SCHEME OF INSTRUCTION AND SYLLABUS

B.Tech in Computer Science and Engineering (Artificial Intelligence and Machine Learning)

Regulation:VR23

w.e.f.2023-24

Department of Computer Science and Engineering

VELAGAPUDI RAMAKRISHNA
SIDDHARTHA ENGINEERING COLLEGE

(An Autonomous, ISO 9001:2015 Certified Institution)

(Approved by AICTE, Accredited by NAAC with 'A+' Grade, Affiliated to JNTUK, Kakinada)

(Sponsored by Siddhartha Academy of General & Technical Education)

Vijayawada, Andhra Pradesh - 520007, INDIA.

www.vrsiddhartha.ac.in

Institute Vision

To nurture excellence in various fields of engineering by imparting timeless core values to the learners and to mould the institution into a centre of academic excellence and advanced research.

Institute Mission

To impart high quality technical education in order to mould the learners into globally competitive technocrats who are professionally deft, intellectually adept and socially responsible. The institution strives to make the learners inculcate and imbibe pragmatic perception and proactive nature so as to enable them to acquire a vision for exploration and an insight for advanced enquiry.

Department Vision

The department vision is clearly defined and is in line with the college's vision. The vision of the department is "To evolve as a centre of academic excellence and advanced research in Computer Science and Engineering discipline."

Department Mission

This mission of the department is concise and supports the college's mission. The mission of the Computer Science and Engineering department is "To inculcate students with profound understanding of fundamentals related to discipline, attitudes, skills, and their application in solving real world problems, with an inclination towards societal issues and research."

Program Educational Objectives
(Undergraduate)

We have program educational objectives for our Computer Science and Engineering program. Program educational objectives are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve.

Our program educational objectives are:

The graduates of the program will

1. Have knowledge and analytical skills, including mathematics, science and basic engineering.

2. Have in-depth learning skills to function productively as leadership role or as supportive members in multidisciplinary teams with effective communication.

3. Have extensive knowledge in state-of the- art frameworks in Artificial Intelligence to design industry accepted AI solutions using modern tools for allied domains with realistic constraints or pursue higher studies and continue to develop their professional knowledge.

4. Practice the profession with ethics, integrity, leadership and social responsibility.

Program Outcomes

On successful completion of the B.Tech in CSE (AI&ML) programme the student will be able to:

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

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

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

PO4 - *Conduct investigations of complex 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, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

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

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

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

PO9 - *Individual and team work:* Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

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

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

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

Program Specific Outcomes

PSO1: Develop software applications or solutions as per the needs of Industry and society.

PSO2: Adopt new and fast emerging technologies in computer science and engineering.

COURSE CATEGORY ABBREVIATIONS

1. Humanities and Sciences-HS

2. Basic Sciences-BS

3. Engineering Science-ES

4. Program Core-PC

5. Soft Skills-SS

6. Skill Enhancement Course-SEC

7. Audit Course-AC

8. Mandatory Course-MC

9. Program Elective-PE

10. Open Elective-OE

11. Humanities and Social Sciences-HSS

12. Advanced Skill Course

13. Institutional Core-IC

SCHEME OF INSTRUCTION

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

(ARTIFICIAL INTELLIGENCE & MACHINE LEARNING)

SCHEME OF INSTRUCTION FOR FOUR YEAR UG PROGRAMME [VR23]

Semester I

			Contact Hours				27
S. No.	Course Code	Course Category	Course Name	L	T	P	C
1	23BS1101	BS	Linear Algebra & Calculus	3	0	0	3
2	23BS1102	BS	Engineering Physics	3	0	0	3
3	23ES1103A	ES	Basic Civil and Mechanical Engineering	3	0	0	3
4	223ES1104	ES	Introduction to Programming	3	0	0	3
5	23HS1105	HSS	Communicative English	2	0	0	2
6	23BS1151	BS	Engineering Physics Lab	0	0	2	1
7	23ES1152	ES	Computer Programming Lab	0	0	3	1.5
8	23HS1153	HSS	Communicative English Lab	0	0	2	1
9	23ES1154	ES	Engineering Workshop	0	0	3	1.5
10	23ES1155	ES	IT Workshop	0	0	2	1
11	23BS1156	BS	NSS/NCC/Community Service	0	0	1	0.5
12	23MC1106	MC	Induction Program				
			Total	14	0	13	20.5

Semester II

				Contact Hours			28
S. No.	Course Code	Course Category	Course Name	L	T	P	C
1	23BS2101	BS	Differential Equations Vector Calculus	3	0	0	3
2	23BS2102B	BS	Chemistry	3	0	0	3
3	23ES2103B	ES	Basic Electrical and Electronics Engineering	3	0	0	3
4	23PC2104A	PC	Data Structures	3	0	0	3
5	23ES2105	ES	Engineering Graphics	1	0	4	3
6	23BS2151B	BS	Chemistry Lab	0	0	2	1
7	23PC2152A	PC	Data Structures Lab	0	0	3	1.5
8	23ES2153	ES	Basic Electrical and Electronics Workshop	0	0	3	1.5
9	23BS2154B	BS	Health and wellness, Yoga and Sports	-	-	1	0.5
10	23MC2106	MC	Design Thinking	2	0	0	-
			Total	15	0	13	19.5

Semester III

				Contact Hours			25
S. No.	Course Code	Course Category	Course Name	L	T	P	C
1	23ES3101B	ES	Artificial Intelligence	3	0	0	3
2	23HS3102	BSH	Universal Human Values 2 -Understanding Harmony	2	1	0	3
3	23ES3103B	ES	Discrete Mathematics	3	0	0	3
4	23AI&ML3304	PC	Advanced Data Structures & Algorithms Analysis	3	0	0	3
5	23AI&ML3305	PC	Object Oriented Programming Through Java	3	0	0	3
6	23TP3106	SS-1	Logic & Reasoning	0	0	2	1
7	23AI&ML3651	SEC	Python Programming Lab	0	0	2	1
8	23AI&ML3352	PC Lab 1	Advanced Data Structures and Algorithms Lab	0	0	3	1.5
9	23AI&ML3353	PC Lab 2	Object Oriented Programming Through Java Lab	0	0	3	1.5
			Total	14	1	10	20

[*L - Lecture, T - Tutorial, P - Practical, C - Credits*]

Semester IV

				Contact Hours			29
S. No.	Course Code	Course Category	Course Name	L	T	P	C
1	23HS4101C	ES	Optimization Techniques	2	0	0	2
2	23BS4102B	BS	Probability & Statistics	3	0	0	3
3	23AI&ML4303	PC	Machine Learning	3	0	0	3
4	23AI&ML4304	PC	Database Management Systems	3	0	0	3
5	23AI&ML4305	PC	Digital Logic & Computer Organization	3	0	0	3
6	23TP4106	SS-2	English For Professionals	0	0	2	1
7	23MC4107	AC	Environmental Science	2	0	0	-
8	23AI&ML4651	SEC	Full Stack Development-I	0	0	2	1
9	23ES4152	ES	Design Thinking & Innovation	1	0	2	2
10	23AI&ML4353	PC Lab-1	AI&ML Lab	0	0	3	1.5
11	23AI&ML4354	PC Lab-2	Database Management Systems Lab	0	0	3	1.5
			Total	17	0	12	21
Summer Internship 6 weeks (Mandatory) during summer vacation (EPICS)							
Honors/ Minor Courses (the hours distribution can be 4-0-0, 3-0-2 or 3-1-0 also)				4	0	0	4

[L - Lecture, T - Tutorial, P - Practical, C - Credits]

Semester V

				Contact Hours			29
S. No.	Course Code	Course Category	Course Name	L	T	P	C
1	23AI&ML5301	PC	Deep Learning	3	0	0	3
2	23AI&ML5302	PC	Computer Networks	3	0	0	3
3	23AI&ML5303	PC	Operating Systems	3	0	0	3
4	23AI&ML5404	PE I	A. Automata Theory & Compiler Design B. Natural Language Processing C. Internet of Things D. Exploratory Data Analysis with Python E. Software Engineering	3	0	0	3
5	23AI&ML5205	OE-I	A. Web Programming B. Internet Of Things	3	0	0	3
6	23AI&ML5351	PC Lab - 1	Deep Learning Lab	0	0	2	1
7	23AI&ML5352	PC Lab - 2	Operating Systems Lab	0	0	2	1
8	23HS5153	HSS	Advanced Communication Skills Laboratory	0	0	2	1
9	23AI&ML5651	SEC	Full Stack Development -II	0	0	2	1
10	23TP5106	SS-3	Personality Development	0	0	2	1
11		ES	User Interface Design using Flutter / SWAYAM Plus - Android Application Development (with Flutter)	0	0	2	1
12	23AI&ML5354	Evaluation of Community Service Internship	EPICS	0	0	0	2
13			IPR	2	0	0	0
			Total	17	0	12	23
Honors/ Minor Courses (the hours distribution can be 4-0-0, 3-0-2 or 3-1-0 also)				4	0	0	4

[*L - Lecture, T - Tutorial, P - Practical, C - Credits*]

Open Elective-I is for the students of Non-CSE/IT allied branches only.

Semester VI

				Contact Hours			26
S. No	Course Code	Course Category	Course Name	L	T	P	C
1	23AI&ML6301	PC	Reinforcement Learning	3	0	0	3
2	23AI&ML6302	PC	Big Data Analytics	3	0	0	3
3	23AI&ML6303	PC	Business Intelligence & Data Visualization	3	0	0	3
4	23AI&ML6404	PE II	A. Cryptography & Network Security B. Recommender Systems C. Object Oriented Analysis and Design D. Social Network Analysis E. 12-Week SWAYAM /NPTEL Course suggested by the BoS	3	0	0	3
5	23AI&ML6405	PE III	A. Computer Vision B. Cloud Computing C. NoSQL databases D. Soft Computing E. 12-Week SWAYAM /NPTEL Course suggested by the BoS	3	0	0	3
6	23AI&ML6206	OE II	Database Management Systems	3	0	0	3
7	23AI&ML6351	PC Lab-1	Big Data Analytics Lab	0	0	3	1.5
8	23AI&ML6352	PC Lab-2	Business Intelligence& Data Visualization Lab	0	0	3	1.5
9		SS - 4	Quantitative Aptitude	0	0	2	1
			Total	18	0	8	22
Honors/ Minor Courses (the hours distribution can be 4-0-0, 3-0-2 or 3-1-0 also)				4	0	0	4

[*L - Lecture, T - Tutorial, P - Practical, C - Credits*]

Semester VII

				Contact Hours			21
S. No.	Course Code	Course Category	Course Name	L	T	P	C
1	23AI&ML7301	PC	Generative AI	3	0	0	3
2	23AI&ML7402	HSS	Human Resource Management	2	0	0	2
3	23AI&ML7403	PE IV	1. Quantum Computing 2. DevOps 3. Robotic Process Automation 4. Software Project Management 5. 12 week MOOC Swayam /NPTEL course recommended by the BoS	3	0	0	3
4	20AI&ML7404	PE V	1. Agile methodologies 2. High Performance Computing 3. Block chain Technology 4. Explainable AI 5. 12 week MOOC Swayam/NPTEL course recommended by the BoS	3	0	0	3
5	20AI&ML7205	OE III	Object Oriented Programming Through Java	3	0	0	3
6	20AI&ML7206	OE IV	A. Computer Networks B. Software Engineering C. IOT Based Smart Systems	3	0	0	3
7		SEC	Prompt Engineering / SWAYAM Plus - Certificate program in Prompt Engineering and ChatGPT Skills	0	1	2	2
8		AC	Constitution of India	2	0	0	-
9		Internship	Evaluation of Industry Internship	-	-	-	2
			Total	19	0	2	21
Industrial/ Research Internship six weeks (Mandatory) during summer vacation							
Honors/ Minor Courses (the hours distribution can be 4-0-0, 3-0-2 or 3-1-0 also)				0	0	0	4

L - Lecture, T - Tutorial, P - Practical, C - Credits]

Note: Open Elective II and Open Elective IV are self-learning. Students may opt from any MOOCs platforms. They have to submit the certificate before the last instruction day of VII semester. Course selection for MOOCs is subject to approval by the Head of the Department.

B.Tech in CSE (Artificial Intelligence and Machine Learning)
Scheme of Instruction - VR23

Semester VIII

S. No.	Course Code	Course Category	Course Name	L	T	P	C
						Contact Hours	24
1	20AI&ML8551	Internship/ Project**	Major Project and Internship (6 Months)	0	0	24	12
			Total	0	0	24	12

[L - Lecture, T - Tutorial, P - Practical, C - Credits]

** The student should undergo internship and simultaneously heshe should work on a project with well-defined objectives. At the end of the semester the student should submit an internship completion certificate and a project report.
**If any of our associated company comes forward to offer an emerging course that will be offered as an industry offered course in V, VI or VII semesters under program elective with the approval of BoS. This is incorporated to enhance student skills and employability in cutting edge technologies.

Minor Engineering Note:

- To obtain Minor Engineering, student needs to obtain 18 credits by successfully completing any of the following courses in the concern stream.

- During Minor/Honors Course selection, there should not be any overlapping with Regular/Major/OPEN Electives

Minor in AIML

- Database Management Systems 3-0-3-4.5 (II-II)

- Operating Systems 3-0-0-3 (III-I)

- Data Visualization 3-0-3-4.5 (III-II)

- Generative AI 3-0-0-3 (IV-I)

Any of the following 12 Week 3 credit NPTEL MOOC Courses

- Artificial Intelligence: Knowledge Representation and Reasoning

- Machine Learning and Deep Learning - Fundamentals and Applications

- Fundamentals of Object Oriented Programming

- Discrete Mathematics for CS

- Computer Networks and Internet Protocol

- Software Engineering

- Natural Language Processing Intelligence & Analytics

SEMESTER III

23ES3101B
ARTIFICIAL INTELLIGENCE

Course Category	Engineering Science		Credits	3
Course Type	Theory		L-T-P	3-0-0
Prerequisites	23BS1101 Linear Algebra & Calculus		Continuous Eval Semester End Eval Total Marks	30 70 100

COURSE OUTCOMES

1. Understand the AI agents for problem solving.
2. Understand AI solutions using Heuristic and Pruning approaches.
3. Apply various knowledge representation techniques.
4. Apply the logic concepts and learnings to Expert Systems.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

| CO | PO | | | | | | | | | | | | PSO | | BTL | POI |
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1	2	2											1	1	2	1.2.1, 1.6.1, 1.7.1, 2.5.2, 2.6.2
2	1	2	2										1	1	2	1.6.1, 1.7.1, 2.5.2, 2.6.4, 2.8.1, 3.5.1
3	1	2	2										1	1	3	1.6.1, 1.7.1, 2.5.2, 2.6.4, 3.5.1
4	2	2	2										1	1	3	1.6.1, 1.7.1, 2.5.2, 2.6.4, 2.7.1, 3.5.1

COURSE CONTENT

UNIT I
Introduction: AI problems, foundation of AI and history of AI.
Intelligent Agents: Agents and Environments, the concept of rationality, the nature of environments, structure of agents.
Problem solving agents: Well defined problems and Solutions, problem formulation, Example problems- 8-puzzle problem, Water jug problem.

UNIT II
Searching: Searching for solutions, uniformed search strategies – Breadth first search, depth first Search.
Heuristic Search: Search with partial information, Informed search strategies, Hill climbing, Best First search, A* Algorithm, Problem Reduction -AO* Algorithms..

Adversarial Search: Games, mini-max algorithm, Problem in Game playing, Alpha-Beta pruning, Evaluation functions.

UNIT III

Representation of Knowledge: Weak Slot and filler structures, Semantic nets-frames and frame systems.
Representing knowledge using rules: Procedural versus declarative knowledge, Logic programming, Forward vs Backward reasoning.
Knowledge Representation Issues: Representation and mapping, Approaches in knowledge representation, Issues in knowledge representation.

UNIT IV

Logic concepts: Predicate Logic, Propositional vs. Predicate Logic, unification & lifts forward chaining, Backward chaining, Resolution.
Learning: Learning from observation, Explanation based learning, Statistical Learning methods, Reinforcement Learning.
Expert Systems: Architecture of expert systems, Roles of expert systems, Knowledge Acquisition, Typical expert systems – MYCIN, DART, Expert systems shells.

TEXTBOOKS

1. S. Russel and P. Norvig, Artificial Intelligence – A Modern Approach, Pearson Education, 2nd Edition, 2007.
2. Kevin Night and Elaine Rich, Nair B, Artificial Intelligence (SIE), Mc Graw Hill, 3rd Edition, 2010.

REFERENCE BOOKS

1. David Poole, Alan Mackworth, Randy Goebel, Computational Intelligence: a Logical approach, Oxford University Press, 1st Edition, 2004.
2. G. Luger, Artificial Intelligence: Structures and Strategies for complex problem-solving, Pearson Education, 4th Edition, 2001
3. J. Nilsson, Artificial Intelligence: A new Synthesis, Elsevier Publishers, 1st Edition, 2003.
4. Saroj Kaushik, Artificial Intelligence, Cengage Learning, 1st Edition, 2011.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Fundamentals of Artificial Intelligence, `https://swayam.gov.in/\nd1_noc19_me71/preview`, Last Accessed On: 31-05-2024.

23HS3102

UNIVERSAL HUMAN VALUES 2: UNDERSTANDING HARMONY

Course Category	Basic Sciences and Humanities	Credits	3
Course Type	Mandatory course (suggested by AICTE)	L-T-P	2-1-0
Prerequisites	Universal Human Values 1	Continuous Eval Semester End Eval Total Marks	30 70 100

COURSE OUTCOMES

1. Understand and aware of themselves and their surroundings(family, society and nature).
2. Handle problems with sustainable solutions, while keeping human relationships and human nature in mind.
3. Exhibit critical ability and become sensitive to their commitment towards their understanding of human values, human relationship and human society.
4. Apply what they have learnt to their own self in different day-to-day settings in real life.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1						1			2						2	6.1.1, 9.2.1, 9.2.2, 9.2.3
2			3												2	3.1.1, 3.2.3
3						2									2	6.2.1
4								3				2			3	8.1.1, 8.2.2 12.1.1, 12.2.2

COURSE CONTENT

UNIT I
Course introduction, need, basic guidelines, content and process for value education:
Part-1: Purpose and motivation for the course, recapitulation from UHV-I, Self-exploration: what is it?, its content and process, 'Natural acceptance' and experiential validation- as the process for self-exploration. Continuous Happiness and Prosperity

– A look at basic Human Aspirations.

Part-2: Right understanding, Relationship and Physical Facility – the basic requirements for fulfillment of aspirations of every human being with their correct priority, Understanding Happiness and Prosperity correctly – A critical appraisal of the current scenario, Method to fulfill the above human aspirations: understanding and living in harmony at various levels. (Practice sessions are to be included to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking).

UNIT II *Understanding Harmony in the Human Being – Harmony in Myself:*
Part-1: Understanding human being as a co-existence of the sentient 'I' and the material 'Body'. Understanding the needs of Self ('I') and 'Body' – happiness and physical facility, Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer).

Part-2: Understanding the characteristics and activities of 'I' and harmony in 'I'. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail, Programs to ensure Sanyam and Health. (Practice sessions are to be included to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs. dealing with disease).

UNIT III *Understanding Harmony in the Family and Society – Harmony in Human-Human Relationship:*
Part-1: Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfillment to ensure mutual happiness; Trust and Respect as the foundational values of relationship, Understanding the meaning of Trust; Difference between intention and competence, Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship.

Part-2: Understanding the harmony in the society (society being an extension of family); Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals, Visualizing a universal harmonious order in society–Undivided Society, Universal Order–from family to world family. (Practice sessions are to be included to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education, etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives).

UNIT IV *Understanding Harmony in Nature & Existence – Whole existence as Coexistence:*

Part-1: Understanding the harmony in the Nature, Inter-connectedness and mutual fulfillment among the four orders of Nature – recyclability and self-regulation in nature, Understanding Existence as Co-existence of mutually interacting units in all-pervasive space, Holistic perception of harmony at all levels of existence.

