SCHEME OF INSTRUCTION AND SYLLABUS

B.Tech in 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 B.Tech in CSE (AI&ML) 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:

1. The graduates of the Program will have solid foundation in the principles and practices of computer science, including mathematics, science and basic engineering.
2. The graduates of the Program will have skills to function as members of multidisciplinary teams and to communicate effectively using modern tools.
3. The graduates of the Program will be prepared for their careers in the software industry or pursue higher studies and continue to develop their professional knowledge.
4. The graduates of the program will 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 -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	23AI&ML5653	SEC	Full Stack Development -II	0	0	2	1
9	23AI&ML5554	EPICS	Evaluation of Community Service Internship	0	0	0	2
8	23HS5155	HSS	Advanced Communication Skills Laboratory	0	0	2	1
11	23ES5156	ES	User Interface Design using Flutter / SWAYAM Plus - Android Application Development (with Flutter)	0	0	2	1
10	23TP5106	SS-3	Personality Development	0	0	2	1
13	23MC5107A	AC	Technincal Paper Writing & IPR	2	0	0	0
			Total	17	0	12	23
Honors/ Minor Courses (Two Courses in each sem)				3	0	0	3

[*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	Business Intelligence & Data Visualization	3	0	0	3
2	23AI&ML6302	PC	Big Data Analytics	3	0	0	3
3	23AI&ML6303	PC	Reinforcement Learning	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	3	0	0	3
6	23AI&ML6206	OE II (NPTEL)	1. Foundations of R Software 2. Social Networks 3. Introduction to Industry 4.0 And Industrial Internet of Things 4. Any Other Course	0	0	0	3
8	23AI&ML6351	PC Lab-1	Business Intelligence& Data Visualization Lab	0	0	3	1.5
7	23AI&ML6352	PC Lab-2	Big Data Analytics Lab	0	0	3	1.5
9	23TP6107	SS - 4	Quantitative Aptitude	0	0	2	1
10	23MC6108	AC	Humanities Elective Foreign Languages (German) Biology For Engineers Human Rights And Legislative Procedures Indian Constitution Psychology	2	0	0	0
			Total	20	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&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
3	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
4	20AI&ML7205	OE III	Object Oriented Programming Through Java	3	0	0	3
5	20AI&ML7206	OE IV	A. Computer Networks B. Software Engineering C. IOT Based Smart Systems	3	0	0	3
6		PC -Lab	Generative AI Lab	0	0	0	3
7		SEC	Prompt Engineering / SWAYAM Plus - Certificate program in Prompt Engineering and ChatGPT Skills	1	0	2	2
8		AC	Constitution of India	2	0	0	-
9		Internship	Evaluation of Industry Internship	-	-	-	2
			Total	18	0	2	22
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

						Contact Hours	24
S. No.	Course Code	Course Category	Course Name	L	T	P	C
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

1. To obtain a Minor in Engineering, a student must earn 18 credits by successfully completing any of the following courses in the concerned stream.
2. During Minor/Honors course selection, there should not be any overlap with Regular/Major/Open Electives.

For Minor in CSE(AIML):	**L-T-P-C**
1. Database Management Systems	3-0-3-4.5 (II-II)
2. Operating Systems	3-0-0-3 (III-I)
3. Data Visualization	3-0-3-4.5 (III-II)
4. Generative AI	3-0-0-3 (IV-I)

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, 2^{nd} Edition, 2007.
2. Kevin Night and Elaine Rich, Nair B, Artificial Intelligence (SIE), Mc Graw Hill, 3^{rd} Edition, 2010.

REFERENCE BOOKS

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

Course Category	Basic Sciences	Credits	3
Course Type	Theory	L-T-P	2-1-0
Prerequisites	–	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	
2			3												2	
3						2									3	
4								3				2			3	

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 require ments 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– Har mony 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 mu tual happiness; Trust and Respect as the foundational values of relationship, Under standing the meaning of Trust; Difference between intention and competence, Under standing 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 comprehen sive 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 scenar ios. Elicit examples from students' lives).

UNIT IV

Understanding Harmony in Nature & Existence– Whole ex istence as Coexistence:

Part-1Understanding the harmony in the Nature, Inter-connectedness and mu tual 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 con duct, Basis for humanistic education, humanistic constitution and humanistic uni versal 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 enrich ing institutions and organizations. (Part-1:Practice sessions are to be included to discuss human being as cause of im balance 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. Human values and professional ethics, R. R. Gaur, R. Sangal and G. P. Bagaria, Excel Books Private Limited, New Delhi (2010).

REFERENCE BOOKS

1. JeevanVidya: EkParichaya, A. Nagaraj, JeevanVidya Prakashan, Amarkantak (1999).
2. Human Values, A. N. Tripathi, New Age International Publishers, New Delhi (2004).
3. The Story of Stuff: The impact of overconsumption on the planet, our com munities, and our health and how we can make it better, Annie Leonard, Free Press, New York (2010).
4. The story of my experiments with truth: Mahatma Gandhi Autobiography, Mohandas Karamchand Gandhi, B. N. Publishing (2008).
5. Small is beautiful: A study of economics as if people mattered, E. F. Schu macher, Vintage Books, London (1993).
6. Slow is beautiful: New Visions of Community, Cecile Andrews, New Society Publishers, Canada (2006).
7. Economy of Permanence, J. C. Kumarappa, Sarva-Seva-Sangh Prakashan, Varanasi (2017).
8. Bharat Mein Angreji Raj, Pandit Sunderlal, Prabhath Prakashan, Delhi (2018).
9. Rediscovering India, Dharampal, Society for Integrated Development of Himi layas (2003).
10. Hind Swaraj or Indian Home Rule, M. K. Gandhi, Navajivan Publishing House,Ahmedabad (1909).
11. India Wins Freedom: The Complete Version, Maulana Abul Kalam Azad, Ori ent Blackswan (1988).

12. The Life of Vivekananda and the Universal gospel, Romain Rolland, Advaitha Ashrama, India (2010).
13. Mahatma Gandhi: The Man who become one with the Universal Being, Romain Rolland, Srishti Publishers & Distributors, New Delhi (2002).

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. AICTE– SIP Youtube Channel: https://www.youtube.com/channel/ UCo8MpJB aaVwB4LWLAx6AhQ , Last Accessed On: 28/05/2025.
2. AICTE– UHV Teaching Learning Material: https://fdp-si.aicte-india.org/download.php1 , Last Accessed On: 27/07/2025.

23ES3103B
DISCRETE MATHEMATICS

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

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, 2^{nd} Edition, 2014. (Unit I)
2. Ellis Horowitz, Satraj Sahni and Rajasekharan, Fundamentals of Computer Algorithms, Galgotia Publications Pvt. Ltd, 2^{nd} Edition, 2008. (Unit II, III, and IV).

REFERENCE BOOKS

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

2^{nd} 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 Semester End Eval Total Marks	30 70 100

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, 11^{th} 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, 4^{th} Edition, 2020.
3. Paul J. Dietel and Dr.Harvey M. Deitel, "Java How to Program", Deitel & Associates, 11^{th} 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, 2^{nd} 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 Semester End Eval Total Marks	100 0 100

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 Semester End Eval Total Marks	30 70 100

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, 2^{nd} Edition, 2014.
2. Ellis Horowitz, Satraj Sahni and Rajasekharan, Fundamentals of Computer Algorithms, Galgotia Publications Pvt. Ltd, 2^{nd} Edition, 2008.

