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POST GRADUATE DEGREE PROGRAMME

MASTER OF COMPUTER APPLICATIONS

Two Years

CURRICULUM & SYLLABUS

REGULATIONS 2026

Effective from the Academic Year 2026 - 2027

Department of Computer Applications (PG)

School of Computing Sciences







VISION OF THE INSTITUTION
To make the Institute an epitome of excellence in higher education by effectively providing high quality education and rigorous training to students in multiple streams of choice with ample scope for all round development to make them excel in their profession for betterment of the society.

MISSION OF THE INSTITUTION	
M1	Effectively imparting knowledge and inculcating innovative thinking.
M2	Facilitating skill enhancement through add on courses and hands on training.
M3	Doing original, socially relevant, high quality research.
M4	Instilling the spirit of integrity, equity, professional ethics and social harmony.

INSTITUTE OF SCIENCE, TECHNOLOGY & ADVANCED STUDIES (VISTAS)
(Deemed to be University Estd. u/s 3 of the UGC Act, 1956)
PALLAVARAM, THALAMBUR, PERIYAPALAYAM, THIRUVANMIYUR - CHENNAI

VISION OF THE DEPARTMENT

To be a centre of **excellence in IT education**, by fostering technical expertise, research aptitude, entrepreneurship, and industry-oriented learning for societal development.

MISSION OF THE DEPARTMENT

M1	Nurturing competent professionals with a deep understanding of emerging technologies across the entire spectrum of Information Technology.
M2	Facilitating multidimensional growth by integrating skill cultivation, leadership development, and extension-oriented engagement.
M3	Striving for excellence through the development of skilled individuals, creative entrepreneurs, and impactful researchers.
M4	Empowering learners through industry collaboration to become successful, ethical, and adaptable professionals committed to lifelong learning, effective problem-solving, and social responsibility.







PROGRAMME OUTCOMES (PO)	
PO1	**Computational Knowledge:** Apply knowledge of computing fundamentals, computing specialization, mathematics – Operation Research and domain knowledge appropriate for the computing specialization to the abstraction and conceptualization of computing models from defined problems and requirements.
PO2	**Problem Analysis:** Identify, formulate, research literature, and solve complex computing problems reaching Substantiated conclusions using fundamental principles of mathematics, Statistical Analysis, computing sciences, and relevant domain disciplines.
PO3	**Design /Development of Solutions:** Design and evaluate solutions for complex computing problems, and design and evaluate systems, components, or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
PO4	**Apply research methods to complex computing problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern Tool Usage:** Create, select, adapt and apply appropriate techniques, resources, and modern computing tools like Tally to complex computing activities, with an understanding of the limitations.
PO6	**Professional Ethics:** Understand and commit to professional ethics and cyber regulations, responsibilities, and norms of professional computing practice.
PO7	**Life-long Learning:** Recognize the need, and have the ability, to engage in independent learning for continual Development as a computing professional.
PO8	**Project management and finance:** Demonstrate knowledge and understanding of the computing 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.
PO9	**Communication Efficacy:** Communicate effectively with the computing community, and with society at large, about complex computing activities by being able to comprehend and write effective reports, design documentation, make effective presentations, and give and understand clear instructions.
PO10	**Societal and Environmental Concern:** Understand and assess societal, environmental, health, safety, legal, and cultural issues within local and global contexts, and the consequential responsibilities relevant to professional computing practice.

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)	
PEO1	Apply advanced computing expertise and contemporary tools to create innovative and scalable solutions that address industry and societal needs.
PEO2	Demonstrate leadership, adaptability, and entrepreneurial capabilities to thrive in rapidly evolving technological and professional ecosystems.
PEO3	Practice ethical decision-making and social responsibility while contributing to sustainable development through impactful computing innovations.
PEO4	Cultivate a culture of inquiry, research, and lifelong learning to sustain professional excellence and career progression.

CURRICULUM STRUCTURE

Master of Computer Applications

Total Number of Credits: 90

SEMESTER 1										
			Hours/Week					Maximum Marks		
Category	Code	Course	L	T	P	SL	C	CIA	SEE	Total
PCC		Mathematical Foundations of Computer Science	3	1	0	4	4	40	60	100
PCC		Problem Solving Techniques & C Programing	4	0	0	4	4	40	60	100
PCC		Operating System with Unix Architecture & Programming	3	0	0	3	3	40	60	100
PCC		Software Engineering Methodology	3	0	0	3	3	40	60	100
PCC		Advanced Database Systems	3	0	0	3	3	40	60	100
PCC		Data Communication and Computer Networks	3	0	0	3	3	40	60	100
SEC		C & Data Structures Laboratory	0	0	2	2	2	40	60	100
PCC LAB		RDBMS Laboratory	0	0	4	2	2	40	60	100
SEC LAB		Communication Skill and Professional Development - I Practical	0	0	4	2	2	40	60	100
		Total	19	1	10	26	26	-	-	-

CIA - Continuous Internal Assessment SEE - Semester End Examination

L – Lecture, T- Tutorial, P- Practical, SL – Self Learning, C - Credit

SEMESTER 2										
			Hours/Week					Maximum Marks		
Category	Code	Course	L	T	P	SL	C	CIA	SEE	Total
PCC		Object Oriented Programming using JAVA	3	1	0	4	4	40	60	100
PCC		Emerging Technologies in Data Processing	4	1	0	5	4	40	60	100
PCC		Design and Analysis of Algorithm	3	1	0	4	4	40	60	100
PEC 1		PEC I	3	0	0	3	3	40	60	100
PEC 2		PEC II	3	0	0	3	3	40	60	100
MDE		Multi Disciplinary Elective	3	0	0	3	2	40	60	100
PCC		Internship/In plant Training	0	0	0	2	1	40	60	100
PCC LAB		Java Programming Laboratory	0	0	4	2	2	40	60	100
PCC LAB		Advanced Python Programming Lab	0	0	4	2	2	40	60	100
		Total	19	3	8	28	26	-	-	-

CIA - Continuous Internal Assessment SEE - Semester End Examination

L – Lecture, T- Tutorial, P- Practical, SL – Self Learning, C - Credit

SEMESTER 3										
			Hours/Week					Maximum Marks		
Category	Code	Course	L	T	P	SL	C	CIA	SEE	Total
PCC		Full Stack Web Development	4	0	0	4	4	40	60	100
PCC		UI & UX Design	4	0	0	4	4	40	60	100
PCC		Financial Accounting	3	1	0	4	4	40	60	100
PEC		PEC III	3	0	0	3	3	40	60	100
PEC		PEC IV	3	0	0	3	3	40	60	100
SEC		Design Thinking and Emotional Intelligence	2	0	0	2	2	40	60	100
SEC		Personality Development-III	2	0	0	2	2	40	60	100
PCC LAB		Full Stack Web Development Laboratory	0	0	4	2	2	40	60	100
PCC LAB		Data Exploration and Visualization Lab	0	0	4	2	2	40	60	100
		Total	21	1	8	26	26	-	-	-

CIA - Continuous Internal Assessment **SEE - Semester End Examination**

L – Lecture, T- Tutorial, P- Practical, SL – Self Learning, C - Credit

SEMESTER 4										
			Hours/Week					Maximum Marks		
Category	Code	Course	L	T	P	SL	C	CIA	SEE	Total
PCC		Research Methodology and IPR	4	0	0	4	4	40	60	100
PRD		*Main Project/ **Industry Project	0	0	12	8	8	40	60	100
		Total	4	0	12	12	12	-	-	-

CIA - Continuous Internal Assessment **SEE - Semester End Examination**

L – Lecture, T- Tutorial, P- Practical, SL – Self Learning, C - Credit

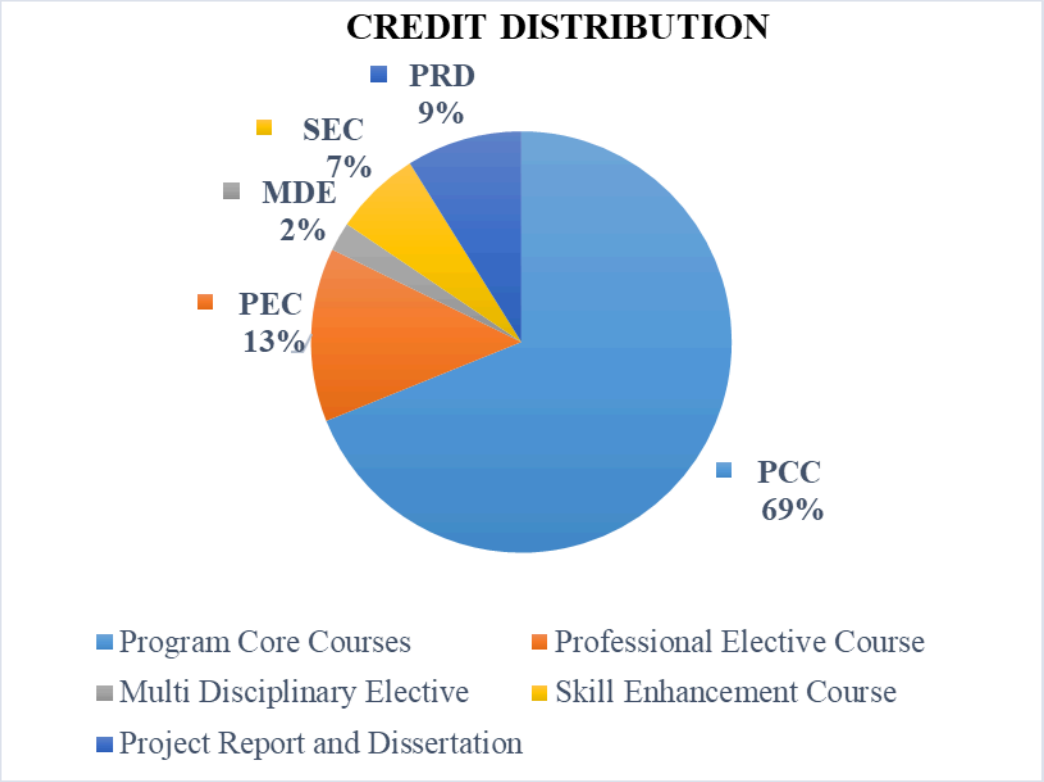
****Artificial Intelligence /Data Science/Cyber Security/Cloud Computing - TCS iON Industry Collaborative Course**

CREDIT DISTRIBUTION

MASTER OF COMPUTER APPLICATIONS

Minimum Credits To Be Earned: 90

COMPONENT	I Sem	II Sem	III Sem	IV Sem	Total Credits
Program Core Courses	24	18	16	4	62
Professional Elective Course	-	6	6	-	12
Multi Disciplinary Elective	-	2	-	-	2
Skill Enhancement Course	2	-	4	-	6
Project Report and Dissertation	-	-	-	8	8
Total Credits	26	26	26	12	90


CREDIT DISTRIBUTION
PRD 9%
SEC 7%
MDE 2%
PEC 13%
PCC 69%
Program Core Courses
Professional Elective Course
Multi Disciplinary Elective
Skill Enhancement Course
Project Report and Dissertation

TCS VERTICALS

IHC New Variant (On-Premise)		
Programme Name	**Intervention**	**Applicable Semester**
MCA – Artificial Intelligence	Statistics using R and Python	II
	Artificial Intelligence for Real World Application	II
	Machine Learning for Real-World Application	III
	Applications of Deep Learning and Neural Networks	III
	Industry Project	III

IHC New Variant (On-Premise)		
Programme Name	**Intervention**	**Applicable Semester**
MCA – Data Science	Statistics using R and Python	II
	Data Analytics and Reporting	II
	Big Data on Cloud	III
	Machine Learning for Real World Application	III
	Industry Project	III

IHC New Variant (On-Premise)		
Programme Name	**Intervention**	**Applicable Semester**
	Statistics using R and Python	II
MCA – Cyber Security	Information Security - Practitioner's Perspective	II
	Practical Approach to Cyber Security	III
	Advanced Cyber Security - An Application Approach	III
	Industry Project	III

IHC New Variant (On-Premise)		
Programme Name	**Intervention**	**Applicable Semester**
MCA – Cloud Computing	Statistics using R and Python	II
	Applied Cloud Computing	II
	Cloud Development	III
	Big Data on Cloud	III
	Industry Project	III

PROFESSIONAL ELECTIVE COURSES (PEC)

Category	Code	Course	L	T	P	SL	C
SEMESTER – II, PEC – I & PEC II							
PEC	PEC001	Blockchain Technologies	3	0	0	3	3
PEC	PEC002	Ethical Hacking & Cyber Security	3	0	0	3	3
PEC	PEC003	Big Data with R	3	0	0	3	3
PEC	PEC004	E-Learning Techniques	3	0	0	3	3
PEC	PEC005	Software Testing	3	0	0	3	3
PEC	PEC006	Deep Learning Techniques and Applications	3	0	0	3	3
PEC	PEC007	Game Programming Techniques	3	0	0	3	3
PEC	PEC008	Multimedia Technologies	3	0	0	3	3
PEC	PEC009	Data Visualization Techniques	3	0	0	3	3
PEC	PEC010	UNIX Programming	3	0	0	3	3
PEC	PEC011	* Statistics and Operations Research Techniques	3	0	0	3	3
PEC	PEC012	**Statistics using R and Python	3	0	0	3	3
PEC	PEC013	*Artificial Intelligence & Machine learning	3	0	0	3	3
PEC	PEC014	**Artificial Intelligence for Real World Application	3	0	0	3	3
PEC	PEC015	**Data Analytics and Reporting	3	0	0	3	3
PEC	PEC016	**Information Security - Practitioner's Perspective	3	0	0	3	3
PEC	PEC017	**Applied Cloud Computing	3	0	0	3	3

SEMESTER – III, PEC – III & PEC – IV							
PEC	PEC018	C# and .NET Programming	3	0	0	3	3
PEC	PEC019	Digital Image Processing and Applications	3	0	0	3	3
PEC	PEC020	Data Warehousing and Data Mining Techniques	3	0	0	3	3
PEC	PEC021	Object Oriented Analysis and Design	3	0	0	3	3
PEC	PEC022	Open Source Software	3	0	0	3	3
PEC	PEC023	Mobile Computing	3	0	0	3	3
PEC	PEC024	IoT & Applications	3	0	0	3	3
PEC	PEC025	Computer Graphics	3	0	0	3	3
PEC	PEC026	Wireless Sensor Networks & Protocols	3	0	0	3	3
PEC	PEC027	Next Generation Networks	3	0	0	3	3
PEC	PEC028	Python Web Development	3	0	0	3	3

PEC	PEC029	Software Project Management and Quality Assurance	3	0	0	3	3
PEC	PEC030	Quantum Computing	3	0	0	3	3
PEC	PEC031	Evolutionary Computing	3	0	0	3	3
PEC	PEC032	Data Mining and analytics	3	0	0	3	3
PEC	PEC033	Multi-dimensional Data Structures	3	0	0	3	3
PEC	PEC034	Multicore Programming	3	0	0	3	3
PEC	PEC035	*Cloud Computing	3	0	0	3	3
PEC	PEC036	SAP in Data Processing – Technical Course	3	0	0	3	3
PEC	PEC037	**Machine Learning for Real-World Application	3	0	0	3	3
PEC	PEC038	**Big Data on Cloud	3	0	0	3	3
PEC	PEC039	**Practical Approach to Cyber Security	3	0	0	3	3
PEC	PEC040	**Cloud Development	3	0	0	3	3
PEC	PEC041	*Cryptography and Cyber Security	3	0	0	3	3
PEC	PEC042	**Applications of Deep Learning and Neural Networks	3	0	0	3	3
PEC	PEC043	**Machine Learning for Real World Application	3	0	0	3	3
PEC	PEC044	**Advanced Cyber Security - An Application Approach	3	0	0	3	3

MULTI DISCIPLINARY ELECTIVES

Category	Code	Course
MDE	MDE1	Energy Conservation and Management in Domestic Sectors
MDE	MDE2	IoT for Smart Systems
MDE	MDE4	Renewable Energy Technology
MDE	MDE5	Smart Grid
MDE	MDE6	Professional Development-II
MDE	MDE7	Medical Robotics
MDE	MDE8	Disaster Management
MDE	MDE9	Environmental Sustainability
MDE	MDE10	IPR, Biosafety and Entrepreneurship
MDE	MDE11	Managerial Economics
MDE	MDE12	Organizational Behaviour

SEMESTER – I

26CMCA11	MATHEMATICAL FOUNDATIONS OF COMPUTER SCIENCE	L	T	P	SL	C
		3	1	0	4	4

COURSE OBJECTIVES

- To introduce the essential concepts of discrete mathematics such as sets, relations, functions, and combinatorics, to equip students with knowledge of matrix algebra for solving systems of equations and understanding Eigen concepts.
- To develop a deep understanding of lattices and Boolean algebra for logical and algebraic reasoning.
- To build the ability to analyse and construct formal logical arguments using propositional and predicate logic.
- To provide foundational knowledge of formal languages and automata for applications in computer science and computation theory.

UNIT I	BASIC SET THEORY	9 Hours

Basic Definitions - Venn Diagrams and set operations - Laws of set theory - Principle of inclusion and exclusion - partitions- Permutation and Combination - Relations- Properties of relations - Matrices of relations - Closure operations on relations - Functions - injective, surjective and bijective functions.

UNIT II	MATRIX ALGEBRA	9 Hours

Matrices, Rank of Matrix, Solving System of Equations-Eigen Values and Eigen Vectors- Inverse of a Matrix - Cayley Hamilton Theorem

UNIT III	LATTICES AND BOOLEAN ALGEBRA	9 Hours

Partial ordering – Posets – Lattices as posets – Properties of lattices – Lattices as algebraic systems – Sub lattices – Direct product and homomorphism – Some special lattices – Boolean algebra – Sub Boolean Algebra – Boolean Homomorphism.

UNIT IV	MATHEMATICAL LOGIC	9 Hours

Propositions and logical operators-Truth table- Propositions generated by a set, Equivalence and implication - Basic laws- Some more connectives - Functionally complete set of connectives- Normal forms - Proofs in Propositional calculus - Predicate calculus.

UNIT V	FORMAL LANGUAGES AND AUTOMATA	9 Hours

Languages and Grammars-Phrase Structure Grammar-Classification of Grammars-Pumping Lemma for Regular Languages-Context Free Languages- Finite State Automata-Deterministic Finite State Automata (DFA), Non Deterministic Finite State Automata (NFA)-Equivalence of DFA and NFA-Equivalence of NFA and Regular Languages.

TOTAL HOURS: 45 SELF LEARNING HOURS:45

COURSE OUTCOMES:

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

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Describe the fundamental concepts of set theory, relations, functions, and principles of counting using suitable representations.	K2
CO2	Compute solutions to matrix algebra problems involving systems of equations, eigenvalues, eigenvectors, and matrix inverses.	K3
CO3	Examine lattice structures and Boolean algebra systems using order relations, algebraic properties, and homomorphisms.	K4
CO4	Differentiate logical expressions and proof techniques in propositional and predicate logic using truth tables and normal forms.	K4
CO5	Construct grammars and finite automata to demonstrate equivalence between regular languages, DFA, and NFA.	K3

TEXT BOOKS:

1. Discrete mathematics and its applications, by Kenneth H.Rosen Tata McGraw Hill, 8th Edition, 2021. (Unit 1, 2 & 3).
2. Hopcroft and Ullman, Introduction to Automata Theory, Languages and Computation, Narosa Publishing House, Delhi, 2022. (Unit 4,5)

REFERENCE BOOKS:

1. A. Tamilarasi & A. M. Natarajan, Discrete Mathematics and its Application, Khanna Publishers, 2021, 3rd Edition.
2. M. K. Venkataraman, Engineering Mathematics, National Publishing Company, 2021,2nd Edition.

WEB LINKS:

1. https://mrce.in/ebooks/Maths-Discrete%20Mathematics%20&%20its%20Applications%208th%20Ed.pdf
2. https://www-2.dc.uba.ar/staff/becher/Hopcroft-Motwani-Ullman-2001.pdf

NPTEL LINKS:

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_cs53

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	-	-	-	-	2	-	2	-	2	-
CO2	2	3	2	-	2	-	-	-	-	-	3	-
CO3	2	3	-	2	-	2	-	-	-	-	2	-
CO4	2	3	-	3	-	2	-	-	2	-	2	-
CO5	2	3	3	-	3	-	-	-	-	-	-	3
Average	**2.4**	**2.8**	**2.5**	**2.3**	**2.5**	**2.0**	**2.0**	**-**	**2.0**	**-**	**2.2**	**3.0**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	**MCQ**	**Projects**	**observation**	**Demonstration/ Presentation**	**Open book test**

26CMCA12	PROBLEM SOLVING TECHNIQUES & C PROGRAMMING	L	T	P	SL	C
		4	0	0	4	4

COURSE OBJECTIVES

- To understand the basics of algorithmic problem solving and learn to solve problems using C conditionals and loops.
- To define C functions and use function calls to solve problems and use C data structures - lists, tuples, dictionaries to represent complex data.
- To do input/output with files in C language

UNIT I	COMPUTATIONAL THINKING AND PROBLEM SOLVING	12 Hours

Fundamentals of Computing – Identification of Computational Problems - Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Introduction to Problem Solving through programs, the compilation process, Syntax and Semantic errors, Variables and Data Types, Illustrative problems.

UNIT II	BASICS OF C PROGRAMMING	12 Hours

Introduction to programming paradigms – Applications of C Language - Structure of C program–C programming: Data Types - Constants – Enumeration Constants - Keywords – Operators: Precedence and Associativity - Expressions – Input / Output statements, Assignment statements – Decision making statements - Switch statement - Looping statements – Preprocessor directives - Compilation process. Introduction to Arrays: Declaration, Initialization – One dimensional array –Two dimensional arrays- String operations.

UNIT III	FUNCTIONS, POINTERS, STRUCTURES AND UNIONS	9 Hours

Introduction to Arrays: Declaration, Initialization – One dimensional array –Two dimensional arrays- String operations, Modular programming - Function prototype - function definition - function call - Built-in functions (string functions, math functions), Parameter passing: Pass by value - Pass by reference- Recursion, Pointers: Pointer expression, pointer arithmetic, Arrays of

pointers, Function returning pointers - Pointer to function, malloc(), calloc (), free(), Structure: Nested structures – Array of structures, Unions.		
UNIT IV	**OVERVIEW OF DATA STRUCTURES**	**9 Hours**
Overview of Data Structure: Need for Data Structure, Execution Time, Algorithm Analysis, Algorithm Complexity, Space Complexity, Time Complexity, Asymptotic Analysis, Asymptotic Notations. Stack and Queue: operations on stack, polish notations-infix, prefix, postfix, evaluation of post and prefix expressions. Operations on queue: Linear queue, circular queue, Enqueue, Dequeue, isfull(), isempty().		
UNIT V	**UDTs, FILE PROCESSING AND STORAGE CLASSES**	**9 Hours**
UDT: Linked Lists, Graphs – Trees – Traversals – searching and sorting methods – Hashing. Files–Types of file processing: Sequential access - Random access, Command line arguments, Storage classes and Visibility.		