Part-2: Natural acceptance of human values, Definitiveness of ethical human conduct, Basis for humanistic education, humanistic constitution and humanistic universal order, Competence in professional ethics: a) ability to utilize the professional competence for augmenting universal human order, b) ability to identify the scope and characteristics of people-friendly and eco-friendly production systems, c) ability to identify and develop appropriate technologies and management patterns for above production systems, Case studies of typical holistic technologies, management models and production systems, Strategy for transition from the present state to Universal Human Order: a) at the level of individual: as socially and ecologically responsible engineers, technologists and managers, b) at the level of society: as mutually enriching institutions and organizations.

(Part-1:Practice sessions are to be included to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology, etc.

Part-2: Practice exercises and case studies are to be taken up in practice (tutorial) sessions eg. to discuss the conduct as an engineer or scientist, etc.)

TEXTBOOKS

1. R. R. Gaur, R. Asthana and G. P. Bagaria, A Foundation Course in Human Values and Professional Ethics, Excel Books Private Limited, New Delhi, 2nd Revised Edition, 2019.
2. R. R. Gaur, R. Sangal and G. P. Bagaria, A Foundation Course in Human Values and Professional Ethics, Excel Books Private Limited, New Delhi, 1st Edition, 2010

REFERENCE BOOKS

1. Pandit Sunderlal, Prabhath Prakashan, Bharat Mein Angreji Raj, Delhi , 2018
2. J. C. Kumarappa, Sarva-Seva-Sangh Prakashan, Economy of Permanence, Varanasi, 2017.
3. Annie Leonard, The Story of Stuff: The impact of overconsumption on the planet, our communities, and our health and how we can make it better, Free Press, New York, 2010.
4. Romain Rolland, Advaitha Ashrama, The Life of Vivekananda and the Universal gospel, India, 2010.
5. Mohandas Karamchand Gandhi, The story of my experiments with truth: Mahatma Gandhi Autobiography, B. N. Publishing, 2008.
6. Cecile Andrews, Slow is beautiful: New Visions of Community, New Society Pub-

lishers, Canada, 2006.

7. A. N. Tripathi, Human Values, New Age International Publishers, New Delhi, 2004.

8. Dharampal, Rediscovering India, Society for Integrated Development of Himilaya, 2003.

9. Romain Rolland, Srishti Publishers & Distributors, Mahatma Gandhi: The Man who become one with the Universal Being, New Delhi, 2002.

10. A. Nagaraj, JeevanVidya Prakashan, Amarkantak, JeevanVidya: EkParichaya, 1999.

11. Maulana Abul Kalam Azad, Orient Blackswan, India Wins Freedom: The Complete Version, 1988.

12. E. F. Schumacher, Small is beautiful: A study of economics as if people mattered, Vintage Books, London, 1993

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. A Foundation Course in Human Values and Professional Ethics, `https://dokumen.pub/a-foundation-course-in-human-values-and-professional-ethicsfirstnbsped-9788174467812.html`, Last Accessed On: 12/05/2024.

2. AICTE – SIP, `https://www.youtube.com/channel/UCo8MpJB\_aaVwB4LWLAx6AhQ`, Last Accessed On: 16/3/2024.

3. AICTE UHV Teaching Learning Material, `https://fdp-si.aicte-india.org/download.php#1`, Last Accessed On: 28/3/2024.

23ES3103B

DISCRETE MATHEMATICS

Course Category	Engineering Science		Credits	3
Course Type	Theory		L-T-P	3-0-0
Prerequisites	-		Continuous Eval	30
			Semester End Eval	70
			Total Marks	100

COURSE OUTCOMES

1. Analyze of propositional calculus and first order logic.
2. Apply the basic and advanced counting techniques.
3. Analyze of relations and digraphs and their applications.
4. Analyze of graphs and their applications.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1	3	3		1								1			4	1.2.1, 1.7.1, 2.5.1, 4.6.3, 12.4.2
2	3	3		1								1			3	1.2.1, 2.5.1, 2.5.3, 4.6.3, 12.4.2
3	3	3		1								1			4	1.2.1, 2.8.1, 4.4.1, 12.4.2
4	3	3		1								1			4	1.2.1, 2.5.3, 4.4.1, 12.4.2

COURSE CONTENT

UNIT I: Propositional Calculus
Fundamentals of Logic:
Propositions, Connectives, Propositional functions, Truth tables, Tautology, Contradiction, Logical equivalences, Normal forms, Logical inferences, Methods of proof of an implication.
First Order Predicate Logic: Predicate, Quantifiers, Rules of inference for Quantified propositions.

UNIT II: Counting Techniques
Basics of Counting:
Sum and product rules, Indirect counting, One to one correspondence, Combinations and permutations, Enumerating combinations and permutations with and without

repetitions.

Advanced Counting Techniques: Generating function of sequences, Recurrence relations, Solving recurrence relations – substitution- Generating functions-The method of characteristic roots, Solution of inhomogeneous recurrences relations.

UNIT III: Relations and Digraphs

Relations and basic graphs, Special properties of binary relations, Equivalence relation, Partially ordered sets, Hasse diagrams, Lattices, Operations on relations, Paths and closures, Directed graphs and Adjacency matrices, Transitive closure, Warshall's algorithm.

UNIT IV: Graph Theory

Introduction(graphs, sub graphs, circuits, trees) Sum of degrees theorem, Isomorphism and sub graphs, planar graphs, Euler's formula, Multi graphs and Euler's circuits, Hamiltonian graphs, Grin-berg's theorem, Graph coloring, Chromatic numbers.

TEXTBOOKS

1. Joe L. Mott, Abraham Kandel, and Theodore P. Baker, Discrete Mathematics for Computer Scientists & Mathematicians, PHI, 2^{nd}Edition, 2008.

REFERENCE BOOKS

1. J. P. Tremblay and R.Manohar, Discrete Mathematical structures with applications to computer science, MGHE, 1^{st}Edition, 2017.
2. K. H. Rosen, Discrete Mathematics and its Applications, Mc Graw Hill Companies, 7^{th}Edition, 2011.
3. D. S. Malik and M. K. Sen, Discrete Mathematical Structures: Theory and applications, Revised Edition, 2012.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Prof. Arindama Singh Department of Maths IIT Madras, `https://nptel.ac.in/courses/111/106/111106052/`, Last accessed On: 25/03/2024.
2. Prof Soumen Maity, Department of Maths, IISER Pune,`https://nptel.ac.in/courses/111/106/111106102/`, Last accessed On: 15/04/2024.
3. Dr.L.Sunil Chandran, Department of Computer Science and Automation, IISC Bangalore, `https://nptel.ac.in/courses/106/108/106108051/`, Last accessed On: 15/03/2024.

23AI&ML3304

ADVANCED DATA STRUCTURES & ALGORITHMS ANALYSIS

Course Category	Program Core		Credits	3
Course Type	Theory		L-T-P	3-0-0
Prerequisites	23PC2104A Data Structures		Continuous Eval Semester End Eval Total Marks	30 70 100

COURSE OUTCOMES

1. Understand the functions of different nonlinear data structures- binary trees, search trees.
2. Apply graph-based algorithms, design technique - divide and conquer, and greedy methods for solving complex problems.
3. Apply dynamic programming and backtracking design techniques to solve complex problems
4. Apply the concepts of Branch and Bound techniques to solve complex problems; Understand NP-Hard, and NP-Complete problems.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1	1	2											1	1	2	1.2.1, 1.6.1, 1.7.1, 2.5.2
2	1	2	3										1	1	3	1.2.1, 1.6.1, 1.7.1, 2.5.2, 2.6.4, 3.5.1
3	1	2	3										1	1	3	1.2.1, 1.6.1, 1.7.1, 2.5.2, 2.7.1, 3.5.1
4	1	2	3										1	1	3	1.2.1, 1.6.1, 1.7.1, 2.5.2, 2.6.4, 2.7.1, 3.5.1

COURSE CONTENT

UNIT I

Introduction to Algorithm Analysis: Space and Time Complexity analysis, Asymptotic Notations.
AVL Trees Creation, Insertion, Deletion operations and Applications.
B-Trees Creation, Insertion, Deletion operations and Applications.

Heap Trees (Priority Queues) Min and Max Heaps, Operations and Applications.

UNIT II

Graphs: Terminology, Representations, Basic Search and Traversals, Connected Components and Biconnected Components, applications
Divide and Conquer: The General Method, Quick Sort, Merge Sort, Stassen's matrix multiplication, Convex Hull
Greedy Method: General Method, Job Sequencing with deadlines, Knapsack Problem, Minimum cost spanning trees, Single Source Shortest Paths.

UNIT III

Dynamic Programming: General Method, All pairs shortest paths, Single Source Shortest Paths– General Weights (Bellman Ford Algorithm), Optimal Binary Search Trees, 0/1 Knapsack, String Editing, Travelling Salesperson problem.
Backtracking: General Method, 8-Queens Problem, Sum of Subsets problem, Graph Coloring, 0/1 Knapsack Problem.

UNIT IV

Branch and Bound:The General Method,0/1Knapsack Problem, Travelling Salesperson problem.
NP Hard and NP Complete Problems: Basic Concepts, Cook's theorem.
NP Hard Graph Problems:Clique Decision Problem (CDP), Chromatic Number Decision Problem (CNDP), Traveling Salesperson Decision Problem (TSP).
NP Hard Scheduling Problems:Scheduling Identical Processors, Job Shop Scheduling.

TEXTBOOKS

1. Reema Thareja, Data Structures using C, Oxford University Press, 2nd Edition, 2014. (Unit I)
2. Ellis Horowitz, Satraj Sahni and Rajasekharan, Fundamentals of Computer Algorithms, Galgotia Publications Pvt. Ltd, 2nd Edition, 2008. (Unit II, III, and IV).

REFERENCE BOOKS

1. Horowitz Sahni and Anderson-Freed, Fundamentals of Data Structures in C, Universies Press, 2nd Edition, 2008.
2. Richard F.Gilberg & B.A.Forouzan, Data Structures A Pseudo code Approach with C, Cengage Learning, 2nd Edition, 2007.
3. M.T.Goodrich and R.Tomassia, Algorithm Design: Foundations, Analysis and Internet examples, John Wiley and sons, 2nd Edition, 2006.
4. T.H.Cormen, C.E.Leiserson, R.L.Rivest and C.Stein, Introduction to Algorithms, Mit Press, 3rd Edition, 2009.
5. Allen Weiss, Data structures and Algorithm Analysis in C, Pearson Education,

2nd Edition, 2002.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Advanced Data Structures Course, https://www.tutorialspoint.com/advanceddatastructures/index.asp, Last Accessed On: 31/5/2024.
2. Computer Algorithms, http://peterindia.net/Algorithms.html, Last Accessed on: 24-06-2024.

23AI&ML3305
OBJECT ORIENTED PROGRAMMING THROUGH JAVA

Course Category	Program Core		Credits	3
Course Type	Theory		L-T-P	3-0-0
Prerequisites	23ES1104 Introduction to Programming		Continuous Eval	30
			Semester End Eval	70
			Total Marks	100

COURSE OUTCOMES

1. Understand the basic concepts of object oriented programming.
2. Interpret multiple inheritances through interfaces for a given application.
3. Apply exceptions, thread capabilities and handling files on a given application.
4. Illustrate the use of functional programming and Collections framework for a given application.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1	2	3													2	1.7.1, 2.5.1, 2.5.2, 2.7.1
2	2	2	3										2	2	3	1.7.1, 2.5.1, 2.5.2, 2.6.3, 2.7.1, 3.5.1, 3.8.2
3	2	2	3										2	2	3	1.7.1, 2.5.1, 2.5.2, 2.6.3, 2.6.4, 3.5.1, 3.8.2
4	1	2	3	2	2								2	2	3	1.7.1, 2.5.1, 2.5.2, 2.6.3, 2.6.4, 3.5.1, 3.6.2, 3.8.2, 4.6.2, 5.4.2

COURSE CONTENT

UNIT I

Introduction, The History and Evolution of Java: Java history and evolution, Java features, Java's Magic: Byte Code, How Java differs from C and C++.
An Overview of Java: Object Oriented Programming: Two paradigms, Principles of OOP, A First simple Program and Control statements. Data Types, Variables and Arrays: Java keywords, Primitive types, Integers, Floating-Point Types, Characters, Booleans, Variables, Operators, Type Conversion, Casting and Arrays.

Introducing Classes and Objects:Class fundamentals, declaring objects, assigning object reference variables, introducing methods, constructors, this keyword, Garbage collection, overloading methods, using objects as parameters, returning objects, static and final keywords, nested and inner classes.

UNIT II

String Handling: The String Constructors, String Buffer Class, String Tokenizer class.

Inheritance: Inheritance basics, using super, multilevel hierarchy, method overriding, dynamic method dispatch, using abstract classes, final with inheritance.

Packages & Interfaces: Defining a package, finding package and CLASSPATH. Access protection, importing packages, Defining an interface, implementing interfaces, nested interfaces, applying interfaces, variables in interfaces.

UNIT III

Exception handling: Exception handling fundamentals, exception types, uncaught exceptions, using try and catch, multiple catch clauses, throw, throws, finally, creating your own exception subclasses.

I/O streams: Byte Streams- Input Stream, Output Stream, File Input Stream, File Output Stream, Character Streams- Reader, Writer, File Reader, and File Writer.

Multithread Programming: The Java Thread Model, Creating a thread: Implementing Runnable, Extending Thread, creating multiple threads, Thread Priorities, Synchronization- Using Synchronized methods, The synchronized Statement.

UNIT IV

Pragmatic Functional Programming using Lambdas: Introduction to Functional programming, Functional Programming concepts and terminology, Functional Interfaces, Working with Lambda Expressions and Method References.

Collections Framework: Collections overview, Collection interfaces: Collection, List, and Set. Collection Classes: Array List, Linked List, Hash Set. Map Classes: Hash Map, Tree Map

The Stream API: Stream basics, Reduction operations, Using parallel streams, Mapping, Collecting, Iterators and Streams.

TEXTBOOKS

1. Herbert Schildt, Java The Complete Reference, Oracle Press, 11th Edition, 2019.

REFERENCE BOOKS

1. Herbert Schildt, Dale Skrien, Java Fundamentals: A Comprehension Introduction, McGraw-Hill Education India Pvt., Special Indian Edition, Ltd, 2017.
2. E Balaguruswamy, Programming with Java, Mc Graw Hill, 4th Edition, 2020.
3. Paul J. Dietel and Dr.Harvey M. Deitel, "Java How to Program", Deitel & Associates, 11th Edition, 2018.

4. Timothy Budd, Understanding Object Oriented Programming with Java, Pearson Education, Updated edition, 2013.
5. Kathy Sierra & Bert Bates, Head First Java, Oreilly, 2nd Edition, 2023.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Prof. Debasis Samanta, Department of Computer Science & Engineering, I.I.T, Kharagpur, Swayam, NPTEL, `https://onlinecourses.nptel.ac.in/noc21_cs03/preview`, Last Accessed On: 14/04/ 2024.
2. Evan Jones, Adam Marcus,Eugene Wu Introduction to Programming in Java, MIT OpenCourseWare, Massachusetts Institute of Technology, `https://ocw.mit.edu/courses/6-092-introduction-to-programming-in-java-january-iap-2010/`, Last Accessed On: 28/05/2024.
3. Prof. Owen Astrachan, Object Oriented Programming in Java, Duke University, `https://www.coursera.org/specializations/object-oriented-programming`, Last Accessed On: 21/05/2024.
4. Dheeru Mundluru, Java In-Depth: Become a Complete Java Engineer, Udemy, `https://www.udemy.com/course/java-in-depth-become-a-complete-java-engineer/`, Last Accessed On: 14/05/2024.
5. Prof. Olufisayo Omojokun, Introduction to Object-Oriented Programming with Java I: Foundations and Syntax Basics, Georgia Institute of Technology, edX, `https://www.edx.org/certificates/professional-certificate/gtx-introduction-to-object-oriented-programming-with-java`, Last Accessed On: 04/05/2024.

23TP3106
LOGIC & REASONING

Course Category	Soft Skill-1	Credits	1
Course Type	Theory	L-T-P	0-0-2

Prerequisites	–	Continuous Eval	100
		Semester End Eval	0
		Total Marks	100

COURSE OUTCOMES

1. Think reason logically in any critical situation.
2. Analyze given information to find correct solution.
3. To reduce the mistakes in day to day activities in practical life.
4. Develop time management skills by approaching different shortcut methods.
5. Use mathematical based reasoning to make decisions.
6. Apply logical thinking to solve problems and puzzles in qualifying exams for companies and in other competitive exams.

COURSE CONTENT
UNIT I
1. Series Completion
2. Coding-Decoding
3. Blood Relation
4. Puzzles test
UNIT II
1. Direction sense test
2. Logical Venn diagrams
3. Number test, ranking test
4. Mathematical operations
UNIT III
1. Arithmetical Reasoning
2. Inserting missing character
3. Syllogism
4. Binary logic
5. Data sufficiency
UNIT IV
1. Water images
2. Mirror images
3. Paper folding
4. Paper cutting
5. Embedded Figures
6. Dot situation

7. Cubes & Dice

TEXTBOOKS

1. R. S. Aggarwal, Verbal and non-verbal reasoning, S Chand publication, Revised Edition, 2017, ISBN:81-219-0551-6,
2. Vikramjeeth, Reasoning Guru Verbal & Non-Verbal Reasoning, Multilingual Edition, 2023, ISBN :978-9358706000.

23AI&ML3651
PYTHON PROGRAMMING LAB

Course Category	Skill Enhancement Course		Credits	1
Course Type	Laboratory		L-T-P	0-0-2
Prerequisites	23ES1152 Computer Programming Lab		Continuous Eval	30
			Semester End Eval	70
			Total Marks	100

COURSE OUTCOMES
1. Introduce core programming concepts of Python programming language.
2. Demonstrate about Python data structures like Lists, Tuples, Sets and dictionaries
3. Implement Functions, Modules and Regular Expressions in Python Programming and to create practical and contemporary applications using these.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1	2	2	1											1	1	1.6.1, 1.7.1, 2.5.2, 3.6.1, 3.7.2
2	2	2		2										1	1	1.7.1, 1.5.1, 2.5.1, 2.6.2, 4.4.2, 4.5.1
3	3		2		2									1	1	1.6.1, 1.7.1, 3.6.1, 3.6.3, 3.8.3, 5.4.2

UNIT-I:
History of Python Programming Language, Thrust Areas of Python, Installing Anaconda Python Distribution, Installing and Using Jupiter Notebook.

Parts of Python Programming Language: Identifiers, Keywords, Statements and Expressions, Variables, Operators, Precedence and Associativity, Data Types, Indentation, Comments, Reading Input, Print Output, Type Conversions, the type () Function and Is Operator, Dynamic and Strongly Typed Language.

Control Flow Statements: if statement, if-else statement, if...elif...else, Nested if statement, while Loop, for Loop, continue and break Statements, Catching Exceptions Using try and except Statement.

Sample Experiments:
1. Write a program to find the largest element among three Numbers.
2. Write a Program to display all prime numbers within an interval
3. Write a program to swap two numbers without using a temporary variable.
4. Demonstrate the following Operators in Python with suitable examples. i) Arithmetic Operators ii) Relational Operators iii) Assignment Operators iv) Logical Operators v) Bit wise Operators vi) Ternary Operator vii) Membership Operators viii) Identity Operators
5. Write a program to add and multiply complex numbers
6. Write a program to print multiplication table of a given number.

UNIT-II:
Functions: Built-In Functions, Commonly Used Modules, Function Definition and Calling the function, return Statement and void Function, Scope and Lifetime of Variables, Default Parameters, Keyword Arguments, *args and **kwargs, Command Line Arguments. Strings: Creating and Storing Strings, Basic String Operations, Accessing Characters in String by Index Number, String Slicing and Joining, String Methods, Formatting Strings. Lists: Creating Lists, Basic List Operations, Indexing and Slicing in Lists, Built-In Functions Used on Lists, List Methods, del Statement.

Sample Experiments:
1. Write a program to define a function with multiple return values.
2. Write a program to define a function using default arguments.
3. Write a program to find the length of the string without using any library functions.
4. Write a program to check if the substring is present in a given string or not.
5. Write a program to perform the given operations on a list: i. Addition ii. Insertion iii. Slicing 6. Write a program to perform any 5 built-in functions by taking any list.