REFERENCE BOOKS

1. Horowitz Sahni and Anderson-Freed, Fundamentals of Data Structures in C, Universities Press, 2^{nd} Edition, 2008.
2. Richard F.Gilberg & B.A.Forouzan, Data Structures A Pseudo code Approach with C, Cengage Learning, 2^{nd} Edition, 2007.
3. M.T.Goodrich and R.Tomassia, Algorithm Design: Foundations, Analysis and Internet examples, John Wiley and sons, 2^{nd} Edition, 2006.
4. T.H.Cormen, C.E.Leiserson, R.L.Rivest and C.Stein, Introduction to Algorithms, Mit Press, 3^{rd} Edition, 2009.
5. Allen Weiss, Data structures and Algorithm Analysis in C, Pearson Education, 2^{nd} 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&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 Semester End Eval Total Marks	30 70 100

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, 11^{th} 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, 4^{th} Edition, 2020.
3. Paul J. Dietel and Dr.Harvey M. Deitel, "Java How to Program", Deitel & Associates Inc.l, 11^{th} 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, 2^{nd} 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 Semester End Eval Total Marks	30 70 100

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 Semester End Eval Total Marks	30 70 100

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 Semester End Eval Total Marks	30 70 100

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, 3^{rd} 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, 3^{rd} Edition. (For Chapters 2, 3, 4)
2. Silberschatz, Korth, Sudarsan, TMH, Database System Concepts, 5^{th} Edition, (For Chapter 1 and Chapter 5)

REFERENCE BOOKS

1. C J Date, Introduction to Database Systems, Pearson, 8^{th} Edition, Ltd,.
2. Ramez Elmasri, Shamkant ,B. Navathe, Database Management System, Mc Graw Hill, Pearson, 6^{th} 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 Semester End Eval Total Marks	30 70 100

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

REFERENCE BOOKS

1. David A. Paterson, John L. Hennessy, Computer Organization and Design, Elsevier.
2. Thomson, Fundamentals of Logic Design, 6^{th} Edition.
3. William Stallings, Computer Organization and Architecture, Pearson, 11^{th} 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 Semester End Eval Total Marks	30 70 100

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 Semester End Eval Total Marks	30 70 100

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.

23AI&ML4651
FULL STACK DEVELOPMENT-I

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

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 'ARMSTRONG 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, 7^{th} 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, 7^{th}, 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 Semester End Eval Total Marks	30 70 100

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=ldYzbV0NDp8,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 Semester End Eval Total Marks	30 70 100

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 L2L_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, 2^{nd} 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, NOTEXISTS, 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 SAVEPOINT 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 COALESCE 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 UPDATE CURSOR, WHERE CURRENT of clause and CURSOR variables.

Task 13: Develop Programs using BEFORE and AFTER Triggers, Row and Statement 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, 4^{th} Edition, 2007.

REFERENCE BOOKS

1. Gordon S Linoff, Data Analysis Using SQL and Excel, Wiley, 2^{nd} 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 Semester End Eval Total Marks	30 70 100

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 Semester End Eval Total Marks	30 70 100

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 Semester End Eval Total Marks	30 70 100

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, 10^{th} Edition, 2018.
2. Tanenbaum A S, Modern Operating Systems, Galgotia Publications Pvt. Ltd, 4^{th} Edition, 2016.

REFERENCE BOOKS

1. Stallings W, Operating Systems -Internals and Design Principles, Pearson, 9^{th} Edition, 2018.
2. D.M Dhamdhere, Operating Systems: A Concept Based Approach, McGraw- Hill, 3^{rd} 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 Semester End Eval Total Marks	30 70 100

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 Semester End Eval Total Marks	30 70 100

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 to Natural Language Processing and Word-Level Analysis: Origins and challenges of NLP, Regular Expressions, Word and Subword Tokenization, Word Normalization, Lemmatization and Stemming, Sentence Segmentation, Minimum Edit Distance, Finite- State Automata, N-grams, Evaluating Language Models, Sampling, Generalization Vs Overfitting the training dataset, Smoothing, Interpolation and Backoff.

UNIT II

Context-Free Grammars and Syntactic Analysis: Constituency in Syntax,

Context Free Grammars, Parse trees and Treebanks, Grammar Equivalence and Normal Forms, Conversion of CFGs to CNF (concept only, no algorithm derivation), Syntactic Ambiguity, CKY Parsing Algorithm Using Dynamic Programming, Evaluating Parsers (Precision, Recall, F1 – basic idea), shallow parsing, Head-finding rules and their role in converting phrase structure to dependency trees.

UNIT III

Semantics and Pragmatics: Need for meaning representation.
First-Order Logic: Basics, Variables and Quantifiers, Lamda Notation, Inference. Syntax-Driven Semantic analysis, Semantic attachments.
Introduction to Word Meaning and Senses: Word Senses, Relations between Senses, Thematic Roles, Selectional restrictions.
Word Sense Disambiguation (WSD): Basics of WSD using Supervised, Dictionary & Thesaurus, Bootstrapping methods, Word Similarity using Thesaurus and Distributional methods.

UNIT IV

Discourse Analysis and Lexical Analysis: Discourse segmentation, Centering theory and Coherence, Reference Phenomena, Anaphora Resolution using Hobbs and Centering Algorithm, Coreference Resolution, NLP tools and Resources: Porter Stemmer, Lemmatizer, Penn Treebank, Brill's Tagger, WordNet, PropBank, FrameNet, Brown Corpus, British NationalCorpus(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/106/105/106105158/, 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 Semester End Eval Total Marks	30 70 100

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 Semester End Eval Total Marks	30 70 100

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 Semester End Eval Total Marks	30 70 100

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" 8^{th} Edition, McGraw-Hill Publication 2019.

REFERENCE BOOKS

1. Ian Somerville, Software Engineering, 9^{th} 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_engineering/index.htm, Last Accessed on: 12/04/2025.
2. Prof. Rajib Mall, IIT Kharagpur, Software Engineering, https://archive.nptel.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 Semester End Eval Total Marks	30 70 100

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 Semester End Eval Total Marks	30 70 100

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), 1^{st} Edition, Universities Press Private Limited, 2014.
2. Raj Kamal, Internet of Things, Architecture and Design Principles, 1^{st} 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, 1^{st} 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 Semester End Eval Total Marks	30 70 100

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 Semester End Eval Total Marks	30 70 100

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, 10^{th} Edition, 2018.
2. Tanenbaum A S, Modern Operating Systems, Galgotia Publications Pvt. Ltd, 4^{th} Edition, 2016.
3. Stallings W, Operating Systems -Internals and Design Principles, Pearson, 9^{th} Edition, 2018.
4. D.M Dhamdhere, Operating Systems: A Concept Based Approach, McGraw- Hill, 3^{rd} 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.

23AI&ML5653
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 Semester End Eval Total Marks	30 70 100

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.

23AI&ML5554
ENGINEERING PROJECT FOR COMMUNITY SERVICES

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

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.

23HS5155
ADVANCED COMMUNICATION SKILLS LAB

Course Category	HSS	Credits	1
Course Type	Laboratory	L-T-P	0-0-2
Prerequisites	20TP4106 English for Professionals	Continuous Eval Semester End Eval Total Marks	30 70 100

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.

23ES5156
USER INTERFACE DESIGN USING FLUTTER

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

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.

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 Semester End Eval Total Marks	100 0 100

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.

23MC5107A
TECHNICAL PAPER WRITING AND IPR

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

COURSE OUTCOMES

1. Understand the basics of writing technical reports, technical sentence formation, using transitions, and appropriate tenses for technical writing.
2. Understand the use of drafts, illustrations, grammar, spelling, readability, and writing in plain English for effective technical documentation.
3. Apply the use of word processor tools such as Table of Contents, citations, footnotes, comments, macros, and document protection.
4. Understand the nature of Intellectual Property and explain the process of patenting and international cooperation on Intellectual Property.

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		3	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

Introduction: An introduction to writing technical reports, technical sentences formation, using transitions to join sentences, Using tenses for technical writing.
Planning and Structuring: Planning the report, identifying reader(s), Voice, Formatting and structuring the report, Sections of a technical report, Minutes of meeting writing.

UNIT II

Drafting report and design issues: The use of drafts, Illustrations and graphics.
Final edits: Grammar, spelling, readability and writing in plain English: Writing in plain English, Jargon and final layout issues, Spelling, punctuation and Grammar, Padding, Paragraphs, Ambiguity.
Proofreading and summaries: Proofreading, summaries, Activities on summaries.
Presenting final reports: Printed presentation, Verbal presentation skills, Introduction to proposals and practice.

UNIT III

Using word processor: Adding a Table of Contents, Updating the Table of Contents, Deleting the Table of Contents, Adding an Index, Creating an Outline, Adding Comments, Tracking Changes, Viewing Changes, Additions, and Comments, Accepting and Rejecting Changes , Working with Footnotes and Endnotes, Inserting citations and Bibliography, Comparing Documents, Combining Documents, Mark documents final and make them read only., Password protect Microsoft Word documents., Using Macros.

UNIT IV

Nature of Intellectual Property: Patents, Designs, Trade and Copyright.
Process of Patenting and Development: Technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property.

TEXT BOOKS

1. Kompal Bansal & Parshit Bansal, "Fundamentals of IPR for Beginner's", 1st Ed., BS Publications, 2016.
2. William S. Pfeiffer and Kaye A. Adkins, "Technical Communication: A Practical Approach", Pearson.
3. Ramappa,T., "Intellectual Property Rights Under WTO", 2nd Ed., S Chand, 2015.