TOTAL HOURS: 60 SELF LEARNING HOURS:60

COURSE OUTCOMES:

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

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Explain computational thinking principles, algorithmic problem-solving strategies, and basic programming concepts used to develop solutions.	K2
CO2	D C programs using control structures, arrays, strings, and input/output operations to solve computational problems.	K3
CO3	Analyse modular programs involving functions, recursion, pointers, structures, unions, and dynamic memory allocation.	K4
CO4	Evaluate the performance of fundamental data structures by examining algorithm complexity, stack and queue operations, and expression evaluation techniques.	K4
CO5	Apply user-defined data structures, file handling mechanisms, and storage classes to develop efficient data-processing applications.	K3

TEXT BOOKS:

1. Reema Thareja, "Programming in C", Oxford University Press, Second Edition, 2022.
2. Kernighan, B.W and Ritchie,D.M, "The C Programming language", Second Edition, Pearson Education, 2021.

REFERENCE BOOKS:

1. Yashwant Kanetkar, Let us C, 17th Edition, BPB Publications, 2022.
2. Byron S. Gottfried, "Schaum's Outline of Theory and Problems of Programming with C", McGraw-Hill Education, 2023.
3. Pradip Dey, Manas Ghosh, "Computer Fundamentals and Programming in C", Second
4. Edition, Oxford University Press, 2022.
5. Anita Goel and Ajay Mittal, "Computer Fundamentals and Programming in C", 1st Edition, Pearson Education, 2023.

WEB LINKS:

1. https://www.w3schools.in/ctutorial.
2. https://nptel.ac.in/courses/programminginbegginers/
3. https://www.wikipedia.org
4. http://ebooks.lpude.in.cprogamming

NPTEL LINKS:

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_cs53

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	-	-		-	2	-	-	-	2	-
CO2	3	3	2	-	3	-	-	-	-	-	3	-
CO3	-	3	2	2	2	-	-	-	-	-	3	-
CO4	2	3	-	3	2	-	-	-	-	-	2	-
CO5	2	2	3	-	-	-	-	-	-	-	3	2
Average	**2.3**	**2.6**	**2.3**	**2.5**	**2.3**	-	**2**	-	-	-	**2.6**	**2**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	**MCQ**	**Projects**	**observation**	**Demonstration/ Presentation**	**Open book test**

26CMCA13	OPERATING SYSTEMS WITH UNIX ARCHITECTURE & PROGRAMMING	L	T	P	SL	C
		3	0	0	3	3

COURSE OBJECTIVES

- To provide an understanding of the major operating system components and describe various features of processes including scheduling, creation and termination also present both software solutions of the critical section problems.
- To describe about memory allocation techniques and virtual memory and explain the UNIX file system architecture and programming

UNIT I	INTRODUCTION TO OPERATING SYSTEMS	9 Hours

Introduction: Definition -Functions of an operating systems – Types of Operating System –Operating System Services – System calls – Operating System Structure (Monolithic, Layered, Microkernel, etc.,) Introduction to Unix/Linux- UNIX Kernel Architecture: Kernel Mode vs User Mode-System Boot Process- Shell and Shell Scripting Basics.

UNIT II	PROCESS MANAGEMENT	9 Hours

Process Concept-Process States-Process Control Block (PCB) - Basics of Inter-process Communication (IPC) - Threads and Multithreading Models. Basic Concepts of CPU Scheduling – Scheduling Criteria– Scheduling Algorithms (FCFS, SJF, Round Robin, Priority Scheduling.

UNIT III	PROCESS SYNCHRONIZATION	9 Hours

Synchronization Tools: Background – Critical Section Problem –Mutex Locks-Semaphores–Semaphores Usage – Semaphores Implementation. Classic Synchronization problems: Dining Philosophers Solutions Using Monitors. Deadlock: System model- Deadlock Characterization-Resource Allocation Graph- Methods for handling Deadlock.

UNIT IV	MEMORY MANAGEMENT and I/O MANAGEMENT	9 Hours

Background – Contiguous Memory Allocation – Memory Allocation Techniques: Paging – Segmentation. Virtual Memory: Demand Paging – Copy-on-Write – Page Replacement Policies: FIFO, Optimal, LRU– Allocation of Frames – Thrashing. Overview of I/O Management.

UNIT V	UNIX SYSTEM PROGRAMMING	9 Hours

Overview-File Systems: Unix File System Architecture- UNIX System Programming: File system hierarchy in Unix- Inodes, file types and permissions-File and Directory Manipulation commands. Basic commands of Shell Programming.

TOTAL HOURS: 45 SELF LEARNING HOURS:45

COURSE OUTCOMES:

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

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Describe the fundamental concepts, services, structures, and system calls of operating systems with reference to UNIX/Linux.	K2
CO2	Illustrate process management concepts including process states, scheduling algorithms, IPC, and multithreading models.	K2
CO3	Classify synchronization mechanisms and deadlock handling techniques using semaphores, monitors, and resource allocation models.	K4
CO4	Examine memory management strategies and I/O management techniques with respect to performance and resource utilization.	K4
CO5	Identify UNIX system programming concepts to perform file, directory, and shell-based operations effectively.	K3

TEXT BOOKS:

1. Silberschatz, Abraham, Greg Gagne and Peter B. Galvin, “Operating System Concepts”, Tenth Global Edition, Wiley, 2022.
2. William Stallings, “Operating Systems: Internals and Design Principles”, Seventh Edition, Pearson Education, 2021.
3. Andrew S. Tanenbaum, “Modern Operating Systems”, 5th edition -Pearson, 2023.

REFERENCE BOOKS:

1. Russ Cox, Frans Kaashoek and Robert Morris, “xv6: A Simple, UNIX – like Teaching Operating System”, Revision 11. (https://pdos.csail.mit.edu/6.828/2021/xv6/book- rev11.pdf)
2. B. Molay, “Understanding Unix/Linux Programming: A Guide to Theory and Practice”, Third Edition, Prentice Hall, 2022.
3. H. M. Deitel, P. J. Deitel, D. R. Choffnes, “Operating Systems”, Third Edition, Pearson Education, 2023.

WEB LINKS:

1. https://www.w3schools.in/ostutorial.
3. https://www.wikipedia.org
4. http://ebooks.lpude.in.operating system

NPTEL LINKS:

1. https://nptel.ac.in/courses/106106144

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	-	-	2	-	-	-	-	-	2	-
CO2	3	3	2	-	2	-	-	-	-	-	2	-
CO3	-	3	2	2	2	-	-	-	-	-	2	-
CO4	2	3	-	3	2	-	-	-	-	-	2	-
CO5	2	2	2		3	-	-	-	-	-	3	-
Average	**2.6**	**2.6**	**2**	**2.5**	**2.2**	-	-	-	-	-	**2.8**	-

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	**MCQ**	**Projects**	**observation**	**Demonstration/ Presentation**	**Open book test**

26CMCA14	SOFTWARE ENGINEERING METHODOLOGY	L	T	P	SL	C
		3	0	0	3	3

COURSE OBJECTIVES

- To understand the concepts of software processes, process models and fundamental process activities and understand the fundamental concepts of requirements engineering & requirements specification and documents.
- To be aware of testing processes, techniques and debugging to solve program defects and to learn how to use software metrics, manage risk, apply basic software quality assurance practices.
- To ensure that software designs, development, and maintenance meet or exceed applicable standards.

UNIT I	INTRODUCTION	9 Hours

Software Characteristics-Comparison with other Engineering disciplines-Software Crisis and Myths-Software life cycle models-Selection of process models for projects- Agile methods-Software Engineering paradigms-cost estimation techniques.

REQUIREMENTS GATHERING: Requirements gathering tasks – Requirements Engineering Process - Qualities of good requirements-Types of Requirements-Requirements elicitation-Requirements documentation- Analysis Documentation.

UNIT II	FUNCTIONAL ORIENTED APPROACH	9 Hours

Functional Decomposition-Context diagram - Data flow diagrams - Data Dictionary- Functional Independence-Modular Design-Coupling-Cohesion- Design tools – Structured Chart, HIPO Diagram, Decision Tree, Decision Table, Pseudo code – User Interface Design - Software Design Documentation.

UNIT III	OBJECT ORIENTED APPROACH	9 Hours

Objects and Classes-Object Identification-Relationship among objects-classification-Use cases-UML Diagrams to support Object Oriented Analysis and Design.

UNIT IV	PROGRAMMING STANDARDS AND CODING	9 Hours

Structured programming coding standards-Maintainability of code.

SOFTWARE TESTING FUNDAMENTALS: Black-Box and White-Box testing – Basis Path testing – Requirements phase testing - Design phase testing - Program phase testing - Desk debugging and program

peer view test tools - Evaluating test results - Installation phase testing - Acceptance testing – Testing GUI – Testing Web Applications.

UNIT V	DEBUGGING	9 Hours

The art of Debugging – Debugging Process – Debugging Strategies.

MANAGEMENT AND METRICS

Software Configuration Management – Project management concepts – Process and Project Metrics – Software Cost Estimation – Project scheduling – Risk Management – Software Quality Assurance – Maintenance and Re – engineering – CASE Tools.

TOTAL HOURS: 45 SELF LEARNING HOURS:45

COURSE OUTCOMES:

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

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Explain software engineering principles, life-cycle models, requirement engineering activities, and cost estimation techniques.	K2
CO2	Develop functional-oriented software designs using DFDs, data dictionaries, modular design principles, and user interface guidelines.	K3
CO3	Interpret object-oriented concepts and UML diagrams to support software analysis and design.	K2
CO4	Assess software quality through programming standards and systematic testing techniques across different development phases.	K4
CO5	Analyse debugging practices, software metrics, project management strategies, and quality assurance activities for effective software maintenance.	K4

TEXT BOOKS:

1. Roger Pressman S and Bruce Maxim “Software Engineering: A Practitioner’s Approach”, Tata McGraw-Hill, 2022
2. Ian Sommerville, “Software Engineering”, Pearson Education, 2021.

REFERENCE BOOKS:

1. Pankaj Jalote's “Software Engineering: A Precise Approach”, Wiley, 2022
2. James Rumbaugh, Ivar Jacobson and Grady Booch, “The Unified Modeling Language Reference Manual”, Pearson Education, 2021.

WEBLINKS:

1.https://www.w3schools.in/setutorial.
2.https://www.wikipedia.org
3.http://ebooks.lpude.in.softwareengineering

NPTEL LINKS:

1.https://nptel.ac.in/courses/106106144/

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	2	2	2	-	-	-	2	2	-	-	-	2
CO2	-	2	3	-	2	-	-	2	-	-	3	2
CO3	2	2	3	-	-	-	-	-	2	-	2	2
CO4	-	3	2	2	2	2	-	-	-	-	2	-
CO5	-	2	-	2		2	-	3	2	-	-	2
Average	**2**	**2.2**	**2.3**	**2**	**2**	**2**	**2**	**2.3**	**2**	-	**2.3**	**2**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	**MCQ**	**Projects**	**observation**	**Demonstration/ Presentation**	**Open book test**

26CMCA15	ADVANCED DATABASE SYSTEMS	L	T	P	SL	C
		3	0	0	3	3

COURSE OBJECTIVES

- To introduce basic concepts of RDBMS.
- To introduce basic concepts of SQL.
- To introduce the concept of transaction processing.
- To implement the database normalization using normal forms.

UNIT I	INTRODUCTION TO DATABASE SYSTEMS	9 Hours

Overview – Data Models – Database System Architecture – Entity Relationship Model Basic Concepts – Constraints – keys – Design Issues – Entity Relationship Diagram – Weak Entity Sets – Extended E–R Features – Design of an E–R Database Schema – Reduction of E–R Schema to Tables –UML.

UNIT II	RELATIONAL MODEL	9 Hours

Relational Algebra – Extended Relational Algebra Operations – Modification of Database – views – SQL fundamentals – Advanced SQL Features – Embedded QL – Dynamic SQL – QBE.

UNIT III	NORMAL FORMS	9 Hours

Integrity and Security Domain Constraints – referential Integrity – Assertions – Triggers – Security and Authorization – Authorization in SQL – Encryption and Authentication. Relational – Database Design Pitfalls in relational – Database Design – Function Dependencies– Decomposition – Desirable Properties of Decomposition – Normal Forms – Boyce – Codd Normal Forms.

UNIT IV	FILE ORGANIZATION	9 Hours

Storage and File Structures Overview of Physical Storage media – magnetic Disks – RAID – Tertiary Storage – Storage Access – File Organization – Organization of Records in Files – Data – Dictionary Storage – Indexing and hashing.

UNIT V	ORACLE, SQL AND PL/SQL	9 Hours

Introduction to Oracle – DDL,DML and DCL – Aggregate functions – sub queries – join Operations – Views – PL/SQL Block – decision making and Control Structures – Procedure – functions – Sequences – Cursors and Triggers – Example Database Programs.

TOTAL HOURS: 45 SELF LEARNING HOURS:45

COURSE OUTCOMES:

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

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Describe database system concepts, data models, E–R modeling techniques, and schema design principles.	K2
CO2	Construct relational queries using relational algebra and SQL to retrieve and manipulate database information.	K3
CO3	Examine database integrity, security mechanisms, and normalization techniques to achieve efficient relational database design.	K4
CO4	Classify file organization methods, indexing, and hashing techniques for efficient data storage and retrieval.	K4
CO5	Implement database applications using Oracle SQL and PL/SQL programming constructs such as procedures, functions, cursors, and triggers.	K3

TEXT BOOKS:

1. A.Silberchatz, H.Korth, Subarshan, “Database System Concepts”, McGraw – Hill Higher Education, 5th Edition, 2022.
2. Koch and Liney, “Oracle9iThe Complete reference”, McGraw–Hill, 2022.

REFERENCE BOOKS:

1. C.J.Date, “An Introduction to Database Systems”, Pearson Education, Seventh Edition, 2023.
2. Elmasri, Navathe, “Fundamentals of Database Systems, Addison Wesley”, 3rd Edition, 2022.
3. Bipin C. Desai, “An Introduction to Database Systems”, Galgotia Publications Pvt. Limited, 2022.
4. Oracle Database Handbook (Oracle Press) 2023.

WEBLINKS:

1.https://www.w3schools.in/setutorial.
2.https://www.wikipedia.org

NPTEL LINKS:

1. https://onlinecourses.nptel.ac.in/noc22_cs91/

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	2	-
CO2	3	3	2	-	3	-	-	-	-	-	3	-
CO3	2	3	-	2	-	2	-	-	-	-	3	-
CO4	-	2	-	2	2	-	-	-	-	-	2	-
CO5	3	2	-	-	3	-	-	-	2	-	-	3
Average	**2.3**	**2.4**	**2**	**2**	**2.6**	**2**	**-**	**-**	**2**	**-**	**2.3**	**3**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	**MCQ**	**Projects**	**observation**	**Demonstration/ Presentation**	**Open book test**

26CMCA16	DATA COMMUNICATION AND COMPUTER NETWORKS	L	T	P	SL	C
		3	0	0	3	3

COURSE OBJECTIVES

- This course will help to understand the network fundamentals and to explore network layer protocols.
- This course will explore the various application layer functionalities and the link layer services and data communication fundamentals.

UNIT I	NETWORKS FUNDAMENTALS	9 Hours

Components -Data Representation –Data Flow - Networks- Distributed Processing- Network Criteria -Physical Structures - Network Models - Categories of Networks, Interconnection of Networks: The OSI Model- TCP/IP Protocol Suite- Addressing

UNIT II	NETWORK LAYER	9 Hours

Network Layer: Logical addressing, Internetworking, IPv4, IPv6, Transition from IPv4 to IPv6, Tunneling, address mapping, ICMP, IGMP, forwarding, Uni-cast routing protocols, multicast routing protocols.

UNIT III	TRANSPORT LAYER	9 Hours

Transport Layer: Process to process delivery, UDP and TCP protocols, SCTP, data traffic, congestion, congestion control, QoS, integrated services, differentiated services, QoS in switched networks.

UNIT IV	APPLICATION LAYER	9 Hours

Application Layer – Domain name space, DNS in Internet, Remote Logging, Telnet, electronic mail, FTP, WWW, HTTP, SNMP, Multi-media, Network security

UNIT V	FUNDAMENTALS OF DATA COMMUNICATION	9 Hours

Communication Model – Data communications – Data Transmission: Concepts and Terminology, Analog and Digital Transmission, Transmission Impairments – Signal Encoding Techniques: Digital Data and Digital Signals – Multiplexing: FDM, TDM, Multiple Channel Access.

TOTAL HOURS: 45 SELF LEARNING HOURS:45

COURSE OUTCOMES:

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

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Explain the fundamentals of computer networks, network models, addressing schemes, and protocol architectures.	K2
CO2	Illustrate network layer mechanisms including logical addressing, routing protocols, and IPv4/IPv6 operations.	K2
CO3	Analyse transport layer protocols and congestion control techniques to ensure reliable and quality data delivery.	K4
CO4	Assess application layer protocols and network security concepts used in Internet-based services.	K4
CO5	Identify data communication principles, signal encoding methods, and multiplexing techniques for efficient transmission.	K3

TEXT BOOKS:

1. Behrouz A. Forouzan , “Data Communications and Networking “, 6th Edition, Aug’ 2022
2. Larry L. Peterson, Bruce S. Davie, “Computer Networks A Systems Approach, Elsevier Educate, 6th Edition, 2021
3. Larry L. Peterson, Bruce S. Davie, “Computer Networks A Systems Approach, Elsevier Educate, 6th Edition, 2020.
4. James F. Kurose, Keith W. Ross, “Computer Networking: A Top-Down Approach”, 8th Edition, Pearson Education, 2020.

REFERENCE BOOKS::

1. Larry L. Peterson and Bruce S. Davie, “Computer Networks: A Systems Approach”, 6th Edition,
   Morgan Kaufmann Publishers, June 2021.
2. Kurose, Ross: Computer Networking - A Top-Down Approach 8th Global edition, Pearson 202.
3. Jacek Rak, “Resilient Routing in Communication Networks, A Systems Perspective”,Springer,2024

WEBLINKS:

1.https://www.w3schools.in/setutorial.
2.https://www.wikipedia.org

NPTEL LINKS:

1. https://onlinecourses.nptel.ac.in/noc22_cs91/

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	2	-
CO2	3	3	2		2	-	-	-	-	-	2	-
CO3	2	3	2	2	2		-	-	-	-	2	-
CO4	-	2	-	2	2	2	-	-	-	-	2	2
CO5	3	2	-	2	2		-	-	-	-	2	-
Average	**2.7**	**2.4**	**2**	**2**	**2**	**2**	-	-	**2**	**2**	**2**	**2**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	**MCQ**	**Projects**	**observation**	**Demonstration/ Presentation**	**Open book test**

26SMCA11	COMMUNICATION SKILL AND PROFESSIONAL DEVELOPMENT -I PRACTICAL	L	T	P	SL	C
		0	0	2	2	2

COURSE OBJECTIVES

- Develop proficiency in English communication through interactive and practice-based modules.
- Equip students with the necessary skills for effective interpersonal and workplace communication.
- Enhance self-awareness and personality traits crucial for personal and professional development. Build confidence in public speaking, presentations, and group dynamics.
- Strengthen leadership, time management, and teamwork abilities.

UNIT I	BASICS OF COMMUNICATION AND SELF – INTRODUCTION	6 Hours

Principles and Process of Communication, Barriers to communication and overcoming Strategies, Effective Self-introduction in personal and professional settings Verbal and Non-verbal communication cues, Self-introduction – Video recording and Feedback

UNIT II	LISTENING, SPEAKING AND PRONUNCIATION SKILLS	6 Hours

Active and Empathetic Listening, Voice clarity, Modulation, Pitch, and Articulation
Accent Neutralization and Pronunciation practice, Role plays: Customer handling & Team interactions, Audio-based listening comprehension tasks

UNIT III	PUBLIC SPEAKING AND PRESENTATION SKILLS	6 Hours

Techniques of public speaking and speech delivery, Preparing effective PowerPoint presentations Handling stage fear and anxiety, Elevator pitch and storytelling, Peer-assessed presentations using multimedia tools

UNIT IV	GROUP DYNAMICS AND PROFESSIONAL INTERACTION	6 Hours

Group Discussion techniques and strategies, Interview skills: HR and technical rounds,
Conflict resolution and Negotiation techniques, Leadership and Teamwork,
Mock Interviews and Group Discussion

UNIT V	PERSONALITY DEVELOPMENT AND CAREER READINESS	6 Hours

Self-awareness and SWOT analysis, Emotional intelligence and Interpersonal skills Grooming, Etiquette, and Positive body language, Goal Setting, Time Management, and Stress Management Resume and E-mail Writing

TOTAL HOURS: 30 SELF LEARNING HOURS:30

COURSE OUTCOMES:

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

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Describe the principles of effective communication and demonstrate confident self-introduction in academic and professional contexts.	K2
CO2	Practice active listening, clear speaking, and accurate pronunciation for meaningful interpersonal interaction.	K3
CO3	Deliver structured presentations and public speeches using appropriate verbal and visual techniques.	K3
CO4	Demonstrate group discussion, interview, leadership, and negotiation skills for professional environments.	K3
CO5	Apply personality development strategies, emotional intelligence, and career readiness skills in real-life situations.	K3

TEXT BOOKS:

1. Carnegie, Dale. *The Quick and Easy Way to Effective Speaking*, Pocket Books, 2022.
2. Leena Sen. *Communication Skills*, PHI Learning Pvt. Ltd., 2021.
   Alex, K. *Soft Skills: Know Yourself and Know the World*, S. Chand Publishing, 2022.

REFERENCE BOOKS:

1. Meenakshi Raman & Sangeeta Sharma. *Technical Communication: Principles and Practice*, Oxford University Press, 2023.
2. Barun K. Mitra. *Personality Development and Soft Skills*, Oxford University Press, 2021.
3. Andrews, Sudhir. *How to Succeed at Interviews*, Tata McGraw-Hill, 2022.