UNIT-III:
Dictionaries: Creating Dictionary, Accessing and Modifying key: value Pairs in Dictionaries, Built-In Functions Used on Dictionaries, Dictionary Methods, del Statement. Tuples and Sets: Creating Tuples, Basic Tuple Operations, tuple() Function, Indexing and Slicing in Tuples, Built-In Functions Used on Tuples, Relation between Tuples and Lists, Relation between Tuples and Dictionaries, Using zip() Function, Sets, Set Methods, Frozenset.

Sample Experiments:
1. Write a program to create tuples (name, age, address, college) for at least two members and concatenate the tuples and print the concatenated tuples.
2. Write a program to count the number of vowels in a string (No control flow allowed).
3. Write a program to check if a given key exists in a dictionary or not.
4. Write a program to add a new key-value pair to an existing dictionary.
5. Write a program to sum all the items in a given dictionary.

UNIT-IV:
Files: Types of Files, Creating and Reading Text Data, File Methods to Read and Write Data, Reading and Writing Binary Files, Pickle Module, Reading and Writing CSV Files, Python os and os.path Modules. Object-Oriented Programming: Classes and Objects, Creating Classes in Python, Creating Objects in Python, Constructor Method, Classes with Multiple Objects, Class Attributes Vs Data Attributes, Encapsulation, Inheritance, Polymorphism.

Sample Experiments:
1. Write a program to sort words in a file and put them in another file. The output file should have only lower-case words, so any upper-case words from source must be lowered.
2. Python program to print each line of a file in reverse order.
3. Python program to compute the number of characters, words and lines in a file.
4. Write a program to create, display, append, insert and reverse the order of the items in the array.
5. Write a program to add, transpose and multiply two matrices.
6. Write a Python program to create a class that represents a shape. Include methods to calculate its area and perimeter.
7. Implement subclasses for different shapes like circle, triangle, and square.

UNIT-V:
Introduction to Data Science: Functional Programming, JSON and XML in Python, NumPy with Python, Pandas.

Sample Experiments:
1. Python program to check whether a JSON string contains complex object or not.
2. Python Program to demonstrate NumPy arrays creation using array () function.
3. Python program to demonstrate use of ndim, shape, size, dtype.
4. Python program to demonstrate basic slicing, integer and Boolean indexing.
5. Python program to find min, max, sum, cumulative sum of array
6. Create a dictionary with at least five keys and each key represent value as a list where this list contains at least ten values and convert this dictionary as a pandas data frame and explore the data through the data frame as follows: a) Apply head () function to the pandas data frame b) Perform various data selection operations on Data Frame
7. Select any two columns from the above data frame, and observe the change in one attribute with respect to other attribute with scatter and plot operations in matplotlib

TEXT BOOKS

1. Anuradha A. Puntambekar, Programming and Problem Solving using Python (Fundamentals and Applications), Technical Publication, 1^{st}Edition, 2020.

REFERENCE BOOKS

1. Gowri shankar S, Veena A, Introduction to Python Programming, CRC Press, Special Indian Edition, 2019.
2. S Sridhar, J Indumathi, V M Hariharan, Python Programming, Pearson Education, 2^{nd}Edition, 2024
3. Daniel Liang, Introduction, to Programming Using Python, Y, Pearson Eduction, 1^{st}Edition, 2023.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Python for Data Science, AI & Development, `https://www.coursera.org/learn/python-for-applied-data-science-ai`, Last Accessed On: 19/03/2024.
2. Programming for Everybody (Getting Started with Python), `https://www.coursera.org/learn/python?specialization=python#syllabus`, Last Accessed On: 05/04/2024.

23AI&ML3352
ADVANCED DATA STRUCTURES & ALGORITHMS LAB

Course Category	Program Core	Credits	1.5
Course Type	Laboratory	L-T-P	0-0-3
Prerequisites	23PC2152A Data Structures Lab	Continuous Eval Semester End Eval Total Marks	30 70 100

COURSE OUTCOMES

1. Implement AVL trees, B-Trees,and Heap Trees, efficient binary trees, M-way search trees, graph traversal and shortest path algorithms.
2. Implement graph-based algorithms, design technique - divide and conquer, and greedy methods for solving complex problems.
3. Implement solutions for problems using dynamic programming and backtracking.
4. Apply Branch and Bound techniques to write programs for different problems.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1	2	2											3		3	1.2.1, 1.7.1, 2.5.1, 2.5.2, 2.5.3, 2,6.3
2	2	3	3										3		3	1.7.1, 2.5.1, 2.5.2, 2.6.3, 2.6.4, 3.5.1
3	2	3	3										3		3	1.7.1, 2.5.1, 2.5.2, 2.6.3, 2.6.4, 3.5.1
4	2	3	3										3		3	1.7.1, 2.5.1, 2.5.2, 2.6.3, 2.6.4, 3.5.1

Experiments covering the Topics:

1. Operations on AVL trees, B-Trees, Heap Trees
2. Graph Traversals
3. Sorting techniques
4. Minimum cost spanning trees
5. Shortest path algorithms
6. 0/1 Knapsack Problem
7. Travelling Salesperson problem
8. Optimal Binary Search Trees

9. N-Queens Problem
10. Job Sequencing

Sample Programs:

1. Construct an AVL tree for a given set of elements which are stored in a file. And implement insert and delete operation on the constructed tree. Write contents of tree into a new file using in-order.
2. Construct B-Tree an order of 5 with a set of 100 random elements stored in array. Implement searching, insertion and deletion operations.
3. Construct Min and Max Heap using arrays, delete any element and display the content of the Heap.
4. Implement BFT and DFT for given graph, when graph is represented by a) Adjacency Matrix b) Adjacency Lists
5. Write a program for finding the biconnected components in a given graph.
6. Implement Quick sort and Merge sort and observe the execution time for various input sizes (Average, Worst and Best cases).
7. Compare the performance of Single Source Shortest Paths using Greedy method when the graph is represented by adjacency matrix and adjacency lists.
8. Implement Job Sequencing with deadlines using Greedy strategy.
9. Write a program to solve 0/1 Knapsack problem Using Dynamic Programming.
10. Implement N-Queens Problem Using Backtracking.
11. Use Backtracking strategy to solve 0/1 Knapsack problem.
12. Implement Travelling Sales Person problem using Branch and Bound approach.

TEXTBOOKS

1. Reema Thareja, Data Structures using C, Oxford University Press, 2nd Edition, 2014.
2. Ellis Horowitz, Satraj Sahni and Rajasekharan, Fundamentals of Computer Algorithms, Galgotia Publications Pvt. Ltd, 2nd Edition, 2008.

REFERENCE BOOKS

1. Horowitz Sahni and Anderson-Freed, Fundamentals of Data Structures in C, Universities Press, 2nd Edition, 2008.
2. Richard F.Gilberg & B.A.Forouzan, Data Structures A Pseudo code Approach with C, Cengage Learning, 2nd Edition, 2007.
3. M.T.Goodrich and R.Tomassia, Algorithm Design: Foundations, Analysis and Internet examples, John Wiley and sons, 2nd Edition, 2006.
4. T.H.Cormen, C.E.Leiserson, R.L.Rivest and C.Stein, Introduction to Algorithms, Mit Press, 3rd Edition, 2009.
5. Allen Weiss, Data structures and Algorithm Analysis in C, Pearson Education, 2nd Edition, 2002.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Advanced Data Structures Course, `https://www.tutorialspoint.com/advance ddatastructures/index.asp`, Last Accessed On: 31/5/2024.
2. Computer Algorithms, `http://peterindia.net/Algorithms.html`, Last Accessed on: 24-06-2024.

23AI&ML3353
OBJECT ORIENTED PROGRAMMING THROUGH JAVA LAB

Course Category	Program Core		Credits	1.5
Course Type	Laboratory		L-T-P	0-0-3
Prerequisites	23ES1152 Computer – Programming Lab		Continuous Eval	30
			Semester End Eval	70
			Total Marks	100

COURSE OUTCOMES

1. Apply the basic concepts of object oriented programming.
2. Apply multiple inheritance through interfaces for a given application.
3. Apply exceptions, thread capabilities and handling files on a given application.
4. Apply functional programming and Collections framework for a given application.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1	2	3													3	1.7.1, 2.5.1, 2.5.2, 2.7.1
2	2	2	3										2	2	3	1.7.1, 2.5.1, 2.5.2, 2.6.3, 2.7.1, 3.5.1, 3.8.2
3	2	2	3										2	2	3	1.7.1, 2.5.1, 2.5.2, 2.6.3, 2.6.4 3.5.1, 3.8.2
4	1	2	3										2	2	3	1.7.1, 2.5.1, 2.5.2, 2.6.3, 2.6.4, 3.5.1, 3.6.2, 3.8.2

COURSE CONTENT

Task 1: Apply fundamentals of Java Data types, Variables, Operators, and Control Statements to a given application.

Task 2: Apply the concepts of Classes and Objects to a given application.

Task 3: Apply the concepts of Arrays to a given application.

Task 4: Apply Inheritance and types of Inheritance of a given application.

Task 5: Use concepts of String and String Tokenizer classes and develop a java application.

Task 6: Use Interfaces and develop a java application.

Task 7: Create a package and access members of a package.

Task 8: Apply the concepts of Method Overloading and Method Overriding.
Task 9: Apply the concepts of Exception Handling.
Task 10: Develop a Java application to copy content from one file to another file using I/O Streams.
Task 11: Apply the concepts of Threads and Multithreading on a given application.
Task12: Apply the concepts of Lambda Expressions, Collections Framework and Stream API.

Lab Projects:
1. Design and develop an automated ballot vote system.
2. Design and develop a banking application.

TEXTBOOKS

1. Herbert Schildt, Java The Complete Reference, Oracle Press, 11th Edition, 2019.

REFERENCE BOOKS

1. Herbert Schildt, Dale Skrien, Java Fundamentals: A Comprehension Introduction, McGraw-Hill Education India Pvt., Special Indian Edition, Ltd, 2017.
2. E Balaguruswamy, Programming with Java, Mc Graw Hill, 4th Edition, 2020.
3. Paul J. Dietel and Dr.Harvey M. Deitel, "Java How to Program", Deitel & Associates Inc.l, 11th Edition, 2018.
4. Timothy Budd, Understanding Object Oriented Programming with Java, Pearson Education, Updated edition, 2013.
5. Kathy Sierra & Bert Bates, Head First Java, Oreilly, 2nd Edition, 2023.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Prof. Debasis Samanta, Department of Computer Science & Engineering, I.I.T, Kharagpur, Swayam, NPTEL, `https://onlinecourses.nptel.ac.in/`, Last Accessed On: 14/04/ 2024.
2. Evan Jones, Adam Marcus, Eugene Wu, Introduction to Programming in Java, MIT OpenCourseWare, Massachusetts Institute of Technology, `https://ocw.mit.edu/search/?s=department_course_numbers.sort_coursenum`, Last Accessed On: 28/05/2024.
3. Prof. Owen Astrachan, Object Oriented Programming in Java, Duke University, `https://www.coursera.org/specializations/object-oriented-programming`, Last Accessed On: 21/05/2024.
4. Dheeru Mundluru, Java In-Depth: Become a Complete Java Engineer, Udemy, `https://www.udemy.com/course/java-in-depth-become-a-complete-java-engineer/`, Last Accessed On: 14/05/2024.
5. Prof. Olufisayo Omojokun, Introduction to OOPS with Java I: Foundations and Syntax Basics, Georgia Institute of Technology, edX, `https://www.edx.org/certificates/professional-certificate/gtx-introduction-to-object-oriented-programming-with-java`, Last Accessed On: 04/05/2024.

SEMESTER IV

23HS4101C
OPTIMIZATION TECHNIQUES

Course Category	Engineering Science	Credits	2
Course Type	Theory	L-T-P	2-0-0
Prerequisites	23BS1101 Linear Algebra & Calculus	Continuous Eval	30
		Semester End Eval	70
		Total Marks	100

COURSE OUTCOMES

1. Formulate and solve mathematical model (linear programming problem) for physical situations like production, distribution of goods and economics.
2. Solve the problem of transporting the products and assigning jobs with minimum cost.
3. Assess the plan and work schedule of a project network in an optimal way.
4. Apply Matlab Optimization Tool Box to solve optimization problems.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1	3	2			1								1	1	3	1.7.1, 2.5.2, 2.6.3, 2.6.4, 5.4.2
2	3	2			1								1	1	3	1.7.1, 2.5.2, 2.6.3, 2.6.4, 5.4.2
3	3	2			1								1	1	4	1.7.1, 2.5.2, 2.6.3, 2.6.4, 5.4.2
4	3	2			2								1	1	3	1.7.1, 2.5.2, 2.6.3, 2.6.4, 5.4.2

COURSE CONTENT

UNIT I

Linear Programming and its Applications: Formulation of LP Problems (simple models), Graphical method, Simplex method, Artificial Variable Techniques, Big-M method, Two-Phase Method, Dual Simplex method.

UNIT II

Transportation Problems: Introduction – Basic feasible solution by Vogel's Approximation Method (VAM), Optimality test by uv-method (Modi method), Degeneracy in transportation problem, Unbalanced transportation Problem.

Assignment Problems: Introduction, Hungarian method, Unbalanced assignment problem, Maximal assignment problem.

UNIT III

Project Management by PERT-CPM: : Introduction, Representation by Network diagram, Rules for drawing network diagram, Fulkerson's rule, Time estimates and Critical path in network analysis, Project Evaluation and Review Technique.

UNIT IV

Matlab Fundamentals: The Matlab Environment, Assignment, Arrays, Vectors and Matrices, Colon operator, linspace and logspace functions, Mathematical operations, Use of Built-In functions, Script files, Function files, Anonymous functions.
Matlab Optimization Tool Box: fminbnd, fminunc, fmincon, quadprog, linprog

TEXTBOOKS

1. S. D. Sharma, Operations Research, Kedar Nath Ram Nath, 17th revised edition, 2014.
2. Steven C Chapra Applied Numerical Methods with Matlab, The Tata McGraw-Hill, 2nd edition.

REFERENCE BOOKS

1. R. Panneerselvam, Operations Research, Prentice Hall of India.
2. Rathindra P. Sen, Operations Research Algorithms and Applications, Prentice Hall of India.
3. P. Sankar Iyer, Operations Research, Sigma Series, Tata McGraw Hill Education Private Limited.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. G. Srinivasan Fundamentals of Operations Research NPTEL, `http://nptel.iitm.ac.in/video.php?courseId=1110`, Last Accessed on: 12/11/2024.
2. Dr. J. Siva Ram Prasad, YouTube Channel `https://www.youtube.com/channel/UChbs0m-w3Fp1TEhiwzB6OQQ`, Last Accessed on: 12/11/2024.
3. Optimization Tool Box for use with Matlab: Online link, `www.cs.ubc.ca/~murphyk/Software/CRF/MatlabOptimizationToolbox.pdf`, Last Accessed on: 12/11/2024.

23BS4102B
PROBABILITY AND STATISTICS

Course Category	Basic Science		Credits	3
Course Type	Theory		L-T-P	3-0-0
Prerequisites	23BS1101 Linear Algebra & Calculus		Continuous Eval	30
			Semester End Eval	70
			Total Marks	100

COURSE OUTCOMES

1. Examine probability distributions with random variables.
2. Apply random phenomena of sample to test the Hypothesis concerning means.
3. Analyze the Hypothesis concerning variance and proportions.
4. Estimate Correlation and Regression coefficients.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1	3	3		2											3	1.2.1, 1.2.2, 2.6.3, 4.6.1
2	3	3		2											3	1.2.2, 2.6.3, 4.6.1, 4.6.3
3	3	3		2											4	1.2.2, 2.6.3, 4.6.1, 4.6.3
4	3	3		2											3	1.2.1, 2.6.3, 4.6.1, 4.6.3

COURSE CONTENT

UNIT I

Probability Distributions: Random Variables (discrete and continuous) , Expectation, Variance and Standard deviation of discrete random variable, Binomial distribution, Poisson distribution. Expectations, Variance and standard deviation of continuous random variables, Normal distribution, Normal approximation to the Binomial distribution.
Joint distribution: Joint distributions-Discrete and Continuous.

UNIT II

Sampling Distributions: Introduction, Populations and Samples.
Inferences Concerning Mean: Point Estimation- Interval Estimation. Test of

Hypothesis – Null Hypothesis and Tests of Hypothesis – Hypothesis concerning one mean – Relation between tests and Confidence intervals –Operating characteristic curves - Inferences concerning two means.

UNIT III

Inferences Concerning Variances: Estimation of variances- Hypothesis concerning one variance- Hypothesis concerning two variances.
Inference Concerning Proportions: Estimation of Proportions- Hypothesis concerning one Proportion- Hypothesis concerning several Proportions – The Analysis of r x c Tables- Goodness of fit.

UNIT IV

Correlation: Types of Correlation, Scatter diagram, Karl Pearson's coefficient of correlation, Rank Correlation.
Regression Analysis: The method of least squares, Multiple Regression.

TEXTBOOKS

1. Johnson, R. A. (2011). Probability and statistics for engineers (8th ed.). Prentice Hall India Learning Private Limited.

REFERENCE BOOKS

1. Walpole, R. E., Myers, R. H., Myers, S. L., & Ye, K. (1993). Probability and statistics for engineers and scientists (Vol. 5). New York: Macmillan.
2. Biswal, P. C.(2007). Probability and statistics. Prentice Hall India Learning Private Limited.
3. Iyengar, T. K. V., Gandhi, B. K., Ranganadham, S., & Prasad, M. V. S. S. N, (2008). Probability and statistics. S. Chand Publishing.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Prof. Somesh Kumar, Department of Maths, IIT Kharagpur, `https://nptel.ac.in/courses/111105090`, Last Accessed on: 10/11/2024.
2. Prof.Niladri Chatterjee, Department of Maths, IIT Delhi, `https://nptel.ac.in/courses/111102112`, Last Accessed on: 10/11/2024.
3. Prof. Soumen Maity, Department of Maths, IISER Pune, `https://nptel.ac.in/courses/111105042`, Last Accessed on: 10/11/2024.

23AI&ML4303
MACHINE LEARNING

Course Category	Program Core		Credits	3
Course Type	Theory		L-T-P	3-0-0
Prerequisites	23BS1101 Linear Algebra & Calculus		Continuous Eval	30
			Semester End Eval	70
			Total Marks	100

COURSE OUTCOMES

1. Understand ML foundations and nearest neighbor models for classification and regression.
2. Analyze decision trees and ensemble methods for predictive accuracy.
3. Apply linear models and neural networks for various data scenarios.
4. Apply clustering techniques on high-dimensional data.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1	2	2	3										1	1	2	1.2.1, 1.2.2, 1.6.1, 1.7.1, 2.5.3, 3.6.2
2	2	2	3										1	1	4	1.2.1, 1.2.2, 1.6.1, 1.7.1, 2.5.3, 3.6.2
3	2	2	3	2									1	2	3	1.2.1, 1.2.2, 1.6.1, 1.7.1, 2.5.3, 3.6.2, 4.6.1, 4.4.2
4	2	2	3										1	2	3	1.2.1, 1.2.2, 1.6.1, 1.7.1, 2.5.3, 3.6.2

COURSE CONTENT

UNIT I

Introduction to Machine Learning: Evolution of Machine Learning, Paradigms for ML, Types of Data, Stages in Machine Learning, Data Acquisition, Feature Engineering: Feature Selection and Feature extraction, Data Representation, Model Selection, Model Learning, Model Evaluation, Model Prediction, Search and Learning, Data Sets.

Nearest Neighbor-Based Models: Introduction to Proximity Measures, Distance Measures, K-Nearest Neighbor Classifier, Approximate Nearest Neighbor (ANN), Performance of Classifiers, Performance of Regression Algorithms.

UNIT II

Models Based on Decision Trees Decision Trees for Classification, Impurity Measures, Properties, Regression Based on Decision Trees, Bias–Variance Trade-off.
Ensemble Techniques: Bagging, Boosting, Stacking, Random Forests, Gradient Boosting.
The Bayes Classifier: Introduction to the Bayes Classifier, Naive Bayes Classifier, Bayesian Neural Network.

UNIT III

Linear Discriminants for Machine Learning: : Introduction to Linear Discriminants, Perceptron Classifier, Support Vector Machines, Linearly Non-Separable Case, Non-linear SVM, Kernel Trick, Logistic Regression, Linear Regression.