REFERENCE BOOKS

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

2. Day R, How to Write and Publish a Scientific Paper, Cambridge University Press, 2006.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Tony Buon — a psychologist, university lecturer, https://www.udemy.com/course/reportwriting/, Last Accessed on: 02/05/2025.
2. https://www.udemy.com/course/professional-business-english-and-technical-report-writing/, Last Accessed on: 02/05/2025.
3. Mark Morris — professional speechwriter, https://www.udemy.com/course/betterbusinesswriting/, Last Accessed on: 02/05/2025.

SEMESTER VI

23AI&ML6301
Business Intelligence and Data Visualization

Course Category	Program Core	Credits	3
Course Type	Theory	L-T-P	3-0-0
Prerequisites	23AI&ML4304: Database Management Systems	Continuous Eval Semester End Eval Total Marks	30 70 100

COURSE OUTCOMES

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

1. Understand the need and value of business intelligence.
2. Understand business intelligence environment and models.
3. Apply data visualization anatomy for data representation and presentation.
4. Analyze the data visualization methods.

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	1.5.1, 1.6.1
2	2	2												2	2	1.6.1, 1.7.1, 2.6.1, 2.6.2, 2.6.3
3	2	3	2		2									2	3	1.6.1, 1.7.1, 2.6.1, 2.6.2, 2.6.3, 2.7.1, 3.5.1, 3.6.1, 5.4.1, 5.4.2
4	2	3	3		2									2	4	1.6.1, 1.7.1, 2.6.1, 2.6.3, 2.6.4, 2.6.5, 2.7.1, 3.5.1, 3.6.1, 3.6.2, 5.4.1, 5.4.2

COURSE CONTENT

UNIT I

Business Intelligence and Information Exploitation: Introduction to Business Intelligence, The Information Asset, Exploiting Information, Business Intelligence and Program Success, Actionable Knowledge.

The Value of Business Intelligence: The Information Asset and Data Valuation, Actionable Knowledge-Return on Investment, Business Intelligence Applications, The Intelligence Dashboard Business Intelligence Adds Value.

UNIT II

The Business Intelligence Environment: The Business Case, The Business Intelligence Process, System Infrastructure, Information Access, Delivery, and Analysis, Services. ***Business Models and Information Flow:*** Information Processing and Information Flow, The Information Flow Model, Usage in Practice, Modeling Frameworks.

UNIT III

The Context of Data Visualization: Visualization as a discovery tool, the bedrock of visualization knowledge, Defining data visualization, Visualization skills for the masses, The data visualization methodology. ***Conceiving and Reasoning Visualization Design Options:***Data visualization design is all about choices, The visualization anatomy – data representation, The visualization anatomy – data presentation.

UNIT IV

Taxonomy of Data Visualization Methods:Data visualization methods, Choosing the appropriate chart type, Comparing categories, Dot plot ,Bar chart, Floating bar, Pixelated bar chart, Histogram, Slope Graph, Radial chart, Glyph chart, Assessing hierarchies and part-to-whole relationships, Pie chart, Stacked bar chart, Square pie, Tree map, Circle packing diagram, Bubble hierarchy, Tree hierarchy, Showing changes over time, Line chart, Sparklines, Area chart, Plotting Connections and Relationships, Scatter plot, Bubble plot, Heat map, Case studies- Coca-Cola: shaping the essence of analytics, LinkedIn: empowering of the sales team.

TEXTBOOKS

1. Loshin, David. Business intelligence: the savvy manager's guide, 2 nd Edition, Newnes, 2012. [UNIT-I, II]
2. Kirk, Andy. Data Visualization: a successful design process, Packt publishing LTD, 2023. [UNIT-III, IV]

REFERENCE BOOKS

1. Hans-Georg Kemper, Walid Mehanna, and Carsten Unger, Business Intelligence: Grundlagen und praktische Anwendungen, 3rd Edition, Vieweg+Teubner, Wiesbaden, 2010.
2. Larissa T. Moss and Shaku Atre, Business Intelligence Roadmap: The Complete Project Lifecycle for Decision-Support Applications, 1st Edition,Addison-Wesley Professional, 2003.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Mathew, S. K. (2023, December 1). Business Intelligence amp; Analytics [Video]. NPTEL. from https://nptel.ac.in/courses/106106361, Last Accessed on: 30/10/2025.
2. Kopare, A. A. (2025, July 9). Business Intelligence with PowerBI: From Data to Strategic Decisions - Course [Video]. Swayam, from https://onlinecourses.swayam2.ac.in/imb25_mg221/preview, Last Accessed on: 30/10/2025.
3. Karimi, J. (2016, November 21). Business Intelligence Concepts, Tools, and Applications [Video]. Coursera. from https://www.coursera.org/learn/business-intelligence-tools Last Accessed on: 30/10/2025.
4. Wilson, A., Acharya, G., Whitney, H., Brar, S. S., & Chen, P. (n.d.). Data Visualization with Tableau [Video]. Coursera. from https://www.coursera.org/specializations/data-visualization Last Accessed on: 30/10/2025.

23AI&ML6302
BIG DATA ANALYTICS

Course Category	Program Core	Credits	3
Course Type	Theory	L-T-P	3-0-3
Prerequisites	23AI&ML3305: Object Oriented Programming Through Java	Continuous Evaluation Semester End Evaluation Total Marks	30 70 100

COURSE OUTCOMES

1. Understand the concepts of Big Data Analytics and Hadoop components used for managing big data.
2. Apply Hadoop MapReduce programs to perform distributed data processing.
3. Apply Pig and Hive tools to process, manage, and analyze structured and unstructured data in Hadoop.
4. Apply Spark and Sqoop concepts to handle and analyze large-scale data in Hadoop.

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										3	2	2	1.7.1, 2.5.2, 3.5.1
2	1	3	2										3	3	3	1.6.1, 2.6.1, 3.8.2
3		1	2	3									3	3	3	2.8.2, 3.7.1, 4.6.1
4		2	1		3								3	3	3	2.8.1, 3.8.3, 5.5.2

COURSE CONTENT

UNIT I

Introduction to Big Data Analytics: Big Data Overview – Data Structures, Analyst perspective on Data Repositories, State of the Practice in Analytics – BI versus Data Science, Current analytical architecture, Drivers of big data, Emerging big data ecosystem and a new approach to analytics, Key Roles for the New Big Data Ecosystem, Examples of Big Data Analytics.

Hadoop Distributed File System: The Design of HDFS, HDFS concepts, Command-Line Interface, Hadoop Filesystems, The Java Interface, Data Flow.

UNIT II

MapReduce: Anatomy of a MapReduce Job Run – Mapper, Reducer, Combiner, Partitioner, Failures, Shuffle and Sort. MapReduce Features: Counters – Built-in

counters, User defined counters; Sorting – Partial sort, Total sort, Secondary sort; Joins – Map-Side joins, Reduce-Side joins.

UNIT III

Pig: Installation and Running of Pig, Execution Types, Running Pig Programs, Comparison with databases, Pig Latin – Structure, Statements, Expressions, Types, Schemas, Functions, Macros, Data processing operators.
Hive: Hive services, The Meta-store, HiveQL – Data types, Operators and Functions, Tables – Managed tables and External tables, Partitions and Buckets, Storage Formats, Querying Data – Sorting and Aggregating.

UNIT IV

Spark: Introduction to Spark Concept, Spark installation, Spark Applications, Jobs Stages and Tasks Spark RDD (Resilient Distributed Dataset) , Creation, Transformations and Actions, Persistence, Serialization, Anatomy of Spark Job Run, Job Submission, DAG construction, Task Scheduling, Task Execution.
Sqoop: Sqoop Connectors-Text and Binary File Formats, Sqoop Import Process - Incremental imports, Direct Mode Imports, Imporitng large objects, Export using MapReduce.

TEXT BOOKS

1. *Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data*, EMC Education Services, John Wiley & Sons, Inc., 2015.