WEBLINKS:

1.https://www.w3schools.in/setutorial.
2.https://www.wikipedia.org

NPTEL LINKS:

1. https://onlinecourses.nptel.ac.in/noc22_cs91/

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	-	-	2	-	-	2	-	-	3	-	-	2
CO2	2	2	-	-	-	-	3	-	-	-	2	2
CO3	2	-	3	-	-	2	-	2	-	-	-	-
CO4	-	2	3	-	-	-	3	3	-	-	-	-
CO5	2	2	-	-	-	3	-	2	-	-	2	2
Average	**2.0**	**2.0**	**2.6**	**-**	**-**	**2.3**	**3.0**	**2.3**	**3.0**	**-**	**2.0**	**2.0**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
		✔	✔	✔	
Quiz	**MCQ**	**Projects**	**observation**	**Demonstration/ Presentation**	**Open book test**
			✔		

26PMCA11	C & DATA STRUCTURES LABORATORY	L	T	P	SL	C
		0	0	2	2	2

COURSE OBJECTIVES

- This lab provides detailed knowledge of Arrays, Pointers, Stack Operations, Doubly Linked list, Graphs and Recursion.
- Also provide knowledge in Prefix, Post Fix Expression evaluation and tree Traversal techniques using C programming

LIST OF EXPERIMENTS

1. Implement PUSH, POP operations of stack using Arrays.
2. Implement PUSH, POP operations of stack using Pointers.
3. Implement add, delete operations of a queue using Arrays.
4. Implement add, delete operations of a queue using Pointers.
5. Conversion of infix to postfix using stack operations
6. Postfix Expression Evaluation. Prefix Expression Evaluation
7. Addition of two polynomials using Arrays and Pointers.
8. Creation, insertion, and deletion in doubly linked list.
9. Binary tree traversals (in-order, pre-order, and post-order) using linked list.
10. Depth First Search for Graphs using Recursion.
11. Breadth first Search for Graphs using Recursion.

TOTAL HOURS: 60 SELF LEARNING HOURS:60

COURSE OUTCOMES:

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

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Construct stack and queue operations using arrays and pointers.	K3
CO2	Execute expression conversion and evaluation techniques using stack structures.	K3

CO3	Develop polynomial operations using arrays and pointer-based representations.	K3
CO4	Implement linked list and tree traversal techniques using dynamic memory allocation.	K3
CO5	Discover graph traversal algorithms using recursion for solving connectivity problems.	K4

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	-	2	-	-	-	-	-	-	-	-	3	-
CO2	3	3		-	-	-	-	-	-	-	3	-
CO3	-	2	2	-	3	-	-	-	-	-	3	-
CO4	3	3	2	-	3	-	-	-	-	-	3	-
CO5	3	-	2	2	3	-	-	-	-	-	3	-
Average	**3**	**2.3**	**2**	**2**	**3**	-	-	-	-	-	**3**	-

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
		✔	✔		
Quiz	**MCQ**	**Projects**	**observation**	**Demonstration/ Presentation**	**Open book test**
			✔		

26PMCA12	RDBMS LABORATORY	L	T	P	SL	C
		0	0	2	2	2

COURSE OBJECTIVES

- This course will help students to learn and implement important commands in SQL, usage of nested and joint queries, procedures and procedural extensions of databases.
- To understand design and implementation of typical database applications.

LIST OF EXPERIMENTS

1. Create a database table, add constraints (primary key, unique, check, Not null), insert rows, update and delete rows using SQL DDL and DML commands.
2. Create set of tables, add foreign key constraints and incorporate referential integrity.
3. Query the database tables using different 'where' clause conditions and also implement aggregate functions.
4. Query the database tables and explore sub queries and simple join operations.
5. Query the database tables and explore natural, equi and outer joins.
6. Write user defined functions and stored procedures in SQL.
7. Execute complex transactions and realize DCL and TCL commands.
8. Write SQL Triggers for insert, delete, and update operations in database table.
9. Create View and index for database tables with large number of records.
10. Develop a simple GUI based database application and incorporate all the above-mentioned features.

TOTAL HOURS: 60 SELF LEARNING HOURS:60

COURSE OUTCOMES:

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

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Construct database tables using SQL DDL commands by applying integrity constraints such as primary key, foreign key, unique, check, and not-null.	K3
CO2	Organize related database tables by enforcing referential integrity through appropriate key relationships.	K3
CO3	Retrieve and summarize data from database tables using conditional queries, aggregate functions, and nested queries.	K4
CO4	Design advanced database components including joins, views, indexes, triggers, stored procedures, and user-defined functions.	K4
CO5	Integrate SQL programming features to build a simple GUI-based database application.	K4

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	2	-	3	-	-	-	-	-	3	-
CO2	-	-	2	-	3	-	-	-	-	-	3	-
CO3	3	3	2	-	3	-	-	-	-	-	-	-
CO4	3	3	3	2	-	-	-	-	-	-	3	-
CO5	-	3	-	2	3	-	-	-	-	-	3	2
Average	**3**	**2.6**	**2.3**	**2**	**3**	-	-	-	-	-	**3**	**2**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
		✔	✔		
Quiz	**MCQ**	**Projects**	**observation**	**Demonstration/ Presentation**	**Open book test**
			✔		

SEMESTER - II

26CMCA21	OBJECT ORIENTED PROGRAMMING USING JAVA	L	T	P	SL	C
		3	1	0	4	4

COURSE OBJECTIVES

- This subject will help to improve the analytical skills of object-oriented programming.
- It gives formal introduction to Java programming language and helps in learning GUI based application development and network programming.

UNIT I	INTRODUCTION TO JAVA	12 Hours

Introduction to Object Oriented Programming - Process Oriented Vs Object Oriented Programming - OOPs Principles - An Overview of Java - A First Simple Program - Data Types and Variable Operators and Expressions- Control Statements- Type Conversion and casting- Lexical Issues in Java- Arrays: Single Dimension - Multi Dimension - Command Line Arguments.

UNIT II	INTRODUCING OOPS CONCEPTS	12 Hours

Class Fundamentals with Variables and Methods- Declaring objects for accessing variables and methods- Constructors: Default and Parameterized - this keyword, Garbage Collection – Final, finally – finalize - Static keywords - Overloading Methods- Overloading Constructors- objects as Parameters- Returning objects- Inheritance: Basics- Types of Inheritance- Using Super keyword for constructor - Method Overriding – static and dynamic binding.

UNIT III	PACKAGES, INTERFACES AND EXCEPTION HANDLING	12 Hours

Defining a Package - importing a package - Package Example- Access Protection - Abstract classes. Interfaces: Defining and Implementing Interfaces. Exception Handling: Fundamentals- Exception Types- throw- throws and finally - Chained Exceptions

UNIT IV	MULTITHREADED PROGRAMMING AND DELEGATION EVENT MODEL WITH SWING	12 Hours

Java Thread Model - the Main thread- Creating a Thread- Creating Multiple Threads- - Synchronization- Inter Thread Communication. Swing: Features- MVC Connection- Components and Containers- Panes- Simple Swing Application- Delegation Event Model with GUI: Event Classes- Sources and Listeners.

UNIT V	EXPLORING JAVA PACKAGES	12 Hours
Wrapper classes - Object- Math- Runtime - The collection frame work: ArrayList- HashSet and HashMap- String Tokenizer- Calender- Random- Scanner. File class- Streams- Socket- ServerSocket- InetAddress- DatagramSocket- URL- Client-Server Program using Sockets.		

TOTAL HOURS: 60 SELF LEARNING HOURS:60

COURSE OUTCOMES:

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

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Explain the fundamentals of object-oriented programming concepts and basic Java language constructs.	K2
CO2	Apply object-oriented principles such as inheritance, polymorphism, and constructor overloading in Java programs.	K3
CO3	Implement modular Java applications using packages, interfaces, abstract classes, and exception handling mechanisms.	K3
CO4	Analyse multithreaded Java programs and GUI applications using Swing and the delegation event model.	K4
CO5	Develop Java applications utilizing collection frameworks, file handling, and networking concepts for client–server communication.	K4

TEXT BOOKS:

1. Herbert Schildt- "*Java The complete reference"*- 11th Edition- McGrawHill- 2021
2. Timothy budd- "*An introduction to object-oriented programming"*- 3rd Edition- Pearson Education- 2022.

REFERENCE BOOKS:

1. Y. Daniel Liang- "*Introduction to Java Programming Comprehensive Version"*- 10th Edition- Pearson- 2021.
2. Yashwant Kanetkar, Let us C, 17th Edition, BPB Publications, 2022.

WEBLINKS:

1.https://www.w3schools.in/setutorial.
2.https://www.wikipedia.org

NPTEL LINK:

1. https://onlinecourses.nptel.ac.in/noc19_cs84/preview

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	-	-	-	2	-	-	-	-	-	2	-
CO2	3	3	2	-	3	-	-	-	-	-	3	-
CO3	3	-	3	-	3	-	-	-	-	-	3	-
CO4	-	3	2	-	3	-	-	-	-	-	3	-
CO5	3	3	3	-	3	-	-	-	-	-	3	2
Average	**3**	**3**	**2.5**	-	**2.8**	-	-	-	-	-	**2.8**	**2**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	**MCQ**	**Projects**	**observation**	**Demonstration/ Presentation**	**Open book test**

26CMCA22	EMERGING TECHNOLOGIES IN DATA PROCESSING	L	T	P	SL	C
		4	1	0	5	4

COURSE OBJECTIVES

- To provide a strong foundation for data science and application areas related to it and understand the underlying core concepts and emerging technologies in data science and Processing.

UNIT I	FUNDAMENTALS OF DATA SCIENCE	12 Hours

Definition –Data, Data Science – Data Scientist – Data Science Process – Data Preparation – Data Exploration – Data Modelling – Big Data characteristics: Volume, Velocity, Variety, Veracity, Value – Data Processing Paradigms –Data warehouse concepts. Definition: Big Data – general Techniques for Big Data – Advantages and Disadvantages of Big data - Applications for Data Science.

UNIT II	ML- ALGORITHMS AND TOOLS	12 Hours

Artificial Intelligence, Machine Learning: Algorithms– Types of Machine learning algorithms – Deep Learning – Algorithms. Statistics in Data Analytics: Descriptive and Inferential Statistics – Tools: Tableau, Python, Definition; Python-Data Types – Numeric types – Strings – Lists – Tuples – Dictionaries – Sets –Input and output operations. NumPy ndarray - Vectorization Operation - Array Indexing and Slicing - Transposing Array and Swapping Axes - Saving and Loading Array.

UNIT III	DATA ANALYSIS TECHNIQUES	12 Hours

Universal Functions – Averages – Variability. Mathematical and Statistical Functions in Numpy .Data Frames - Indexing, Selection and Filtering in Series and Data Frames -Arithmetic Operations between Data Frames and Series. Basic plotting with matplotlib – creating line plots- scatter plots – subplots – adding annotation and text – Time series Analysis. T Test, Z Test, Anova.

UNIT IV	ENTERPRISE DATA AND APPLICATION ENABLING	12 Hours

ENTERPRISE DATA ENABLING: Enterprise Data - Basis of JDBC, Distributed transactions. ORM, JPA, Hibernate framework, NOSQL in Enterprise applications – CRUD operations and Query Languages.

ENTERPRISE APPLICATION ENABLING: Enterprise Java Beans, Stateless Session Beans, Stateful Session Beans, Message Driven Beans, Entity beans, Accessing and integrating EJBs.		
UNIT V	**ENTERPRISE-WEB PROGRAMMING AND APPLICATIONS**	**12 Hours**
ENTERPRISE-WEB PROGRAMMING: Java Servlets - Java Server pages, State and session management – MVC architecture SPRING frameworks for web tier. SINGLE PAGE WEB APPLICATIONS Angular JS – Java script, Controllers, pages, components, widgets – Data tables, Switching between pages, AJAX programming.		

TOTAL HOURS:60 SELF LEARNING HOURS:60

COURSE OUTCOMES

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Understand fundamentals of data science, big data characteristics and data processing paradigms.	K2
CO2	Explain ML concepts and identify suitable algorithms for different application domains.	K2
CO3	Use Python/NumPy for basic data operations, exploratory data analysis and preprocessing.	K3
CO4	Demonstrate enterprise data handling using technologies such as JDBC, Hibernate, NoSQL, and Enterprise Java Beans (EJB).	K3
CO5	Design and develop web applications using Servlets, JSP, Spring framework, and AngularJS.	K3

TEXT BOOKS:

1. Practical Data Science with R. Nina Zumel, John Mount. Manning, 2022
2. Data Science for business, F. Provost, T Fawcett, 2021
3. R cookbook: proven Recipes for data analysis, statistics and graphics, O'Reilly.

REFERENCE BOOKS:

1. Introducing Data Science, Davy Cielen, Arno D. B. Meysman, Mohamed Ali, Manning Publications Co., 1st edition, 2022.
2. Introduction to Python ProgrammingDo Your First Steps Into Programming with Python By Greytower Corp , 2024
3. Data Visualization using Python Programming- A Technical Guide For Beginners, Researchers and Data Analyst, By Dr.Abhinav, 2023

WEBLINKS:

1. https://spark.apache.org/documentation.html
2. https://kafka.apache.org/documentation/
3. https://flink.apache.org/learn/
4. https://cloud.google.com/architecture/data-processing

NPTEL LINK:

1. https://onlinecourses.nptel.ac.in/noc19_cs84/preview

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	-	-	2	-	-	-	-	-	2	-
CO2	-	3	-	-	2	-	-	-	-	-	3	-
CO3	3	-	2	-	3	-	-	-	-	-	3	-
CO4	3	-	3	2	3	-	-	-	-	-	3	2
CO5	3	3	3	2	3	-	-	-	-	-	3	3
Average	**3**	**2.6**	**2.6**	**2**	**2.6**	-	-	-	-	-	**2.8**	**2.5**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	**MCQ**	**Projects**	**observation**	**Demonstration/ Presentation**	**Open book test**

26CMCA23	DESIGN AND ANALYSIS OF ALGORITHMS	L	T	P	SL	C
		3	1	0	4	4

COURSE OBJECTIVES

- To learn to analyse the performance of algorithms using asymptotic notations.
- To choose appropriate data structures and algorithm design methods for specific Problems.
- To understand how algorithm design impacts program efficiency (time/space).
- To solve real-world problems using techniques like greedy, dynamic programming, and backtracking.

UNIT I	INTRODUCTION TO ALGORITHMS	12 Hours

Definition, Characteristics, Algorithm Analysis (Space and Time Complexity).
Asymptotic Notations: Big O notation, Recurrence Relations: Substitution method, Recursion Tree method, Master Theorem.

UNIT II	DIVIDE AND CONQUER	12 Hours

General Method, Binary Search, Merge Sort, Quick Sort. Strassen's Matrix Multiplication.

UNIT III	GREEDY APPROACH	12 Hours

General Method, Knapsack Problem, Job Sequencing with Deadlines, Minimum-Cost Spanning Trees (Prim's and Kruskal's Algorithm). Optimal Storage on Tapes, Optimal Merge Patterns, Huffman Coding.

UNIT IV	DYNAMIC PROGRAMMING	12 Hours

General Method, Principle of Optimality, Optimal Binary Search Tree, 0/1 Knapsack Problem, Traveling Salesperson Problem, Dice Throw Problem, Matrix Chain Multiplication.

UNIT V	BACKTRACKING & BRANCH AND BOUND	12 Hours

Backtracking: 8-Queens Problem, Hamiltonian Circuit Problem, Subset Sum Problem.
Branch and Bound: Assignment Problem, Traveling Salesperson Problem.
Introduction to NP-Completeness: Clique Problem, Vertex Cover Problem.

TOTAL HOURS: 60 SELF LEARNING HOURS:60

COURSE OUTCOME

Upon successful completion, students will be able to:

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Evaluate the correctness and analyze the complexity (time/space) of algorithms.	K4
CO2	Implement various algorithm design techniques (divide-and-conquer, greedy, dynamic programming).	K3
CO3	Apply appropriate algorithms to solve practical problems.	K3
CO4	Understand and analyze NP-hard and NP-complete problems.	K4
CO5	Perform amortized analysis to determine the efficiency of data structures.	K4

TEXT BOOKS:

Horowitz E., Sahni S., Rajasekaran S., "Fundamentals of Computer Algorithms".

Aho A.V., Hopcroft J.E., Ullman J.D., "The Design and Analysis of Computer Algorithms".

REFERENCE BOOKS:

1. Cormen T.H., Leiserson C.E., Rivest R.L., Stein C., "Introduction to Algorithms".
2. "Algorithmic Thinking, Peak Finding" by Prof. Eric Grimson and Prof. John Guttag.

WEBLINKS:

1. https://onlinecourses.nptel.ac.in/noc19_cs47/
2. https://www.coursera.org/specializations/algorithms
3. https://ocw.mit.edu/courses/6-046j-design-and-analysis-of-algorithms-spring-2015/

NPTEL LINK:

1. https://onlinecourses.nptel.ac.in/noc19_cs84/preview

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	3	-	2	2	-	-	-	-	-	3	-
CO2	3	3	2	-	2	-	-	-	-	-	3	-
CO3	3	-	3	-	2	-	-	-	-	-	3	-
CO4	-	3	-	2	-	-	-	-	-	-	2	-
CO5	3	3	-	3	-	-	-	-	-	-	2	-
Average	**3**	**3**	**2.5**	**2.3**	**2**	-	-	-	-	-	**2.6**	-

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	**MCQ**	**Projects**	**observation**	**Demonstration/ Presentation**	**Open book test**

26PMCA21	JAVA PROGRAMMING LABORATORY	L	T	P	SL	C
		0	0	2	2	2

COURSE OBJECTIVES

- To understand and apply the fundamentals of core Java and to implement inheritance, polymorphism, interfaces, multithreading, networking.
- Developing applications using client side and server side programming.

LIST OF EXPERIMENTS

1. Program to define a structure of a basic JAVA program.
2. Program to define operators, arrays and control structures.
3. Program to define class and constructors. Demonstrate constructors.
4. Program to define class, methods and objects.
5. Program to demonstrate method overloading.
6. Program to define inheritance and show method overriding.
7. Program to demonstrate Packages.
8. Program to demonstrate Exception Handling.
9. Program to demonstrate Multithreading.
10. Program to demonstrate Applet structure
11. Program to demonstrate Network Programming.
12. Java socket programming
13. Implementation of chat client-server application.
14. Implementation of simple http client/server application.
15. Reading websites using URL class

TOTAL HOURS: 60 SELF LEARNING HOURS:60

COURSE OUTCOMES:

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

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Describe the structure of Java programs including data types, operators, arrays, and control statements.	K2
CO2	Implement object-oriented concepts in Java using classes, constructors, methods, inheritance, and polymorphism.	K3
CO3	Demonstrate the use of packages, exception handling, and multithreading to build modular Java applications.	K3
CO4	Analyse Java networking programs involving applets, sockets, URL classes, and client–server communication.	K4
CO5	Design Java-based network applications such as chat systems and simple HTTP client-server applications.	K4

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	-	-	-	2	-	-	-	-	-	2	-
CO2	3	3	2	-	3	-	-	-	-	-	3	-
CO3	-	3	2	-	3	-	-	-	-	-	3	-
CO4	-	3	2	-	3	-	-	-	-	-	3	-
CO5	3	-	3	-	3	-	-	-	-	-	3	2
Average	**3**	**3**	**2.3**	-	**2.8**	-	-	-	-	-	**2.8**	**2**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
		✔	✔		
Quiz	**MCQ .**	**Projects**	**observation**	**Demonstration/ Presentation**	**Open book test**
			✔		

26PMCA22	ADVANCED PYTHON PROGRAMMING LABORATORY	L	T	P	SL	C
		0	0	2	2	2

COURSE OBJECTIVES

- To understand and apply the fundamentals of data science and to implement various concepts using python programming.
- Developing applications using python libraries.

LIST OF EXPERIMENTS

1. Write a program to demonstrate a) Different numeric data types and b) To perform different Arithmetic Operations on numbers in Python
2. Write a program to create, append, and remove lists in Python.
3. Write a program to demonstrate working with tuples and dictionaries in Python.
4. Write a program to compute correlation coefficient using python.
5. Write a program to demonstrate a) arrays b) array indexing such as slicing, integer array indexing and boolean array indexing along with their basic operations in NumPy.
6. Write a program to demonstrate Numpy mathematical functions.
7. Write a program to compute weighted averages in python or using Numpy
8. Write a program to create pandas dataframe using a list of elements.
9. Write a program to compute summary statistics such as mean, median, mode, standard deviation and variance using pandas.
10. Write a program to perform univariate data analysis.
11. Write a program to perform bivariate data analysis.
12. Write a program to demonstrate basic plots in python using Matplotlib

TOTAL HOURS: 60 SELF LEARNING HOURS:60

COURSE OUTCOMES:

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

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Explain Python numeric data types, arithmetic operations, and core data structures such as lists, tuples, and dictionaries.	K2
CO2	Develop Python programs using NumPy arrays, indexing techniques, and mathematical functions for numerical computation.	K3
CO3	Compute statistical measures including correlation, weighted averages, and summary statistics using Python and Pandas.	K3
CO4	Categorize univariate and bivariate datasets using appropriate statistical and exploratory data analysis techniques.	K4
CO5	Visualize data effectively using Matplotlib to interpret patterns and trends in datasets.	K4

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	-	-	-	2	-	-	-	-	-	2	-
CO2	3	3	2	-	3	-	-	-	-	-	3	-
CO3	-	3	-	3	3	-	-	-	-	-	-	-
CO4	3	3	-	3	3	-	-	-	-	-	-	-
CO5	3	-	2	2	3	-	-	-	-	-	3	2
Average	**3**	**2.3**	**2**	**2.6**	**2.8**	-	-	-	-	-	**2.6**	**2**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
		✔	✔		
Quiz	**MCQ**	**Projects**	**observation**	**Demonstration/ Presentation**	**Open book test**
			✔		

26IMCA21	INTERNSHIP	L	T	P	SL	C
		0	0	2	2	2

COURSE OBJECTIVES

- To provide students with hands-on exposure to industry or research environments and real-world problem-solving practices.
- To enable students to apply advanced domain knowledge, technical skills, and modern tools to solve practical or research-oriented problems.
- To develop professional competencies such as analytical thinking, teamwork, communication skills, ethical responsibility, and documentation of work.

COURSE OUTCOMES:

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

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Apply domain-specific knowledge and advanced technical skills to solve real-world industry or research problems	K3
CO2	Analyze practical problems, workflows, or case studies encountered during the internship and propose feasible solutions.	K3
CO3	Use modern tools, technologies, and platforms relevant to the professional or research environment effectively.	K4
CO4	Demonstrate professional competencies such as teamwork, communication, ethical responsibility, and time management in a work environment.	K4
CO5	Document and present internship outcomes, technical work, or learning experiences in a structured and professional manner.	K3

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	3	-	-	3	-	-	-	-	-	3	2
CO2	3	3	-	2	-	-	-	-	-	-	3	2
CO3	2	-	2	-	3	-	-	-	-	-	3	2
CO4	-	-	-	-	-	3	2	3	3	2	-	-
CO5	-	-	-	-	-	-	-	-	3	-	2	2
Average	**2.7**	**2.6**	**2.7**	**2.**	**3**	**3**	**2**	**3**	**3**	**2**	**2.6**	**2.2**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	MCQ	Projects	observation	Demonstration/ Presentation	Open book test

PROFESSIONAL ELECTIVE COURSES

PEC 001	BLOCK CHAIN TECHNOLOGIES	L	T	P	SL	C
		3	0	0	3	3

COURSE OBJECTIVES

- Understand the structure of a block chain and why/when it is better than a simple distributed database.
- Evaluate the setting where a block chain-based structure may be applied, its potential and its limitations.
- Understand how blockchain systems mainly Bitcoin and Ethereum work, Design, build, and deploy smart contracts and distributed applications.