Artificial Neural Network: : Multi-Layer Perceptrons (MLPs), Backpropagation for Training an MLP, Activation Functions.

UNIT IV

Clustering: Introduction to Clustering, Partitioning of Data, Density-Based Clustering: DBSCAN, HDBSCAN, Hierarchical Clustering: Agglomerative Clustering, Divisive Clustering, K-Means Clustering: K-Means++, Mini-Batch K-Means, Fuzzy C-Means Clustering, Gaussian Mixture Models (GMMs), Expectation-Maximization Clustering, Spectral Clustering, Challenges in High-Dimensional Clustering, Integration of Clustering with Neural Networks.

TEXTBOOKS

1. Ethem.Alpaydin, Introduction to Machine Learning, Cambridge, U.K.:MIT Press, 3rd Edition, 2014.
2. M. N. Murthy and V. S. Ananthanarayana, Machine Learning Theory and Practice. Hyderabad, India: Universities Press, 2024.
3. T. M. Mitchell, Machine Learning, New York, NY, USA: McGraw-Hill, 1997.
4. C. M. Bishop, Pattern Recognition and Machine Learning. New York, NY, USA: Springer, 2006.

REFERENCE BOOKS

1. A. Zheng and A. Casari, Feature Engineering for Machine Learning: Principles and Techniques for Data Scientists. Sebastopol, CA, USA: O'Reilly Media, 2018.
2. Hastie, R. Tibshirani, and J. Friedman, The Elements of Statistical Learning. New York, NY, USA: Springer, 2009.
3. D. Barber, Bayesian Reasoning and Machine Learning. Cambridge, U.K.: Cambridge University Press, 2012.
4. I. Goodfellow, Y. Bengio, and A. Courville, Deep Learning. Cambridge, MA, USA: MIT Press, 2016.
5. C. C. Aggarwal, Neural Networks and Deep Learning: A Textbook. Cham,

Switzerland: Springer, 2018.

6. A. Kumar, Clustering Algorithms for Data Science: A Complete Guide to K-Means, Hierarchical, DBSCAN, and More. Birmingham, U.K.: Packt Publishing, 2019.

7. K. P. Murphy, Machine Learning: A Probabilistic Perspective. Cambridge, MA, USA: MIT Press, 2012.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Brownlee, Machine Learning Mastery. Online. Available: `https://machinelearningmastery.com`, Last Accessed on: 12/11/2024.

2. A. Ng, Machine Learning. Online Course. Available: `https://www.coursera.org/learn/machine-learning`, Last Accessed on: 12/11/2024.

3. Math for Machine Learning with Python. edX Online Course. Available: `https://www.edx.org/course/math-for-machine-learning-with-python`, Last Accessed on: 12/11/2024.

4. K. Naik, Complete Data Science, Machine Learning, Deep Learning, NLP Bootcamp. Online Course. Available: `https://www.krishnaik.in`, Last Accessed on: 12/11/2024.

23AI&ML4304
DATABASE MANAGEMENT SYSTEMS

Course Category	Program Core		Credits	3
Course Type	Theory		L-T-P	3-0-0
Prerequisites	23PC2104A: Data Structures 23AI&ML3304: Advanced Data Structures & Algorithms Analysis		Continuous Eval Semester End Eval Total Marks	30 70 100

COURSE OUTCOMES

1. Apply database management techniques using relational SQL database to real world applications.
2. Analyse the Entity-Relationship models, in turn develop the Relational models that leads to database design.
3. Apply various normalization techniques to relational models in order to improve database design quality.
4. Understand database transactions processing, protocols for Concurrency control and Recovery techniques in database.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1	1	2	3										2	2	3	1.7.1, 2.5.2, 2.5.3, 2.6.3, 2.6.4, 2.8.4, 3.5.6.
2	1	2	3										1	1	4	1.7.1, 2.5.2, 2.5.3, 2.6.3, 2.7.2, 3.5.6, 3.6.2
3	1	2	3										1	1	3	1.7.1, 2.5.2, 2.5.3, 2.6.3, 2.7.2, 3.5.6, 3.6.2
4	1	2											1	1	2	1.7.1, 2.5.2, 2.6.3, 2.7.2

COURSE CONTENT

UNIT I

Introduction: Database system, Characteristics (Database Vs File System), Database Users, Advantages of Database systems, Database applications. Brief introduction of different Data Models; Concepts of Schema, Instance and data independence; Three tier schema architecture for data independence; Database system structure, environment, Centralized and Client Server architecture for the database.

SQL: Simple Database schema, data types, table definitions (create, alter), different DML operations (insert, delete, update). Basic SQL querying (select and project) using where clause, arithmetic & logical operations, SQL functions (Date and Time, Numeric, String conversion).Creating tables with relationship, implementation of key and integrity constraints, nested queries, sub queries, grouping, aggregation, ordering, implementation of different types of joins, view(updatable and non updatable), relational set operations.

UNIT II

Entity Relationship Model: Introduction, Representation of entities, attributes, entity set, relationship, relationship set, constraints, sub classes, super class, inheritance, specialization, generalization using ER Diagrams.
Relational Model: Introduction to relational model, concepts of domain, attribute, tuple, relation, importance of null values, constraints (Domain, Key constraints, integrity constraints) and their importance, Relational Algebra, Relational Database Design using ER-to-Relational Mapping.

UNIT III

Schema Refinement (Normalization): Purpose of Normalization or schema refinement, concept of functional dependency, normal forms based on functional dependency Lossless join and dependency preserving decomposition, (1NF, 2NF and 3 NF), concept of surrogate key, Boyce-Codd normal form(BCNF), MVD, Fourth normal form(4NF), Fifth Normal Form (5NF).

UNIT IV

Transaction Processing, Concurrency Control, and Recovery: Introduction to Transaction Processing, Transaction and System Concepts, Desirable Properties of Transactions, Characterizing Schedules Based on Recoverability, Characterizing Schedules Based on Serializability, Two-Phase Locking Techniques for Concurrency Control, Recovery Concepts, NO-UNDO/REDO Recovery Techniques based on Deferred Update, Recovery Techniques Based on Immediate Update, Shadow Paging, The ARIES Recovery Algorithm.

TEXTBOOKS

1. Raghurama Krishnan, Johannes Gehrke, TMH, Database Management Systems, 3rd Edition. (For Chapters 2, 3, 4)
2. Silberschatz, Korth, Sudarsan, TMH, Database System Concepts, 5th Edition, (For Chapter 1 and Chapter 5)

REFERENCE BOOKS

1. C J Date, Introduction to Database Systems, Pearson, 8th Edition, Ltd,.
2. Ramez Elmasri, Shamkant ,B. Navathe, Database Management System, Mc Graw Hill, Pearson, 6th Edition.

3. Corlos Coronel, Steven Morris, Peter Robb, Database Principles Fundamentals of Design Implementation and Management, Cengage Learning.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Dr S.Srinath IIT-Madras "Conceptual design process " `https://nptel.ac.in/courses/106/106/106106093/`, Last accessed on: 12/11/2024.
2. Prof P.Srinivasa Kumar IIT-Madras " Normalization process" `https://nptel.ac.in/courses/106/106/106106095/` Lecture 7, Last accessed on 12/11/2024.
3. Prof D.Janakiram IIT-Madras Concurrency Control techniques, `https://nptel.ac.in/courses/106/106/106106093/` Lecture 20,21,22,23, Last accessed on: 12/11/2024.
4. Andy Pavlo, Carnegie Mellon University, Relational model concepts, `https://15445.courses.cs.cmu.edu/fall2017/slides/01-introduction.pdf` Last accessed on: 12/11/2024.

23AI&ML4305
DIGITAL LOGIC & COMPUTER ORGANIZATION

Course Category	Prorgram Core		Credits	3
Course Type	Theory		L-T-P	3-0-0
Prerequisites	–		Continuous Eval	30
			Semester End Eval	70
			Total Marks	100

COURSE OUTCOMES

1. Understand digital logic principles and basic structure of a computer.
2. Apply concepts of combinational and sequential logic to design digital circuits.
3. Apply algorithms to perform arithmetic operations on fixed point and floating point data.
4. Understand Processor, Memory and I/O organization of basic computer.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1	2													2	2	1.2.1, 1.7.1
2	1	2	2										1		3	1.7.1, 2.7.1, 2.7.2, 3.7.1, 3.8.1
3	1	2											1		3	1.6.1, 1.7.1 , 2.7.1, 2.8.1
4	1	2												2	2	1.6.1, 1.7.1, 2.7.1, 2.7.2

COURSE CONTENT

UNIT I

Data Representation: Binary Numbers, Fixed Point Representation, Floating Point Representation, Number base conversions, Octal and Hexadecimal Numbers, components, Signed binary numbers, Binary codes.

Digital Logic Circuits-I: Basic Logic Functions, Logic gates, universal logic gates, Minimization of Logic Expressions. K-Map Simplification, Combinational Circuits, Decoders, Multiplexers.

UNIT II

Digital Logic Circuits-II: Sequential Circuits, Flip-Flops, Binary counters, Registers, Shift Registers, Ripple counters.

Basic Structure of Computers: Computer Types, Functional units, Basic operational concepts, Bus structures, Software, Performance, multiprocessors and multi computers, Computer Generations, VonNeumann Architecture.

UNIT III

Computer Arithmetic : Addition and Subtraction, Multiplication Algorithms – Signed Magnitude Multiplication, Booth Multiplication(Signed 2's Complement Multiplication), Array Multipliers, Division Algorithm, Floating-point Arithmetic operations.

Processor Organization: General Register Organization, Stack Organization, Instruction Formats and Addressing Modes, Hardwired Control and Multi programmed Control.

UNIT IV

The Memory Organization: Memory Hierarchy, Main Memory, Auxiliary Memory, Associative Memory, Cache Memory and Virtual Memory.

Input/ Output Organization: Peripheral Devices, Input Output Interface, Asynchronous Data Transfer, Modes of Transfer, Priority Interrupt, Direct Memory Access (DMA).

TEXTBOOKS

1. M. Morris Mano, Digital Design, Pearson, Education, 6th Edition.
2. Morris M. Mano, Computer System Architecture, Pearson/PHI, 3rd Edition, 2007.
3. Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Computer Organization, McGraw Hill, 5th Edition,

REFERENCE BOOKS

1. David A. Paterson, John L. Hennessy, Computer Organization and Design, Elsevier.
2. Thomson, Fundamentals of Logic Design, 6th Edition.
3. William Stallings, Computer Organization and Architecture, Pearson, 11th Edition.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Prof. Jatindra Kumar, IIT Guwahati, Computer Organization and Architecture, Dekahttps://nptel.ac.in/courses/106/103/106103068/, Last Accessed on: 25/10/2024.

23TP4106
ENGLISH FOR PROFESSIONALS

Course Category	Soft Skill-2	Credits	1
Course Type	Theory	L-T-P	0-0-2
Prerequisites	–	Continuous Eval	30
		Semester End Eval	70
		Total Marks	100

COURSE OUTCOMES

1. How conversations are made
2. The usage of grammar
3. Apply speaking skills through activities
4. Apply Etiquettes and manners

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1	2	2											2	2	2	1.6.1, 1.7.1, 2.5.1, 2.5.2, 2.6.5, 2.7.1.
2	2	2	3										1	2	3	1.6.1, 1.7.1, 2.6.2, 2.7.1, 3.5.1, 3.5.2, 3.5.3, 3.5.6.
3	2	2	3										1	2	3	1.6.1, 1.7.1, 2.5.1, 2.7.1, 3.5.1, 3.6.1, 3.6.3, 3.8.1, 3.8.2.
4	2	2	3										1	2	3	1.6.1, 1.7.1, 2.5.2, 2.6.2, 2.7.1, 3.5.4, 3.6.1, 3.6.2.

COURSE CONTENT

UNIT I

Introduction: Beginners, Functional, Situational Conversations Introduction -Importance of spoken English in the placements and Group Discussion Beginners Conversation -Self Introduction-Introducing Self -Introducing each other in a team (Pair Activity) Functional Conversation -Seeking Permission from Seniors Teachers and other superiors (Team Activity) -Asking Direction-Direction from stranger or from Helpline -Making Requests-Requests for borrowing books, applications, or any other help from office staff in college or outside. Just a minute: -Give a topic and ask the student to

talk impromptu. -To present the topic in a structured manner.

UNIT II

Structuring and forming sentences -Structure of mother tongue and pit falls in translation to English. -Formation of sentences in English Errors in Usage -Difficulty in right usage of words. -Difficulty in Pronunciation-Phonetic differences in mother tongue and English –areas to improve. -Idioms and Phrase –Frequently used Idiom and Phrases which help to enhance the quality of presentation and make the presentation meaningful. -Meaning of frequently used Idioms and Phrases.

UNIT III

Introduction to different ways of speaking. -Elocution, Debate and Extempore - Principles of Elocution and its challenges practice in session. -Principles of Debates and its challenges –practice session. -Principles of Extempore - its pitfalls- practice sessions.

UNIT IV

Etiquette -Need of Etiquette in Social arena -Dining Etiquette -Social Etiquette in conversation -formal and informal gathering. -Book a table etc. Versant Test -Mode of versant Test, -Aim of the test and various methods it follows -Practice session.

REFERENCE BOOKS

1. Kamalesh Sadanand, "A Spoken English", VOL 1&2; Orient BlackSwan, Second Edition,2014.
2. "Communicative English"; Pearson; 2010

23MC4107
ENVIRONMENTAL SCIENCE

Course Category	Audit Course	Credits	-
Course Type	Theory	L-T-P	2-0-0
Prerequisites	–	Continuous Eval	30
		Semester End Eval	70
		Total Marks	100

COURSE OUTCOMES

1. Identify various factors causing degradation of natural resource.
2. Identify various ecosystem and need for biodiversity.
3. Realize and explore the problems related to environmental pollution and its management.
4. Apply the information and technology to analyze social issues, use acts associated with environment.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1	2	2													2	1.6.1, 1.7.1, 2.5.1, 2.5.2, 2.6.5, 2.7.1.
2	2	2													2	1.6.1, 1.7.1, 2.5.1, 2.5.2, 2.6.5, 2.7.1.
3	2	2													2	1.6.1, 1.7.1, 2.5.1, 2.5.2, 2.6.5, 2.7.1.
4	2	2													3	1.6.1, 1.7.1, 2.5.1, 2.5.2, 2.6.5, 2.7.1.

COURSE CONTENT

UNIT I

Multidisciplinary Nature Of Environmental Studies: – Definition, Scope and Importance – Need forPublicAwareness. Natural Resources:Renewable and non-renewable resources – Natural resources and associated problems – Forest resources – Use and over – exploitation, deforestation, case studies – Timberextraction – Mining, dams and other effects on forest and tribal people – Water resources – Use andover utilization of surface and ground water – Floods, drought, conflicts over water, dams – benefits and problems–Mineral resources:Use and exploitation, environmental effects of extracting and using mineral resources, case studies–Food resources:World

food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity,casestudies.–Energy resources:

UNIT II

Ecosystems:Ecosystems: Concep to fan ecosystem.–Structure and function of an ecosystem–Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs and ecological pyramids–Introduction, types, characteristic features, structure and function of the following ecosystem: a. Forest ecosystem. b. Grassl and ecosystem c. Desert ecosystem d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Biodiversity And Its Conservation: Introduction Definition: genetic, species and ecosystem diversity–Bio-geographical classification of India–Value of biodiversity: consumptive use, Productive use, social, ethical, aesthetic and option values – Biodiversity at global, National and locallevels – India as a mega-diversity nation – Hot-sports of biodiversity – Threats to biodiversity: habitat loss,poaching of wildlife, man-wildlife conflicts–Endangered and endemic species of India –Conservation of biodiversity:In-situand Ex-situ conservation of biodiversity.

UNIT III

Environmental Pollution: Definition, Cause, effects and control measures of: a. Air Pollution. b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution f. Thermal pollution g. Nuclear hazards

Solid Waste Management: Causes, effects and control measures of urban and industrial wastes – Roleof an individual in prevention of pollution – Pollution case studies.

Disaster management: floods, earthquake, cyclone and landslides.

UNIT IV

Social Issues and the Environment:From Unsustainable to Sustainable development–Urban problems related to energy – Water conservation, rain water harvesting, watershed management –Resettlement and rehabilitation of people; its problems and concerns. Case studies.

Environmental ethics: Issues and possible solutions–Climate change, global warming, acidrain, ozone layer depletion, nuclear accidents and holocaust. Case Studies – Waste and reclamation. – Consumerism and waste products. – Environment Protection Act. – Air (Prevention and Control of Pollution) Act. –Water (Prevention and control of Pollution) Act–Wild life Protection Act–Forest Conservation Act–Issues involved inenforcement of environment allegislation

Public awareness: Human Population And The Environment, Population growth, variation among nations. Population explosion – Family Welfare Programmes. – Environment and human health – Human Rights – Value Education–HIV/AIDS–Women and Child Welfare–Role of information Technology in Environment and human health, Case studies.

Field Work: Visit to a local area to document environmental assets River/ forest grassland/ hill/ mountain – Visit to a local polluted site-Urban/Rural/Industrial, Agricultural Study of common plants,insects, and birds–river, hills lopes,etc.

Self Study:
Water resources, soil resources, mineral resource: radioactive elements, Threats to biodiversity, Solid waste management, Role of Information Technology in environment and human health.

TEXTBOOKS

1. Erach Bharucha. 2004, Environmental Studies for undergraduate courses, University Grants Commission, New Delhi, Bharati Vidyapeeth Institute of Environment Education and Research.
2. Palaniswamy, Environmental Studies, Pearson education.
3. S.AzeemUnnisa,"Environmental Studies"Academic Publishing Company.
4. K.RaghavanNambiar,"Text book of Environmental Studies for Undergraduate Courses as per UGC model syllabus", Scitech Publications (India), Pvt.Ltd.

REFERENCE BOOKS

1. AnjaneyuluY. Introduction to Environmental sciences, B S Publications PVT Ltd, Hyderabad
2. Anjireddy.M Environmental science & Technology, BS Publications PVT Ltd, Hyderabad.
3. Benny Joseph, 2005, Environmental Studies, The Tata McGraw- Hill publishing company limited, New Delhi.
4. Principles of Environmental Science. &Engg. P.Venu Gopala Rao, 2006, Prentice-Hall of India Pvt. Ltd., New Delhi.
5. Ecological and Environmental Studies – Santosh Kumar Garg, Rajeswari Garg (or) Rajani Garg, 2006, Khanna Publishers, New Delhi. Essentials of Environmental Studies, Kurian Joseph & R Nagendran, Pearson Education publishers, 2005.
6. A.K Dee – Environmental Chemistry, New Age India Publications.
7. BharuchaErach- Biodiversity of India, Mapin Publishing Pvt.Ltd..

REFERENCE BOOKS

1. Erach Bharucha. 2004, Environmental Studies for undergraduate courses, University Grants Commission, New Delhi, Bharati Vidyapeeth Institute of Environment Education and Research.https://www.ugc.ac.in/oldpdf/modelcurriculum/env.pdf
2. NPTEL Courses - Environmental Studies by Dr. Tushar Banerjee, Devi Ahilya Viswavidyalaya, Indore.

FULL STACK DEVELOPMENT-I

Course Category	Skill Enhancement Course	Credits	1
Course Type	Laboratory	L-T-P	0-0-2
Prerequisites	–	Continuous Eval	30
		Semester End Eval	70
		Total Marks	100

COURSE OUTCOMES

1. Understand the fundamentals of HTML elements, CSS Styles.
2. Apply HTML elements and their attributes for designing static web pages.
3. Create a web page by applying appropriate CSS styles and HTML elements.
4. Create dynamic web application and validate forms using JavaScript.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1	2	2													2	1.7.1, 2.5.1, 2.5.2
2	2	2	3		2								2	2	3	1.7.1, 2.5.1, 2.5.2, 2.6.3, 3.5.1, 5.5.2
3	2	2	3		2								2	2	6	1.7.1, 2.5.1, 2.5.2, 2.6.3, 2.6.4 ,3.5.1, 5.5.2
4	2	2	3		2								2	2	6	1.7.1, 2.5.1, 2.5.2, 2.6.3, 2.6.4, 3.5.1, 5.5.2

1. **Lists, Links and Images**

   - Write a HTML program, to explain the working of lists Note: It should have an ordered list, unordered list, nested lists and ordered list in an unordered list and definition lists.