2. White, T. (2012). *Hadoop: The Definitive Guide*. O'Reilly Media, Inc.

REFERENCE BOOKS

1. *Hadoop in Action* by Chuck Lam, MANNING Publ.
2. *Hadoop for Dummies* by Dirk de Roos, Paul C. Zikopoulos, Roman B. Melnyk, Bruce Brown, Rafael Coss.
3. *Hadoop in Practice* by Alex Holmes, MANNING Publ.
4. *Big Data Analytics* by Dr. A. Krishna Mohan and Dr. E. Laxmi Lydia.
5. *Hadoop MapReduce Cookbook* by Srinath Perera and Thilina Gunarathne.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Prof. A Ramesh, IIT Roorkee, Data Analytics with Python, https://nptel.ac.in/courses/106107220, Last Accessed on: 29/10/2025.
2. Prof. Nandan Sudarsanam, and Prof. Balaraman Ravindran, IIT Madras, Introduction to Data Analytics https://nptel.ac.in/courses/110106072, Last Accessed on: 29/10/2025.

3. Prof. Dr. Mohit Bhatnagar, O.P. Jindal Global University, Big Data Analytics https://www.coursera.org/learn/big-data-analytics-1, Last Accessed on: 29/10/2025.
4. Prof. Gerald Balekaki and Ming-Long Lam, Illinois Tech, Data Analytics and Big Data Specialization, https://www.coursera.org/specializations/data-analytics-and-big-data, Last Accessed on: 29/10/2025.

23AI&ML6303
REINFORCEMENT LEARNING

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

COURSE OUTCOMES

1. Understand RL fundamentals and agent–environment framework interprets tasks.
2. Apply action-value methods to solve n-armed bandits to analyze stationary vs. non-stationary behavior.
3. Apply Model problems as finite MDPs to compute value functions and analyze optimality for episodic and continuing tasks.
4. Analyze classic RL case studies using Monte Carlo prediction and control (on/off-policy with importance sampling).

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, 3.7.1
3	2	2	3										1	2	3	1.7.1,2.5.2,2.8.3, 2.8.4, 3.7.1
4	2	2	3										1	1	4	2.6.3, 2.6.4, 2.8.4, 3.7.1

COURSE CONTENT

UNIT I

The Reinforcement Learning Problem: Reinforcement Learning: Introduction and Motivation, Real-world Examples of Reinforcement Learning, Elements of Reinforcement Learning, Limitations and Scope of RL, Extended Example: Tic-Tac-Toe, Summary of the RL Framework, History of Reinforcement Learning.

UNIT II

Multi-Armed Bandits: The n-Armed Bandit Problem, Action-Value Methods, Incremental Implementation, Tracking a Non-stationary Problem, Optimistic Initial Values, Upper-Confidence-Bound (UCB) Action Selection, Gradient Bandits, Asso-

ciative Search (Contextual Bandits)

UNIT III

Finite Markov Decision Processes (MDPs): The Agent–Environment Interface, Goals and Rewards, Returns, Unified Notation for Episodic and Continuing Tasks, The Markov Property, Definition of Markov Decision Processes, Value Functions, Optimal Value Functions, Optimality and Approximation.

UNIT IV

Monte Carlo Methods: Monte Carlo Prediction, Monte Carlo Estimation of Action Values, Monte Carlo Control, Monte Carlo Control without Exploring Starts, Off-Policy Prediction via Importance Sampling, Incremental Implementation, Off-Policy Monte Carlo Control, Importance Sampling on Truncated Returns.
Applications and Case Studies: TD-Gammon, Samuel's Checkers Player, The Acrobot, Elevator Dispatching, Dynamic Channel Allocation, Job-Shop Scheduling

TEXTBOOKS

1. Richard S. Sutton and Andrew G. Barto, "Reinforcement Learning-An Introduction", 2ndEdition, The MIT Press, 2018
2. Marco Wiering, Martijn van Otterlo Reinforcement Learning: State-of-the-Art (Adaptation, Learning, and Optimization (12)) 2012th Edition

REFERENCE BOOKS

1. Vincent François-Lavet, Peter Henderson,Riashat Islam - An Introduction to Deep Reinforcement Learning (Foundations and Trends(r) in Machine Learning) , 2019.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Prof. Balaraman Ravindran, IIT Madras – NPTEL Course on Reinforcement Learning, https://nptel.ac.in/courses/106106143, Last Accessed on 30/10/2025.
2. Balaraman Ravindran, IIT Madras – Lecture Notes on Reinforcement Learning, https://dsai.iitm.ac.in/~ravi/nptel-courses/reinforcement-learning/, Last Accessed on: 30/10/2025.
3. Aritra Hazra, IITKGP – Reinforcement Learning, https://cse.iitkgp.ac.in/~aritrah/course/theory/RL/Autumn2022/, Last Accessed on: 30/10/2025.

23AI&ML6404A
CRYPTOGRAPHY & NETWORK SECURITY

Course Category	PE II	Credits	3
Course Type	Theory	L-T-P	3-0-0
Prerequisites	23AI&ML5302 Computer Networks	Continuous Eval Semester End Eval Total Marks	30 70 100

COURSE OUTCOMES

1. Understand core principles and mathematical foundations of cryptography.
2. Apply symmetric encryption techniques for secure data communication.
3. Apply asymmetric encryption techniques with key management and authentication mechanisms for secure data communication.
4. Apply security mechanisms across network layers and implement basic system protection 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	1												1	2	1.2.1, 1.7.1, 2.5.2
2	2	3	3										2	2	3	1.2.1, 1.7.1, 2.5.1, 2.5.2, 2.5.3, 2.6.4, 3.5.1, 3.6.1
3	2	3	3										2	2	3	1.2.1, 1.7.1, 2.5.1, 2.5.2, 2.5.3, 2.6.4, 2.8.3, 3.5.1, 3.6.1
4	2	3	2										2	2	3	1.2.2, 1.7.1, 2.5.2, 2.6.1, 2.6.5, 2.8.3, 3.6.1

COURSE CONTENT

UNIT I

Basic Principles: Security Goals, Cryptographic Attacks, Services and Mechanisms, Mathematics of Cryptography- integer arithmetic, modular arithmetic, matrices, linear congruence, Mathematics of Symmetric Key Cryptography-algebraic structures, GF(2n) Fields, Introduction to Modern Symmetric Key Ciphers-modern block ciphers, modern stream ciphers, Introduction to Post Quantum Cryptography.

UNIT II

Symmetric Encryption Algorithms: Data Encryption Standard- DES structure, DES analysis, Security of DES, Multiple DES, Advanced Encryption Standard transformations, key expansions, AES ciphers, Analysis of AES, RC4.
Asymmetric Encryption Algorithms: Mathematics of Asymmetric Key Cryptography co-primes, primality testing, factorization, Asymmetric Key Cryptography, Chinese Reminder Theorm, RSA crypto system, Elliptic Curve Cryptography.

UNIT III

Message Integrity and Hash Functions: Message Integrity and Message Authentication code, Random Oracle model, Message authentication, Cryptographic Hash Functions-whirlpool, MD5, SHA-512.
Digital Signature & Key Management Protocols: Digital Signature Process, services, attacks, schemes, applications, Key Management-symmetric key distribution.

UNIT IV

Network Security-I: Security at application layer: PGP and S/MIME, Security at the Transport Layer: SSL and TLS.
Network Security-II: Security at the Network Layer: IPSec, security association, IKE, ISAKMP, System Security - Users, Trust, Trusted systems, Buffer Overflow, Malicious Software, Worms, Viruses, IDS, Firewalls.

TEXTBOOKS

1. William Stallings, Cryptography and Network Security, 7th Edition, Pearson, 2020.
2. Behrouz A. Forouzan, Debdeep Mukhopadhyay, Cryptography and Network Security, 3rd Edition, McGraw Hill, 2015.

REFERENCE BOOKS

1. Bernard Menezes, Network Security and Cryptography, 1st Edition, Cengage Learning, 2018.
2. Keith M. Martin, Everyday Cryptography, 1st Edition, Oxford University Press, 2016.
3. E. Harlow, Post-Quantum Cryptography: Securing the Future of Digital Security, 1st Edition, Everett Harlow Publishing, 2025.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Prof. Sourav Mukhopadhyay, IIT Kharagpur, NPTEL Course on Cryptography and Network Security, https://onlinecourses.nptel.ac.in/noc22_cs90/preview , Last Accessed On: 18/10/2025.
2. Dr. Manish Kumar, Coursera, Encryption and Cryptography Essentials, https:

//www.coursera.org/learn/encryption-and-cryptography-essentials , Last Accessed On: 18/10/2025.