UNIT I	INTRODUCTION	9 Hours

Introduction of block chain- the basic terms about block chain-advent of block chain technology-evolution of block chain technology –block chain mechanism -the advantages introduced by the block chain technology -challenges of block chain adoption -Distinguish different types of block chains.

UNIT II	BITCOIN	9 Hours

Transactions, blocks, mining, scripting, attacks on mining-Building blocks: Hash functions, signature schemes, zero-knowledge proofs, consensus algorithms- Proof of work, proof of stake, proof of burn, proof of storage-Distinguish Proof-of-Work and Proof-of-Stake concepts - Byzantine Fault Tolerance- Sharding - Layer 2 approaches

UNIT III	SMART CONTRACTS	9 Hours

Basic terms about smart contract -the advent of smart contract - the smart contract mechanism-Restate the advantages introduced by the smart contract -challenges of smart contract - different applications of smart contract -Implement hands-on the smart contract using solidity and Ethereum

UNIT IV	PRIVACY ISSUES	9 Hours

Anonymity, mixing techniques, privacy with ZK-Snarks.-Permissioned block chains: Distributed consensus, sharing algorithms, privacy issues.

UNIT V	SCALING ISSUES	9 Hours

Sharding - Layer 2 approaches Lightning networks, Payment networks. Platforms and ledgers: Ethereum, Ripple, Hyper ledger, Algorand, etc –Block chain applications Government- Identity management-Auto executing contracts-Three signature escrow- Triple entry account- Elections and voting.

TOTAL HOURS: 45 SELF LEARNING HOURS:45

COURSE OUTCOMES:

On completion of the course, students will be able to:

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Define the core principles, evolution, categories, and operational mechanisms of blockchain systems.	K2
CO2	Dissect Bitcoin architecture including consensus protocols and cryptographic components.	K4
CO3	Construct secure smart contracts using Solidity within Ethereum frameworks.	K3
CO4	Distinguish privacy-preserving mechanisms and security models in blockchain networks.	K4
CO5	Appraise scalability solutions and emerging blockchain platforms for real-world deployment.	K4

TEXTBOOKS:

1. A. Narayanan, J. Bonneau, E. Felten, A. Miller, S Goldfeder, J. Clark: Bitcoin and Cryptocurrency Technologies, Princeton University Press. 2021.
2. A. M. Antonopoulos: Mastering Bitcoin: Programming the Open Blockchain, O'Reilly, 2022.
3. Nakamoto, S. (2021). Bitcoin: A Peer-to-Peer Electronic Cash System.
4. Bashir, I. (2021). Mastering Blockchain. Packt Publishing.

REFERENCE BOOKS:

1. Draft version of "S. Shukla, M. Dhawan, S. Sharma, S. Venkatesan, 'Blockchain Technology: Cryptocurrency and Applications', Oxford University Press, 2022.
2. J.A.Garay et al, the Bitcoin backbone protocol - analysis and applications eurocrypt 2021 lncs vol 9057, (volii), pp 281-310.
3. R.Pass et al, Analysis of blockchain protocol in asynchronous networks , eurocrypt 2022,
4. Blockchain Basics: A Non-Technical Introduction in 25 Steps, Daniel Drescher
5. Udemy: Ethereum and Solidity: The Complete Developer's Guide.
6. IBM Blockchain Platform Documentation for practical insights.

7. Blockchain Technology for Data Privacy Management, Zibin Zheng, Muhammad Imran, Athman Bouguettaya,2022.

WEBLINKS:

1. https://blockchain.gov.in
2. https://www.blockchain.com

NPTEL LINK:

1. https://nptel.ac.in/courses/106105235

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	–	–	2	–	–	–	–	–	3	2
CO2	2	3	–	2	2	–	–	–	–	–	3	2
CO3	–	2	3	2	3	–	–	–	–	–	3	–
CO4	2	2	–	3	2	2	–	–	–	–	3	–
CO5	–	2	–	2	2	–	3	–	–	–	2	3
Average	**2.33**	**2.20**	**3.00**	**2.25**	**2.20**	**2.00**	**3.00**	**–**	**–**	**–**	**2.80**	**2.33**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	**MCQ**	**Projects**	**observation**	**Demonstration/ Presentation**	**Open book test**

PEC 002	ETHICAL HACKING & CYBER SECURITY	L	T	P	SL	C
		3	0	0	3	3

COURSE OBJECTIVES

- To understand and analyse Information security threats & countermeasures.
- To perform security auditing & testing.
- To understand issues relating to ethical hacking.
- To study & employ network defence measures.
- To understand penetration and security testing issues

UNIT I	ETHICAL HACKING OVERVIEW & VULNERABILITIES	9 Hours

Understanding the importance of security, Concept of ethical hacking and essential Terminologies Threat, Attack, Vulnerabilities, Target of Evaluation, Exploit. Phases involved in hacking.

UNIT II	FOOTPRINTING & PORT SCANNING	9 Hours

Foot printing - Introduction to foot printing, Understanding the information gathering methodology of the hackers, Tools used for the reconnaissance phase. Port Scanning - Introduction, using port scanning tools, ping sweeps, Scripting Enumeration-Introduction, Enumerating windows OS & Linux OS. Various methods of password cracking, Keystroke Loggers, Understanding Sniffers, Comprehending.

UNIT III	INCIDENT AND INCIDENT RESPONSE	9 Hours

Introduction to Security Threats: Introduction, Computer Crimes, Computer Threats and Intrusions, Telecommunication Fraud, Phishing, Identity Theft, Cyber Terrorism and Cyber War – Need for Security: Information Security, OS Security, Database Security, Software Development Security – Security Architecture – Introduction to Incident – Incident Response Methodology – Steps – Activities in Initial Response Phase After Detection of an Incident.

UNIT IV	NETWORK AND EMAIL FORENSICS	9 Hours

Network Evidence – Types of Network Monitoring – Setting Up a Network Monitoring System–

Network Data Analysis – Email Clients – Email Tracing – Internet Fraud –Spam Investigations Mobile Forensics – Subscriber Identity Module (SIM) Investigations – Wireless Device Investigations – PDA Investigations.		
UNIT V	**SYSTEM FORENSICS**	**9 Hours**
Hacking: Investigating Hacker Tools – Ethical Issues – Cybercrime. Forensic and Investigative Tools – Forensic Equipment for Evidence Collection – Post Exploitation.		

TOTAL HOURS: 45 SELF LEARNING HOURS:45

COURSE OUTCOMES:

On successful completion of the course, students will be able to:

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Explain the fundamentals of ethical hacking, security concepts, hacking phases, and common vulnerabilities in computing systems.	K2
CO2	Apply footprinting, port scanning, enumeration, and password cracking techniques using appropriate tools for vulnerability assessment.	K3
CO3	Analyse security incidents by examining cyber threats, attack patterns, and incident response methodologies.	K4
CO4	Investigate network, email, mobile, and wireless evidence using forensic techniques and monitoring tools.	K4
CO5	Classify system-level forensic practices, ethical considerations, and post-exploitation activities in cybercrime investigations.	K4

TEXT BOOKS:

1. CEH official Certfied Ethical Hacking Review Guide, Wiley India Edition, 2022.
2. Bill Nelson, Amelia Phillips, Christopher Steuart, “Guide to Computer Forensics and Investigations”, Delmar Cengage Learning, 2021.
3. Parker, D. B. (2022). Cybersecurity: Protecting critical infrastructure 1st edition Elsevier.
4. Kennes, K., & Möller, S. (2021). Cybersecurity: A practitioner's guide to the fundamentals 1st ed.. Springer.

REFERENCE BOOKS:

1. Kimberly Graves, "Certified Ethical Hacker", Wiley India Pvt Ltd, 2021.

2. Ramachandran V, BackTrack 5 Wireless Penetration Testing Beginner's Guide (3rd ed.). Packt Publishing, 2022.
3. Stallings, W., & Brown, L. (2021). Computer security: Principles and practice (4th ed.). Pearson.
4. Miller, C. (2022). Cybersecurity for beginners: Safeguarding the digital world (1st ed.). Wiley.

WEBLINK:

1. netacad.com/courses/ethical-hacker

NPTEL LINK:

1. https://nptel.ac.in/courses/106105217
2. http://www.digimat.in/nptel/courses/video/106105217/L01.html

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	–	–	2	2	–	–	–	–	3	–
CO2	–	3	2	–	3	–	–	–	–	–	3	2
CO3	–	3	2	3	–	2	–	–	–	–	3	–
CO4	–	2	2	3	3	–	–	–	–	–	3	–
CO5	–	2	–	2	–	3	2	–	–	–	3	–
Average	**3.00**	**2.40**	**2.00**	**2.67**	**2.67**	**2.33**	**2.00**	**–**	**–**	**–**	**3.00**	**2.00**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	**MCQ**	**Projects**	**observation**	**Demonstration/ Presentation**	**Open book test**

PEC 003	BIG DATA WITH R	L	T	P	SL	C
		3	0	0	3	3

COURSE OBJECTIVES

- Be exposed to big data, Learn the different ways of Data Analysis,.
- Be familiar with data streams and Learn the basic understanding of R programming, data structures, functions, how to work with packages, files and know about the data visualization and data management techniques using R tool

UNIT I	INTRODUCTION TO BIG DATA	9 Hours

Analytics – Nuances of big data – Value – Issues – Case for Big data – Big data options Team challenge – Big data sources – Acquisition – Nuts and Bolts of Big data. Features of Big Data -Security, Compliance, auditing and protection - Evolution of Big data – Best Practices for Big data Analytics - Big data characteristics - Volume, Veracity, Velocity, Variety – Data Appliance and Integration tools.

UNIT II	DATA ANALYSIS	9 Hours

Evolution of analytic scalability – Convergence – parallel processing systems – Cloud computing –grid computing – map reduce – enterprise analytic sand box – analytic data sets – Analytic methods –analytic tools – Cognos – Microstrategy - Pentaho. Analysis approaches – Statistical significance –business approaches – Analytic innovation – Traditional approaches – Iterative

UNIT III	PREDICTIVE ANALYTICS AND VISUALIZATION	9 Hours

Predictive Analytics – Supervised – Unsupervised learning – Neural networks – Kohonen models –Normal – Deviations from normal patterns – Normal behaviours – Expert options – Variable entry -Mining Frequent itemsets - Market based model – Apriori Algorithm – Handling large data sets in Main memory- IBM for Big Data – Map Reduce Framework - Hadoop – Hive - – Sharding – NoSQL Databases - S3 -Hadoop Distributed file systems.

UNIT IV	INTRODUCTION TO R	9 Hours

Overview of R programming - Evolution of R - Applications of R programming – Basic syntax - Basic Concepts of R, Control flow of R -R packages - Data Reshaping: Joining Columns and Rows

in a Data Frame - Merging Data Frames - Melting and Casting		
UNIT V	**DATA VISUALIZATION AND DATA MANAGEMENT USING R**	**9 Hours**
Data visualization in R and Data Management - Bar Chart, Dot Plot, Scatter Plot (3D), Spinning Scatter Plots, Pie Chart - Histogram (3D) [including colorful ones], Overlapping Histograms.		

TOTAL HOURS: 45 SELF LEARNING HOURS:45

COURSE OUTCOMES:

On successful completion of the course, students will be able to:

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Describe the concepts, characteristics, architecture, challenges, and best practices of Big Data and Big Data analytics.	K2
CO2	Examine scalable data analysis approaches, parallel processing models, cloud frameworks, and enterprise analytics tools.	K4
CO3	Categorize predictive analytics techniques and big data processing frameworks including MapReduce, Hadoop, and NoSQL systems.	K4
CO4	Build R programming constructs, packages, and data manipulation techniques to perform data analysis tasks.	K3
CO5	Implement data visualization and data management techniques in R for effective exploration and presentation of large datasets.	K3

TEXT BOOKS:

1. Frank J Ohlhorst, “Big Data Analytics: Turning Big Data into Big Money”, Wiley and SAS BusinessSeries, 2022.
2. Colleen Mccue, “Data Mining and Predictive Analysis: Intelligence Gathering and Crime Analysis”,Elsevier, 2021.
3. Michael Berthold, David J. Hand,” Intelligent Data Analysis”, Springer, 2021.
4. Norman Matloff , “The Art of R Programming-a tour of statistical software design”, William Pollock, 2022.
5. Paul Teetor “R Cookbook: Proven Recipes for Data Analysis, Statistics, and Graphics”, O'Reilly Cookbooks, O'Reilly Media , 2021.
6. *Big Data Analytics with R and Hadoop,* Vignesh Prajapati, 2022.
7. *R for Data Science: Import, Tidy, Transform, Visualize, and Model Data,* Hadley, Wickham, Garrett Grolemund, 2021.

REFERENCE BOOKS:

1. Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge UniversityPress, 2021.
2. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams
3. With Advanced Analytics", Wiley and SAS Business Series, 2022.
4. Paul Zikopoulos, Chris Eaton, Paul Zikopoulos, "Understanding Big Data: Analytics for
5. EnterpriseClass Hadoop and Streaming Data", McGraw Hill, 2021.
6. Pete Warden, Big Data Glossary, O'Reilly, 2023.
7. Jiawei Han, Micheline Kamber "Data Mining Concepts and Techniques", Second Edition, Elsevier,Reprinted 2021.
8. Glenn J. Myatt, Making Sense of Data, John Wiley & Sons, 2021.
9. Practical Data Science with R, Nina Zumel, John Mount, 2022.
10. R for Data Science: Import, Tidy, Transform, Visualize, and Model Data,**:** Hadley Wickham, Garrett Grolemund, 2022.
11. Learning R: A Step-by-Step Function Guide to Data Analysis, Richard Cotton, 2021.

WEBLINK:

1. https://tell.colvee.org/course/
2. https://www.tutorialspoint.com/big_data_analytics/r_introduction.htm

NPTEL LINK:

1. https://nptel.ac.in/courses/106104189
2. http://www.digimat.in/nptel/courses/video/106104189/L24.html

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	–	–	2	–	–	–	–	–	3	2
CO2	–	3	2	2	2	–	–	–	–	–	3	2
CO3	–	3	2	2	3	–	–	–	–	–	3	–
CO4	2	–	3	–	3	–	–	–	–	–	3	2
CO5	–	2	–	2	2	–	–	–	3	–	–	3
Average	**2.50**	**2.40**	**2.33**	**2.00**	**2.40**	–	–	–	**3.00**	–	**3.00**	**2.25**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	**MCQ**	**Projects**	**observation**	**Demonstration/ Presentation**	**Open book test**

PEC 004	E-LEARNING TECHNIQUES	L	T	P	SL	C
		3	0	0	3	3

COURSE OBJECTIVES

- This course will make the students learn the various E-learning approaches, components and the types of design models of E-Learning.
- This course will also help to explore the models for E-learning courseware development and E-learning authoring tools.

UNIT I	INTRODUCTION	9 Hours

Need for E-Learning – Approaches of E-Learning – Components of E-Learning – Synchronous and Asynchronous Modes of Learning – Quality of E-Learning – Blended Learning: Activities, Team and Technology – Work Flow to Produce and Deliver E-Learning Content – Basics of Design Thinking.

UNIT II	DESIGNING E-LEARNING COURSE CONTENT	9 Hours

Design Models of E-Learning – Identifying and Organizing E-Learning Course Content: Needs Analysis – Analysing the Target Audience – Identifying Course Content – Defining Learning Objectives – Defining the Course Sequence – Defining Instructional Methods – Defining Evaluation and Delivery Strategies – Case Study.

UNIT III	CREATING INTERACTIVE CONTENT	9 Hours

Preparing Content: Tips for Content Development and Language Style – Creating Storyboards: Structure of an Interactive E-Lesson – Techniques for Presenting Content – Adding Examples – Integrating Multimedia Elements – Adding Examples – Developing Practice and Assessment Tests – Adding Additional Resources– Courseware Development – Authoring Tools – Types of Authoring Tools – Selecting an Authoring Tool. .

UNIT IV	LEARNING PLATFORMS	9 Hours

Types of Learning Platforms – Proprietary Vs. Open – Source LMS – LMS Vs LCMS – Internally Handled and Hosted LMS – LMS Solutions – Functional Areas of LMS.

UNIT V	COURSE DELIVERY AND EVALUATION	9 Hours

Components of an Instructor-Led or Facilitated Course – Planning and Documenting Activities – Facilitating Learners Activities – E-Learning Methods and Delivery Formats – Using Communication Tools for E-Learning – Course Evaluation.

TOTAL HOURS:45 SELF LEARNING HOURS:45

COURSE OUTCOMES:

On completion of the course, students will be able to:

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Explain the concepts, approaches, components, and quality considerations of e-learning and blended learning environments.	K2
CO2	Design structured e-learning course content by performing needs analysis, defining learning objectives, and organizing instructional strategies.	K4
CO3	Develop interactive e-learning materials using storyboards, multimedia elements, authoring tools, and assessment techniques.	K3
CO4	Differentiate learning platforms by examining LMS and LCMS models, deployment options, and functional capabilities.	K4
CO5	Evaluate e-learning delivery methods and course effectiveness through learner facilitation, communication tools, and assessment strategies.	K4

TEXT BOOKS:

1. "The E-Learning Handbook: Past Promises, Present Challenges", Michael Simonson, Sharon Smaldino, and Anthony S. Albright, 2020.
2. "E-Learning: Strategies for Delivering Knowledge in the Digital Age", L. K. Sharma, 2021.
3. "The Distance Learning Playbook: Teaching for Engagement and Impact in Any Setting", Douglas Fisher, Nancy Frey, and John Hattie, 2022.

REFERENCE BOOKS::

1. "Creating E-Learning Experiences: A Step-by-Step Guide for Designing and Delivering Effective Training", Geri S. Huser, 2021
2. "Virtual Reality and Augmented Reality in Education", Timothy Jung, M. C. K. Lee, 2021
3. "Design for How People Learn" (4th Edition), Julie Dirksen, 2020

WEB LINK:

1. The eLearning Guild, https://www.learningguild.com/
2. Association for Talent Development, https://www.td.org/
3. Adobe Captivate, https://www.adobe.com/products/captivate.html/

NPTEL LINK:

1.

2. https://elearn.nptel.ac.in

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PSO 1	PSO 2
CO1	3	2	–	–	2	–	–	–	–	–	3	2
CO2	–	2	3	–	2	–	–	–	2	–	3	–
CO3	–	2	3	–	3	–	–	–	2	–	3	–
CO4	2	3	–	2	2	–	–	–	–	–	3	–
CO5	–	2	–	3	–	–	2	–	3	–	–	3
Average	**2.50**	**2.20**	**3.00**	**2.50**	**2.25**	**–**	**2.00**	**–**	**2.33**	**–**	**3.00**	**2.50**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	**MCQ**	**Projects**	**observation**	**Demonstration/ Presentation**	**Open book test**

PEC 005	SOFTWARE TESTING	L	T	P	SL	C
		3	0	0	3	3

COURSE OBJECTIVES

- To introduce the basics and necessity of Software testing.
- To introduce various testing techniques along with software production, and to introduce the concepts of Software bugs and its impact

UNIT I	INTRODUCTION	9 Hours

Software testing background – software bugs- cost of bugs-software testing realities- Testing Axioms – Precision and Accuracy-verification and validation- quality and reliability-testing and quality assurance

UNIT II	SOFTWARE TESTING METHODOLOGY	9 Hours

Functional testing, Structural testing – Static and Dynamic testing – low level specification test techniques – Equivalence Partitioning – Data testing – State Testing –formal reviews – coding standards and guidelines – code review checklist– data coverage- code coverage.

UNIT III	SOFTWARE TESTING TECHNIQUES	9 Hours

Configuration testing –Compatibility tests – foreign language testing – usability testing – testing the documentation - testing for software security – website testing.

UNIT IV	AUTOMATED TESTING AND TEST TOOLS	9 Hours

Benefits of automation and tools – viewers and monitors – drivers – stubs – stress and load tools – analysis tools- software test automation – random testing –beta testing

UNIT V	TEST DOCUMENTATION	9 Hours

Goal of Test Planning – test phases – test strategy – resource requirements – test schedule – writing and tracking test cases- Bug tracking systems – metrics and statistics- risks and issues

TOTAL HOURS: 45 SELF LEARNING HOURS:45

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Demonstrate the fundamentals of software testing, quality assurance concepts, verification and validation processes, and testing principles.	K2
CO2	Choose software testing methodologies by using functional, structural, and specification-based test techniques to assess software quality.	K3
CO3	Classify software systems using advanced testing techniques such as configuration, usability, security, and compatibility testing.	K4
CO4	Implement automated testing approaches and tools to perform stress, load, random, and beta testing effectively.	K3
CO5	Assume test plans, test cases, defect tracking systems, and testing metrics to manage software testing activities.	K4

TEXT BOOKS:

1. "Foundations of Software Testing: ISTQB Certification" (5th Edition), Dorothy Graham, Rex Black, Erik van Veenendaa, 2021
2. "Software Testing: A Practical Approach", Naresh Chauhan, Sujata Banerjee, 2021.

REFERENCE BOOKS::

1 "Practical Software Testing: A Process-Oriented Approach", Ilene Burnstein, 2022.
2. The Complete Software Testing Guide: Best Practices, Tools, and Techniques", Brian Hambling, 2022.

WEB LINKS:

1. Ministry of Testing, https://www.ministryoftesting.com/
2. Software Testing Help, https://www.softwaretestinghelp.com/
3. Stack Overflow (Testing), https://stackoverflow.com/questions/tagged/software-testing

NPTEL LINK:

1. https://nptel.ac.in/courses/106101163

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	–	–	2	2	–	–	–	–	3	–
CO2	–	3	2	2	3	–	–	–	–	–	3	–
CO3	–	3	2	2	2	2	–	–	–	–	3	–
CO4	–	2	3	–	3	–	–	–	–	–	3	2
CO5	–	2	2	2	–	–	–	3	2	–	–	3
Average	**3.00**	**2.40**	**2.25**	**2.00**	**2.50**	**2.00**	**–**	**3.00**	**2.00**	**–**	**3.00**	**2.50**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	**MCQ**	**Projects**	**observation**	**Demonstration/ Presentation**	**Open book test**

PEC 006	DEEP LEARNING TECHNIQUES AND APPLICATIONS	L	T	P	SL	C
		3	0	0	3	3

COURSE OBJECTIVES

- To understand the basics of machine learning and deep learning and to apply the Machine learning principles.
- To study the deep learning architectures. Explore and create deep learning applications with tensor flow.

UNIT I	INTRODUCTION	9 Hours

Introduction to different types of learning, Supervised and Unsupervised learning – Reinforcement learning- Basics of Neural Network – Limits of Traditional Computing – Machine Learning – Neuron – FF Neural Networks – Types of Neurons – Softmax output layers

UNIT II	TENSOR FLOW	9 Hours

Tensor flow – Variables – Operations – Placeholders – Sessions – Sharing Variables – Graphs – Visualization.