   - Write a HTML program, to explain the working of hyperlinks using `<a>`tag and href, target Attributes

   - Create a HTML document that has your image and your friend's image with a specific height and width. Also when clicked on the images it should navigate to their respective profiles

- Write a HTML program, in such a way that, rather than placing large images on a page, the preferred technique is to use thumbnails by setting the height and width parameters to something like to 100*100 pixels. Each thumbnail image is also a link to a full sized version of the image. Create an image gallery using this technique

2. **HTML Tables, Forms and Frames**

   - Write a HTML program, to explain the working of tables. (use tags: `<table>`, `<tr>`, `<th>`, `<td>` and attributes: border, rowspan, colspan)

   - Write a HTML program, to explain the working of tables by preparing a timetable (Note: Use ¡caption¿tag to set the caption to the table& also use cell spacing, cell padding, border, rowspan, colspan etc.)

   - Write a HTML program, to explain the working of forms by designing Registration form (Note: Include text field, password field, number field, date of birth field, checkboxes, radio buttons, list boxes using `<select>`& `<option> tags`, `<text area>` and two buttons ie: submit and reset. Use tables to provide a better view)

   - Write a HTML program, to explain the working of frames, such that page is to be divided into 3 parts on either direction. (Note: first frame image, second frame paragraph, third frame hyperlink. And also make sure of using "no frame" attribute such that frames to be fixed)

3. **HTML 5 and Cascading Style Sheets, Types of CSS**

   - Write a HTML program, that makes use of `<article>`, `<aside>`, `<figure>`, `<figcaption>`, `<footer>`, `<header>`, `<main>`, `<nav>`, `<section>`,`<div>`, `<span>` tags

   - Write a HTML program, to embed audio and video into HTML web page

   - Write a program to apply different types (or levels of styles or style specification formats) - inline, internal, external styles to HTML elements. (identify selector, property and value)

4. **Selector forms**

   - Write a program to apply different types of selector forms
     (i) Simple selector (element, id, class, group, universal)
     (ii) Combinator selector (descendant, child, adjacent sibling, general sibling)
     (iii) Pseudo-class selector
     (iv) Pseudo-element selector
     (v) Attribute selector

5. **CSS with Color, Background, Font, Text and CSS Box Model**

- Write a program to demonstrate the various ways you can reference a color in CSS.

- Write a CSS rule that places a background image halfway down the page, tilting it horizontally. The image should remain in place when the user scrolls up or down.

- Write a program using the following terms related to CSS font and text:
  (i) font-size
  (ii) font-weight
  (iii) font-style
  (iv) text-decoration
  (v) text-transformation
  (vi) text-alignment

- Write a program, to explain the importance of CSS Box model using
  (i) Content
  (ii) Border
  (iii) Margin
  (iv) Padding

6. **Applying JavaScript - internal and external, I/O, Type Conversion**

- Write a program to embed internal and external JavaScript in a web page

- Write a program to explain the different ways for displaying output

- Write a program to explain the different ways for taking input

- Create a webpage which uses prompt dialogue box to ask a voter for his name and age. Display the information in table format along with either the voter can vote or not

7. **JavaScript Pre-defined and User-defined Objects**

- Write a program using document object properties and methods

- Write a program using window object properties and methods

- Write a program using array object properties and methods

- Write a program using math object properties and methods

- Write a program using string object properties and methods

- Write a program using regex object properties and methods

- Write a program using date object properties and methods

- Write a program to explain user-defined object by using properties, methods, accessors, constructors and display.

8. **JavaScript Conditional Statements and Loops**

- Write a program which asks the user to enter three integers, obtains the numbers from the user and outputs HTML text that displays the larger number followed by the words "LARGER NUMBER" in an information message dialog. If the numbers are equal, output HTML text as "EQUAL NUMBERS".

- Write a program to display week days using switch case.

- Write a program to print 1 to 10 numbers using for, while and do-while loops.

- Develop a program to determine whether a given number is an 'ARM-STRONG NUMBER' or not. [Eg: 153 is an Armstrong number, since sum of the cube of the digits is equal to the number i.e.,13 + 53+ 33 = 153]

- Write a program to display the denomination of the amount deposited in the bank in terms of 100's, 50's, 20's, 10's, 5's, 2's & 1's. (Eg: If deposited amount is Rs.163, the output should be 1-100's, 1-50's, 1- 10's, 1-2's & 1-1's)

9. **Javascript Functions and Events**

- Design a appropriate function should be called to display
(i) Factorial of that number
(ii) Fibonacci series up to that number
(iii) Prime numbers up to that number
(iv) Is it palindrome or not

- Design a HTML having a text box and four buttons named Factorial, Fibonacci, Prime, and Palindrome. When a button is pressed an appropriate function should be called to display
(i) Factorial of that number
(ii) Fibonacci series up to that number
(iii) Prime numbers up to that number
(iv) Is it palindrome or not

- Write a program to validate the following fields in a registration page
(i) Name (start with alphabet and followed by alphanumeric and the length should not be less than 6 characters)
(ii) Mobile (only numbers and length 10 digits)
(iii) E-mail (should contain format like xxxxxxx@xxxxxx.xxx)

TEXTBOOKS

1. Programming the World Wide Web, 7th Edition, Robet W Sebesta, Pearson, 2013.
2. Web Programming with HTML5, CSS and JavaScript, John Dean, Jones & Bartlett Learning, 2019 (Chapters 1-11).

3. Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node, Vasan Subramanian, 7th, APress, O'Reilly.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. https://www.w3schools.com/html, Last Accessed on: 10/10/2024.
2. https://www.w3schools.com/css, Last Accessed on: 10/10/2024.
3. https://www.w3schools.com/js/, Last Accessed on: 10/10/2024.
4. https://www.w3schools.com/nodejs, Last Accessed on: 10/10/2024.
5. https://www.w3schools.com/typescript, Last Accessed on: 10/10/2024.

23ES4152
DESIGN THINKING AND INNOVATION

Course Category	Engineering Science			Credits	3
Course Type	Theory			L-T-P	1-0-2
Prerequisites	–			Continuous Eval	30
				Semester End Eval	70
				Total Marks	100

COURSE OUTCOMES

1. Understand the fundamentals of Design Thinking and innovation.
2. Apply the design thinking techniques for solving problems in various sectors.
3. Analyse to work in a multidisciplinary environment.
4. Analyse the value of creativity.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1	2	2											2	2	2	1.7.1, 2.6.2, 2.7.1
2	2	2											1	2	3	1.6.1, 1.7.1, 2.6.2, 2.7.1
3	2	2											1	2	4	1.6.1, 1.7.1, 2.5.1, 2.7.1
4	2	2											1	2	4	1.6.1, 1.7.1, 2.6.2, 2.7.1

COURSE CONTENT

UNIT I

Introduction to Design Thinking: Introduction to elements and principles of Design, basics of design-dot, line, shape, form as fundamental design components. Principles of design. Introduction to design thinking, history of Design Thinking, New materials in Industry.

Design Thinking Process: Design thinking process (empathize, analyze, idea & prototype), implementing the process in driving inventions, design thinking in social innovations. Tools of design thinking - person, costumer, journey map, brainstorming, product development.
Activity: Every student presents their idea in three minutes, Every student can present design process in the form of flow diagram or flow chart etc. Every student should explain about product development.

UNIT II

Innovation: Art of innovation, Difference between innovation and creativity, role

of creativity and innovation in organizations. Creativity to Innovation. Teams for innovation, Measuring the impact and value of creativity.

Activity: Debate on innovation and creativity, Flow and planning from idea to innovation, Debate on value-based innovation.

UNIT III

Product Design: : Software reliability. Problem formation, introduction to product design, Product strategies, Product value, Product planning, product specifications. Innovation towards product design Case studies.

Activity: Importance of modeling, how to set specifications, Explaining their own product design.

UNIT IV

Design Thinking in Business Processes: : Design Thinking applied in Business & Strategic Innovation, Design Thinking principles that redefine business – Business challenges: Growth, Predictability, Change, Maintaining Relevance, Extreme competition, Standardization. Design thinking to meet corporate needs. Design thinking for Startups. Defining and testing Business Models and Business Cases. Developing & testing prototypes..

Activity: How to market our own product, about maintenance, Reliability and plan for startup.

TEXTBOOKS

1. Tim Brown, Change by design, 1/e, Harper Bollins, 2009.
2. Idris Mootee, Design Thinking for Strategic Innovation, 1/e, Adams Media, 2014.

REFERENCE BOOKS

1. David Lee, Design Thinking in the Classroom, Ulysses press, 2018.
2. Shrrutin N Shetty, Design the Future, 1/e, Norton Press, 2018.
3. William lidwell, Kritinaholden, &Jill butter, Universal principles of design, 2/e, Rockport Publishers, 2010.
4. Chesbrough.H, The era of open innovation, 2003.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. IDEO U - Design Thinking Online Courses, Created by IDEO, pioneers in design thinking, "Foundations in Design Thinking" and "Advanced Design Thinking Methods", `https://www.ideou.com/products/design-thinking-certificate?_pos=8&_sid=0c2902189&_ss=r`, Last Accessed On: 12/12/2024.
2. Interaction Design Foundation (IxDF) Design Thinking Guide Rich articles and in-depth tutorials with an engineering focus, `https://www.youtube.com/watch?v=ldYzbVONDp8`,Last Accessed On: 12/12/2024.
3. AI x Design Thinking Workshop Series, `https://www.ideou.com/products/aiworkshop?_pos=1&_sid=0c2902189&_ss=r`

23AI&ML4353

AI&ML LAB

Course Category	Program Core		Credits	1.5
Course Type	Laboratory		L-T-P	0-0-3
Prerequisites	23AI&ML3651 Python Programming		Continuous Eval	30
			Semester End Eval	70
			Total Marks	100

COURSE OUTCOMES

1. Apply data preprocessing and visualization techniques for improved dataset analysis.
2. Analyse machine learning models, including Decision Trees and K-Nearest Neighbors.
3. Apply ensemble methods like Random Forest and Gradient Boosting.
4. Apply various clustering algorithms and the Expectation-Maximization algorithm, evaluating their effectiveness using appropriate metrics.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1	2	2	3										1	1	2	1.2.1, 1.2.2, 1.6.1, 1.7.1, 2.5.3, 3.6.2
2	2	2	3										1	1	4	1.2.1, 1.2.2, 1.6.1, 1.7.1, 2.5.3, 3.6.2
3	2	2	3	2									1	2	3	1.2.1, 1.2.2, 1.6.1, 1.7.1, 2.5.3, 3.6.2, 4.6.1, 4.4.2
4	2	2	3										1	2	3	1.2.1, 1.2.2, 1.6.1, 1.7.1, 2.5.3, 3.6.2

COURSE CONTENT

Task 1: Data Preprocessing

    1. Use ML libraries such as numpy, pandas, matplotlib, etc., for data preprocessing and visualization.

    2. Normalize or standardize your data, detailing the techniques used.

    3. Encode categorical variables in your dataset appropriately.

    4. Apply Principal Component Analysis (PCA) to reduce the dimensionality of your dataset.

5. Visualize the results of PCA to assess the separability of different classes in your data.

Task 2: Heuristic Search

1. Implement a python program for A* algorithm.

2. Implement a python program for AO* algorithm. (Ex: find the shortest path)

Task 3: Decision Trees and Model Explainability

1. Build a Decision Tree for a complex classification problem.

2. Perform hyperparameter tuning and visualize the tree structure.

3. Implement SHAP (SHapley Additive exPlanations) values to explain feature importance and model predictions.

Task 4: K-Nearest Neighbors with Hyperparameter Optimization

1. Apply KNN to a classification problem and experiment with various distance metrics (e.g., Euclidean, Manhattan, Minkowski).

2. Conduct hyperparameter optimization using grid search or random search to identify the best K value and distance metric.

3. Evaluate using precision, recall, F1-score, and confusion matrix and compare results with optimized parameters.

Task 5: Ensemble Methods - Random Forest and Gradient Boosting

1. Train a Random Forest model for both classification and regression problems, analyzing feature importance.

2. Implement Gradient Boosting and compare its performance with Random Forest.

3. Explore the impact of ensemble techniques and compare results in terms of accuracy and generalization.

Task 6: Naïve Bayes for Text Classification with NLP Processing

1. Preprocess text data with tokenization, stop-word removal, stemming, and vectorization using TF-IDF.

2. Train a Naïve Bayes classifier and evaluate performance metrics.

3. Analyze and discuss where the model performs well or struggles and refine preprocessing for improved performance.

Task 7: Support Vector Machines (SVM) with Kernel Trick

1. Train an SVM classifier and experiment with different kernel functions (linear, polynomial, RBF).

2. Visualize decision boundaries and evaluate model performance under each kernel setting.

3. Compare the results and discuss the suitability of kernels for different types of data.

Task 8: Linear and Logistic Regression Analysis

1. Build a Linear Regression model, analyze residuals, and assess model assumptions.

(linearity, homoscedasticity). 2. Apply Logistic Regression for binary classification, evaluate model fit, and interpret model coefficients.

3. Plot the regression line or decision boundary and compare model accuracy.

Task 9: Multi-layer Perceptron (MLP) with Early Stopping and Regularization 1. Train a Multi-layer Perceptron for classification and explore different network architectures (number of layers and nodes).

2. Apply early stopping, dropout, and $L2\_2L2$ regularization to prevent overfitting.

3. Evaluate training and validation accuracy over epochs and analyze the impact of regularization techniques.

Task 10: Clustering Analysis with K-Means and DBSCAN

1. Apply K-Means clustering on a dataset, determining the optimal Kusing the elbow method and silhouette score.

2. Implement DBSCAN for density-based clustering and compare clustering results with K-Means.

3. Evaluate clusters by measuring intra-cluster and inter-cluster distances and analyze the effectiveness of each clustering method.

Task 11: Advanced Clustering with Hierarchical and Spectral Clustering.

1. Use hierarchical clustering with different linkage criteria (single, complete, average) and visualize the resulting dendrogram.

2. Apply spectral clustering for a high-dimensional dataset,

analyzing the clustering structure. 3. Compare hierarchical and spectral clustering techniques and discuss their suitability for complex data.

Task 12: Expectation-Maximization Clustering for Gaussian Mixture Models

1. Implement Gaussian Mixture Models (GMM) using the Expectation-Maximization algorithm on a multivariate dataset.

2. Visualize clusters and analyze the convergence of the EM algorithm.

3. Evaluate clustering performance using metrics like the Adjusted Rand Index and compare results with K-Means.

TEXT BOOKS

1. Andrew Ng, Machine Learning Yearning. (more of a practical guide).
2. A. Geron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition, O'Reilly, 2019.

REFERENCE BOOKS

1. K. P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
2. A. A. Patel, Hands-On Unsupervised Learning Using Python, O'Reilly Media, Inc., March 2019.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. J. Brownlee, Machine Learning Mastery, Online. Available: `https://machinelearningmastery.com/start-here/#python`, Last Accessed on: 12/11/2024.
2. A. Ng, Machine Learning Specialization, Coursera, Online. Available: `https://www.coursera.org/specializations/machine-learning-introduction`, Last Accessed on: 12/11/2024.

23AI&ML4354
DATABASE MANAGEMENT SYSTEMS LAB

Course Category	Program Core	Credits	1.5
Course Type	Laboratory	L-T-P	0-0-3
Prerequisites	23PC2104A Data Structures 23AI&ML3304 Advanced Data Structures & algorithms Analysis	Continuous Eval Semester End Eval Total Marks	30 70 100

COURSE OUTCOMES

1. Apply DDL, DML and DCL statements with integrity constraints
2. Design relational database and manipulate the same using simple and complex queries in SQL.
3. Develop Entity Relationship and the corresponding Relational models for the given real-world application.
4. Analyze database objects like Procedure, Functions, Triggers and Package using PL/SQL

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1	1	2	2		2								1	1	3	1.2.1, 1.7.1, 2.5.2, 2.5.3, 2.6.3, 3.5.1, 3.6.2, 5.4.2
2	1	3	3		3								1	1	6	1.2.1, 1.7.1, 2.5.2, 2.5.3, 2.6.3, 3.5.1, 3.6.2, 5.4.2, 5.5.2
3	1	3	3		3								1	1	6	1.2.1, 1.7.1, 2.5.2, 2.5.3, 2.6.3, 3.5.1, 3.6.2, 5.4.2, 5.5.2
4	1	2	2		2								1	1	4	1.2.1, 1.7.1, 2.5.2, 2.5.3, 2.6.3, 3.5.1, 3.6.2, 5.4.2

COURSE CONTENT

Task 1: Creation, altering and dropping of tables and inserting rows into a table (use constraints while creating tables) examples using SELECT command.

Task 2: Queries using Conversion functions (to_char, to_number and to_date), string functions (Concatenation, lpad, rpad, ltrim, rtrim, lower, upper, initcap, length,

substr and instr), date functions (Sysdate, next_day, add_months, last_day, months_between, least, greatest, trunc, round, to_char, to_date)

Task 3: Queries (along with sub Queries) using ANY, ALL, IN, EXISTS, NOTEX-ISTS, UNION, INTERSET, Constraints. Example: Select the roll number and name of the student who secured fourth rank in the class.

Task 4: Implementation of basic building blocks of Queries(Joins,Aggregate Functions,Set Operations,Cartesian Product,GROUP BY, HAVING clause),Creation and dropping of Views.

Task 5: Draw ER diagram for an application with at least 3 entities and establish relationships between them using a tool. Perform ER to Relational mapping to derive Relational database.

Task 6: Implementation of first, second, third, BCNF, fourth Normal forms and conversions.

Task 7: (I) Create a simple PL/SQL program which includes declaration section, executable section and exception –Handling section (Ex. Student marks can be selected from the table and printed for those who secured first class and an exception can be raised if no records were found)

(II) Insert data into student table and use COMMIT, ROLLBACK and SAVE-POINT in PL/SQL block.

Task 8: Develop a program that includes the features NESTED IF, CASE and CASE expression. The program can be extended using the NULLIF and COA-LESCE functions.

Task 9: Program development using WHILE LOOPS, numeric FOR LOOPS, nested loops using ERROR Handling, BUILT –IN Exceptions, USE defined Exceptions, RAISE- APPLICATION ERROR.

Task 10: Programs development using creation of procedures, passing parameters IN and OUT of PROCEDURES.

Task 11: Program development using creation of stored functions, invoke functions in SQL Statements and write complex functions.

Task 12: Develop programs using features parameters in a CURSOR, FOR UP-DATE CURSOR, WHERE CURRENT of clause and CURSOR variables.

Task 13: Develop Programs using BEFORE and AFTER Triggers, Row and State-ment Triggers and INSTEAD OF Triggers.

Task 14: Real Time Database Application for uploads(File,Image,Video).

TEXT BOOKS

1. Oracle: The Complete Reference by Oracle Press
2. Nilesh Shah, Database Systems Using Oracle, PHI, 2007
3. Rick F Vander Lans, Introduction to SQL, Pearson, 4th Edition, 2007.

REFERENCE BOOKS

1. Gordon S Linoff, Data Analysis Using SQL and Excel, Wiley, 2nd Edition, 2016.
2. Joan Casteel, Oracle 12c:SQL, Cengage Learning, 2017.

3. J D Ullman, —Principles of database systems, Computer Science Press, 2001.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Prof Arnab Bhattacharya, IIT Kanpur, SQL Introduction, `https://nptel.ac.in/courses/106104135/10`, Last accessed on: 12/11/2024.
2. Prof Arnab Bhattacharya, IIT Kanpur, SQL: Updates, Joins, Views and Triggers `https://nptel.ac.in/courses/106104135/11`, Last accessed on: 12/11/2024.
3. Geoff Allix and Graeme Malcolm: Microsoft , Querying with Transact-SQL (edX), `https://www.mooc-list.com/course/querying-transact-sql-edx` Last accessed on: 12/11/2024.