23AI&ML6404B
RECOMMENDER SYSTEMS

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

COURSE OUTCOMES

1. Understand the mathematical foundations, applications, and challenges of Recommender systems.
2. Apply collaborative filtering techniques to generate recommendations.
3. Apply content-based and knowledge-based recommendation techniques to build item profiles and generate personalized recommendations.
4. Apply Hybrid recommendation techniques to build improved recommendation 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	3	3	3	2									1	1	2	1.7.1, 2.8.4, 3.5.3, 4.1.1
2	2	3	2										1	1	3	1.7.1, 2.8.4, 3.5.3
3	2	3	2										1	1	3	1.7.1, 2.8.4, 3.5.3
4	2	3	2										3	3	3	1.7.7, 2.8.4, 3.5.3

COURSE CONTENT

UNIT I

Introduction: Recommender system functions, Linear Algebra notation: Matrix addition, Multiplication, transposition, and inverses; covariance matrices, Understanding ratings, Applications of recommendation systems, Issues with recommender system.

UNIT II

Collaborative Filtering: User-based nearest neighbour recommendation, Item-based nearest neighbour recommendation, Model based and pre-processing based approaches, Attacks on collaborative recommender systems.

UNIT III

Content-based recommendation: High level architecture of content-based systems, Advantages and drawbacks of content-based filtering, Item profiles, discovering features of documents, obtaining item features from tags, representing item profiles, Methods for learning user profiles, Similarity based retrieval, Classification algorithms.
Knowledge based recommendation: Knowledge representation and reasoning, Constraint based recommenders, Case based recommenders.

UNIT IV

Hybrid approaches: Opportunities for hybridization, Monolithic hybridization design: Feature combination, Feature augmentation, Parallelized hybridization design: Weighted, Switching, Mixed, Pipelined hybridization design: Cascade Meta-level, Limitations of hybridization strategies.

TEXTBOOKS

1. Jannach D., Zanker M. and FelFering A., Recommender Systems: An Introduction, Cambridge, 1 st edition 2010

REFERENCE BOOKS

1. Ricci F., Rokach L., Shapira D., Kantor B.P., Recommender Systems Handbook, 1 st editon, Springer(2011), 1st ed.
2. Manouselis N., Drachsler H., Verbert K., Duval E., Recommender Systems For Learning, 1 st editon, Springer Wiley.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Prof. Mamata Jenamani, Recommender Systems, IIT Kharagpur, NPTEL https://nptel.ac.in/courses/127105390 **Last accessed on: 06-11-2025**

23AI&ML6404C
Object-Oriented Analysis and Design

Course Category	PE II	Credits	3
Course Type	Theory	L-T-P	3-0-0
Prerequisites	23AI&ML5404E Software Engineering	Continuous Eval Semester End Eval Total Marks	30 70 100

COURSE OUTCOMES

1. Understand fundamental concepts, principles, and architecture of Unified Modeling Language.
2. Apply UML modeling techniques to develop structural diagrams such as Class, Object, Package, Component, and Deployment diagrams for real-time systems.
3. Apply behavioral and interaction diagrams including Use Case, Activity, State Machine, Sequence, and Communication diagrams.
4. Apply concepts of advanced diagrams such as Interaction Overview, Timing, and Composite Structure diagrams to model complex system behaviors.

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	2	2	3										2		3	1.7.1, 2.5.1, 3.5.2, 3.5.6
3	2	2	3										2		3	1.7.1, 2.5.1, 3.5.2, 3.5.6
4	1	2	3										2		4	1.7.1, 2.5.1, 3.5.2, 3.5.6

COURSE CONTENT

UNIT I

What is UML: What is UML, birth of UML, MDA, meaning of 'unified', objects and UML, UML structure, UML building blocks, UML common mechanisms, architecture. Unified Process: Concept of UP, birth of UP, Rational Unified Process, instantiating UP, UP axioms, structure, and phases. Requirements: Requirements workflow, software requirements metamodel, workflow details, defining and finding requirements, importance of requirements.

Use Case Modeling: Use case modelling concepts, UP activities, finding actors and use cases, detailing use cases, use case specification, requirements tracing, when to apply use case modeling. Advanced Use Case Modeling: Actor generalization, use case generalization, hints and guidelines for writing use cases. Analysis: Analysis

workflow, analysis artifacts metamodel, analysis workflow details, rules of thumb. Objects and Classes: Objects and UML object notation, classes and UML class notation, scope, object construction and destruction.

UNIT II

Finding Analysis Classes: Identifying analysis classes, analysing use cases, creating a first-cut analysis model. Relationships: Links, associations, dependencies. Inheritance and Polymorphism: Generalization, class inheritance, polymorphism, advanced generalization concepts. Analysis Packages: Package concepts and structuring analysis models.

Use Case Realization: Interactions, lifelines, messages, interaction diagrams, sequence diagrams, combined fragments, communication diagrams.

UNIT III

Activity Diagrams: Activity diagram concepts, semantics, partitions, action nodes, control nodes, object nodes, pins. Advanced Activity Diagrams: Connectors, interruptible regions, exception handling, expansion nodes, signals, events, streaming, multicast, multireceive, parameter sets, central buffer nodes, interaction overview diagrams.

Design Classes: Detailed discussion of design classes. Refining Analysis Relationships: Aggregation, composition, refining associations, one-to-one, many-to-one, one-to-many associations, collections, reified relationships, structured classes. Interfaces and Components: Interfaces, provided/required interfaces, interface realization vs inheritance, ports, components, stereotypes, subsystems, designing with interfaces, advantages and disadvantages. Use Case Realization in Design: Interaction diagrams in design, modeling concurrency.

UNIT IV

Use Case Realization – Design: Subsystem interactions, timing diagrams, example design realization.

State Machines: State machine concepts, diagrams, states, transitions, events, advanced state machine concepts – composite states, submachine states, communication, and history.

Implementation Workflow: Concepts of the implementation workflow.

Deployment: Deployment diagram concepts, nodes, artifacts, deployment structure.

TEXTBOOKS

1. Jim Arlow , Ila Neustadt , "UML 2 and the Unified Process", Practical Object-Oriented Analysis and Design, 2nd Edition 2005, Pearson Education.

REFERENCE BOOKS

1. Grady Booch, Robert A. Maksimchuk, Michael W. Engle, Bobbi J. Young, Jim

Conallen, Kellia Houston, "Object-Oriented Analysis and Design with Applications", 3rd edition, 2013, PEARSON.
2. Grady Booch, James Rumbaugh, Ivar Jacobson: "The Unified Modeling Language User Guide", Pearson Education.
3. Pascal Roques: "Modeling Software Systems Using UML2", 1st edition, 2004, WILEY-Dreamtech India Pvt. Ltd.
4. Atul Kahate: "Object-Oriented Analysis Design", 1st edition, 2004, The McGraw-Hill Companies.
5. Meilir Page-Jones: "Fundamentals of Object-Oriented Design in UML", Pearson Education.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Prof. Partha Pratim Das, Software system Complexities - Object-Oriented Analysis and Design, Module 1, Module 2, https://nptel.ac.in/courses/106105153 Last accessed on 16-10-2025
2. Prof. Samiran Chattopadhyay, Relationships Among Objects - Object Oriented Analysis and Design, Module 12 https://nptel.ac.in/courses/106105153 Last Accessed on 16-10-2025

23AI&ML6404D
SOCIAL NETWORK ANALYSIS

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

COURSE OUTCOMES

1. Understand the principles, structure, and evolution of the Semantic Web and Social Web.
2. Apply ontology-based frameworks for semantic representation and social network modeling.
3. Analyse algorithms and tools for community detection, data mining, and behavioural analysis in social networks.
4. Analyse privacy, trust, and visualization techniques to interpret and apply social network data effectively.

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	1.6.1, 2.5.2
2	1	2	3											2	3	1.6.1, 2.5.2, 3.6.1
3		2	3	3										2	4	2.5.2, 3.6.1, 4.4.3
4		2	3		2	2								2	4	2.5.2,3.6.1,5.4.1,6.3.1

COURSE CONTENT

UNIT I

Introduction: Limitations of the current Web – Evolution and development of the Semantic Web, Emergence of the Social Web and integration with the Semantic Web, Development and fundamentals of Social Network Analysis (SNA), Key concepts and measures in network analysis, Electronic sources for network analysis: Discussion networks, blogs, and online communities, Web-based networks and Applications of Social Network Analysis.