UNIT III	CONVOLUTION NEURAL NETWORKS	9 Hours

Convolution Neural Network – Feature Selection – Max Pooling – Filters and Feature Maps – Convolution Layer –Applications

UNIT IV	RECURRENT NEURAL NETWORKS	9 Hours

Recurrent Neural Network – Memory cells – sequence analysis – word2vec- LSTM - Memory augmented Neural Networks – NTM—Application.

UNIT V	REINFORCEMENT LEARNING	9 Hours

Reinforcement Learning – MDP – Q Learning – Applications

TOTAL HOURS: 45 SELF LEARNING HOURS:45

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Illustrate different learning paradigms, neural network fundamentals, and limitations of traditional computing approaches.	K2
CO2	Demonstrate the use of TensorFlow components such as variables, operations, graphs, and visualization techniques.	K3
CO3	Discover convolutional neural network architectures by examining feature extraction, pooling mechanisms, and application scenarios.	K4
CO4	Evaluate recurrent neural network models including LSTM and memory-augmented networks for sequence-based applications.	K4
CO5	Construct reinforcement learning techniques using MDPs and Q-learning to solve decision-making problems.	K3

TEXTBOOKS:

1. "Deep Learning: A Practitioner's Approach" (2nd Edition), Adam Gibson, Josh Patterson, 2022
2. "Deep Learning: From Basics to Practice", Tomaso A. Poggio, Aaron C. Courville, Yoshua Bengio, Geoffrey Hinton, 2022

REFERENCE BOOKS::

1. "Deep Learning with Python" (2nd Edition), François Chollet, 2021
2. "Deep Learning for NLP and Speech Recognition", Uday Kamath, John Liu, James Whitaker, 2021
3. "Deep Learning for Robotics", Peter Corke, David R. Topping, Jenny A. Willis, 2023
4. "Deep Reinforcement Learning Hands-On" (2nd Edition), Maxim Lapan, 2022

WEB LINKS:

1. fast.ai, https://www.fast.ai/
2. Keras, https://keras.io/
3. arXiv (Deep Learning Category), https://arxiv.org/list/cs.LG/recent

NPTEL LINK:

1. https://nptel.ac.in/courses/106106184
2. https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_cs01

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	–	–	2	–	–	–	–	–	3	2
CO2	2	–	2	–	3	–	–	–	–	–	3	2
CO3	–	3	2	2	3	–	–	–	–	–	3	–
CO4	–	3	–	3	2	–	–	–	–	–	2	3
CO5	–	2	3	–	–	–	2	–	–	–	3	3
Average	**2.50**	**2.40**	**2.33**	**2.50**	**2.50**	**–**	**2.00**	**–**	**–**	**–**	**2.80**	**2.50**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	MCQ	Projects	observation	Demonstration/ Presentation	Open book test

PEC 007	GAME PROGRAMMING TECHNIQUES	L	T	P	SL	C
		3	0	0	3	3

COURSE OBJECTIVES

- To understand the concepts of Game design and development, learn the processes, mechanics and issues in Game Design, be exposed to the Core architectures of Game Programming.
- Know about Game programming platforms, frameworks and engines and Learn to develop games.

UNIT I	3D GRAPHICS FOR GAME PROGRAMMING	9 Hours

3D Transformations, Quaternions, 3D Modeling and Rendering, Ray Tracing, Shader Models, Lighting, Color, Texturing, Camera and Projections, Culling and Clipping, Character Animation, Physics-based Simulation, Scene Graphs.

UNIT II	GAME ENGINE DESIGN	9 Hours

Game engine architecture, Engine support systems, Resources and File systems, Game loop and real-time simulation, Human Interface devices, Collision and rigid body dynamics, Game profiling.

UNIT III	GAME PROGRAMMING	9 Hours

Application layer, Game logic, Game views, managing memory, controlling the main loop, loading and caching game data, User Interface management, Game event management.

UNIT IV	GAMING PLATFORMS AND FRAMEWORKS	9 Hours

2D and 3D Game development using Flash, DirectX, Java, Python, Game engines - Unity. DX Studio.

UNIT V	GAME DEVELOPMENT	9 Hours

Developing 2D and 3D interactive games using DirectX or Python – Isometric and Tile Based Games, Puzzle games, Single Player games, Multi Player games.

TOTAL HOURS: 45 SELF LEARNING HOURS:45

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Explain 3D graphics concepts used in game programming including transformations, rendering techniques, lighting, animation, and physics simulation.	K2
CO2	Analyse game engine architecture by examining engine subsystems, real-time simulation, collision handling, and performance profiling.	K4
CO3	Apply game programming principles to implement game logic, memory management, event handling, and user interface control.	K3
CO4	Differentiate game development platforms and frameworks by comparing tools, languages, and engines used for 2D and 3D games.	K4
CO5	Develop interactive 2D and 3D games using suitable game engines or programming frameworks for single-player and multi-player scenarios.	K3

TEXT BOOKS:

1. Mike Mc Shaffrfy and David Graham, “Game Coding Complete”, Fourth Edition, Cengage Learning, PTR, 2022.
2. Jason Gregory, “Game Engine Architecture”, 4th Edition,2023.
3. Tomas Akenine-Möller, “Real-Time Rendering, Fourth Edition, 2022
4. Jesse Schell, The Art of Game Design: A book of lenses, 4th Edition, CRC Press, 2021.

REFERENCE BOOKS:

1. Jesse Schell, The Art of Game Design: A book of lenses, 4th Edition, CRC Press, 2022.
2. Ernest Adams and Andrew Rollings, “Fundamentals of Game Design”, 2nd Edition Prentice Hall / New Riders, 2021.
3. Eric Lengyel, “Mathematics for 3D Game Programming and Computer Graphics”, 3rd Edition, Course Technology PTR, 2021.

WEB LINKS:

1. https://www.gamedev.net/
2. https://www.codecademy.com/learn/paths/game-development
3. https://github.com/trekhleb/awesome-game-development

NPTEL LINK:

1. https://onlinecourses.nptel.ac.in/noc26_cs69/preview
2. https://nptel.ac.in/courses/106105237

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	–	–	2	–	–	–	–	–	3	2
CO2	–	3	–	3	2	–	–	–	–	–	3	2
CO3	–	2	3	–	3	–	–	–	–	–	3	2
CO4	2	3	–	2	2	–	–	–	–	–	3	–
CO5	–	2	3	–	3	–	–	–	–	–	3	2
Average	**2.50**	**2.40**	**3.00**	**2.50**	**2.40**	**–**	**–**	**–**	**–**	**–**	**3.00**	**2.00**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	**MCQ**	**Projects**	**observation**	**Demonstration/ Presentation**	**Open book test**

PEC 008	MULTIMEDIA TECHNOLOGIES	L	T	P	SL	C
		3	0	0	3	3

COURSE OBJECTIVES

- To understand the concepts of multimedia, Learn the processes, mechanics and issues in multimedia platform, Game Design, be exposed to various tools of multimedia.
- Know about multimedia audio, video & image formats, Learn to shoot ,edit video and deliver to www.

UNIT I	INTRODUCTION TO MULTIMEDIA	9 Hours

Definitions - CD-ROM and the Multimedia Highway - where to use Multimedia - introduction to Making Multimedia: The stages of a Project - What you need - Macintosh and Windows Production Platforms: The Macintosh Platform - The Windows Multimedia PC platform - Hardware Peripherals Connection - Memory and Storage Devices - Input Devices - Output Hardware - Communication Devices

UNIT II	BASIC TOOLS	9 Hours

Text Editing and Word Processing Tools - OCR Software - Painting and Drawing Tools - 3- D Modeling and Animation Tools - Image - Editing Tools - Helpful Accessories - Making Instant Multimedia: Linking Multimedia Objects - Office Suites - Word Processors - Spread sheets - Databases - Presentation Tools. Multimedia Authoring Tools.

UNIT III	TEXT	9 Hours

The Power of Meaning - About Fonts and Faces - Using Text in Multimedia - Computers and Text - Font Editing and Design Tools - Hypermedia and Hypertext - Multimedia System Sounds - Digital Audio - Making MIDI Audio - Audio File Formats

UNIT IV	IMAGES	9 Hours

Making Still Images - Color - Image File Formats. Animation: The Power of Motion - Principles of Animation - Making Animations That Work - Video: Using video - How video works - Broadcast Video Standards - Integrating Computers and Television - Shooting and Editing Video - Video Tips - Recording Formats - Digital Video.

UNIT V	PLANNING AND COSTING	9 Hours

Disc Technology - Wrapping It Up - Delivering on the World Wide Web. Project planning - Estimating - RFPs and Bid proposals - Designing and producing: Designing - Producing - Content and Talent: Acquiring Content - Using content created by others testing - Preparing for Delivery – Compact.

TOTAL HOURS: 45 SELF LEARNING HOURS:45

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Describe the fundamentals of multimedia systems, project stages, hardware platforms, peripherals, and communication devices used in multimedia production.	K2
CO2	Utilize basic multimedia tools such as text editors, image editors, animation tools, and authoring software to create integrated multimedia content.	K3
CO3	Categorize the role of text and audio elements in multimedia applications by examining fonts, hypertext structures, digital audio formats, and sound integration.	K4
CO4	Examine image, animation, and video components by studying colour models, file formats, animation principles, and digital video technologies.	K4
CO5	Evaluate multimedia project planning and delivery strategies by considering costing, content acquisition, testing, and web-based deployment methods.	K4

TEXT BOOKS:

1. Tay Vaughan - Multimedia : Making it work - 8th Edition - Tata McGraw-Hill Edition, 2021.
2. Walterworth John A - Multimedia Technologies and Application - Ellis Horwood Ltd. - London- 2022.
3. Ching- Man Au and Hoi“Understanding Multimedia From Technology to Applications”, First Edition, 2021.

REFERENCE BOOKS:

1. J1. John F Koegel Buford - Multimedia Systems - Addison Wesley - First Indian Reprint - 2022.

2. B. K. Tripathy, S. K. Srivastava, and V. K. Agarwal, “"Multimedia Technologies and Applications: A Practical Approach" 1st Edition 2021.

WEB LINKS:

1. https://www.multimedia.net/
2. https://www.codecademy.com/learn/paths/game-development
3. https://github.com/trekhleb/awesome-game-development

NPTEL LINKS:

1. https://onlinecourses.nptel.ac.in/noc26_cs69/preview
2. https://nptel.ac.in/courses/106105237

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	–	–	2	–	–	–	–	–	3	2
CO2	–	2	3	–	3	–	–	–	–	–	3	2
CO3	–	3	–	2	2	–	–	–	–	–	3	2
CO4	–	3	–	2	3	–	–	–	–	–	3	2
CO5	–	2	–	3	–	–	–	3	–	–	2	3
Average	**3.00**	**2.40**	**3.00**	**2.33**	**2.50**	**–**	**–**	**3.00**	**–**	**–**	**2.80**	**2.20**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	**MCQ**	**Projects**	**observation**	**Demonstration/ Presentation**	**Open book test**

PEC 009	DATA VISUALISATION TECHNIQUES	L	T	P	SL	C
		3	0	0	3	3

COURSE OBJECTIVES

- To understand the concepts of different types of visualization and how humans perceive information.
- Learn the processes, mechanics in implementing principles of design and color to make effective visualizations, learn how to visualize graphs, be exposed to visualization dashboards.
- To apply techniques from user-interface design to create an effective visualization system.

UNIT I	THE COMPUTER AND THE HUMAN	9 Hours

Defining data visualization Visualization workflow-describing data visualization workflow- process in practice

UNIT II	VISUALIZATION OF NUMERICAL DATA	9 Hours

Data Representation: chart types: categorical, hierarchical, relational, temporal & spatial; 2- D: bar charts, Clustered bar charts, dot plots, connected dot plots, pictograms, proportional shape charts, bubble charts, radar charts, polar charts, Range chart

UNIT III	VISUALIZATION OF NON-NUMERICAL DATA	9 Hours

Range chart, Box-and-whisker plots, univariate scatter plots, histograms word cloud, pie chart, waffle chart, stacked bar chart, back-to-back bar chart.

UNIT IV	VISUALIZATION DASHBOARD	9 Hours

Visualization system for large datasets and dashboards, Tools for dashboard, graph data visualization; Annotation.

UNIT V	2-D & 3-D DATA VISUALISATION	9 Hours

Relevant 2-D charts. 3-D: surfaces, contours, hidden surfaces, pm3d coloring, 3D mapping; multi-dimensional data visualization

TOTAL HOURS: 45 SELF LEARNING HOURS:45

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Explain the principles of data visualization and the interaction between computers and humans through the visualization workflow.	K2
CO2	Demonstrate numerical data visualization techniques by constructing appropriate charts and graphical representations.	K3
CO3	Analyse non-numerical and distribution-based data using suitable visual forms such as histograms, box plots, word clouds, and composite charts.	K4
CO4	Design visualization dashboards for large datasets by integrating tools, graph-based views, and annotation techniques.	K4
CO5	Discover multidimensional data visualization approaches by examining 2-D and 3-D visual models and their effectiveness.	K4

TEXT BOOKS:

1. Andy Kirk, Data Visualization A Handbook for Data Driven Design, Sage Publications, 2021.
2. Philipp K. Janert, Gnuplot in Action, Understanding Data with Graphs, Manning Publications, 2022.

REFERENCE BOOKS:

1. Information Dashboard Design-Displaying data for at-a-glance monitoring-Stephen Few
2. Practical Data Visualization with Power BI" by M. K. Yadav (2022)
3. Beautiful Visualization, Looking at data through the eyes of experts by Julie steele

WEBLINKS:

1. https://www.tableau.com/learn/training
2. https://matplotlib.org/stable/tutorials/index.html

NPTEL LINKS:

1. https://onlinecourses.nptel.ac.in/noc22_cs36/

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	–	–	2	–	–	–	2	–	3	–
CO2	–	2	3	–	3	–	–	–	2	–	3	–
CO3	–	3	–	2	2	–	–	–	2	–	3	–
CO4	–	2	3	2	3	–	–	–	–	–	3	–
CO5	–	3	–	2	2	–	–	–	–	–	3	2
Average	**3.00**	**2.40**	**3.00**	**2.00**	**2.40**	–	–	–	**2.00**	–	**3.00**	**2.00**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	**MCQ**	**Projects**	**observation**	**Demonstration/ Presentation**	**Open book test**

PEC 010	UNIX PROGRAMMING	L	T	P	SL	C
		3	0	0	3	3

COURSE OBJECTIVES

- To study and understand the UNIX architecture, file systems, basic commands.
- To understand Shell programming and Analyse various system calls and processes.

UNIT I	INTRODUCTION TO UNIX	9 Hours

Architecture of UNIX, Features of UNIX , UNIX Commands – man, echo, printf, script, passwd, uname, who, date, stty, pwd, cd, mkdir, ls, cp, mv, rm, cat, more, wc, lp, od, tar, gzip, env . Environment Variables**:** PATH, LOGNAME, SHELL, USER.

UNIT II	UNIX UTILITIES	9 Hours

Introduction to UNIX file system, vi editor, file handling utilities, security by file permissions, process utilities, disk utilities ,Networking commands, unlink, du, df, mount, umount, find, unmask, ulimit, ps, w, finger, arp, ftp, telnet, rlogin Text processing utilities and backup utilities , tail, head, sort, nl, uniq, grep, egrep, fgrep, cut, paste, join, tee, pg, comm, cmp, diff, tr, awk, cpio.

UNIT III	INTRODUCTION TO SHELL	9 Hours

UNIX Session, Standard Streams, Redirection, Pipes, Tee Command, Command Execution, Command Line Editing, Quotes, Command Substitution, Job Control, Aliases, Variables, Predefined Variables, Shell/Environment Customization, Filters, grep, sed, awk, Functions, String Functions, Mathematical Functions, User – Defined Functions, Using System commands in awk, Applications, awk and grep, sed and awk .

UNIT IV	FILE MANAGEMENT	9 Hours

File Structures, System Calls for File Management – create, open, close, read, write, lseek, link, symlink, unlink, stat, fstat, lstat, chmod, chown, Directory API – opendir, readdir, closedir, mkdir, rmdir, umask

UNIT V	PROCESS MANAGEMENT	9 Hours

Categories of process, Parent & Child process, Zombie and Orphan process, mechanism of init(), termination of a process, process control mechanism

TOTAL HOURS: 45 SELF LEARNING HOURS:45

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Outline the architecture, features, commands, and environment variables of UNIX operating system.	K2
CO2	Identify UNIX utilities for file handling, process management, networking, and text processing using relevant commands.	K3
CO3	Develop shell scripts using redirection, pipes, filters, functions, and awk/sed for automating UNIX tasks.	K3
CO4	Build system calls and APIs for file and directory management to implement file handling operations in UNIX.	K3
CO5	Analyse process management concepts including process creation, termination, and control mechanisms in UNIX.	K4

TEXT BOOKS:

1. UNIX and Shell Programming; Behrouz A. Forouzan, Richard F. Gilberg; Thomson 2022
2. UNIX: Concepts and Applications; Sumitava Das; TMH,2023.

REFERENCE:

1. UNIX for Programmers and Users; Graham Glass, King Ables; Pearson Education
2. UNIX Programming Environment; Kernighan and Pike; PHI/Pearson Education
3. The Complete Reference UNIX; Rosen, Host, Klee, Farber, Rosinski; TMH
4. Your UNIX – The Ultimate Guide; Sumitava Das; TMH
5. Design of UNIX Operating System; Maurice Bach; PHI

WEBLINKS:

1. https://linuxjourney.com/
2. https://www.gnu.org/software/bash/manual/

NPTEL LINKS:

1. https://nptel.ac.in/courses/106102132
2. https://onlinecourses.nptel.ac.in/noc24_cs84/preview

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	–	–	2	–	–	–	–	–	3	2
CO2	2	3	–	–	3	–	–	–	–	–	3	2
CO3	–	2	3	–	3	–	–	–	–	–	3	2
CO4	2	2	3	–	3	–	–	–	–	–	3	–
CO5	–	3	–	2	2	–	–	–	–	–	3	2
Average	**2.33**	**2.40**	**3.00**	**2.00**	**2.60**	–	–	–	–	–	**3.00**	**2.00**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	**MCQ**	**Projects**	**observation**	**Demonstration/ Presentation**	**Open book test**

PEC 011	STATISTICS AND OPERATIONS RESEARCH TECHNIQUES	L	T	P	SL	C
		3	0	0	3	3

COURSE OBJECTIVES

- To understand the fundamental concepts of statistics and probability, including data classification, graphical representation, measures of central tendency, and dispersion.
- To comprehend the concepts of correlation, regression analysis, curve fitting, and least squares methods for studying relationships between variables.
- To gain knowledge of sampling distributions, hypothesis testing procedures, levels of significance, and statistical decision-making techniques.
- To learn the principles of experimental design, classification models, and analysis of variance using appropriate statistical designs.
- To study linear programming, transportation, and assignment models for optimizing real-world resource allocation problems.

UNIT I	BASIC STATISTICS	9 Hours

Basic concepts of Statistics Qualitative and quantitative data, classification of data, construction of frequency distribution, diagrammatic representation of data. Measures of Central tendency: Mean, Median and Mode Measure of Dispersion - Range, Mean deviation - Standard Deviation and coefficient of variation. Basic Probability: Sample space and events – Probability – The axioms of probability – Some elementary theorems.

UNIT II	CORRELATION AND REGRESSION	9 Hours

Curve fitting- The method of least squares – Inferences based on the least squares estimations - Curvilinear regression — correlation coefficients-Karl persons and Spearman's rank correlation coefficient problems.

UNIT III	SAMPLING THEORY	9 Hours

Introduction to small sample- Means and proportions – Hypothesis concerning one and two means –Type I and Type II errors. One tail, two-tail tests. Tests of significance –Z-test, Student's t-test, F-test- chi square –test of goodness of fit and test of independence of attributes.

UNIT IV	DESIGN OF EXPERIMENTS	9 Hours
One way and two way classifications - Completely randomized design - Randomized block design - Latin square design - 2^2 factorial design.		
UNIT V	**LINEAR PROGRAMMING PROBLEM**	**9 Hours**
Linear Programming Problem (LPP): Formulating LPPs, Simplex Algorithm; Transportation Problem- Mathematical Formulation of Transportation problem, Methods of selecting initial basic feasible solution: Matrix minima method- North-West Corner Rule, Vogel's Approximation Method, Unbalanced Transportation Problem Assignment problems: Algorithm, Unbalanced Assignment Problem, Hungarian Method.		

TOTAL HOURS: 45 SELF LEARNING HOURS:45

COURSE OUTCOMES:

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

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Summarize the fundamental concepts of statistics and probability and interpret measures of central tendency and dispersion for real-world data.	K2
CO2	Plan correlation and regression techniques to examine relationships between variables and solve curve-fitting problems.	K3
CO3	Categorize sampling distributions and perform hypothesis testing using standard statistical tests to draw valid inferences.	K4
CO4	Evaluate experimental data using appropriate design of experiments techniques to determine treatment effects.	K4
CO5	Build linear programming, transportation, and assignment models to obtain optimal solutions for resource optimization problems.	K3

TEXT BOOKS:

1. Statistical Inference, George Casella and Roger Berger, Duxbury Advanced Series, 2nd ed., 2024.
2. The Practice of Business Statistics, Manish Sharma, Amit Gupta, Khanna Book Publishing Company, 2010 (AICTE Recommended Textbook)
3. Statistical Methods, Das N. G., Combined Edition, Tata McGraw Hill, 2010.

4. Operations Research: An Introduction, Taha H. A, Pearson Education, 11th ed., 2022.

REFERENCE BOOKS::

1. Operations Research, Swarup, K., Gupta, P. K., & Man Mohan, Sultan Chand & Sons, 20th ed.,2022.
2. Quantitative Techniques in Management, Vohra, N. D., & Arora, H, McGraw-Hill Education, 6th ed., 2021.
3. Operations Research, Panneerselvam. R, PHI Learning Pvt. Ltd, 3rd ed., 2023.

WEBLINKS:

1. https://www.statisticshowto.com/
2. https://www.geeksforgeeks.org/operations-research/

NPTEL LINKS:

1.https://nptel.ac.in/courses/111106112
2. https://nptel.ac.in/courses/111105041
3.https://nptel.ac.in/courses/111105090
4.https://nptel.ac.in/courses/111105041
5.https://onlinecourses.nptel.ac.in/noc21_ma74/preview

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	–	–	2	–	–	–	–	–	3	2
CO2	2	3	2	–	–	–	–	–	–	–	3	2
CO3	–	3	–	3	2	–	–	–	–	–	3	2
CO4	–	2	–	3	2	–	–	–	–	–	3	2
CO5	2	3	3	2	–	–	–	–	–	–	3	–
Average	**2.33**	**2.60**	**2.50**	**2.67**	**2.00**	–	–	–	–	–	**3.00**	**2.00**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	MCQ	Projects	observation	Demonstration/ Presentation	Open book test

PEC 012	STATISTICS USING R AND PYTHON	L	T	P	SL	C
		3	0	0	3	3

COURSE OBJECTIVES

- To develop a solid foundation in statistical concepts.
- To master the fundamentals of R and Python for statistical computing.
- To effectively utilize R and Python for data manipulation and analysis.
- To apply statistical methods to real-world problems.