SEMESTER V

23AI&ML5301
DEEP LEARNING

Course Category	PC		Credits	3
Course Type	Theory		L-T-P	3-0-0
Prerequisites	23AI&ML4303 Machine Learning		Continuous Eval	30
			Semester End Eval	70
			Total Marks	100

COURSE OUTCOMES

1. Understand the fundamentals of Applied Math for deep learning approaches and paradigms.
2. Understand various Architectures of Deep Networks.
3. Analyze feed forward networks and Deep Neural networks.
4. Apply the deep learning techniques for various applications.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1	1	1											1	1	2	1.2.1, 1.7.1, 2.8.1
2	1	2	2										2	2	2	1.2.1, 1.7.1, 2.8.1, 3.6.2
3	1	2	3		2								1	1	4	1.2.1, 1.7.1, 2.5.2, 3.6.2, 5.5.2
4	1	2	2		2								1	1	3	1.2.1, 1.7.1, 2.8.1, 3.6.2, 5.5.2

COURSE CONTENT

UNIT I
Basics- Biological Neuron, Idea of computational units, McCulloch–Pitts unit and Thresholding logic, Linear Perceptron, Perceptron Learning Algorithm, Linear separability, Convergence theorem for Perceptron Learning Algorithm.

UNIT II
Feed forward Networks: Multilayer Perceptron, Gradient Descent, Backpropagation, Empirical Risk Minimization, regularization, auto encoders.
Deep Neural Networks: Difficulty of training deep neural networks, Greedy layer wise training.

UNIT III

Better Training of Neural Networks: Newer optimization methods for neural networks (Adagrad, adadelta, rmsprop, adam, NAG), second order methods for training, Saddle point problem in neural networks, Regularization methods (dropout, drop connect, batch normalization).

Recurrent Neural Networks: Back propagation through time, Long Short-Term Memory, Gated Recurrent Units, Bidirectional LSTMs, Bidirectional RNNs.

UNIT IV

Convolutional Neural Networks: LeNet, AlexNet. Generative models: Restrictive Boltzmann Machines (RBMs), Introduction to MCMC and Gibbs Sampling, gradient computations in RBMs, Deep Boltzmann Machines.

Recent trends: Variational Autoencoders, Transformers, GPT Applications: Vision, NLP, Speech.

TEXTBOOKS

1. Ian Good fellow and Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, 1st Edition, 2016.

REFERENCE BOOKS

1. R. Rojas, Neural Networks: A Systematic Introduction, 1st edition, Berlin, Germany: Springer-Verlag, 1996.
2. C. M. Bishop, Pattern Recognition and Machine Learning, 1st edition, New York, NY, USA: Springer, 2007.
3. F. Chollet, Deep Learning with Python, 1st edition, Shelter Island, NY, USA: Manning Publications Co., 2017.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Prof. Sudarshan Iyengar, Prof. Sanatan Sukhija, Introduction to Deep learning, https://nptel.ac.in/courses/106/106/106106184/, Last accessed on: 19/04/2025.
2. Ian Goodfellow , Adversarial Deep Learning, https://www.youtube.com/watch?v=OcbPg1VtsSM , Last accessed on Last accessed on: 19/04/2025.

23AI&ML5302
COMPUTER NETWORKS

Course Category	PC		Credits	3
Course Type	Theory		L-T-P	3-0-0
Prerequisites	–		Continuous Eval	30
			Semester End Eval	70
			Total Marks	100

COURSE OUTCOMES

1. Understand the concepts related to network categories, topologies, and reference models.
2. Analyze error and flow control mechanisms in data link layer
3. Analyse subnetting and various routing protocols of network layer
4. Analyze transport layer and application layer protocols for specific applications.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1	2	3											1	3	2	1.2.1, 1.6.1, 1.7.1, 2.5.2
2	2	3											1	3	4	1.6.1, 1.7.1, 2.5.2, 2.6.4
3	2	3											1	3	4	1.7.1, 2.5.2, 2.6.4
4	2	3											1	3	4	1.6.1, 1.7.1, 2.5.2, 2.6.4

COURSE CONTENT

UNIT I

Introduction: Types of Computer Networks, Reference Models- The OSI Reference Model, The TCP/IP Reference Model, A Critique of the OSI Model and Protocols, A Critique of the TCP/IP Reference Model. History of Internet. Physical Layer: Transmission Media, Guided and Un-guided media

UNIT II

Data link layer: Data Link Layer Design Issues, Services Provided To the Network Layer, Error detecting and Error Correcting codes, Elementary Data Link Protocols, Sliding Window Protocols, HDLC, PPP. Multiple Access Protocols Wired Lans: Ethernet, Fast Ethernet, Gigabit Ethernet.

UNIT III

The Network Layer: Network Layer Design Issues, Routing Algorithms, Congestion, Congestion control algorithms. The Network Layer in the Internet, The IP Version 4 Protocol, IP Addresses- Classful, CIDR, NAT, IP Version 6 Protocol, Transition from IPV4 to IPV6.

UNIT IV

The Transport Layer: The Transport Layer Services, Transport Layer Protocols: UDP, TCP and SCTP.

Application Layer: The World Wide Web, HTTP, Domain Name Space, Remote Loging, Electronic Mail and File Transfer.

TEXTBOOKS

1. Andrew S Tanenbaum, David J Wetherall, Computer Networks, 5th Edition, Pearson Education, 2011.
2. Behrouz A.Fourozan, Data Communications and Networking. 4th Edition, TATA McGraw Hill, 2007.

REFERENCE BOOKS

1. J.F. Kurose and K. W. Ross, Computer Networking: A Top-Down Approach Featuring the Internet, 6th Edition, Pearson Education, 2012.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Prof Sowmya Kanti Ghosh, IIT Kharagpur, NPTEL Lectures, Video Lectures, Available: https://nptel.ac.in/courses/106105183, Last Accessed on: 18/4/2025.
2. Prof. Hari Balakrishnan, MIT Open Courseware, MIT, Video Lectures, Available: https://ocw.mit.edu/courses/6-829-computer-networks-fall-2002/, Last Accessed on: 18/4/2025.
3. Dheeraj, IIT Kharagpur, Lecture Notes, Available: http://www.cse.iitk.ac.in/users/dheeraj/cs425, Last Accessed on: Last Accessed on: 18/4/2025.

23AI&ML5303
OPERATING SYSTEMS

Course Category	PC		Credits	3
Course Type	Theory		L-T-P	3-0-0
Prerequisites	23ES1104 Introduction to Programming		Continuous Eval	30
			Semester End Eval	70
			Total Marks	100

COURSE OUTCOMES

1. Understand the basic components of an Operating System.
2. Apply CPU Scheduling techniques and mechanisms used for process synchronization.
3. Analyse Memory management techniques and methods for handling deadlocks.
4. Analyse File system Implementation techniques and protection mechanisms.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1	3												1	1	2	1.7.1
2	2	2	3										1	1	3	1.7.1, 2.6.3, 2.6.4, 2.8.3, 2.8.4, 3.7.1
3	2	2	3										1	2	4	1.7.1, 2.5.2, 2.6.3, 2.6.4, 2.8.4, 3.7.1
4	2	2	3										1	2	4	1.7.1, 2.5.2, 2.6.3, 2.6.4, 2.8.4, 3.7.1

COURSE CONTENT

UNIT I

System Structures: Operating System Services, User and Operating-System Interface, system calls, Types of System Calls, system programs, operating system Design and Implementation, operating system structure, Building and Booting an Operating System, Operating system debugging.

Processes: Process Concept, Process scheduling, Operations on processes, Interprocess communication.

Threads and Concurrency: Multithreading models, Thread libraries, threading issues.

UNIT II

CPU Scheduling: Basic concepts, Scheduling criteria, Scheduling algorithms, multiple processor scheduling.

Synchronization Tools: The Critical Section Problem, Peterson's Solution, Mutex Locks, Semaphores, Monitors, Classic problems of Synchronization.

UNIT III

Deadlocks: system Model, Deadlock characterization, Methods for handling Deadlocks, Deadlock prevention, Deadlock avoidance, Deadlock detection, Recovery from Deadlock.

Memory-Management Strategies: Introduction, Contiguous memory allocation, Paging, Structure of the Page Table, Swapping.

Virtual Memory Management: Introduction, Demand paging, Copy-on-write, Page replacement, Allocation of frames, Thrashing.

Storage Management: Overview of Mass Storage Structure, HDD Scheduling.

UNIT IV

File System: File System Interface: File concept, Access methods, Directory Structure; File system Implementation: File-system structure, File-system Operations, Directory implementation, Allocation method.

Free space management: File-System Internals: File-System Mounting, Partitions and Mounting, File Sharing.

Protection: Goals of protection, Principles of protection, Protection Rings, Domain of protection, Access matrix.

TEXTBOOKS

1. Silberschatz A, Galvin P B, Gagne G, Operating System Concepts, Wiley, 10th Edition, 2018.
2. Tanenbaum A S, Modern Operating Systems, Galgotia Publications Pvt. Ltd, 4th Edition, 2016.

REFERENCE BOOKS

1. Stallings W, Operating Systems -Internals and Design Principles, Pearson, 9th Edition, 2018.
2. D.M Dhamdhere, Operating Systems: A Concept Based Approach, McGraw- Hill, 3rd Edition, 2013.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Prof Santanu Chattopadhyay - NPTEL Course on Operating Sytems, `https://nptel.ac.in/courses/106/105/106105214/`, Last Accessed On: 28/04/2025.
2. Stanford University - Lecture Notes on Operating Systems, `https://www.scs.stanford.edu/21wi-cs140/notes`, Last Accessed on: 28/04/2025.
3. IIT Bombay – Lecture Notes on Operating Systems , `https://www.cse.iitb.a`

`c.in/~mythili/os/`, Last Accessed on: 28/04/2025.

23AI&ML5404A
AUTOMATA THEORY AND COMPILER DESIGN

Course Category	PE -I	Credits	3
Course Type	Theory	L-T-P	3-0-0
Prerequisites	23AI&ML4305 Digital Logic and Computer organization	Continuous Eval	30
		Semester End Eval	70
		Total Marks	100

COURSE OUTCOMES

1. Understand the theoretical foundations of computation through finite automata, regular languages, and their limitations.
2. Analyze and construct context-free grammars and pushdown automata for language parsing and recognition.
3. Demonstrate the capability to design lexical and syntax analyzers using formal methods and compiler construction tools.
4. Apply syntax-directed translation techniques and intermediate code generation strategies for compiler design.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1	2	2											2		2	1.2.1, 1.6.1, 1.7.1, 2.5.2
2	2	2	3										2		4	1.2.1, 1.6.1, 1.7.1, 2.5.2, 3.5.1
3	2	3	3										2		3	1.2.1, 1.6.1, 1.7.1, 2.5.2, 3.5.1
4		2	3										2		3	2.5.2, 2.6.4, 2.7.1, 3.5.1

COURSE CONTENT

UNIT I

Introduction to Finite Automata: Structural Representations, Automata and Complexity, the Central Concepts of Automata Theory – Alphabets, Strings, Languages, Problems. Nondeterministic Finite Automata: Formal Definition, an application, Text Search, Finite Automata with Epsilon-Transitions.

Deterministic Finite Automata: Definition of DFA, How A DFA Process Strings, The language of DFA, Conversion of NFA with €-transitions to NFA without €-transitions. Conversion of NFA to DFA.

Regular Expressions: Finite Automata and Regular Expressions, Applications of Regular Expressions, Algebraic Laws for Regular Expressions, Conversion of Finite Automata to Regular Expressions. Pumping Lemma for Regular Languages: Statement of the pumping lemma, Applications of the Pumping Lemma.

UNIT II

Context-Free Grammars: Definition of Context-Free Grammars, Derivations Using a Grammar, Leftmost and Rightmost Derivations, the Language of a Grammar, Parse Trees, Ambiguity in Grammars and Languages.
Push Down Automata: Definition of the Pushdown Automaton, the Languages of a PDA, Equivalence of PDA's and CFG's, Acceptance by final state.
Turing Machines: Introduction to Turing Machine, Formal Description, Instantaneous description, The language of a Turing machine.
Undecidability: Undecidability, A Language that is Not Recursively Enumerable, An Undecidable Problem That is RE, Undecidable Problems about Turing Machines.

UNIT III

Introduction: The structure of a compiler.
Lexical Analysis: The Role of the Lexical Analyzer, Input Buffering, Recognition of Tokens, The Lexical- Analyzer Generator Lex.
Syntax Analysis: Introduction, Context-Free Grammars, Writing a Grammar, Top-Down Parsing, Bottom- Up Parsing, Introduction to LR Parsing: Simple LR, More Powerful LR Parsers.

UNIT IV

Syntax-Directed Translation: Syntax-Directed Definitions, Evaluation Orders for SDD's, Syntax Directed Translation Schemes, Implementing L-Attributed SDD's.
Intermediate- Code Generation: Variants of Syntax Trees, Three-Address Code.
Run-Time Environments: Stack Allocation of Space, Access to Nonlocal Data on the Stack, Heap Management.

TEXTBOOKS

1. John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, Introduction to Automata Theory, Languages, and Computation, 3rd Edition, Pearson Education, 2006.
2. V. Aho, Monica S. Lam, Ravi Sethi, Jeffry D. Ullman, Compilers: Principles, Techniques and Tools, Alfred 2nd Edition, Pearson, 2006.
3. Mishra and Chandra shekaran, Theory of Computer Science – Automata languages and computation, 2nd Edition, PHI, 2006.

REFERENCE BOOKS

1. Kamala Krithivasan, Introduction to Formal languages Automata Theory and Computation, Rama R, Pearson, 1st Edition, 2009.

2. John C Martin, Introduction to Languages and The Theory of Computation, TMH, 3rd Edition, 2003.
3. John R. Levine, Tony Mason, Doug Brown, Lex & Yacc, O'reilly, 2nd Edition, 1992.
4. Kenneth C. Louden, Thomson, Compiler Construction, Course Technology, 1st Edition, 1997.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Prof. Sourav Mukhopadhyay, Introduction to Automata, Languages and Computation, Dept. of Mathematics, IIT Kharagpur, `https://archive.nptel.ac.in/courses/106/105/106105196/`, Last accessed on: 26/04/2025.
2. Prof.Santanu Chatopadhyay, Compiler Design by, IIT Kharagpur `https://archive.nptel.ac.in/courses/106/105/106105190/`, Last accessed on: 26/04/2025.

23AI&ML5404B
NATURAL LANGUAGE PROCESSING

Course Category	PE-I	Credits	3
Course Type	Theory	L-T-P	3-0-0
Prerequisites	23AI&ML4303 Machine Learning	Continuous Eval	30
		Semester End Eval	70
		Total Marks	100

COURSE OUTCOMES

1. Understand key NLP concepts, including language modeling, tokenization, and part-of-speech tagging.
2. Understand NLP techniques like grammar parsing, dependency parsing, and word sense disambiguation.
3. Analyze syntactic, semantic, and pragmatic structures using probabilistic models and logic.
4. Apply the effectiveness of discourse analysis and lexical resources in NLP tasks.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1	1	1											1	1	2	1.2.1, 1.7.1, 2.8.1
2	1	2	2										2	2	2	1.2.1, 1.7.1, 2.8.1 3.7.1
3	1	2	3										2	2	4	1.7.1, 2.5.2, 2.6.3, 2.6.4, 2.8.4, 3.7.1
4	1	2	2										1	1	3	1.7.1, 2.5.2, 2.6.3, 2.6.4, 2.8.4, 3.7.1

COURSE CONTENT

UNIT I
Introduction and Word Level Analysis: Origins and challenges of NLP, Language Modelling: Grammar-based LM, Statistical LM, Regular Expressions, Finite-State Automata, English Morphology, Transducers for lexicon and rules, Tokenization, Detecting and Correcting Spelling Errors, Minimum Edit Distance – Unsmoothed N-grams, Evaluating N-grams, Smoothing, Interpolation and Backoff – Word Classes, Part-of-Speech Tagging, Rule-based, Stochastic and Transformation-based tagging, Issues in PoS tagging, Hidden Markov and Maximum Entropy models.

UNIT II

Syntactic Analysis: Context-Free Grammars, Grammar rules for English, Tree-banks, Normal Forms for grammar, Dependency Grammar, Syntactic Parsing, Ambiguity, Dynamic Programming parsing, Shallow parsing, Probabilistic CFG, Probabilistic CYK, Probabilistic Lexicalized CFGs, Feature structures, Unification of feature structures.

UNIT III

Semantics and Pragmatics: Requirements for representation, First-Order Logic, Description Logics, Syntax-Driven Semantic analysis, Semantic attachments, Word Senses, Relations between Senses, Thematic Roles, Selectional restrictions, Word Sense Disambiguation, WSD using Supervised, Dictionary & Thesaurus, Bootstrapping methods, Word Similarity using Thesaurus and Distributional methods.

UNIT IV

Discourse Analysis and Lexical Analysis: Discourse segmentation, Coherence, Reference Phenomena, Anaphora Resolution using Hobbs and Centering Algorithm, Coreference Resolution, Resources: Porter Stemmer, Lemmatizer, Penn Treebank, Brill's Tagger, WordNet, PropBank, FrameNet, Brown Corpus, British National Corpus (BNC).

TEXTBOOKS

1. Daniel Jurafsky, James H. Martin, Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech, 2nd Edition, Pearson Publication, 2014.
2. Steven Bird, Ewan Klein and Edward Loper, Natural Language Processing with Python, First Edition, OReilly Media, 2009.

REFERENCE BOOKS

1. Breck Baldwin, Language Processing with Java and Ling Pipe Cookbook, 1st Edition, Atlantic Publisher, 2015.
2. Richard M Reese, Natural Language Processing with Java, 2nd Edition, OReilly Media, 2015.
3. Nitin Indurkhya and Fred J. Damerau, Handbook of Natural Language Processing, 2nd Edition, Chapman and Hall/CRC Press, 2010.
4. Tanveer Siddiqui, U.S. Tiwary, Natural Language Processing and Information Retrieval, 3rd Edition, Oxford University Press, 2008.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Prof. Dan Jurafsky – NPTEL Course on Natural Language Processing, https://nptel.ac.in/courses/106/106/106106211/, Last Accessed On: 28/04/2025.
2. Prof. Pushpak Bhattacharyya – NPTEL Course on Introduction to Natural Lan-

Natural Language Processing, https://nptel.ac.in/courses/106/105/106105 158/, Last Accessed On: 28/04/2025.

3. Prof. P. Balamurugan – NPTEL Course on Natural Language Processing, https://nptel.ac.in/courses/111/102/111102115/, Last Accessed On: 28/04/2025.

4. Prof. Sudeshna Sarkar – NPTEL Course on Deep Learning for Natural Language Processing, https://nptel.ac.in/courses/106/105/106105195/, Last Accessed On: 28/04/2025.

23AI&ML5404C
INTERNET OF THINGS (IoT)

Course Category	PE -I		Credits	3
Course Type	Theory		L-T-P	3-0-0
Prerequisites	23AI&ML4305 Digital Logic& Computer Organization		Continuous Eval	30
			Semester End Eval	70
			Total Marks	100

COURSE OUTCOMES

1. Understand how the Internet and Internet of Things (IoT) function at a conceptual level.
2. Analyze the constraints and opportunities of wireless and mobile networks used in IoT applications.
3. Apply basic sensing and measurement techniques to evaluate real-time network performance of connected devices.
4. Design prototype models for practical applications using IoT technologies.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1	2												1	2	2	1.6.1, 1.7.1
2	2												1	2	4	1.6.1, 1.7.1
3		2	2										2		3	2.7.1, 2.7.2, 3.6.2
4	1				2										3	1.6.7, 1.7.1, 5.4.1

COURSE CONTENT

UNIT I

The Internet of Things: An Overview of Internet of things, Internet of Things Technology, behind IoTs Sources of the IoTs, M2M Communication, Examples of IoTs, Design Principles For Connected Devices Internet Connectivity Principles, Internet connectivity, Application Layer Protocols: HTTP, HTTPS, FTP, Telnet.

UNIT II

Business Models for Business Processes in the Internet of Things, IoT/M2M systems LAYERS AND designs standardizations, Modified OSI Stack for the IoT/M2M Systems, ETSI M2M domains and High- level capabilities ,Communication Technologies, Data Enrichment and Consolidation and Device Management Gateway Ease of designing and affordability.

