisites if any	Strong understanding of relevant theoretical concepts and principles in field of computer science and Engineering.
Learning objectives	• Gain a comprehensive understanding of the industry-standard processes for software project development and management. • Learn about the latest technologies and tools used in the industry and understand their relevance to specific projects. • Develop problem-solving skills by tackling real-world challenges and finding innovative solutions. • Understand and adhere to the industry's best practices, standards, and procedures.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Understand the industry-standard process for software project development.	Understanding
CO2	Gain insight into the technologies involved and their relevance to the projects undertaken during the internship.	Apply
CO3	Apply the technologies and processes appropriately to complete assigned tasks within the expected timeline.	Apply
CO4	Demonstrate the technical skills and process knowledge acquired during the internship and summarize the work done in detailed reports.	Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	-	-	-	-	2	2	-	2	-	-	-		2	2
CO2	2	2	-	-	-	2	2	-	2	1	1	-		2	2
CO3	3	3	3	-	3	2	2	3	2	1	1	1		2	2
CO4	1	1	-	2	-	-	-	-	2	2	3	2		2	2

Mapping Strength: Strong– 3 Medium – 2 Low – 1