  To foster critical thinking and problem-solving skills in the context of statistics.

UNIT I	INTRODUCTION TO PYTHON AND PANDAS	9 Hours

Introduction to Python, Python installation, variables and operators, reading data from keyboard, Data types - numbers, lists, dictionary; Decision making Loops - for, while; Loop control statements - break, continue, pass; Introduction to Pandas - Pandas Installation, data structures - series, data frame; Reading from csv files, loc(), iloc() function, descriptive statistics, inserting columns into DataFrame, deleting columns from DataFrame, concatenating DataFrame, writing back to csv files, reading from excel files; Merging or joining DataFrame; Group bv and aggregate functions; Connecting Python to MySQL

UNIT II	INTRODUCTION TO R PROGRAMMING, DATA VISUALIZATION AND ELEMENTARY STATISTICS	9 Hours

Introduction to R programming, R programming installation and running, Variables, Operators, Data Types, Decision making, Loops, Functions, Reading from csv files, writing back to csv files, reading from excel files, Packages - installation, loading; Introduction to dplyr Library, dplyr functions, arrange, join, select, rename, filter, summarize, Pipe operator, group_by, do, join, if, across; Connecting R to MySQL. Data Visualization - bar charts, grouped bar charts, stacked bar charts, histogram, line charts, pie charts, box plots, scatter plots, density plots, strip charts, QQ plots - implementation in both Python and ; Probability distributions - binomial, Poisson, normal, exponential, chi-squared, student's t; F distribution and Uniform distribution; Z-Test, one sample Z-Test, two sample Z-Test, F-Test, Student's t-Test - implementation of tests in Python and R.

UNIT III	TESTS OF HYPOTHESIS AND NON- PARAMETRIC TESTS	9 Hours
Tests of Hypothesis - population mean with known variance, population with unknown variance, population proportion, goodness of fit, chi-square test; Implementation of tests in Python and R; Non-parametric tests - one-sample test, two-sample test - two-sample sign test with binomial distribution, two-sample sign test with normal approximation; Wilcoxon signed-rank test, Mann-Whitney-Wilcoxon test, Kolmogorov-Smirnov test, K-Samples test - Kruskal-Wallis H test - implementation of tests in Python and R.		
UNIT IV	**ANOVA AND MULTIVARIATE ANALYSIS**	**9 Hours**
Analysis of variance - one-way ANOVA, Two-way ANOVA; ANOVA - implementation in Python and R; Multivariate Analysis - correlation, covariance, forecasting - simple moving average. weighted moving average, simple exponential smoothing implementation in Python and R; Regression - simple linear regression, multiple linear regression, polynomial regression, logistic regression, poisson regression.		
UNIT V	**ADVANCED GRAPHS, CASE STUDIES AND DISCUSSION**	**9 Hours**
Advanced graphs - lattice graphs, ggplot2 graphs, probability graphs, mosaic graphs, correlograms; implementation in Python and R; Case studies and discussion		

TOTAL HOURS:45 SELF LEARNING HOURS:45

COURSE OUTCOMES

On completion of the course, students will be able to

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Explain Python programming fundamentals and utilize Pandas for data manipulation, including reading, processing, and managing datasets from various sources.	**K2**
CO2	Apply R programming concepts and data visualization techniques to analyze datasets and implement elementary statistical methods.	**K3**
CO3	Analyze statistical hypothesis testing methods and non-parametric tests using Python and R for data-driven decision making.	**K4**

CO4	Apply ANOVA, regression models, and multivariate analysis techniques using Python and R for interpreting complex datasets.	**K3**
CO5	Analyze advanced graphical techniques and real-world case studies to interpret and present data insights effectively.	**K4**

References

1. Eric Matthes, Python Crash Course, 3rd Edition, No Starch Press, 2023.
2. Wes McKinney, Python for Data Analysis, 3rd Edition, O'Reilly Media, 2022.
3. Hadley Wickham and Garrett Grolemund, R for Data Science, 2nd Edition (updated online version), O'Reilly Media, 2023.
4. Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani, An Introduction to Statistical Learning, 2nd Edition, Springer, 2021.

WEBLINKS:

1. https://www.r-project.org/
2. https://jakevdp.github.io/PythonDataScienceHandbook/

NPTEL LINKS:

1. https://onlinecourses.nptel.ac.in/noc23_cs95/
2. https://nptel.ac.in/courses/106106212

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	–	–	3	–	–	–	–	–	3	2
CO2	–	2	2	–	3	–	–	–	2	–	3	2
CO3	–	3	–	3	2	–	–	–	–	–	3	2
CO4	–	2	3	2	2	–	–	–	–	–	3	2
CO5	–	2	–	2	2	–	–	–	3	–	3	–
Average	3.00	2.20	2.50	2.33	2.40	–	–	–	2.50	–	3.00	2.00

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	MCQ	Projects	observation	Demonstration/ Presentation	Open book test

PEC 013	ARTIFICIAL INTELLIGENCE & MACHINE LEARNING	L	T	P	SL	C
		3	0	0	3	3

COURSE OBJECTIVES

- To introduce the fundamental principles, techniques, and applications of Artificial Intelligence and Machine Learning and develop an understanding of problem-solving and search strategies in AI.
- To familiarize students with key concepts and algorithms in supervised and unsupervised learning.
- To equip students with skills in designing and implementing basic neural networks and deep learning models.
- To explore advanced AI topics including NLP, reinforcement learning, and ethical implications of AI technologies.
- To encourage practical learning through lab exercises and case studies relevant to real-world AI & ML applications.

UNIT I	INTRODUCTION TO AI & ML	9 Hours

Introduction– History and Evolution of AI - Definition - Future of Artificial Intelligence – Problem Solving Approach to Typical AI problems – Search Strategies- Uninformed- Heuristics- Informed. Introduction to Machine Learning, Types of Learning: Supervised, Unsupervised, Reinforcement, Intelligent Agents & Environment.

UNIT II	PROBLEM SOLVING AND SEARCH TECHNIQUES IN AI	9 Hours

Problem Formulation, State Space Representation, Local Search Algorithms and Optimization Problems – Constraint Propagation - Backtracking Search - Uninformed Search: BFS, DFS, Depth Limited Search, Informed Search: Greedy Search, A* Algorithm, Constraint Satisfaction Problems (CSP), Game Playing: Minmax, Alpha-Beta Pruning - Stochastic Game

UNIT III	SUPERVISED & UNSUPERVISED LEARNING	9 Hours

Supervised Learning: Linear & Logistic Regression, SVM, random forest, Decision Trees, k-NN, Naive Bayes, Model E, valuation Techniques: Cross-validation, Confusion Matrix, Classification –

ROC measure. Unsupervised Learning: K-Means, Hierarchical Clustering, Dimensionality Reduction: PCA, t-SNE.		
UNIT IV	**ANN & DEEP LEARNING**	**9 Hours**
Basics of Neural Networks: Perceptron, Activation Functions, Multilayer Perceptron (MLP), Backpropagation & Optimization Algorithms, Types of ANN, Introduction to Deep Learning, Transfer Learning Applications, GenAI		
UNIT V	**ADVANCED TOPICS AND APPLICATIONS**	**9 Hours**
Basics of Neural Networks: Perceptron, Activation Functions, Multilayer Perceptron (MLP), Backpropagation & Optimization Algorithms, Types of ANN, Introduction to Deep Learning, Transfer Learning Applications, GenAI.		

TOTAL HOURS: 45 SELF LEARNING HOURS:45

COURSE OUTCOMES:

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

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Explain the fundamental concepts of artificial intelligence, machine learning paradigms, intelligent agents, and search strategies.	K2
CO2	Formulate AI problem-solving tasks using state-space representation, search techniques, constraint satisfaction, and game-playing strategies.	K4
CO3	Apply supervised and unsupervised learning algorithms to build and evaluate machine learning models.	K3
CO4	Analyse neural network architectures and deep learning techniques including optimization, transfer learning, and generative AI.	K4
CO5	Examine real-world AI and ML applications using appropriate tools and frameworks such as Scikit-learn, TensorFlow, and Keras.	K4

TEXT BOOKS:

1. Stuart Russell & Peter Norvig, Artificial Intelligence: A Modern Approach, Pearson Education 2021.

2. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly 2022.
3. Tom M. Mitchell, Machine Learning, McGraw-Hill 2021.
4. Ian Goodfellow, Yoshua Bengio & Aaron Courville, Deep Learning, MIT Press 2023.

REFERENCE BOOKS::

1. François Chollet, Deep Learning with Python, Manning 2022.
2. Kevin Knight, Artificial Intelligence, McGraw-Hill 2023.
3. Richard S. Sutton & Andrew G. Barto, Reinforcement Learning: An Introduction, MIT Press 2021.

WEBLINKS:

1. https://developers.google.com/machine-learning/crash-course
2. https://scikit-learn.org/stable/

NPTEL LINKS:

1. https://nptel.ac.in/courses/106106139
2. https://onlinecourses.nptel.ac.in/noc24_cs81/preview

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	–	–	2	–	–	–	–	–	3	2
CO2	2	3	2	–	–	–	–	–	–	–	3	2
CO3	–	3	3	2	–	–	–	–	–	–	3	2
CO4	–	3	2	2	2	–	–	–	–	–	3	–
CO5	–	2	–	2	3	–	2	–	–	–	3	–
Average	**2.50**	**2.60**	**2.33**	**2.00**	**2.33**	**–**	**2.00**	**–**	**–**	**–**	**3.00**	**2.00**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	**MCQ**	**Projects**	**observation**	**Demonstration/ Presentation**	**Open book test**

PEC 014	ARTIFICIAL INTELLIGENCE FOR REAL WORLD APPLICATION	L	T	P	SL	C
		3	0	0	3	3

COURSE OBJECTIVES

- Understand the fundamental concepts and evolution of Artificial Intelligence.
- Apply basic mathematical concepts and Python programming for AI applications.
- Explain the core principles of machine learning techniques.
- Understand the working principles of neural networks and deep learning models.

  Explore Natural Language Processing techniques and Understand Generative AI, Large Language Models, and prompt engineering concepts

UNIT I	INTRODUCTION TO ARTIFICIAL INTELLIGENCE (AI)	9 Hours

Definition, history, and evolution of Artificial - Distinction between Artificial Intelligence, Machine Learning, and Deep Learning- Overview of major branches of AI- Real-world applications of AI in healthcare, finance, autonomous systems, customer service, gaming, and content creation.

UNIT II	FOUNDATIONAL MATHEMATICS AND PYTHON FOR AI	9 Hours

Probability and Statistics for AI- Basic probability rules, descriptive statistics, data distributions- Python Fundamentals- Data structures, control flow, functions, object-oriented programming (OOPs) concepts- NumPy & Pandas-Efficient numerical computing and data manipulation- Scikit-learn- Building, training & evaluating ML modelS-Matplotlib & Seaborn- Basic data visualization.

UNIT III	INTRODUCTION TO MACHINE LEARNING	9 Hours

Core machine learning concepts-Overview of supervised learning techniques including regression and classification methods - Linear Regression, Logistic Regression, and Decision Trees-Introduction to unsupervised learning including clustering using K-Means-PCA-Reinforcement learning - model evaluation techniques like accuracy - confusion matrix.

UNIT IV	INTRODUCTION TO NEURAL NETWORKS AND DEEP LEARNING	9 Hours

The Perceptron- neural networks; Feedforward Neural Networks (MLPs)-Sigmoid- ReLU) - Training Neural Networks: Loss functions, Backpropagation algorithm-; Introduction to Deep Learning- CNNs – RNNs- Conceptual understanding of recurrence- TensorFlow-Keras.		
UNIT V	**NATURAL LANGUAGE PROCESSING FUNDAMENTALS**	**9 Hours**
Introduction to NLP-Challenges of human language, key applications- Text Preprocessing - Word Embeddings: Representing words as vectors - NLP Tasks: Sentiment analysis, text classification- Introduction to Transformers- Generative AI & LLMs- Autoencoders, Generative Adversarial Networks- Basic Prompt Engineering, and Applications of LLMs.		

TOTAL HOURS: 45 SELF LEARNING HOURS:45

COURSE OUTCOMES:

On completion of the course, students will be able to:

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Explain the fundamental concepts, history, and applications of Artificial Intelligence and distinguish between AI, Machine Learning, and Deep Learning.	K2
CO2	Apply foundational mathematics and Python programming concepts including NumPy, Pandas, and Scikit-learn for data analysis and model development.	K3
CO3	Analyze machine learning techniques including supervised and unsupervised learning methods such as regression, classification, clustering, and evaluate model performance.	K4
CO4	Apply neural network concepts and deep learning techniques including perceptron, feedforward networks, CNNs, and RNNs using TensorFlow/Keras.	K3
CO5	Analyze natural language processing techniques including text preprocessing, embeddings, transformers, and applications of generative AI models.	K4

TEXT BOOKS:

1. Artificial Intelligence: A Modern Approach – Stuart Russell and Peter Norvig, Pearson Education.
2. Machine Learning – Tom M. Mitchell, McGraw-Hill Education.

REFERENCE BOOKS:

1. Deep Learning – Ian Goodfellow, Yoshua Bengio, Aaron Courville, MIT Press.
2. Python Machine Learning – Sebastian Raschka and Vahid Mirjalili, Packt Publishing.
3. Speech and Language Processing – Daniel Jurafsky and James H. Martin, Pearson.

WEBLINKS:

1. https://www.ibm.com/topics/artificial-intelligence
2. https://openai.com/resources/

NPTEL LINKS:

1. https://onlinecourses.nptel.ac.in/noc22_cs56/
2. https://nptel.ac.in/courses/106106140

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	–	–	2	–	–	–	–	–	3	–
CO2	2	–	2	–	3	–	–	–	–	–	3	2
CO3	–	3	3	2	–	–	–	–	–	–	3	2
CO4	–	2	3	2	3	–	–	–	–	–	3	–
CO5	–	3	–	2	–	–	2	–	–	–	3	3
Average	**2.33**	**2.50**	**2.67**	**2.00**	**2.67**	–	**2.00**	–	–	–	**3.00**	**2.33**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	MCQ	Projects	observation	Demonstration/ Presentation	Open book test

PEC 015	DATA ANALYTICS & REPORTING	L	T	P	SL	C
		3	0	0	3	3

COURSE OBJECTIVES

- To understand the core principles of data analysis, including data collection, cleaning, and transformation.
- To learn techniques for exploring and analysing data using descriptive statistics and visualization methods.
- To gain knowledge in handling missing values, outliers, and inconsistencies in datasets.
- To develop skills in creating effective data visualizations using charts and graphs.
- To master techniques for generating clear, concise, and informative data reports for decision-making.

UNIT I	INTRODUCTION TO DATA SCIENCE AND ANALYTICS	9 Hours

Data, features; preprocessing on data; cleaning of data; feature selection techniques like Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA); components of analytics – reporting and analysis. .

UNIT II	HANDLING DATA SOURCES	9 Hours

Different types of data sources including structured, unstructured, and semi-tructured data; relational databases covering normal forms and transactional data; Structured Query Language (SQL); NoSQL databases and their types; handling semi-structured data using JSON, CSV files, XML, and more.

UNIT III	EXPLORATORY DATA ANALYSIS (EDA), MODELS AND TECHNIQUES	9 Hours

Working with trend detection, outlier detection, summarization, association rule mining, missing distribution and imputation techniques, spurious relationship or spurious correlation, concept of performance window, missing trends or percentile distribution from a time perspective, and concept of winsorization or flooring; regression models including linear and non-linear, logistic regression, variable transformation, spinning of variables, population stability index and characteristic analysis; regularization, overfitting and underfitting, mean square error, root mean square error, mean

absolute percentage error; decision tree classification, SVM, k-means clustering, and usage of clustering techniques in variable selection.		
UNIT IV	**REPORTING FUNDAMENTALS**	**9 Hours**
Anatomy and types of reports; top-down approach including drill-down reports and dashboards; bottom-up approach including analysis and prediction with ad-hoc queries; strategies and techniques for effective reporting and best practices.		
UNIT V	**REPORTS FOR DATA ANALYSIS AND DATA REPORTING TOOLS**	**9 Hours**
Descriptive analysis and its reports such as Key Performance Indicator (KPI) dashboards and periodic reports; diagnostic analysis and detailed drill-down reports; predictive analysis and reports based on predictive models; prescriptive analysis and reports based on AI/ML models; graphs and charts including types and implementation; tables and their usage in standard reports; dashboards and drill-down reports; interactive reports; report generation best practices based on case studies.		

TOTAL HOURS: 45 SELF LEARNING HOURS:45

COURSE OUTCOMES

On completion of the course, students will be able to

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Explain data science fundamentals, data preprocessing techniques, and feature selection methods such as PCA and LDA.	**K2**
CO2	Apply techniques to handle structured, semi-structured, and unstructured data using SQL, NoSQL, and data formats like JSON, CSV, and XML.	**K3**
CO3	Analyze exploratory data analysis methods and machine learning models including regression, classification, and clustering techniques.	**K4**
CO4	Apply reporting fundamentals and design effective reports using top-down and bottom-up approaches.	**K3**
CO5	Analyze data reporting tools and develop dashboards and analytical reports for descriptive, diagnostic, predictive, and prescriptive analysis.	**K4**

REFERENCE BOOKS:

1. Han, J., Kamber, M., & Pei, J., *Data Mining: Concepts and Techniques*, 3rd Edition, Morgan Kaufmann, 2011.
2. Provost, F., & Fawcett, T., *Data Science for Business*, 1st Edition, O'Reilly Media, 2013.
3. McKinney, W., *Python for Data Analysis*, 2nd Edition, O'Reilly Media, 2017.
4. Few, S., *Information Dashboard Design*, 2nd Edition, Analytics Press, 2013.
5. Sharda, R., Delen, D., & Turban, E., *Business Intelligence, Analytics, and Data Science*, 4th Edition, Pearson, 2019.

WEBLINKS:

1. https://learn.microsoft.com/en-us/training/powerplatform/power-bi/
2. https://grow.google/certificates/data-analytics/

NPTEL LINKS:

1. https://onlinecourses.nptel.ac.in/noc23_cs21/
2. https://nptel.ac.in/courses/106106179

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	–	–	2	–	–	–	–	–	3	2
CO2	2	2	2	–	3	–	–	–	–	–	3	2
CO3	–	3	3	2	–	–	–	–	–	–	3	2
CO4	2	–	2	–	2	–	–	–	3	–	3	–
CO5	–	2	–	2	2	–	–	–	3	–	–	3
Average	**2.33**	**2.20**	**2.33**	**2.00**	**2.25**	–	–	–	**3.00**	–	**3.00**	**2.25**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	MCQ	Projects	observation	Demonstration/ Presentation	Open book test

PEC 016	INFORMATION SECURITY - PRACTITIONER'S PERSPECTIVE	L	T	P	SL	C
		3	0	0	3	3

COURSE OBJECTIVES

- To understand fundamental information security principles, including the CIA triad and security architecture.
- To analyze common attack techniques, vulnerabilities, and defense mechanisms in computer networks.
- To explore cryptographic techniques for securing data and communication systems.
- To examine malicious software, its propagation methods, and mitigation strategies.
- To study security auditing practices along with legal, ethical, and regulatory aspects of information security.

UNIT I	FUNDAMENTALS OF INFORMATION SECURITY	9 Hours

Computer security concepts, Confidentiality, Integrity, and Availability: CIA triad, Security architecture for open systems. Overview of computer security trends

UNIT II	ANATOMY OF CYBER ATTACKS AND DEFENCE	9 Hours

Network mapping using ICMP queries and TCP ping techniques. Port scanning: TCP and UDP scanning. FTP bounce scanning, Vulnerability scanning, System and network penetration techniques, Denial-of-Service (DoS) attacks: defense and response

UNIT III	PROTOCOL ATTACKS AND DEFENSE MECHANISMS	9 Hours

Attacks at Network layer, Attacks at the transport layer, Attacks at the application layer, Defense mechanisms for protocol-based attacks

UNIT IV	MALICIOUS SOFTWARE AND CRYPTOGRAPHIC TECHNIQUES	9 Hours

Types of malware: viruses, worms, Trojans, spyware, ransomware, Malware propagation methods: infected content, vulnerability exploits, Social engineering attacks: phishing, spam emails, Malware payloads: system corruption, bots, keyloggers, backdoors, rootkits, Introduction to cryptographic tools and techniques, Encryption and decryption concepts , Key management basics.

UNIT V	SECURITY AUDITING, LEGAL AND ETHICAL ASPECTS	9 Hours

Security auditing concepts and architecture, Security audit trails and implementation, Cybercrime and computer crime, Intellectual property rights, Privacy issues in information security, Ethical issues and professional responsibility.

TOTAL HOURS: 30 SELF LEARNING HOURS:30

COURSE OUTCOMES:

On completion of the course, students will be able to

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Explain fundamental concepts of information security, including CIA triad, security architecture, and current security trends.	**K2**
CO2	Apply techniques to identify and defend against cyber-attacks such as port scanning, vulnerability scanning, and denial-of-service attacks.	**K3**
CO3	Analyze protocol-based attacks at network, transport, and application layers and evaluate appropriate defense mechanisms.	**K4**
CO4	Apply knowledge of malware types, propagation methods, and basic cryptographic techniques for securing systems.	**K3**
CO5	Analyze security auditing processes and evaluate legal, ethical, and privacy issues in information security.	**K4**

REFERENCE BOOKS:

1. Stallings, W. (2017). Computer Security: Principles and Practice (4th ed.). Pearson.
2. Whitman, M. E., & Mattord, H. J. (2018). Principles of Information Security (6th ed.). Cengage Learning.
3. Pfleeger, C. P., Pfleeger, S. L., & Margulies, J. (2015). Security in Computing (5th ed.). Pearson.
4. Bishop, M. (2018). Computer Security: Art and Science (2nd ed.). Addison-Wesley.
5. Kaufman, C., Perlman, R., & Speciner, M. (2002). Network Security: Private Communication in a Public World (2nd ed.). Prentice Hall.