UNIT II

Modelling, Aggregating and Knowledge Representation: Role of Ontologies

in the Semantic Web, Ontology-based Knowledge Representation, Ontology languages for the Semantic Web: Resource Description Framework (RDF), Web Ontology Language (OWL), Modelling and aggregating social network data – State-of-the-art in network data representation, Ontological representation of social individuals and social relationships, Aggregating and reasoning with social network data – Advanced representations

UNIT III

Extraction and Minning Communities in Web Social Networks: Extraction of communities from Web archives and dynamic social networks, Definition and evaluation of communities, Methods and algorithms for community detection and mining, Applications of community mining algorithms, Tools for community detection— Social network infrastructures and decentralized online social networks, Multi-relational characterization of dynamic communities,
Predicting Human Behaviour: Predicting human behaviour in social communities—user data management, inference, and distribution, Reality mining and context awareness

UNIT IV

Privacy Issues: Privacy and trust in online social networks, Trust in online environments:, Trust models based on subjective logic, Trust network and transitivity analysis, Combining trust and reputation, Trust derivation and attack countermeasures,
Visualization and Applications of Social Networks:Visualization of social networks: Graph theory, centrality, clustering, Node-edge diagrams, matrix representations, hybrid visualizations, Applications of social network analysis and visualization: Cover networks, community welfare, collaboration networks, co-citation networks.

TEXTBOOKS

1. Peter Mika, —Social Networks and the Semantic Web, First Edition, Springer 2007.
2. Borko Furht, —Handbook of Social Network Technologies and Applications, 1st Edition, Springer, 2010.

REFERENCE BOOKS

1. R. Missaoui and I. Sarr, Social Network Analysis and Community Detection and Network Evolution, 1st Edition, Springer, Cham, Switzerland, 2014.
2. E. Segev, Semantic Network Analysis in Social Sciences, 1st Edition, Routledge, London, U.K., 2022.
3. G. Cota, M. Daquino, and G. L. Pazzato, Applications and Practices in Ontology Design, Extraction, and Reasoning, 1st Edition, IOS Press, Amsterdam, The

Netherlands, 2020.
4. J. Paliszkiewicz, K. Chen, and J. Gołuchowski, Privacy, Trust and Social Media, 1st Edition, Routledge, London, U.K., 2025.
5. M. Alfaqeeh and D. B. Skillicorn, Finding Communities in Social Networks Using Graph Embeddings, 1st Edition, Springer, Cham, Switzerland, 2024.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Peter Halfpenny and Rob Procter, "Innovations in Digital Research Methods", Sage Publishing.https://study.sagepub.com/node/25861/student-resources/chapter-2/links-to-online-sources Available: Last accessed on 18-10-2025.
2. Prof. Ian McCulloh, Social Network Analysis, Coursera. https://www.coursera.org/learn/social-network-analysis2, Available: Last accessed on 18-10-2025.

23AI&ML6405A
COMPUTER VISION

Course Category	PE III	Credits	3
Course Type	Theory	L-T-P	3-0-0
Prerequisites	23AI&DS3651:Python Programming lab	Continuous Eval Semester End Eval Total Marks	30 70 100

COURSE OUTCOMES

1. Understand image formation, radiometry, shading, and color representation in computer vision
2. Apply filtering, transforms, texture analysis, and feature extraction for image processing.
3. Apply multi-view geometry and segmentation methods for scene and object understanding.
4. Apply model fitting, tracking, and camera calibration techniques in vision 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	2											1	2	2	1.6.1, 1.7.1, 2.6.1, 2.6.2
2	2	3	2										1	2	3	1.6.1, 1.7.1, 2.6.1 2.6.2,3.5.1
3	2	3	3										1	2	3	1.2.1, 1.6.1, 2.5.3, 2.6.3 2.6.4, 3.5.1, 3.6.1
4	2	3	2										1	2	3	1.2.1, 1.6.1, 2.5.3, 2.6.3 2.6.4, 3.5.1, 3.6.1

COURSE CONTENT

UNIT I

Light, Shading, and Color Modeling: Pinhole Cameras, Light in Space, Light Surfaces, Important Special Cases, Qualitative Radiometry, Sources and Their Effects, Local Shading Models, Application: Photometric Stereo, Interreflections: Global Shading Models, The Physics of Color, Human Color Perception, Representing Color, A Model for Image Color, Surface Color from Image Color.

UNIT II

Linear Filters:Linear Filters and Convolution, Shift Invariant Linear Systems, Spatial and Frequency domain Transforms: DFT, DCT, DWT, Sampling and Aliasing, Representing Texture, Feature Extraction: Edges – Canny, LOG, Hough Transform, Corners – Orientation Histogram, SIFT, SURF, HOG, Scale-Space Analysis: Image Pyramids and Gabor filters.

UNIT III

Geometry of Multiple Views: Two Views, Stereopsis Reconstruction, Human Stereopsis, Binocular Fusion, Segmentation by Clustering: Segmentation, Grouping and Gestalt principles, Shot Boundary Detection and Background Subtraction, Image Segmentation by Clustering Pixels, Image Segmentation: Region Growing, Edge Based approaches to segmentation, Graph-cut, Mean shift, Texture Segmentation; object detection: Viola Jones Algorithm.

UNIT IV

Segmentation by Fitting a Model: Fitting Lines, Fitting Curves, EM Algorithm, Tracking with Linear Dynamic Models: Tracking as an Abstract Inference Problem, Linear Dynamic Models, Kalman Filtering, Data Association, Geometric Camera Models: Elements of Analytical Euclidean Geometry, Camera Parameters and the Perspective Projection, Affine Cameras and Affine Projection Equations, Geometric Camera Calibration: Least-Squares Parameter Estimation.

TEXTBOOKS

1. R. C. Gonzalez, R. E. Woods, Digital Image Processing, 3rd Edition, Addison-Wesley, 2008.
2. David A. Forsyth, Jean Ponce, Computer Vision: A Modern Approach, 1st Edition, PHI Learning (Indian Edition), 2009.

REFERENCE BOOKS

1. E. R. Davies, Computer and Machine Vision: Theory, Algorithms and Practicalities, 4th Edition, Elsevier (Academic Press), 2013.
2. Richard Szeliski, Computer Vision: Algorithms and Applications, 1st Edition, Springer-Verlag London Limited, 2011.
3. Richard Hartley, Andrew Zisserman, Multiple View Geometry in Computer Vision, 2nd Edition, Cambridge University Press, 2004.
4. K. Fukunaga, Introduction to Statistical Pattern Recognition, 2nd Edition, Academic Press / Morgan Kaufmann, 1990.
5. Richard Szeliski, Computer Vision: Algorithms and Applications, 1st Edition, Springer, 2011.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. P. K. Biswas, IIT Kharagpur, NPTEL Course: Digital Image Processing, https:

//nptel.ac.in/courses/117105135 , Last Accessed On: 13/10/2025.
2. Prof. Jayanta Mukhopadhyay, IIT Kharagpur, NPTEL Course: Computer Vision, https://nptel.ac.in/courses/106105216 , Last Accessed On: 12/09/2025.
3. Prof. Vineeth N. Balasubramanian, IIT Hyderabad, NPTEL Course: Deep Learning for Computer Vision, https://nptel.ac.in/courses/106106224 , Last Accessed On: 25/11/2025.

23AI&ML6405B
CLOUD COMPUTING

Course Category	PE III	Credits	3
Course Type	Theory	L-T-P	3-0-0
Prerequisites	23AI&ML5302 Computer Networks	Continuous Eval Semester End Eval Total Marks	30 70 100

COURSE OUTCOMES

1. Understand the fundamental cloud concepts, architecture, and service models.
2. Understand cloud-enabling technologies such as distributed computing, SOA.
3. Apply virtualization and container technologies to create scalable and secure cloud systems.
4. Apply advanced concepts in cloud computing to enable efficient automation and optimized cloud deployments.

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			3							1		2	2	1.7.1, 2.6.3, 5.4.1, 12.4.1
2	2	3	2	2	3							1	3	3	2	1.7.1,2.6.2, 3.5.1 5.4.1, 12.4.2
3	2	3			3							2		3	3	1.7.1,2.5.1,2.6.4 5.4.1,12.6.1
4	2	2	3	2	3							3	3	3	3	1.7.1,2.6.2,3.5.1 4.4.1,5.4.1,12.5. 1

COURSE CONTENT

UNIT I

Introduction to Cloud Computing Fundamentals: Cloud computing at a glance, defining a cloud, cloud computing reference model (IaaS, PaaS, SaaS), cloud deployment models (public, private, hybrid), utility Oriented computing, cloud computing characteristics and benefits, cloud service providers (Amazon Web Services, Microsoft Azure, Google AppEngine).