UNIT III

Design Principles for the Web Connectivity for Connected:Devices, Web Communication protocols for Connected Devices, Message Communication protocols for Connected Devices, Web Connectivity for Connected-Devices. Data Acquiring, Organizing and Analytics in IoT/M2M, Applications /Services /Business Processes, IOT/M2M Data Acquiring and Storage, Business Models for Business Processes in the Internet Of Things, Organizing Data, Transactions, Business Processes, Integration and Enterprise Systems.

UNIT IV

Data Collection, Storage and Computing Using a Cloud Platform for IoT/M2M Applications/Services, Data Collection, Storage and Computing Using cloud platform Everything as a service and Cloud Service Models, IOT cloud-based services using the Xively (Pachube/COSM), Nimbits and other platforms Sensor, Participatory Sensing, Actuator, Radio Frequency Identification, and Wireless, Sensor Network Technology, Sensors Technology, Sensing the World.

TEXT BOOKS

1. Rajkamal, Internet of Things: Architecture, Design Principles And Applications, McGraw Hill Higher Education, 2nd Edition, 2022.
2. A. Bahgya and V.Madisetti, Internet of Things, Univesity Press, 1ast Edition, 2015.

REFERENCE BOOKS

1. A. McEwen and H. Cassimally, Designing the Internet of Things, 1st edition, Wiley, 2013.
2. C. Pfister, Getting Started with the Internet of Things, 1st edition, O'Reilly Media, 2011.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Prof. Sudip Misra, IIT Kharagpur Introduction to Internet of things, Available: https://nptel.ac.in/courses/106/105/106105166/, Last accessed on 25/04/2025.
2. Prof. T V Prabhakar, IISc Bangalore, Design for Internet of things, Available: https://nptel.ac.in/courses/108/108/108108098/, Last accessed on 25/04/2025.

23AI&ML5404D
EXPLORATORY DATA ANALYSIS WITH PYTHON

Course Category	PE-I	Credits	3
Course Type	Theory	L-T-P	2-0-2
Prerequisites	23AI&ML3651 - Python Programming Lab	Continuous Eval	30
		Semester End Eval	70
		Total Marks	100

COURSE OUTCOMES

1. Apply exploratory data analysis techniques using statistical and visualization tools to interpret and present different types of data effectively.
2. Apply data transformation techniques to prepare, analyze, and interpret datasets.
3. Apply descriptive statistical methods and grouping techniques to analyze and organize datasets effectively.
4. Analyze data using correlation and multivariate techniques and examine patterns in time series data.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1	1	2			3								1	2	3	1.2.1, 2.5.3, 5.4.1
2		1	2	3									1	2	3	2.6.3, 3.6.2, 4.6.1
3		1	2		3								1	2	3	2.5.3, 2.6.3, 3.6.2, 5.4.2
4		3	1		2								1	2	4	2.8.2, 3.8.2, 5.5.1

COURSE CONTENT

UNIT I

Exploratory Data Analysis Fundamentals: Understanding data science, The significance of EDA, Making sense of data – Numerical data; Categorical data; Measurement scales, Comparing EDA with classical and Bayesian analysis, Software tools available for EDA. Getting started with EDA – NumPy; Pandas; SciPy; Matplotlib.
Visual Aids for EDA: : Line chart, Bar charts, Scatter plot – Bubble chart; Scatter plot using seaborn, Area plot and stacked plot, Pie chart, Table chart, Polar chart, Histogram, Lollipop chart, Choosing the best chart.
Sample Experiments:
1. a) Download Dataset from Kaggle using the following link : https://www.kaggle.com/datasets/sukhmanibedi/cars4u

b) Install python libraries required for Exploratory Data Analysis (numpy, pandas, matplotlib, seaborn)

2. Perform Numpy Array basic operations and Explore Numpy Built-in functions.

3. Loading Dataset into pandas dataframe.

4. Selecting rows and columns in the dataframe.

5. Apply different visualization techniques using sample dataset

a.) Line Chart b.) Bar Chart c.) Scatter Plots d.) Bubble Plot

6. Apply following visualization Techniques for a sample dataset

a.) Area Plot b.) Stacked Plot c.) Pie chart d.) Table Chart

UNIT II

EDA with Personal Email: Data transformation – Data cleansing; Loading the CSV file; Converting the date; Removing NaN values; Applying descriptive statistics; Data refactoring; Dropping columns; Refactoring timezones, Data analysis.

Data Transformation: Merging database-style data frames, Transformation techniques – Performing data deduplication; Replacing values; Handling missing data; Renaming axis indexes; Discretization and binning; Outlier detection and filtering; Permutation and random sampling, Benefits of data transformation.

Sample Experiments:

1. Perform the following operations

a) Merging Dataframes b) Reshaping with Hierarchical Indexing c) Data Deduplication d) Replacing Values

2. Apply different Missing Data handling techniques a)NaN values in mathematical Operations b) Filling in missing data c) Forward and Backward filling of missing values d) Filling with index values e) Interpolation of missing values

3. Apply different data transformation techniques

a) Renaming axis indexes b)Discretization and Binning c) Permutation and Random Sampling d) Dummy variables

UNIT III

Descriptive Statistics: Understanding statistics – Distribution function; Cumulative distribution function; Descriptive statistics, Measures of central tendency – Mean/average; Median; Mode, Measures of dispersion – Standard deviation; Variance; Skewness; Kurtosis; Calculating percentiles; Quartiles.

Grouping Datasets: Understanding groupby(), Groupby mechanics – Selecting a subset of columns; Max and min; Mean, Data aggregation – Group-wise operations; Group-wise transformations, Pivot tables and cross-tabulations – Pivot tables; Cross-tabulations.

Sample Experiments:

1. Study the following Distribution Techniques on a sample data a) Uniform Distribution b) Normal Distribution c) Gamma Distribution d) Exponential Distribution e) Poisson Distribution f) Binomial Distribution

2. Perform Data Cleaning on a sample dataset.

3. Compute measure of Central Tendency on a sample dataset

a) Mean b)Median c)Mode

4. Explore Measures of Dispersion on a sample dataset

a) Variance b) Standard Deviation c) Skewness d) Kurtosis

UNIT IV

Correlation:Introducing correlation, Types of analysis – univariate analysis; bivariate analysis; multivariate analysis, Discussing multivariate analysis using the Titanic dataset, Outlining Simpson's paradox.

Time Series Analysis: Understanding the time series dataset – Fundamentals of TSA; Characteristics of time series data, TSA with Open Power System Data – Data cleaning; Time-based indexing; Visualizing time series; Grouping time series data; Resampling time series data.

Sample Experiments:

1. a) Calculating percentiles on sample dataset b) Calculate Inter Quartile Range(IQR) and Visualize using Box Plots

2. Perform the following analysis on automobile dataset.

a) Bivariate analysis b)Multivariate analysis 3. Perform Time Series Analysis on Open Power systems dataset

TEXTBOOKS

1. Suresh Kumar Mukhiya, Usman Ahmed, Hands-On Exploratory Data Analysis with Python, Packt Publishing, 1st Edition, 2020.

REFERENCE BOOKS

1. Ronald K. Pearson, Exploratory Data Analysis Using R, CRC Press, 1st Edition, 2020.
2. Radhika Datar, Harish Garg, Hands-On Exploratory Data Analysis with R: Become an expert in exploratory data analysis using R packages, 1st Edition, Packt Publishing, 2019.

E-RESOURCES AND OTHER DIGITAL MATERIALS:

1. Prof. Ragunathan Rengasamy, Python for Data Science `https://onlinecourses.nptel.ac.in/noc22_cs32/preview`, Last Accessed on: 25/04/2025.
2. Exploratory Data Analysis in Python, `https://www.udemy.com/course/exploratory-data-analysis-in-python/`, Last Accessed on: 25/04/2025.

23AI&ML5404E
SOFTWARE ENGINEERING

Course Category	Program Core		Credits	2
Course Type	Theory		L-T-P	2-0-0
Prerequisites	-		Continuous Eval	30
			Semester End Eval	70
			Total Marks	100

COURSE OUTCOMES

1. Understand the different software engineering process models.
2. Apply analysis model for different applications.
3. Apply design model for different application.
4. Apply different testing techniques.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1	2	3											2	2	2	1.7.1, 2.5.1, 2.5.2, 2.6.4, 2.7.1
2	2	2	3										1	2	3	1.7.1, 2.5.1, 2.7.1, 3.5.1, 3.5.2, 3.5.6
3	2	2	3										1	2	3	1.7.1, 2.5.1, 2.6.4 3.5.1, 3.8.1
4	2	2	3										2	3	3	1.7.1, 2.5.1, 2.6.4 3.5.1, 3.6.2, 3.8.2

COURSE CONTENT

UNIT I

The Nature of Software: The Nature of Software, The changing nature of software. Software engineering: The Software Process, Software Engineering Practice, Software Development Myths.
The Software Process: Software Process Structure. A Generic Process Model, Defining a framework activity, identifying a task set, Process patterns, Process Assessment and Improvement. Process models: Prescriptive Process Models, Specialized Process Models, The Unified Process, Personal and Team Process Models.
Agile Development: Agility and the Cost of Change, Extreme Programming (XP) Other Agile Process Models, A Tool Set for the Agile Process.

UNIT II

Understanding Requirements: Requirements Engineering, Establishing the Groundwork, Eliciting Requirements, Developing Use Cases, Building the Analysis Model, Negotiating Requirements, Requirements monitoring, and Validating Requirements.

Requirements Modeling: Scenario Based Methods: Requirements Analysis, Scenario-Based Modeling, UML Models That Supplement the Use Case. Class based methods, Identifying Analysis classes, specifying attributes, Defining operators, Class-Responsibility-Collaborator Modeling, Associates and Dependencies, Analysis Packages.

Behavior, Patterns, And Web apps: Creating a Behavioral Model, identifying events with Use Cases, State Representations, Patterns for Requirements Modeling, Requirements Modeling for Web and Mobile Apps.

UNIT III

Design Concepts: Design within the Context of Software Engineering, the Design Process, Design Concepts, the Design Model.

Architectural Design: Software Architecture, Architectural Genres, Architectural Styles, Architectural Considerations, Architectural Decisions, Architectural Design. Component-Level Design: Designing Class-Based Components, Conducting Component Level Design, and Component level design for Web Apps, Component Level Design for Mobile Apps.

User Interface Design: The Golden Rules, User Interface Analysis and Design, Interface Analysis, Interface Design Steps, Web app and Mobile Interface Design

UNIT IV

Software Testing Strategies: A Strategic Approach to Software Testing, Strategic Issues, Test Strategies for Conventional Software, Test Strategies for Object-Oriented Software, Test Strategies for Web Apps, Test Strategies for Mobile Apps, Validation testing, System testing, the art of debugging. ***Testing Conventional Applications:*** Software Testing Fundamentals, Internal and External Views of Testing, White Box Testing, Basis Path Testing, Control Structure Testing, Black-Box Testing.

TEXTBOOKS

1. Roger S. Pressman, Bruce R.Maxim, Software Engineering a practitioners approach" 8th Edition, McGraw-Hill Publication 2019.

REFERENCE BOOKS

1. Ian Somerville, Software Engineering, 9th Edition, Pearson Education. 2011.
2. Software Engineering principles and practice- Waman S Jawadekar, The Mc Graw Hill Companies.
3. Fundamentals of object-oriented design using UML Meiler page-Jones: Pearson Education.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Software Engineering Course, `https://www.tutorialspoint.com/software_en gineering/index.htm`, Last Accessed on: 12/04/2025.
2. Prof. Rajib Mall, IIT Kharagpur, Software Engineering, `https://archive.npte l.ac.in/courses/106/105/106105182/` Last Accessed On: 12/04/2025.

23AI&ML5205A
WEB PROGRAMMING

Course Category	OE- I	Credits	3
Course Type	Theory	L-T-P	3-0-0
Prerequisites	–	Continuous Eval	30
		Semester End Eval	70
		Total Marks	100

COURSE OUTCOMES

1. Understand the concepts of Web designing.
2. Apply the concepts of HTML5 and CSS to design static web pages.
3. Apply client side technologies to design interactive Web interfaces
4. Apply interactive server side scripting for a web application.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1	3	2													2	1.3.1, 2.1.1
2		2	3										2		3	2.2.3, 3.2.1, 3.2.2
3		2	3										3		3	2.2.3, 2.2.4, 3.3.1, 3.2.1, 3.2.2
4		2	3										3		3	2.2.3, 3.2.1, 3.2.2

COURSE CONTENT

UNIT I

Introduction: Concept of WWW, Internet and WWW, HTTP Protocol : Request and Response, Web browser and Web servers, Features of Web 2.0.
Web Design: Concepts of effective web design, Web design issues including Browser, Bandwidth and Cache, Display resolution, Look and Feel of the Website, Page Layout and linking, User centric design, Sitemap, Planning and publishing website, Designing effective navigation.

UNIT II

HTML: Basics of HTML, formatting and fonts, commenting code, color, hyperlink, lists, tables, images, forms, XHTML, Meta tags, Character entities, frames and frame sets, Browser architecture and Web site structure. Overview and features of HTML5.
Style sheets: Need for CSS, introduction to CSS, basic syntax and structure, using

CSS, background images, colors and properties, manipulating texts, using fonts, borders and boxes, margins, padding lists, positioning using CSS, CSS2, Overview and features of CSS3

UNIT III

JavaScript: Client side scripting with JavaScript, variables, functions, conditions, loops and repetition, Pop up boxes, Advance JavaScript: Javascript and objects, JavaScript own objects, the DOM and web browser environments, Manipulation using DOM, forms and validations, DHTML : Combining HTML, CSS and Javascript, Events and buttons.
XML: Introduction to XML, uses of XML, simple XML, XML key components, DTD and Schemas, Using XML with application. Transforming XML using XSL and XSLT.

UNIT IV

PHP: Introduction and basic syntax of PHP, decision and looping with examples, PHP and HTML, Arrays, Functions, Browser control and detection, string, Form processing, Files, Advance Features: Cookies and Sessions, Object Oriented Programming with PHP.
PHP and MySQL: Basic commands with PHP examples, Connection to server, creating database, selecting a database, listing database, listing table names, creating a table, inserting data, altering tables, queries, deleting database, deleting data and tables, PHP myadmin and database bugs.

TEXT BOOKS

1. R. Moseley and M. T. Savaliya, Developing Web Applications, 2nd ed. New Delhi, India: Wiley India Pvt. Ltd., 2011.

REFERENCE BOOKS

1. J. Sklar, Web Design Principles, 5th edition, Boston, MA: Course Technology Cengage Learning, 2012.
2. H. M. Deitel, P. J. Deitel, and T. R. Nieto, Internet & World Wide Web: How to Program, 3rd edition, Upper Saddle River, NJ: Pearson/Prentice Hall, 2004.
3. B. M. Harwani, Developing Web Applications in PHP and AJAX. New Delhi, India: Tata McGraw-Hill Education, 2010.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Sengupta, Internet Technology, NPTEL, Jun. 28, 2014. `https://nptel.ac.in/courses/106105084`, Last Accessed: 05/05/2025.
2. PHP Group, PHP: MySQL - Manual, PHP: Hypertext Preprocessor, `https://www.php.net/manual/en/book.mysql.php`, Last Accessed: 05/05/2025.

23CS5205B
INTERNET OF THINGS

Course Category	OE- I		Credits	3
Course Type	Theory		L-T-P	3-0-0
Prerequisites			Continuous Eval	30
			Semester End Eval	70
			Total Marks	100

COURSE OUTCOMES

1. Understand the design concepts and applications of Internet of Things
2. Understand Standards and Key Technologies in IoT.
3. Apply the steps of the design methodology in developing IoT applications using Raspberry Pi
4. Understand the Privacy, security and Vulnerabilities of internet of Things

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1	2												1	2	2	1.6.1,1.7.1
2	2												1	2	2	1.6.1, 1.7.1
3		2	2										2		3	2.7.1, 2.7.2, 3.6.2
4	1				2										2	1.6.1, 1.7.1, 5.4.1

COURSE CONTENT

UNIT I

Introduction to Internet of things: Introduction, Physical design of IoT, Logical Design of IoT, IoT Enabling technologies, IoT levels & Deployment templates.
Domain Specific IoTs – Home Automation, Cities, Environment, Energy, Retail, Logistics, Agriculture, Industry, Health and Lifestyle

UNIT II

IoT and M2M: Introduction, M2M, Difference between IoT and M2M, SDN and NFV for IoT, Software Defined Networking, Network Function Virtualization.
IoT Platforms Design Methodology: Introduction, IoT Design Methodology, Case Study on IoT System for Home Automation , IoT system for Weather Monitoring.

UNIT III

IoT Physical Devices and Endpoints: Basic building blocks of an IoT Deice, Introduction to Raspberry Pi Board, Linux on Raspberry Pi, Raspberry Pi Interfaces (serial, SPI, I2C)

Programming Raspberry PI with Python – Controlling LED with Raspberry Pi, Interfacing an LED and Switch with Raspberry Pi, Interfacing a Light sensor (LDR) with Raspberry Pi.

UNIT IV

IoT Privacy, Security and Vulnerabilities Solutions: Introduction, Vulnerabilities, Security Requirements and Threat Analysis – Privacy, Vulnerabilities of IoT, Security Requirements, Threat Analysis, Use Cases and Misuse Cases, IoT Security Tomography and Layered Attacker model. Security models, profiles and protocols for IoT.

TEXTBOOKS

1. Arshdeep Bahga , Vijay Madisetti, Internet of Things (A Hands-on Approach), 1st Edition, Universities Press Private Limited, 2014.
2. Raj Kamal, Internet of Things, Architecture and Design Principles, 1st Edition, McGraw Hill Education Private Limited, 2017.

REFERENCE BOOKS

1. Matt Richardson & Shawn Wallace, Getting Started with Raspberry Pi, O'Reilly (SPD), 2014.
2. David Hanes, IOT Fundamentals, 1st Edition, CISCO Press, 2018.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Prof. Sudip Misra, IIT Kharagpur, Introduction to Internet of things, Available: https://nptel.ac.in/courses/106/105/106105166/, Last Accessed on: 24/04/2025.
2. Prof. T V Prabhakar, IISc Bangalore, Design for Internet of things, Available: https://nptel.ac.in/courses/108/108/108108098/, Last Accessed on: 24/04/2025.

23AI&ML5351

DEEP LEARNING LAB

Course Category	PC	Credits	1
Course Type	Laboratory	L-T-P	0-0-2
Prerequisites	23AI&ML4353 AI&ML Lab	Continuous Eval	30
		Semester End Eval	70
		Total Marks	100

COURSE OUTCOMES

1. Implement deep neural networks to solve real world problems
2. Choose appropriate pre-trained model to solve real time problem
3. Interpret the results of two different deep learning models
4. Evaluate the deep learning models for optimized solutions

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1	1	1											1	1	3	1.2.1, 1.7.1, 2.8.1
2	1	2	2										2	2	3	1.2.1, 1.7.1, 2.8.1, 3.6.2
3	1	2	3		2								1	1	4	1.2.1, 1.7.1, 2.5.2, 3.6.2, 5.5.2
4	1	2	2		2								1	1	4	1.2.1, 1.7.1, 2.8.1, 3.6.2, 5.5.2

COURSE CONTENT

Task 1: Implement multi-layer perceptron algorithm for MNIST Handwritten Digit Classification.

Task 2: Design a neural network for classifying movie reviews (Binary Classification) using IMDB dataset.

Task 3: Design a neural Network for classifying news wires (Multi class classification) using Reuters dataset.

Task 4: Design a neural network for predicting house prices using Boston Housing Price dataset.

Task 5: Build a Convolution Neural Network for MNIST Handwritten Digit Classification.

Task 6: Build a Convolution Neural Network for simple image (dogs and Cats) Classification

Task 7: Use a pre-trained convolution neural network (VGG16) for image classificat

Task 8: Implement one hoten coding of words or characters.

Task 9: Implement word embeddings for IMDB dataset.

Task 10: Implement a Recurrent Neural Network for IMDB Movie review classification problem.