WEBLINKS:

1. https://owasp.org/
2. https://www.kaspersky.com/resource-center

NPTEL LINKS:

1. https://nptel.ac.in/courses/106105217
2. https://onlinecourses.nptel.ac.in/noc24_cs58/preview

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	–	–	2	2	–	–	–	–	3	–
CO2	–	3	2	–	3	–	–	–	–	–	3	2
CO3	–	3	2	2	2	–	–	–	–	–	3	2
CO4	2	2	2	–	3	–	–	–	–	–	3	–
CO5	–	2	–	2	–	3	2	–	–	–	3	–
Average	**2.50**	**2.40**	**2.00**	**2.00**	**2.50**	**2.50**	**2.00**	**–**	**–**	**–**	**3.00**	**2.00**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	**MCQ**	**Projects**	**observation**	**Demonstration/ Presentation**	**Open book test**

PEC 017	APPLIED CLOUD COMPUTING	L	T	P	SL	C
		3	0	0	3	3

COURSE OBJECTIVES

- To understand the core concepts of cloud computing, including deployment models (IaaS, PaaS, SaaS), service models (XaaS), and cloud architecture components.
- To identify the benefits and limitations of cloud computing compared to traditional on-premises IT infrastructure.
- To analyse real-world use cases where cloud computing offers significant advantages.
- To design and implement cloud-based solutions for specific business needs, such as data analytics, web applications, and high-performance computing.

  To gain awareness of emerging cloud technologies like serverless computing, continuation (Docker, Kubernetes), and cloud automation tools

UNIT I	INTRODUCTION TO THE CLOUD	9 Hours

Evolution of information technology (IT) and business computing models; Definition of cloud computing, business drivers for the cloud; Essential characteristics; Cloud computing vs cluster computing vs grid computing; Cloud computing architecture; Service and deployment models; Benefits, risks and challenges of cloud computing.

UNIT II	CLOUD COMPUTING STACK	9 Hours

Comparison with traditional computing architecture (client/server); Services provided at various levels, types of cloud services - public, private and hybrid; Role of networks in cloud computing; Service models (XaaS); Deployment models - public cloud, private cloud, hybrid cloud, community cloud.

UNIT III	SERVICES AND SERVICE MANAGEMENT IN CLOUD COMPUTING	9 Hours

Infrastructure as a service (IaaS); Platform as a service (PaaS); Software as a

service (SaaS). Service management - service level agreements (SLAs), billing and accounting; Service improvement and roadmap.

UNIT IV	CLOUD SECURITY	9 Hours
Infrastructure security; Network level security; Host level security; Application level security; Data security and storage; Jurisdictional issues - data location identity; Access management, access control trust, reputation, risk authentication in cloud computing.		
UNIT V	**CASE STUDIES**	**9 Hours**
Kubernetes (K8s) - Amazon Web Services (AWS) Database Migration Service - cloud extract, transform, load (ETL), Amazon SageMaker - platform to build, train and deploy machine learning models quickly; Cloud-based analytic databases - Amazon Redshift, Snowflake and Google BigQuery		

TOTAL HOURS: 30 SELF LEARNING HOURS:30

REFERENCE BOOKS:

1. Cloud Computing: Concepts, Technology & Architecture
   Covers: Cloud fundamentals, architecture, deployment models, and service models (IaaS, PaaS, SaaS).
2. Cloud Computing: Theory and Practice
   Covers: Cloud design principles, virtualization, scalability, and cloud infrastructure.
3. Mastering Cloud Computing
   Covers: Advanced cloud computing concepts, distributed systems, and service models.

WEBLINKS:

1. https://aws.amazon.com/training/learn-about/cloud-computing/
2. https://learn.microsoft.com/en-us/training/azure/

NPTEL LINKS:

1. https://nptel.ac.in/courses/106105167
2. https://onlinecourses.nptel.ac.in/noc24_cs118/preview

Course Outcomes

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Explain core concepts of cloud computing, including service models (IaaS, PaaS, SaaS), deployment models, and cloud architecture.	K2

CO2	Describe the benefits, limitations, and challenges of cloud computing compared to traditional IT infrastructure.	K2
CO3	Analyze real-world use cases and identify scenarios where cloud computing provides optimal solutions.	K4
CO4	Design and implement cloud-based solutions for business applications such as web services, data analytics, and scalable systems.	K6
CO5	Apply modern cloud technologies such as containerization using Docker and orchestration with Kubernetes, along with cloud automation tools.	K3

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	–	–	2	–	–	–	–	–	3	2
CO2	2	3	–	2	–	–	–	–	–	–	3	2
CO3	–	3	2	2	–	–	–	–	–	–	3	2
CO4	–	2	3	2	–	–	–	–	–	–	3	2
CO5	–	2	2	–	3	–	2	–	–	–	3	–
Average	**2.50**	**2.40**	**2.33**	**2.00**	**2.50**	**–**	**2.00**	**–**	**–**	**–**	**3.00**	**2.00**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	**MCQ**	**Projects**	**observation**	**Demonstration/ Presentation**	**Open book test**

MULTI DISCIPLINARY ELECTIVES

MDE1 ENERGY CONSERVATION AND MANAGEMENT IN DOMESTIC SECTORS

L	T	P	C
2	0	0	2

COURSE OBJECTIVES:

- To learn the present energy scenario and the need for energy conservation.
- To understand the different measures for energy conservation in utilities.
- To identify the energy demand and bridge the gap with suitable technology for sustainable habitat.
- To get familiar with the energy technology, current status of research and find the ways to optimize a system as per the user requirement

UNIT-I: ENERGY SCENARIO **9**

Primary energy resources - Sectorial energy consumption (domestic, industrial and other sectors), Energy pricing, Energy conservation and its importance, Energy Conservation Act-2001 and its features – Energy star rating.

UNIT-II: HEATING, VENTILLATION & AIR CONDITIONING **9**

Basics of Refrigeration and Air Conditioning – COP / EER / SEC Evaluation – SPV system design & optimization for Solar Refrigeration.

UNIT-III: LIGHTING, COMPUTER, TV **9**

Specification of Luminaries – Types – Efficacy – Selection & Application – Time Sensors –Occupancy Sensors – Energy conservation measures in computer – Television – Electronic devices.

UNIT-IV: ENERGY EFFICIENT BUILDINGS **9**

Conventional versus Energy efficient buildings – Landscape design – Envelope heat loss and heat gain – Passive cooling and heating – Renewable sources integration.

UNIT-V: ENERGY STORAGE TECHNOLOGIES **9**

Necessity & types of energy storage – Thermal energy storage – Battery energy storage, charging and discharging– Hydrogen energy storage & Super capacitors – energy density and safety issues – Applications.

TOTAL HOURS: 45 SELF LEARNING HOURS:45

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Define the national energy scenario, consumption trends, pricing policies, and provisions of the Energy Conservation Act-2001.	K2
CO2	Examine refrigeration and air-conditioning systems for operational efficiency.	K4
CO3	Utilize appropriate techniques to enhance energy efficiency in electrical appliances and lighting systems.	K3
CO4	Assess sustainable building concepts incorporating passive heating, cooling, and renewable integration.	K4
CO5	Determine the suitability of various energy storage technologies for practical applications.	K4

REFERENCE BOOKS:

1. Yogi Goswami, Frank Kreith, Energy Efficiency and Renewable energy Handbook, CRC Press, 2022
2. ASHRAE Handbook 2020 – HVAC Systems & EquipmentPaolo Bertoldi, Andrea Ricci, Anibal de Almeida, Energy Efficiency in Household Appliances and Lighting, Conference proceedings, Springer, 2021David A. Bainbridge, Ken Haggard, Kenneth L. Haggard, Passive Solar Architecture: Heating, Cooling, Ventilation, Daylighting, and More Using Natural Flows, Chelsea Green Publishing, 2021.
3. Guide book for National Certification Examination for Energy Managers and Energy Auditors (Could be downloaded from www.energymanagertraining.com)
4. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2022.117
5. Ru-shiliu, Leizhang, Xueliang sun, Electrochemical technologies for energy storage and conversion, vWiley publications, 2022.

WEBLINKS:

1. https://beeindia.gov.in/
2. https://energyeducation.ca/

NPTEL LINKS:

1. https://nptel.ac.in/courses/108105058
2. https://onlinecourses.nptel.ac.in/noc24_ce63/preview

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	–	–	–	2	–	–	–	–	3	2
CO2	2	3	–	–	2	–	–	–	–	–	3	2
CO3	–	2	3	–	3	–	–	–	–	–	3	–
CO4	2	3	–	2	–	2	–	–	–	–	3	2
CO5	–	2	3	–	2	–	–	–	–	–	3	2
Average	**2.33**	**2.40**	**3.00**	**2.00**	**2.33**	**2.00**	–	–	–	–	**3.00**	**2.00**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	**MCQ**	**Projects**	**Observation**	**Demonstration/ Presentation**	**Open book test**

MDE2 IoT FOR SMART SYSTEMS

L	T	P	C
2	0	0	2

COURSE OBJECTIVES:

- To study about Internet of Things technologies and its role in real time applications.
- To introduce the infrastructure required for IoT.
- To familiarize the accessories and communication techniques for IoT.
- To provide insight about the embedded processor and sensors required for IoT.
- To familiarize the different platforms and Attributes for IoT

UNIT-I: INTRODUCTION TO INTERNET OF THINGS 9

Overview, Hardware and software requirements for IOT, Sensor and actuators, Technology drivers, Business drivers, Typical IoT applications, Trends and implications.

UNIT-II: IOT ARCHITECTURE 9

IoT reference model and architecture -Node Structure - Sensing, Processing, Communication, Powering, Networking - Topologies, Layer/Stack architecture, IoT standards, Cloud computing for IoT, Bluetooth, Bluetooth Low Energy beacons.

UNIT-III: PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT 9

PROTOCOLS: NFC, SCADA and RFID, Zigbee MIPI, M-PHY, UniPro, SPMI, SPI, M-PCIe GSM, CDMA, LTE, GPRS, small cell. Wireless technologies for IoT: WiFi (IEEE 802.11), Bluetooth/Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN, Proprietary systems-Recent trends.

UNIT-IV: IOT PROCESSORS 9

Services/Attributes: Big-Data Analytics for IOT, Dependability, Interoperability, Security, Maintainability. Embedded processors for IOT: Introduction to Python programming -Building IOT with RASPERRY PI and Arduino.

UNIT-V: CASE STUDIES 9

Industrial IoT, Home Automation, smart cities, Smart Grid, connected vehicles, electric vehicle charging, Environment, Agriculture, Productivity Applications, IOT Defense

TOTAL HOURS: 45 SELF LEARNING HOURS:45

COURSE OUTCOMES:

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

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Explain the fundamentals of IoT, including hardware/software requirements, sensors/actuators, and IoT application trends.	K2
CO2	Describe IoT reference architecture, node structure, networking topologies, and standards including cloud integration.	K2
CO3	Compare IoT protocols and wireless technologies (e.g., NFC, RFID, Zigbee, WiFi, 6LoWPAN) based on suitability and performance.	K4
CO4	Develop IoT solutions using embedded processors, Python programming, and platforms such as Raspberry Pi and Arduino.	K3
CO5	Evaluate real-world IoT case studies across industries like smart cities, smart grid, agriculture, and defense.	K4

REFERENCE BOOKS:

1. ArshdeepBahga and VijaiMadisetti : A Hands-on Approach “Internet of Things”, Universities Press 2021.
2. Oliver Hersent , David Boswarthick and Omar Elloumi “ The Internet of Things”, Wiley, 2022.
3. Samuel Greengard, “ The Internet of Things”, The MIT press, 2022.
4. Adrian McEwen and Hakim Cassimally“Designing the Internet of Things “Wiley, 2024.
5. Jean- Philippe Vasseur, Adam Dunkels, “Interconnecting Smart Objects with IP: The Next Internet” Morgan Kuffmann Publishers, 2022.
6. Adrian McEwen and Hakim Cassimally, “Designing the Internet of Things”, John Wiley and sons, 2021.

WEBLINKS:

1. https://docs.arduino.cc/
2. https://thingspeak.com/

NPTEL LINKS:

1. https://nptel.ac.in/courses/106105166
2. https://onlinecourses.nptel.ac.in/noc24_cs49/preview

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	–	–	2	–	–	–	–	–	3	2
CO2	2	3	–	–	2	–	–	–	–	–	3	2
CO3	–	2	3	–	3	–	–	–	–	–	3	2
CO4	–	2	3	–	3	–	–	–	–	–	3	2
CO5	–	3	–	2	–	–	2	–	–	–	3	2
Average	**2.50**	**2.40**	**3.00**	**2.00**	**2.50**	**–**	**2.00**	**–**	**–**	**–**	**3.00**	**2.00**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	**MCQ**	**Projects**	**Observation**	**Demonstration/ Presentation**	**Open book test**

MDE 03 MACHINE LEARNING AND DEEP LEARNING

L	T	P	C
2	0	0	2

COURSE OBJECTIVES:

The course is aimed at

- Understanding about the learning problem and algorithms
- Providing insight about neural networks
- Introducing the machine learning fundamentals and significance
- Enabling the students to acquire knowledge about pattern recognition.
- Motivating the students to apply deep learning algorithms for solving real life problems.

UNIT-I: LEARNING PROBLEMS AND ALGORITHMS 9

Various paradigms of learning problems, Supervised, Semi-supervised and Unsupervised algorithms

UNIT-II: NEURAL NETWORKS 9

Differences between Biological and Artificial Neural Networks - Typical Architecture, Common Activation Functions, Multi-layer neural network, Linear Separability, Hebb Net, Perceptron, Adaline, Standard Back propagation Training Algorithms for Pattern Association - Hebb rule and Delta rule, Hetero associative, Auto associative, Kohonen Self Organising Maps, Examples of Feature Maps, Learning Vector Quantization, Gradient descent, Boltzmann Machine Learning.

UNIT-III: MACHINE LEARNING – FUNDAMENTALS & FEATURE SELECTIONS & CLASSIFICATIONS 9

Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1- Score, the curse of dimensionality, training, testing, validation, cross validation, overfitting, under-fitting the data, early stopping, regularization, bias and variance. Feature Selection, normalization, dimensionality reduction, Classifiers: KNN, SVM, Decision trees, Naïve Bayes, Binary classification, multi class classification, clustering**.**

UNIT-IV: DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS 9

Feed forward networks, Activation functions, back propagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, Examples of CNNs.

UNIT-V: DEEP LEARNING: RNNS, AUTOENCODERS AND GANS 9

State, Structure of RNN Cell, LSTM and GRU, Time distributed layers, Generating Text, Autoencoders: Convolutional Autoencoders, Denoising autoencoders, Variational autoencoders, GANs: The discriminator, generator, DCGANs

TOTAL HOURS: 45 SELF LEARNING HOURS:45

COURSE OUTCOMES:

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

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Classify different learning paradigms and their characteristics, including supervised, semi-supervised, and unsupervised learning algorithms.	K2
CO2	Differentiate various neural network models, learning rules, and training algorithms including perceptron, back propagation, SOM, and Boltzmann machines.	K4
CO3	Discover machine learning fundamentals such as performance metrics, over fitting/under fitting, feature selection, and classification techniques (KNN, SVM, Decision Trees, Naïve Bayes).	K4
CO4	Examine convolutional neural network architectures and components including convolution, pooling, optimizers, batch normalization, and dropout.	K4
CO5	Build recurrent neural networks, auto encoders, and GANs to sequence modelling and representation learning problems.	K3

REFERENCE BOOKS:

1. J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence, 2012, PHI learning
2. Deep Learning, Ian Good fellow, YoshuaBengio and Aaron Courville, MIT Press, ISBN: 9780262035613, 2016.
3. The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009.
4. Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006.
5. Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.

WEBLINKS:

1. https://developers.google.com/machine-learning/crash-course
2. https://scikit-learn.org/stable/

NPTEL LINKS:

1. https://nptel.ac.in/courses/106106139
2. https://onlinecourses.nptel.ac.in/noc24_cs81/preview

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	–	–	2	–	–	–	–	–	3	2
CO2	3	2	2	–	–	–	–	–	–	–	3	2
CO3	2	3	2	–	3	–	–	–	–	–	3	–
CO4	–	2	3	2	3	–	–	–	–	–	3	2
CO5	–	2	3	2	3	–	–	–	–	–	3	2
Average	**2.67**	**2.20**	**2.50**	**2.00**	**2.75**	**–**	**–**	**–**	**–**	**–**	**3.00**	**2.00**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	**MCQ**	**Projects**	**Observation**	**Demonstration/ Presentation**	**Open book test**

MDE4 RENEWABLE ENERGY TECHNOLOGY

L	T	P	C
2	0	0	2

COURSE OBJECTIVES:

To impart knowledge on

- Different types of renewable energy technologies
- Standalone operation, grid connected operation of renewable energy systems

UNIT-I: INTRODUCTION 9

Classification of energy sources – Co2 Emission - Features of Renewable energy - Renewable energy scenario in India -Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment Per Capital Consumption - CO2 Emission - importance of renewable energy sources, Potentials – Achievements– Applications.

UNIT-II: SOLAR PHOTOVOLTAICS 9

Solar Energy: Sun and Earth-Basic Characteristics of solar radiation- angle of sunrays on solar collector-Estimating Solar Radiation Empirically - Equivalent circuit of PV Cell- Photovoltaic cell-characteristics: P-V and I-V curve of cell-Impact of Temperature and Insolation on I-V characteristics-Shading Impacts on I-V characteristics-Bypass diode -Blocking diode.

UNIT-III: PHOTOVOLTAIC SYSTEM DESIGN 9

Block diagram of solar photo voltaic system : Line commutated converters (inversion mode) - Boost and buck-boost converters - selection of inverter, battery sizing, array sizing - PV systems classification- standalone PV systems - Grid tied and grid interactive inverters- grid connection issues.

UNIT-IV: WIND ENERGY CONVERSION SYSTEMS 9

Origin of Winds: Global and Local Winds- Aerodynamics of Wind turbine-Derivation of Betz's limit- Power available in wind-Classification of wind turbine: Horizontal Axis wind turbine and Vertical axis wind turbine- Aerodynamic Efficiency-Tip Speed-Tip Speed Ratio-Solidity-Blade Count-Power curve of wind turbine - Configurations of wind energy conversion systems: Type A, Type B, Type C and Type D Configurations- Grid connection Issues - Grid integrated SCIG and PMSG based WECS.

UNIT-V: OTHER RENEWABLE ENERGY SOURCES 9

Qualitative study of different renewable energy resources: ocean, Biomass, Hydrogen energy systems, Fuel cells, Ocean Thermal Energy Conversion (OTEC), Tidal and wave energy, Geothermal Energy Resources.

TOTAL HOURS: 45 SELF LEARNING HOURS:45

COURSE OUTCOMES:

After successful completion of the course, the student will be able to:

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Relate the energy scenario, environmental impacts, and the importance of renewable energy sources along with India's renewable energy status.	K2
CO2	Inference solar photovoltaic principles, PV cell characteristics, and the effects of temperature, insolation, and shading on PV performance.	K4
CO3	Design solar PV systems by selecting appropriate converters, inverters, batteries, and sizing PV arrays for standalone and grid-connected systems.	K3
CO4	Contrast wind energy conversion systems by examining turbine aerodynamics, power curves, Betz limit, and grid integration issues.	K4
CO5	Compare various other renewable energy technologies including biomass, hydrogen, fuel cells, tidal, wave, geothermal, and ocean energy.	K4

REFERENCE BOOKS:

1. S.N.Bhadra, D. Kastha, & S. Banerjee "Wind Electrical Systems", Oxford UniversityPress, 2009.
2. Rai. G.D, "Non conventional energy sources", Khanna publishes, 1993.
3. Rai. G.D," Solar energy utilization", Khanna publishes, 1993.
4. Chetan Singh Solanki, "Solar Photovoltaics: Fundamentals, Technologies and Applications", PHI Learning Private Limited, 2012.
5. John Twideu and Tony Weir, "Renewal Energy Resources" BSP Publications, 2006
6. Gray, L. Johnson, "Wind energy system", prentice hall of India, 1995.
7. B.H.Khan, " Non-conventional Energy sources", , McGraw-hill, 2nd Edition, 2009.
8. Fang Lin Luo Hong Ye, " Renewable Energy systems", Taylor & Francis Group,2013.

WEBLINKS:

1. https://www.energy.gov/eere/renewable-energy
2. https://www.irena.org/

NPTEL LINKS:

1. https://nptel.ac.in/courses/103107155
2. https://onlinecourses.nptel.ac.in/noc24_ce116/preview

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	–	–	–	2	–	–	–	2	3	2
CO2	3	2	–	2	2	–	–	–	–	–	3	2
CO3	2	3	3	–	2	–	–	–	–	–	3	2
CO4	2	3	–	2	–	–	–	–	–	2	3	2
CO5	2	2	–	–	–	2	–	–	–	2	3	2
Average	**2.40**	**2.40**	**3.00**	**2.00**	**2.00**	**2.00**	**–**	**–**	**–**	**2.00**	**3.00**	**2.00**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	**MCQ**	**Projects**	**Observation**	**Demonstration/ Presentation**	**Open book test**

MDE5 SMART GRID

L	T	P	C
2	0	0	2

COURSE OBJECTIVES:

- To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure.
- To know about the function of smart grid.
- To familiarize the power quality management issues in Smart Grid.
- To familiarize the high performance computing for Smart Grid applications
- To get familiarized with the communication networks for Smart Grid applications

UNIT-I: INTRODUCTION TO SMART GRID 9

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Comparison of Micro grid and Smart grid, Present development & International policies in Smart Grid, Smart Grid Initiative for Power Distribution Utility in India – Case Study.

UNIT-II: SMART GRID TECHNOLOGIES 9

Technology Drivers, Smart Integration of energy resources, Smart substations, Substation Automation, Feeder Automation ,Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/Var control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV) – Grid to Vehicle and Vehicle to Grid charging concepts.

UNIT-III: SMART METERS AND ADVANCED METERING INFRASTRUCTURE 9

Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU) & their application for monitoring & protection. Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing.

UNIT-IV: POWER QUALITY MANAGEMENT IN SMART GRID 9

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

UNIT-V: HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9

Architecture and Standards -Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), PLC, Zigbee, GSM, IP based Protocols, Basics of Web Service and CLOUD Computing, Cyber Security for Smart Grid.

TOTAL HOURS: 45 SELF LEARNING HOURS:45

COURSE OUTCOMES:

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

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Outline the evolution, concepts, drivers, functions, and benefits of smart grid systems, and distinguish them from conventional grids.	K2
CO2	Analyse smart grid technologies including smart substations, automation, EMS/FACTS/HVDC, and integration of DERs with grid operations.	K4
CO3	Explain smart metering and AMI architecture, standards, PMU applications, and demand-side management strategies.	K2
CO4	Evaluate power quality issues and mitigation techniques in smart grids, including monitoring and audit practices.	K4
CO5	Apply high-performance computing, communication networks, cloud services, and cyber security concepts for smart grid applications.	K3

REFERENCE BOOKS:

1. Stuart Borlase ‘Smart Grid: Infrastructure, Technology and Solutions’, CRC Press 2012.
2. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, ‘Smart Grid: Technology and Applications’, Wiley, 2012.
3. Mini S. Thomas, John D McDonald, ‘Power System SCADA and Smart Grids’, CRC Press, 2015
4. Kenneth C.Budka, Jayant G. Deshpande, Marina Thottan, ‘Communication Networks for Smart Grids’, Springer, 2014
5. SMART GRID Fundamentals of Design and Analysis, James Momoh, IEEE press, A John Wiley & Sons, Inc., Publication.