UNIT II

Cloud Enabling Technologies:Parallel and distributed computing, elements of parallel computing, hardware architectures for parallel computing (SISD, SIMD,

MISD, MIMD), elements of distributed computing, Components Of A Distributed System, technologies for distributed computing, remote procedure calls (RPC), service-oriented architecture (SOA), Web services.

UNIT III

Virtualization, Containers and Cloud computing challenges: Characteristics of virtualized environments, taxonomy of virtualization techniques, virtualization and cloud Computing, pros and cons of virtualization, technology examples (XEN, VMware), building blocks of containers, container platforms (LXC, Docker), container orchestration, Docker Swarm and Kubernetes, public cloud VM (e.g. Amazon EC2) and container (e.g. Amazon Elastic Container Service) offerings. Economics of the cloud, cloud interoperability and standards, scalability and fault tolerance, federated clouds.

UNIT IV

Advanced concepts in cloud computing: Cloud computing security, fundamentals of computer security, cloud security architecture, security in cloud deployment models. Serverless computing, Function-as-a-Service, serverless computing architecture, public cloud (e.g. AWS Lambda) and open-source (e.g. OpenFaaS) serverless platforms, Internet of Things (IoT), applications, cloud-centric IoT and layers, edge and fog computing, DevOps, infrastructure-as-code, quantum cloud computing.

TEXTBOOKS

1. Rajkumar Buyya, Christian Vecchiola, Thamarai Selvi, Shivananda Poojara, Satish N. Srirama, Mastering Cloud Computing, 2nd Edition, McGraw Hill, 2024.
2. Kai Hwang, Geoffrey C. Fox, Jack J. Dongarra, Distributed and Cloud Computing, 1st Edition, Elsevier, 2012.

REFERENCE BOOKS

1. Dan C. Marinescu, Cloud Computing: Theory and Practice, 2nd Edition, Elsevier, 2018.
2. K. Chandrasekharan, Essentials of Cloud Computing, 1st Edition, CRC Press, 2014.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Prof. Soumya Kanti Ghosh, NPTEL Course: Cloud Computing, https://onlinecourses.nptel.ac.in/noc21_cs14/preview , Last Accessed On: 18/10/2025.
2. AWS, AWS Documentation, https://docs.aws.amazon.com/ , Last Accessed On: 18/10/2025.
3. Google Cloud, Google Cloud Documentation, https://cloud.google.com/docs , Last Accessed On: 19/10/2025.
4. Stanford University, Technology Training: Introduction to Cloud Computing, https://uit.stanford.edu/service/techtraining/class/introduction-clo

ud-computing , Last Accessed On: 21/10/2025.

23AI&ML6405C
NoSQL DATABASES

Course Category	PE III	Credits	3
Course Type	Theory	L-T-P	3-0-0
Prerequisites	23AI&ML4304: Database Management Systems	Continuous Eval Semester End Eval Total Marks	30 70 100

COURSE OUTCOMES

1. Understand the concepts, evolution, and classifications of NoSQL databases along with their role in overcoming limitations of traditional relational systems.
2. Apply document-oriented database operations using MongoDB to handle real-time, scalable, and semi-structured data applications.
3. Analyze the architecture, consistency models, and performance characteristics of column-oriented NoSQL databases such as HBase and Cassandra.
4. Apply key-value and graph database models to solve data storage, querying, and relationship-centric problems in distributed environments.

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	2	1.7.1, 2.5.1, 2.6.3, 5.4.1
2	1	3	2										1	2	3	1.7.1, 2.5.1, 2.6.3, 3.5.1
3	1	3	2										1	2	4	1.7.1, 2.5.1, 2.6.3, 3.5.1
4	1	2	3										1	2	3	1.7.1, 2.5.1, 2.6.3, 3.5.1

COURSE CONTENT

UNIT I

Introduction to NoSQL Databases: Overview and History of NoSQL Databases. Definition of the Four Types of NoSQL Database,CAP Theorem, The Value of Relational Databases, Getting at Persistent Data, Concurrency, Integration, Impedance Mismatch, Application and Integration Databases, Attack of the Clusters, The Emergence of NoSQL.

UNIT II

Document-Oriented NoSQL Databases (Using MongoDB): NoSQL Key/Value

databases using MongoDB, Document Databases, Document oriented Database Features, Consistency, Transactions, Availability, Query Features, Scaling, Web Analytics or Real- Time Analytics, E-Commerce Applications,BASE Properties, Complex Transactions Spanning Different Operations.

UNIT III

Column-Oriented NoSQL Databases (Using Apache HBase and Cassandra): Column- oriented NoSQL databases using Apache HBASE, Column-oriented NoSQL databases using Apache Cassandra, Architecture of HBASE, Column-Family Data Store Features, Consistency, Transactions, Availability.

UNIT IV

Key-Value and Graph NoSQL Databases: NoSQL Key/Value databases using Riak, Key-Value Databases, Key-Value Store, Key-Value Store Features, Consistency, Transactions, Storing Session Information, Query by Data, Operations by Sets. Graph NoSQL databases using Neo4j, NoSQL database development tools and programming languages, Graph Databases, Graph Database Features, Consistency, Transactions, Availability.

TEXTBOOKS

1. Fowler, M., & Sadalage, P. J. (2013). NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence (1st ed.). United Kingdom: Addison-Wesley.
2. Bradshaw, S., Chodorow, K., & Brazil, E. (2020). MongoDB: The Definitive Guide (3rd ed.). United States: O'Reilly Media.
3. George, L. (2011). HBase: The Definitive Guide (1st ed.). United States: O'Reilly Media.

REFERENCE BOOKS

1. Christopher, D. M., Prabhakar, R., and Hinrich, S., Introduction to Information Retrieval, 1st Edition, Cambridge University Press, 2008.
2. Harizopoulos, S., Idreos, S., Madden, S., Boncz, P., and Abadi, D., The Design and Implementation of Modern Column-oriented Database Systems, 1st Edition, CWI / ACM Publications, Netherlands, 2013.
3. Harrison, G., Next Generation Databases: NoSQL and Big Data, 1st Edition, Apress, United States, 2015.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Prof. Arnab Bhattacharya, Fundamentals of Database Systems, IIT Kanpur, https://nptel.ac.in/courses/106104135 Last Accessed on 22-11-2025.
2. Prof. Rajiv Misra, Big Data Computing, IIT Patna, https://nptel.ac.in/courses/106104189 Last Accessed on 22-11-2025.

23AI&ML6405D
SOFT COMPUTING

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

COURSE OUTCOMES

1. Understand the soft computing techniques and models of neural networks.
2. Understand principles of fuzzy set theory, fuzzy operations, and fuzzy relations to analyze and model uncertainty and imprecision in real-world data.
3. Apply Fuzzy membership functions and fuzzy inference systems and Rough sets for decision-making problems.
4. Apply genetic algorithm to solve computer science 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, 1.6.1, 1.7.1, 2.5.3
2	2	2	2										1	1	2	1.2.1, 1.6.1, 1.7.1, 2.5.3, 2.6.4, 3.5.1
3	2	2	2										1	1	3	1.2.1, 1.6.1, 1.7.1, 2.5.3, 3.5.1
4	2	2	2										1	1	3	1.2.1, 1.6.1, 1.7.1, 2.5.3, 2.6.4, 3.5.1

COURSE CONTENT

UNIT I

Introduction to Soft Computing:Concept of computing, "Soft" computing versus "Hard" computing, Characteristics of soft computing, Types of soft computing, Applications of soft computing techniques.

Artificial Neural Network:Biological neurons, Basic models of neural networks, Connections Learning ,Activation Function, McCulloch and Pitts Neuron, Hebb network.

UNIT II

Introduction to Fuzzy Logic, Classical Sets and Fuzzy Sets: Introduction of Fuzzy logic, Crisp sets, Operations, Union, Intersection, Complement, Difference, Properties of Classical sets, Function mapping of Classical sets, Fuzzy sets, Operations, Union, Intersection, Complement, Properties of Fuzzy sets.
Classical Relations and Fuzzy Relations: Introduction, Cartesian product of Relation, Classical Relation, Cardinality, Operations, Properties, Composition, Fuzzy relations, Cardinality, Operations, Properties, Composition.