TEXTBOOKS

1. Ian Good fellow and Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, 1st Edition, 2016.

REFERENCE BOOKS

1. R. Rojas, Neural Networks: A Systematic Introduction, 1st edition, Berlin, Germany: Springer-Verlag, 1996.
2. C. M. Bishop, Pattern Recognition and Machine Learning, 1st edition, New York, NY, USA: Springer, 2007.
3. F. Chollet, Deep Learning with Python, 1st edition, Shelter Island, NY, USA: Manning Publications Co., 2017.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Prof. Sudarshan Iyengar, Prof. Sanatan Sukhija, Introduction to Deep learning, https://nptel.ac.in/courses/106/106/106106184/, Last accessed on: 19/04/2025.
2. Ian Goodfellow , Adversarial Deep Learning, https://www.youtube.com/watch?v=OcbPg1VtsSM , Last accessed on Last accessed on: 19/04/2025.

23AI&ML5352
OPERATING SYSTEMS LAB

Course Category	PC		Credits	1
Course Type	Laboratory		L-T-P	0-0-2
Prerequisites	23ES1104 Introduction to Programming		Continuous Eval	30
			Semester End Eval	70
			Total Marks	100

COURSE OUTCOMES

1. Implement UNIX concepts for creation of Shell Scripts
2. Apply CPU Scheduling algorithms, page replacement algorithms, thread implementation
3. Analyze Bankers Algorithm for Dead Lock avoidance and process Synchronization
4. Analyze the memory management techniques

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1	1	2											1	1	3	1.7.1, 2.6.4
2	1	3	3	2									1	1	3	1.7.1, 2.6.3, 2.6.4, 2.8.3, 2.8.4, 3.7.1, 4.6.1
3	1	3	3	2									1	1	4	1.7.1, 2.5.2, 2.6.3, 2.6.4, 2.8.4, 3.7.1, 4.6.1
4	1	3	3	2									1	1	4	1.7.1, 2.5.2, 2.6.3, 2.6.4, 2.8.4, 3.7.1, 4.6.1

COURSE CONTENT

Task 1: Practicing of Basic UNIX Commands.
Task 2: Write programs using the following UNIX operating system calls fork, exec, getpid, exit, wait, close, stat, opendir and readdir
Task 3: Simulate UNIX commands like cp, ls, grep, etc.,
Task 4: Simulate the following CPU scheduling algorithms a) FCFS b) SJF c) Priority d) Round Robin
Task 5: Control the number of ports opened by the operating system with a) Semaphore b) Monitors.

Task 6: Write a program to illustrate concurrent execution of threads using pthreads library.

Task 7: Write a program to solve producer-consumer problem using Semaphores.

Task 8: Implement the following memory allocation methods for fixed partition a) First fit b) Worst fit c) Best fit

Task 9: Simulate the following page replacement algorithms a) FIFO b) LRU c) LFU

Task 10: Simulate Paging Technique of memory management.

Task 11: Implement Bankers Algorithm for Dead Lock avoidance and prevention

Task 12: Simulate the following file allocation strategies a) Sequential b) Indexed c) Linked

Task 13: Download and install nachos operating system and experiment with it

REFERENCE BOOKS

1. Silberschatz A, Galvin P B, Gagne G, Operating System Concepts, Wiley, 10th Edition, 2018.
2. Tanenbaum A S, Modern Operating Systems, Galgotia Publications Pvt. Ltd, 4th Edition, 2016.
3. Stallings W, Operating Systems -Internals and Design Principles, Pearson, 9th Edition, 2018.
4. D.M Dhamdhere, Operating Systems: A Concept Based Approach, McGraw- Hill, 3rd Edition, 2013.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Prof Santanu Chattopadhyay - NPTEL Course on Operating Sytems, `https://nptel.ac.in/courses/106/105/106105214/`, Last Accessed On: 28/04/2025.
2. Stanford University - Lecture Notes on Operating Systems, `https://www.scs.stanford.edu/21wi-cs140/notes`, Last Accessed on: 28/04/2025.
3. IIT Bombay – Lecture Notes on Operating Systems , `https://www.cse.iitb.ac.in/~mythili/os/`, Last Accessed on: 28/04/2025.

23HS5153
ADVANCED COMMUNICATION SKILLS LAB

Course Category	Institutional Core	Credits	1
Course Type	Laboratory	L-T-P	0-0-2

Prerequisites	20TP4106 English for Professionals	Continuous Eval	30
		Semester End Eval	70
		Total Marks	100

COURSE OUTCOMES

1. Execute rational pronunciation of speech sounds including accentuation.
2. Apply elements of listening comprehension in professional environments.
3. Develop the abilities of rational argumentation and skills of public speaking.
4. Demonstrate proficiency in the elements of professional communication including the competitive examination.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1										3					3	5.5.1, 10.4.1, 10.4.2, 10.5.2
2					2					3					4	5.5.2, 10.4.1, 10.4.2, 10.5.1
3					2					3					4	5.5.2, 10.4.1, 10.4.2, 10.5.2
4					1					3					4	5.5.1, 5.5.2, 10.4.1, 10.4.2

COURSE CONTENT/TASK

UNIT:I Elements of Spoken Expression and processes of Listening Comprehension:

- Speech Mechanism

- Articulation of vowels and consonants

- Patterns of Accentuation

- Types and processes of Listening comprehension

UNIT II: Patterns of Substantiation and Refutation in Public Speaking:

- Group Discussion(Open and Monitored)

- Pyramid Discussion

- PNI

- Seminar Talk and Power Point Presentation

UNIT III: Professional Communication:

- Self Affirmation Advanced Composition including

- Memo and e-mail

- Résumé Preparation

- Corporate ethic of Non-Verbal Communication

UNIT IV: Life Skills and Vocabulary for Competitive Examinations:

- Select Life Skills(50)

- Select Logies, Isms, Phobias and Manias (25 each)

- Sentence Completion and Double Unit Verbal Analogies (50 items)

- Fundamentals of Syllogisms(Descriptive and Pictorial)

TEXTBOOKS TEXTBOOKS

1. M. Cutts, Oxford Guide to Plain English, 7th impression, Oxford, UK: Oxford University Press, 2011.
2. Department of Phonetics and Spoken English, Exercises in Spoken English, 21st impression, Hyderabad, India: Central Institute of English and Foreign Languages (CIEFL), published by Oxford University Press, 2003.

REFERENCE BOOKS

1. S. R. Covey, The 7 Habits of Highly Effective People, 2nd edition, London, UK: Simon & Schuster UK Ltd (Pocket Books), 2004.
2. J. S. Brubacher, Eclectic Philosophy of Education: A Book of Readings, Englewood Cliffs, NJ, USA: Prentice-Hall, 1951.

23AI&ML5651
FULL STACK DEVELOPMENT-II

Course Category	SEC		Credits	1
Course Type	Laboratory		L-T-P	0-0-2
Prerequisites	23AI&ML3305 Object Oriented Programming Through Java		Continuous Eval	30
			Semester End Eval	70
			Total Marks	100

COURSE OUTCOMES

1. Implement router, template engine and authentication using sessions to develop application in ExpressJS.
2. Build a single page application using RESTful APIs in ExpressJS
3. Apply router and hooksin designing ReactJS application
4. Implement MongoDB queries to perform CRUD operations on document database

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1	2	2													3	1.7.1, 2.5.1, 2.5.2
2	2	2	3										2	2	3	1.7.1, 2.5.1, 2.5.2, 2.6.3, 2.7.1, 3.5.1
3	2	2	3										2	2	3	1.7.1, 2.5.1, 2.5.2, 2.6.3, 2.6.4 3.5.1
4		2	3	2									2	2	3	2.5.1, 2.5.2, 2.6.3, 2.6.4, 3.5.1, 4.6.2

Experiments covering the Topics:

- ExpressJS – Routing, HTTP Methods, Middleware, Templating, Form Data

- ExpressJS – Cookies, Sessions, Authentication, Database, RESTful APIs

- ReactJS – Render HTML, JSX, Components – function & Class, Props and States, Styles, Respond to Events

- ReactJS – Conditional Rendering, Rendering Lists, React Forms, React Router, Updating the Screen

- ReactJS – Hooks, Sharing data between Components, Applications – To-do list and Quiz

- MongoDB – Installation, Configuration, CRUD operations, Databases, Collections and Records

Sample Experiments:

1. **ExpressJS – Routing, HTTP Methods, Middleware**

   - Write a program to define a route, Handling Routes, Route Parameters, Query Parameters and URL building.

   - Write a program to accept data, retrieve data and delete a specified resource using http methods.

   - Write a program to show the working of middleware.

2. **ExpressJS – Templating, Form Data**

   - Write a program using templating engine.

   - Write a program to work with form data.

3. **ExpressJS – Cookies, Sessions, Authentication**

   - Write a program for session management using cookies and sessions.

   - Write a program for user authentication

4. **ExpressJS – Database, RESTful APIsl**

   - Write a program to connect MongoDB database using Mangoose and perform CRUD operations.

   - Write a program to develop a single page application using RESTful APIs.

5. **ReactJS – Render HTML, JSX, Components – function & Class**

   - Write a program to render HTML to a web page.

   - Write a program for writing markup with JSX.

   - Write a program for creating and nesting components (function and class).

6. **ReactJS – Props and States, Styles, Respond to Events**

   - Write a program to work with props and states.

   - Write a program to add styles (CSS & Sass Styling) and display data.

- Write a program for responding to events.

7. **ReactJS – Conditional Rendering, Rendering Lists, React Forms**

  - Write a program for conditional rendering.

  - Write a program for rendering lists.

  - Write a program for working with different form fields using react forms.

8. **ReactJS – React Router, Updating the Screen**

  - Write a program for routing to different pages using react router.

  - Write a program for updating the screen.

9. **ReactJS – Hooks, Sharing data between Components**

  - Write a program to understand the importance of using hooks.

  - Write a program for sharing data between components.

10. **MongoDB – Installation, Configuration, CRUD operations**

  - Install MongoDB and configure ATLAS

  - Write MongoDB queries to perform CRUD operations on document using insert(), find(), update(), remove()

11. **MongoDB – Databases, Collections and Records**

  - Write MongoDB queries to Create and drop databases and collections.

  - Write MongoDB queries to work with records using find(), limit(), sort(), createIndex(), aggregate().

12. **Augmented Programs: (Any 2 must be completed)**

  - Design a to-do list application using NodeJS and ExpressJS.

  - Design a Quiz app using ReactJS.

  - Complete the MongoDB certification from MongoDB University website.

TEXTBOOKS

1. Vasan Subramanian, Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node, 2nd edition, APress, O'Reilly.
2. Mike Cantelon, Mark Harter, T.J. Holowaychuk, Nathan Rajlich, Node.Js in Action, Manning Publications. (Chapters 1-11)
3. AzatMardan, React Quickly, Manning Publications, 2nd Edition, 2017.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. ExpressJS - https://www.tutorialspoint.com/expressjs, Last Accessed on: 25/03/2025.
2. ReactJS - https://www.w3schools.com/REACT/DEFAULT.ASP, Last Accessed on: 25/03/2025.
3. MongoDB - https://learn.mongodb.com/learning-paths/introduction-to-mongodb , Last Accessed on: 25/03/2025.

23TP5106
PERSONALITY DEVELOPMENT

Course Category	SS-3		Credits	1
Course Type	Learning by Doing		L-T-P	0-0-2
Prerequisites	20TP4106 English for Professionals	Continuous Eval		100
		Semester End Eval		0
		Total Marks		100

COURSE OUTCOMES

1. Understand the corporate etiquette.
2. Make presentations effectively with appropriate body language.
3. Be composed with positive attitude.
4. Understand the core competencies to succeed in professional and personal life.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1									2	3					2	9.5.2, 10.5.1, 10.4.2
2									2	3					3	9.5.1, 10.4.1, 10.4.2
3									3	3					3	9.4.1, 10.5.1, 10.4.2
4									2	3					2	9.5.2, 10.4.1, 10.4.2

COURSE CONTENT

UNIT I

Analytical Thinking and Communication Skills: Self-Introduction, Shaping Young Minds - A Talk by Azim Premji (Listening Activity), Self–Analysis, Developing Positive Attitude, Perception; Verbal Communication, Non Verbal Communication (Body Language)

UNIT II

Self-Management Skills and Etiquette: Anger Management, Stress Management, Time Management, Six Thinking Hats, Team Building, Leadership Qualities; Social Etiquette, Business Etiquette, Telephone Etiquette, Dining Etiquette

UNIT III

Standard Operation Methods and Verbal Ability: Note Making, Note Taking, Minutes Preparation, Email Letter Writing; Synonyms, Antonyms, One Word Substitutes-Correction of Sentences-Analogies, Spotting Errors, Sentence Completion, Course of

Action -Sentences Assumptions, Sentence Arguments, Reading Comprehension, Practice work.

UNIT IV

Career-Oriented Skills: Group Discussion, Mock Group Discussions, Resume Preparation, Interview Skills, Mock Interviews

METHODOLOGY Audio—Visuals / Hand Outs (Compiled/Created by Training Division, T&P Cell, VR Siddhartha Engineering College), Board & Chalk and Interactive Sessions.

REFERENCE BOOKS

1. Mitra, B. K., Personality development and soft skills (Vol. 156). Oxford University Press, 2011.
2. Dhanavel, S. P, English and Soft Skills. Orient Blackswan Pvt Limited, 2011.
3. Aggarwal, R. S., A Modern Approach to Verbal & Non Verbal Reasoning. S. Chand, 2018.
4. Meenakshi, R. & Sharma, S, Technical Communication Principles and Practice, Oxford University Press, 2011.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Aptitude Questions and Answers. (n.d.). IndiaBIX. `https://www.indiabix.com`, Last accessed on 02/05/25.
2. Placement Papers of all IT Companies. (n.d.). Freshersworld, `https://placement.freshersworld.com/placement-papers`, Last accessed on 02/05/25.

USER INTERFACE DESIGN USING FLUTTER

Course Category	ES	Credits	1
Course Type	Laboratory	L-T-P	0-0-2

Prerequisites	–	Continuous Eval	30
		Semester End Eval	70
		Total Marks	100

COURSE OUTCOMES

1. Learns to Implement Flutter Widgets and Layouts
2. Understand Responsive UI Design and with Navigation in Flutter
3. Knowledge on Widges and customize widgets for specific UI elements, Themes
4. Understand to include animation apart from fetching data

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1	2	2													2	1.7.1, 2.5.1, 2.5.2
2	2	2	3										2	2	2	1.7.1, 2.5.1, 2.5.2, 2.6.3, 2.7.1, 3.5.1
3	2	2	3										2	2	2	1.7.1, 2.5.1, 2.5.2, 2.6.3, 2.6.4 3.5.1
4		2	3	2									2	2	2	2.5.1, 2.5.2, 2.6.3, 2.6.4, 3.5.1, 4.6.2

List of Experiments: Students need to implement the following experiments:

1. (a) Install Flutter and Dart SDK

   (b) Write a program to accept data, retrieve data and delete a specified resource using http methods.

2. (a) Explore various Flutter widgets (Text, Image, Container, etc.).

   (b) Implement different layout structures using Row, Column, and Stack widgets

3. (a) Design a responsive UI that adapts to different screen sizes.

   (b) Implement media queries and breakpoints for responsiveness.

4.   (a) Set up navigation between different screens using Navigator.

      (b) Implement navigation with named routes.

5.   (a) Learn about stateful and stateless widgets.

      (b) Implement state management using set State and Provider.

6.   (a) Create custom widgets for specific UI elements.

      (b) Apply styling using themes and custom styles.

7.   (a) Design a form with various input fields.

      (b) Implement form validation and error handling.

8.   (a) Add animations to UI elements using Flutter's animation framework.

      (b) Experiment with different types of animations (fade, slide, etc.).

9.   (a) Fetch data from a REST API.

      (b) Display the fetched data in a meaningful way in the UI.

10.   (a) Write unit tests for UI components.

      (b) Use Flutter's debugging tools to identify and fix issues.

TEXTBOOKS

1. Marco L. Napoli, Beginning Flutter: A Hands-on Guide to App Development.
2. Rap Payne, Beginning App Development with Flutter: Create Cross-Platform Mobile Apps 1st Edition, Apres
3. Richard Rose, Flutter & Dart Cookbook, Developing Full stack Applications for the Cloud, Oreilly.

23AI&ML5354
ENGINEERING PROJECT FOR COMMUNITY SERVICES

Course Category	Project Work/Internship	Credits	2
Course Type	Laboratory	L-T-P	0-0-0
Prerequisites	–	Continuous Eval	30
		Semester End Eval	70
		Total Marks	100

COURSE OUTCOMES

1. Identify the Societal problems.
2. Solve the problems.
3. Design of the problem/work plan.
4. Design of the prototype/model.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

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

EPICS: Engineering Project for community services will be carried out during summer vacation for a period of six weeks after IV Semester and the report shall be submitted in V Semester. Students will go to the society (Villages/ Hospitals/Towns, etc,.) to identify the problem and survey the literature for a feasible solution. The student(s) is encouraged to solve real life problems leading to innovative model building.. This can be done in a group of students or as an individual.

20MC5107
INTELLECTUAL PROPERTY RIGHTS (IPR)

Course Category	MC	Credits	–
Course Type	Theory	L-T-P	2-0-0

Prerequisites	–	Continuous Eval	100
		Semester End Eval	0
		Total Marks	100

COURSE OUTCOMES

1. Learn the innovation concepts related to business organizations.
2. Understand the importance of innovation in new start-ups.
3. Know fundamental aspects of Intellectual property Rights.
4. Learn the basic concepts of entrepreneurship and its benefits.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO												PSO		BTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1		1						2	2		2		1		2	2.5.1, 2.5.1, 2.6.2, 2.6.3, 2.6.4, 8.3.1, 8.4.2, 9.4.2, 9.5.1, 11.6.1, 11.6.2
2		2						1	2		2		1		2	2.5.1, 2.5.1, 2.6.2, 2.6.3, 2.6.4, 8.3.1, 8.4.2, 9.4.2, 9.5.1, 11.6.1, 11.6.2
3		2						2	3		3		1		2	2.5.1, 2.5.1, 2.6.2, 2.6.3, 2.6.4, 8.3.1, 8.4.2, 9.4.2, 9.5.1, 11.6.1, 11.6.2
4		1						3	2		2		1		2	2.5.1, 2.5.1, 2.6.2, 2.6.3, 2.6.4, 8.3.1, 8.4.2, 9.4.2, 9.5.1, 11.6.1, 11.6.2

COURSE CONTENT

UNIT I

Innovation Management: Introduction Innovation: Definition, Importance –

The need to view innovation in an organizational context – Different types of innovation - Innovation and Invention – Popular views of innovation – Innovation as a management process.

UNIT II

Innovation: New Product Development (NPD): Innovation Management and New Product Development – Considerations when developing as NPD strategy - NPD as a strategy for growth – What is new product? – Classification of new products – NPD as an industry innovation cycle.

UNIT III

Intellectual Property Rights (IPR): Introduction and the need for intellectual property right (IPR) - Kinds of Intellectual Property Rights: Patent, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and Layout Design – Genetic Resources and Traditional Knowledge – Trade Secret - IPR in India : Genesis and development.

UNIT IV

Entrepreneurship Concept and need of entrepreneurship: Characteristics and Types of Entrepreneurship - Entrepreneurship as a career - Entrepreneurship as a style of Management - The changing role of the entrepreneur - Entrepreneurial traits, factors affecting entrepreneurs.

TEXT BOOKS

1. P. Trott, Innovation Management and New Product Development, 6th edition, Harlow, UK: Pearson Education Limited, 2017.
2. K. V. Nithyananda, Intellectual Property Rights: Protection and Management, 1st edition, New Delhi, India: Cengage Learning India Pvt. Ltd., 2019.
3. S. S. Khanka, Entrepreneurial Development, Revised edition, New Delhi, India: S. Chand Publishing, 2020.

REFERENCE BOOKS

1. J. Tidd and J. R. Bessant, Managing Innovation: Integrating Technological, Market and Organizational Change, 6th edition, Hoboken, NJ, USA: Wiley, 2018.
2. N. Pandey and K. Dharni, Intellectual Property Rights, 1st edition, New Delhi, India: PHI Learning Pvt. Ltd., 2014.
3. V. Desai, The Dynamics of Entrepreneurial Development and Management, 6th edition, Mumbai, India: Himalaya Publishing House, 2022.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Prof . K. D. Raju, Prof. Niharika Sahoo Bhattacharya, Intellectual Property Rights and Competition Law, NPTEL, IIT Kharagpur, `https://archive.nptel.ac.in/courses/110/105/110105139/#`, Last Accessed on: 02/05/2025.