WEBLINKS:

1. https://smartgrid.ieee.org/

2. https://www.energy.gov/oe/activities/technology-development/grid-modernization-and-smart-grid

NPTEL LINKS:

1. https://nptel.ac.in/courses/108105131
2. https://onlinecourses.nptel.ac.in/noc24_ee82/preview

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	–	–	–	2	–	–	–	–	3	2
CO2	2	3	3	–	2	–	–	–	–	–	3	2
CO3	2	3	–	2	2	–	–	–	–	–	3	2
CO4	–	3	2	2	–	–	–	–	–	–	3	2
CO5	–	2	3	–	3	2	–	–	–	–	3	2
Average	**2.33**	**2.60**	**2.67**	**2.00**	**2.33**	**2.00**	**–**	**–**	**–**	**–**	**3.00**	**2.00**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	**MCQ**	**Projects**	**Observation**	**Demonstration/ Presentation**	**Open book test**

MDE6 INTERNET OF THINGS AND CLOUD

L	T	P	C
2	0	0	2

COURSE OBJECTIVES:

- To understand Smart Objects and IoT Architectures
- To learn about various IOT-related protocols
- To build simple IoT Systems using Arduino and Raspberry Pi.
- To understand data analytics and cloud in the context of IoT
- To develop IoT infrastructure for popular applications

UNIT-I: FUNDAMENTALS OF IoT **9**

Introduction to IoT – IoT definition – Characteristics – IoT Complete Architectural Stack – IoT enabling Technologies – IoT Challenges. Sensors and Hardware for IoT – Hardware Platforms – Arduino, Raspberry Pi, Node MCU. A Case study with any one of the boards and data acquisition from sensors**.**

UNIT-II: PROTOCOLS FOR IoT **9**

Infrastructure protocol (IPV4/V6/RPL), Identification (URIs), Transport (Wifi, Lifi, BLE), Discovery, Data Protocols, Device Management Protocols. – A Case Study with MQTT/CoAP usage-IoT privacy, security and vulnerability solutions.

UNIT-III: CASE STUDIES/INDUSTRIAL APPLICATIONS **9**

Case studies with architectural analysis: IoT applications – Smart City – Smart Water – Smart Agriculture – Smart Energy – Smart Healthcare – Smart Transportation – Smart Retail – Smart waste management.

UNIT-IV: CLOUD COMPUTING INTRODUCTION **9**

Introduction to Cloud Computing - Service Model – Deployment Model- Virtualization Concepts – Cloud Platforms – Amazon AWS – Microsoft Azure – Google APIs.

UNIT-V: IoT AND CLOUD **9**

IoT and the Cloud - Role of Cloud Computing in IoT - AWS Components - S3 – Lambda - AWS IoT Core -Connecting a web application to AWS IoT using MQTT- AWS IoT Examples. Security Concerns, Risk Issues, and Legal Aspects of Cloud Computing- Cloud Data Security

TOTAL HOURS: 45 SELF LEARNING HOURS:45

COURSE OUTCOMES:

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

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Demonstrate IoT fundamentals, architectural stack, enabling technologies, and hardware platforms with sensor data acquisition.	K2
CO2	Compare IoT communication, transport, and management protocols and apply MQTT/CoAP for IoT messaging.	K4
CO3	Discover industrial IoT applications through architectural case studies in smart city, agriculture, healthcare, energy, and transportation domains.	K4
CO4	Describe cloud computing models, virtualization, and major cloud platforms such as AWS, Azure, and Google Cloud.	K2
CO5	Implement IoT-cloud integration using AWS IoT services and evaluate cloud security, privacy, and risk issues in IoT deployments.	K3

REFERENCE BOOKS:

1. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman ,CRC Press, 2017
2. Adrian McEwen, Designing the Internet of Things, Wiley,2013.
3. EMC Education Services, “Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data”, Wiley publishers, 2015.
4. Simon Walkowiak, “Big Data Analytics with R” PackT Publishers, 2016
5. Bart Baesens, “Analytics in a Big Data World: The Essential Guide to Data Science and its Applications”, Wiley Publishers, 2015.

WEBLINKS:

3. https://docs.arduino.cc/
4. https://thingspeak.com/

NPTEL LINKS:

3. https://nptel.ac.in/courses/106105166

4. https://onlinecourses.nptel.ac.in/noc24_cs49/preview

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	–	–	2	–	–	–	–	–	3	2
CO2	2	3	–	–	3	–	–	–	–	–	3	2
CO3	–	2	3	–	2	–	–	–	–	–	3	2
CO4	3	2	–	–	2	–	–	–	–	–	3	2
CO5	2	3	3	–	2	–	–	–	–	–	3	2
Average	**2.50**	**2.40**	**3.00**	**–**	**2.20**	**–**	**–**	**–**	**–**	**–**	**3.00**	**2.00**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	**MCQ**	**Projects**	**Observation**	**Demonstration/ Presentation**	**Open book test**

MDE7 MEDICAL ROBOTICS

L	T	P	C
2	0	0	2

COURSE OBJECTIVES:

- To explain the basic concepts of robots and types of robots
- To discuss the designing procedure of manipulators, actuators and grippers
- To impart knowledge on various types of sensors and power sources
- To explore various applications of Robots in Medicine
- To impart knowledge on wearable robots

UNIT-I: INTRODUCTION TO ROBOTICS **9**

Introduction to Robotics, Overview of robot subsystems, Degrees of freedom, configurations and concept of workspace, Dynamic Stabilization. Sensors and Actuators Sensors and controllers, Internal and external sensors, position, velocity and acceleration sensors, Proximity sensors, force sensors Pneumatic and hydraulic actuators, Stepper motor control circuits, End effectors, Various types of Grippers, PD and PID feedback actuator models.

UNIT-II: MANIPULATORS & BASIC KINEMATICS **9**

Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and pneumatic manipulator, Forward Kinematic Problems, Inverse Kinematic Problems, Solutions of Inverse Kinematic problems. Navigation and Treatment Planning Variable speed arrangements, Path determination – Machinery vision, Ranging – Laser –Acoustic, Magnetic, fiber optic and Tactile sensor.

UNIT-III: SURGICAL ROBOTS **9**

Da Vinci Surgical System, Image guided robotic systems for focal ultrasound based surgical applications, System concept for robotic Tele-surgical system for off-pump, CABG surgery, Urologic applications, Cardiac surgery, Neuro-surgery, Pediatric and General Surgery, Gynecologic Surgery, General Surgery and Nanorobotics. Case Study.

UNIT-IV: REHABILITATION AND ASSISTIVE ROBOTS **9**

Pediatric Rehabilitation, Robotic Therapy for the Upper Extremity and Walking, Clinical-Based Gait Rehabilitation Robots, Motion Correlation and Tracking, Motion Prediction, Motion Replication. Portable Robot for Tele rehabilitation, Robotic Exoskeletons – Design considerations, Hybrid assistive limb. Case Study.

UNIT-V: WEARABLE ROBOTS **9**

Augmented Reality, Kinematics and Dynamics for Wearable Robots, Wearable Robot technology, Sensors, Actuators, Portable Energy Storage, Human–robot cognitive interaction (cHRI), Human–robot physical interaction (pHRI), Wearable Robotic Communication - case study.

TOTAL HOURS: 45 SELF LEARNING HOURS:45

COURSE OUTCOMES:

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

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Explain the fundamentals of robotics including subsystems, degrees of freedom, sensors, actuators, and feedback control models.	K2
CO2	Solve manipulator kinematics and path planning problems using forward and inverse kinematic models and navigation techniques.	K3
CO3	Analyse surgical robotic systems, including design concepts, applications, and clinical case studies.	K4
CO4	Evaluate rehabilitation and assistive robotic technologies for gait, motion therapy, and exoskeleton applications using design considerations and case studies.	K4
CO5	Apply wearable robotic concepts including AR integration, sensor/actuator selection, energy storage, and human–robot interaction for real-world applications.	K3

REFERENCE BOOKS:

1. Nagrath and Mittal, “Robotics and Control”, Tata McGraw Hill, First edition, 2003
2. Spong and Vidhyasagar, “Robot Dynamics and Control”, John Wiley and Sons,First edition, 2008
3. Fu.K.S, Gonzalez. R.C., Lee, C.S.G, “Robotics, control”, sensing, Vision and Intelligence,Tata McGraw Hill International, First edition, 2008
4. Bruno Siciliano, Oussama Khatib, Springer Handbook of Robotics, 1st Edition, Springer, 2008
5. Jacob Rosen, Blake Hannaford & Richard M Satava, “Surgical Robotics: System Applications & Visions”, Springer 2011
6. Jocelyn Troccaz, Medical Robotics, Wiley, 2012
7. Achim Schweikard, Floris Ernst, Medical Robotics, Springer, 2015

WEBLINKS:

1. https://www.intuitive.com/
2. https://robotics.sciencemag.org/

NPTEL LINKS:

1. https://nptel.ac.in/courses/112107289
2. https://onlinecourses.nptel.ac.in/noc24_me96/preview

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	–	–	2	–	–	–	–	–	3	2
CO2	2	3	3	–	2	–	–	–	–	–	3	2
CO3	–	3	2	2	–	–	–	–	–	–	3	2
CO4	–	3	2	3	–	–	–	–	–	–	3	2
CO5	2	2	3	–	3	–	–	–	–	–	3	2
Average	**2.33**	**2.60**	**2.50**	**2.50**	**2.33**	**–**	**–**	**–**	**–**	**–**	**3.00**	**2.00**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	**MCQ**	**Projects**	**observation**	**Demonstration/ Presentation**	**Open book test**

MDE8 EMBEDDED AUTOMATION

L	T	P	C
2	0	0	2

COURSE OBJECTIVES:

- To learn about the process involved in the design and development of real-time embedded system
- To develop the embedded C programming skills on 8-bit microcontroller
- To study about the interfacing mechanism of peripheral devices with 8-bit microcontrollers
- To learn about the tools, firmware related to microcontroller programming
- To build a home automation system

UNIT-I: INTRODUCTION TO EMBEDDED C PROGRAMMING 9

C Overview and Program Structure - C Types, Operators and Expressions - C Control Flow - C Functions and Program Structures - C Pointers and Arrays - FIFO and LIFO - C Structures - Development Tools

UNIT-II: AVR MICROCONTROLLER 9

ATMEGA 16 Architecture - Nonvolatile and Data Memories - Port System - Peripheral Features: Time Base, Timing Subsystem, Pulse Width Modulation, USART, SPI, Two Wire Serial Interface, ADC, Interrupts - Physical and Operating Parameters

UNIT-III: HARDWARE AND SOFTWARE INTERFACING WITH 8-BIT SERIES CONTROLLERS 9

Lights and Switches - Stack Operation - Implementing Combinational Logic - Expanding I/O - Interfacing Analog To Digital Convertors - Interfacing Digital To Analog Convertors - LED Displays : Seven Segment Displays, Dot Matrix Displays - LCD Displays - Driving Relays - Stepper Motor Interface - Serial EEPROM - Real Time Clock - Accessing Constants Table - Arbitrary Waveform Generation - Communication Links - System Development Tools

UNIT-IV: VISION SYSTEM 9

Fundamentals of Image Processing - Filtering - Morphological Operations - Feature Detection and Matching - Blurring and Sharpening - Segmentation - Thresholding - Contours - Advanced Contour Properties - Gradient - Canny Edge Detector - Object Detection - Background Subtraction

UNIT-V: HOME AUTOMATION 9

Home Automation - Requirements - Water Level Notifier - Electric Guard Dog - Tweeting Bird Feeder - Package Delivery Detector - Web Enabled Light Switch - Curtain Automation - Android

Door Lock - Voice Controlled Home Automation - Smart Lighting - Smart Mailbox - Electricity Usage Monitor -Proximity Garage Door Opener - Vision Based Authentic Entry System

TOTAL HOURS: 45 SELF LEARNING HOURS:45

COURSE OUTCOMES:

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

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Illustrate the fundamentals of C programming and embedded C constructs including pointers, arrays, structures, and program flow for embedded applications.	K2
CO2	Summarize the architecture and peripheral features of AVR microcontrollers such as ATmega16 for embedded system design.	K2
CO3	Interface AVR microcontrollers with various hardware components (sensors, displays, motors, ADC/DAC, communication links) for real-time applications.	K3
CO4	Examine vision system techniques including filtering, edge detection, segmentation, feature matching, and object detection for embedded vision applications.	K4
CO5	Design home automation solutions by integrating embedded systems, sensors, and vision-based methods for smart home applications.	K4

REFERENCE BOOKS:

1. Dhananjay V. Gadre, "Programming and Customizing the AVR Microcontroller", McGraw-Hill, 2001.
2. Joe Pardue, "C Programming for Microcontrollers ", Smiley Micros, 2005.
3. Steven F. Barrett, Daniel J. Pack, "ATMEL AVR Microcontroller Primer : Programming and Interfacing", Morgan & Claypool Publishers, 2012
4. Mike Riley, "Programming Your Home - Automate With Arduino, Android and Your Computer", the Pragmatic Programmers, Llc, 2012.
5. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 2011.
6. Kevin P. Murphy, "Machine Learning - a Probabilistic Perspective", the MIT Press Cambridge, Massachusetts, London, 2012.

WEBLINKS:

1. https://www.embedded.com/
2. https://www.arduino.cc/en/Guide/

NPTEL LINKS:

1. https://nptel.ac.in/courses/108102045
2. https://onlinecourses.nptel.ac.in/noc24_ee81/preview

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	–	–	2	–	–	–	–	–	3	2
CO2	3	2	–	–	2	–	–	–	–	–	3	2
CO3	2	3	3	–	2	–	–	–	–	–	3	2
CO4	–	3	2	3	2	–	–	–	–	–	3	2
CO5	2	3	3	–	3	–	–	–	–	–	3	2
Average	**2.50**	**2.60**	**2.67**	**3.00**	**2.20**	**–**	**–**	**–**	**–**	**–**	**3.00**	**2.00**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	**MCQ**	**Projects**	**observation**	**Demonstration/ Presentation**	**Open book test**

MDE9 ENVIRONMENTAL SUSTAINABILITY

L	T	P	C
2	0	0	2

COURSE OBJECTIVES:

- To understand environmental valuation methods, sustainability concepts, and the economic causes of environmental problems.
- To analyse the significance of biodiversity, pollution impacts, and resource management in achieving sustainable development.
- To examine the role of environmental economics and policies in addressing global environmental challenges and shaping future development.

UNIT-I: INTRODUCTION **9**

Valuing the Environment: Concepts, Valuing the Environment: Methods, Property Rights, Externalities, and Environmental Problems

UNIT-II: CONCEPT OF SUSTAINABILITY **9**

Sustainable Development: Defining the Concept, the Population Problem, Natural Resource Economics: An Overview, Energy, Water, Agriculture

UNIT-III: SIGNIFICANCE OF BIODIVERSITY **9**

Biodiversity, Forest Habitat, Commercially Valuable Species, Stationary - Source Local Air Pollution, Acid Rain and Atmospheric Modification, Transportation

UNIT-IV: POLLUTION IMPACTS **9**

Water Pollution, Solid Waste and Recycling, Toxic Substances and Hazardous Wastes, Global Warming.

UNIT-V: ENVIRONMENTAL ECONOMICS **9**

Development, Poverty, and the Environment, Visions of the Future, Environmental economics and policy by Tom Tietenberg, Environmental Economics

TOTAL HOURS: 45 SELF LEARNING HOURS:45

COURSE OUTCOMES:

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

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Demonstrate the concepts of environmental valuation, property rights, externalities, and environmental problems.	K2
CO2	Outline the principles of sustainability, population challenges, and natural resource economics including energy, water, and agriculture.	K2
CO3	Discover the significance of biodiversity, forest habitats, commercially valuable species, and the impact of air pollution and transportation.	K4
CO4	Evaluate the effects of water pollution, solid waste management, toxic substances, hazardous wastes, and global warming on the environment.	K4
CO5	Assess environmental economics frameworks, policy interventions, development impacts, poverty, and future sustainability visions.	K4

REFERENCE BOOKS:

1. Andrew Hoffman, Competitive Environmental Strategy - A Guide for the Changing Business Landscape, Island Press.
2. Stephen Doven, Environment and Sustainability Policy: Creation, Implementation, Evaluation, the Federation Press, 2005
3. Robert Brinkmann., Introduction to Sustainability, Wiley-Blackwell., 2016
4. Niko Roorda., Fundamentals of Sustainable Development, 3rd Edn, Routledge, 2020
5. Bhavik R Bakshi., Sustainable Engineering: Principles and Practice, Cambridge University Press, 2019

WEBLINKS:

1. https://www.unep.org/
2. https://www.sustainability.com/

NPTEL LINKS:

1. https://nptel.ac.in/courses/120107011
2. https://onlinecourses.nptel.ac.in/noc24_bt32/preview

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	–	–	–	2	–	–	–	–	3	2
CO2	3	2	–	–	2	2	–	–	–	–	3	2
CO3	2	3	–	2	–	–	–	–	–	–	3	2
CO4	2	3	3	–	–	2	–	–	–	–	3	2
CO5	–	2	2	3	–	3	–	–	–	–	3	2
Average	**2.50**	**2.40**	**2.50**	**2.50**	**2.00**	**2.25**	**–**	**–**	**–**	**–**	**3.00**	**2.00**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	**MCQ**	**Projects**	**observation**	**Demonstration/ Presentation**	**Open book test**

MDE10 IPR, BIOSAFETY AND ENTREPRENEURSHIP

L	T	P	C
2	0	0	2

COURSE OBJECTIVES:

- To understand intellectual property rights, patent systems, treaties, and filing procedures, with special reference to biotechnology and innovation.
- To examine biosafety principles, GMO regulations, and risk assessment frameworks at national and international levels.
- To develop awareness of entrepreneurship concepts, enterprise development, and institutional support mechanisms for launching and managing small ventures.

UNIT I: IPR **9**

Intellectual property rights – Origin of the patent regime – Early patents act & Indian pharmaceutical industry – Types of patents – Patent Requirements – Application preparation filing and prosecution – Patentable subject matter – Industrial design, Protection of GMO's IP as a factor in R&D,IP's of relevance to biotechnology and few case studies.

UNIT-II: AGREEMENTS, TREATIES AND PATENT FILING PROCEDURES **9**

History of GATT Agreement – Madrid Agreement – Hague Agreement – WIPO Treaties – Budapest Treaty – PCT – Ordinary – PCT – Conventional – Divisional and Patent of Addition – Specifications – Provisional and complete – Forms and fees Invention in context of "prior art" – Patent databases – Searching International Databases – Country-wise patent searches (USPTO,espacenet(EPO) – PATENT Scope (WIPO) – IPO, etc National & PCT filing procedure – Time frame and cost – Status of the patent applications filed – Precautions while patenting – disclosure/non-disclosure – Financial assistance for patenting – Introduction to existing schemes Patent licensing and agreement Patent infringement – Meaning, scope, litigation, case studies

UNIT-III: BIOSAFETY **9**

Introduction – Historical Backround – Introduction to Biological Safety Cabinets – Primary Containment for Biohazards – Biosafety Levels – Biosafety Levels of Specific Microorganisms – Recommended Biosafety Levels for Infectious Agents and Infected Animals – Biosafety guidelines – Government of India.

UNIT-IV: GENETICALLY MODIFIED ORGANISMS **9**

Definition of GMOs & LMOs – Roles of Institutional Biosafety Committee – RCGM – GEAC etc. for GMO applications in food and agriculture – Environmental release of GMOs – Risk Analysis – Risk Assessment – Risk management and communication – Overview of National Regulations and relevant International Agreements including Cartegana Protocol.

UNIT-V: ENTREPRENEURSHIP DEVELOPMENT 9

Introduction – Entrepreneurship Concept – Entrepreneurship as a career – Entrepreneurial personality – Characteristics of successful Entrepreneur – Factors affecting entrepreneurial growth – Entrepreneurial Motivation – Competencies – Mobility – Entrepreneurship Development Programmes (EDP) - Launching Of Small Enterprise - Definition, Characteristics – Relationship between small and large units – Opportunities for an Entrepreneurial career – Role of small enterprise in economic development – Problems of small scale industries – Institutional finance to entrepreneurs - Institutional support to entrepreneurs.

TOTAL HOURS: 45 SELF LEARNING HOURS:45

COURSE OUTCOMES:

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

COURSE OUTCOMES	DESCRIPTION	KNOWLEDGE LEVEL
CO1	Explain the fundamentals of intellectual property rights, patent types, patent requirements, and IP relevance in biotechnology.	K2
CO2	Summarize international agreements, patent filing procedures, and legal aspects of patent databases, licensing, and infringement.	K2
CO3	Analyse biosafety principles, containment practices, biosafety levels, and government guidelines for handling biohazards.	K4
CO4	Categorize the roles of Institutional Biosafety Committees, regulatory authorities, risk assessment, and management of genetically modified organisms (GMOs).	K4
CO5	Formulate entrepreneurial strategies by understanding entrepreneurship concepts, personality traits, business planning, and institutional support mechanisms for small enterprises.	K4

REFERENCE BOOKS:

1. Bouchoux, D.E., “Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets for the Paralegal”, 3rd Edition, Delmar Cengage Learning, 2008.
2. Fleming, D.O. and Hunt, D.L., “Biological Safety: Principles and Practices”, 4th Edition, American Society for Microbiology, 2006.
3. Irish, V., “Intellectual Property Rights for Engineers”, 2nd Edition, The Institution of Engineering and Technology, 2005.

4. Mueller, M.J., "Patent Law", 3rd Edition, Wolters Kluwer Law & Business, 2009.
5. S.S Khanka, "Entrepreneurial Development", S.Chand & Company LTD, New Delhi, 2007.

WEBLINKS:

1. https://www.wipo.int/
2. https://www.startupindia.gov.in/

NPTEL LINKS:

1. https://nptel.ac.in/courses/109104135
2. https://onlinecourses.nptel.ac.in/noc24_mg60/preview

COURSE ARTICULATION MATRIX

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	–	–	–	2	–	–	–	–	3	2
CO2	2	3	–	–	2	2	–	–	–	–	3	2
CO3	2	3	–	2	–	2	–	–	–	–	3	2
CO4	–	3	2	2	–	2	–	–	–	–	3	2
CO5	–	2	3	–	2	–	–	–	–	–	3	2
Average	**2.33**	**2.40**	**2.50**	**2.00**	**2.00**	**2.00**	–	–	–	–	**3.00**	**2.00**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✔	✔	✔	✔	✔	
Quiz	**MCQ**	**Projects**	**observation**	**Demonstration/ Presentation**	**Open book test**