UNIT III

Membership Function:Introduction, Features of the Membership Functions, Fuzzification.
Fuzzy Rule Base and Approximate Mapping:Introduction, Fuzzy Reasoning, Categorical reasoning, Qualitative reasoning, Syllogistic reasoning, Dispositional reasoning, Fuzzy Inference system, Construction and Working Principle of FIS, Methods of FIS, Mandani FIS, Takagi-Sugeno Fuzzy Model, Comparison between Mamdani and Sugeno Method.
Rough sets: Fundamentals of Rough Set Theory,Rough Approximations, Properties of approximations, Complement, Union ,Intersection of Rough sets ,Rough Membership Function ,Difference between Fuzzy sets and Rough sets.

UNIT IV

Genetic Algorithm: Introduction, Biological Background, Genetic Algorithm vs Traditional Algorithms, Basic Terminology in Genetic Algorithms, Individuals, Genes, Fitness, Populations, Simple GA, Generic Genetic Algorithm, Operations of Genetic Algorithm, Encoding, Selection, Crossover, Mutation, Stopping Condition in Generic Algorithm, Constraints in Genetic Algorithm.
Hybrid Systems: Sequential, Auxiliary, Embedded hybrid systems, Fuzzy Neural systems, Genetic Fuzzy systems, Genetic Neural system.

TEXTBOOKS

1. Sivanandam, S. N., Deepa, S. N. (2019). Principles of soft computing (3rd ed). John Wiley Sons.
2. Rajasekaran, S., Pai, G. V. (2007). Neural networks, fuzzy systems and evolu tionary algorithms: Synthesis and applications. PHI Learning Pvt. Ltd.

REFERENCE BOOKS

1. N. K. Sinha and M. M. Gupta, Soft Computing amp; Intelligent Systems: Theory amp; Applications, 1st Edition, Academic Press / Elsevier, 2009.
2. B.K Tripathy and J.Anuradha ,Soft Computing Advances and Applications Cengage Learning ,2015.
3. R. Eberhart and Y. Shi, Computational Intelligence: Concepts to Implementation, 1st Edition, Morgan Kaufmann / Elsevier, 2007.
4. D. Driankov, H. Hellendoorn, and M. Reinfrank, An Introduction to Fuzzy Control, 2nd Edition, Narosa Publishing House, 2001.

5. Bart Kosko, Neural Networks and Fuzzy Systems, 1st Edition, Prentice Hall, Englewood Cliffs, 1992.
6. D. E. Goldberg, Genetic Algorithms in Search, Optimization, and Machine Learning, 1st Edition, Addison Wesley, 1989.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. D. Samanta, Introduction to Soft Computing, NPTEL Online Courses, Apr. 3, 2018. [Online]. Available: https://nptel.ac.in/courses/106105173 Last Accessed on: 30/10/2025.
2. M.Wall, GAlib: AC++LibraryofGeneticAlgorithmComponents, Massachusetts Institute of Technology, Aug. 1996. [Online].
Available: http://lancet.mit.edu/ga/dist/galibdoc.pdf Last Accessed on: 30/10/2025.

23AI&ML6351

BUSINESS INTELLIGENCE AND DATA VISUALIZATION LABORATORY

Course Category	Program Core	Credits	1.5
Course Type	Laboratory	L-T-P	0-0-3
Prerequisites	23AI&ML4304: Database Management Systems	Continuous Eval Semester End Eval Total Marks	30 70 100

COURSE OUTCOMES

1. Apply Tableau workspace features, data connections, and visualization techniques to create interactive analytical dashboards.
2. Apply Power BI workspace concepts, data preparation methods, and visualization tools to create meaningful analytical reports.
3. Apply data modeling techniques and DAX expressions in Power BI to build functional, relational, and analytical data models.
4. Apply Power BI dashboarding, advanced analytics, and publishing features to develop and share secure, interactive business intelligence 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	2	3	2		3								2	3	3	1.6.1, 1.7.1, 2.5.1, 2.5.2, 2.6.3, 2.6.4, 2.8.4, 3.5.1, 3.6.1, 3.6.2, 5.4.1, 5.4.2, 5.5.2
2	2	3	2		2								1	2	3	1.6.1, 1.7.1, 2.5.1, 2.5.2, 2.6.3, 2.6.4, 2.8.4, 3.5.1, 3.6.1, 3.6.2, 5.4.1, 5.4.2
3	2	3	2		2								2	2	3	1.6.1, 1.7.1, 2.5.1, 2.5.2, 2.6.3, 2.6.4, 2.8.4, 3.5.1, 3.6.1, 3.6.2, 5.4.1, 5.4.2
4	2	3	3		3								2	3	3	1.6.1, 1.7.1, 2.5.1, 2.5.2, 2.6.3, 2.6.4, 2.8.4, 3.5.1, 3.5.2, 3.6.1, 3.6.2, 3.8.2, 5.4.1, 5.4.2, 5.5.2

COURSE CONTENT

Task 1: Getting Started Tableau: i. Tableau Workspace, ii. Tableau Terminologies, iii. Basic Functionalities.
Task 2: Connecting to Data Source: i. Connecting to Database, ii. Different types of iii. Tableau Joins.
Task 3:Creating a View: i. Formatting Charts, ii. Adding Filters, iii. Creating Calculated Fields and Defining Parameters.
Task 4: Dashboard Design and Storytelling: i. Components of Dashboard, ii. Place Worksheets in Containers, iv. Action Filters and its Types.
Task 5:Introducing Power BI: i. Power BI Workspace, ii. Terminologies, iii. Basic Services.
Task 6: Preparing Data in Power BI: i. Query Editor, ii. Connecting Data Source, iii. Clean and Transform Data.
Task 7:Creating Reports amp; Visualizations: i. Different Types of Charts, ii. Formatting Charts with Title, Colors.
Task 8:Data Modelling in Power BI: i. Create Model Relationships, ii. Configure Tables, iii. Review model interface, iv. Many-to-many relationships, v. Quick measures
Task 9:DAX in Power BI: i. Create Calculated Tables, ii. Create Measures, iii. Work with Filter Context and Time Intelligence
Task 10: Dashboards: i. Filters in Power BI, ii. Formatting dashboards.
Task 11:Data Analysis in Power BI: i. Create Forest, ii. Work with Decomposition tree, iii. Work with Key influencers
Task 12:Publishing and Sharing Power BI Content: i. Configure Dataset Security, ii. Share a Dashboard, iii. Publish an App.

TEXTBOOKS

1. Sleeper, R. (2018). Practical Tableau: 100 tips, tutorials, and strategies from a tableau Zen master (First Edition).
2. Brett, P., amp; Deckler, G. (2022). Mastering Microsoft Power BI (Second Edition). Packt Publishing Ltd.

REFERENCE BOOKS

1. Brown, L. (2021). Tableau Desktop Cookbook (First Edition). O'Reilly Media.
2. Deckler, G. (2022). Learn Power BI: a comprehensive, step-by-step guide for beginners to learn real-world business intelligence. Packt Publishing Ltd.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Sinha, R. K. (2025, July 15). Business Intelligence with PowerBI: From Data to Strategic Decisions - Course [Video]. Swayam. from https://onlinecourses.swayam2.ac.in/imb25_mg221/preview, Last Accessed on November 20, 2025.
2. Kopare, A. A. (2025b, July 15). Data Analytics and Visualization with MS Power

BI - course [Video]. Swayam. from https://onlinecourses.swayam2.ac.in/imb25_mg218/preview,Last Accessed on November 20, 2025.
3. edX. (2025, September 19). RITX: Data Representation and Visualization in Tableau—EDX. https://www.edx.org/learn/data-visualization/rochester-institute-of-technology-data-representation-and-visualization-in-tableau,Last Accessed on November 20, 2025.
4. Egger, D., amp; Borg, J. S. (2019, January 6). Data visualization and communication with Tableau [Video]. Coursera from https://www.coursera.org/learn/analytics-tableau,Last Accessed on November 20, 2025.
5. Microsoft. (2024, February 29). Data analysis and visualization with Power BI [Video]. Coursera from https://www.coursera.org-/learn/data-analysis-and-visualization-with-power-bi,Last Accessed on November 20, 2025.
6. bconcepts. (2021). Power BI – labs. In Bconcepts. from https://www.bconcepts.pt/wp-content/uploads/2021/04/PowerBI.pdf, Last Accessed on November 20, 2025.

23AI&ML6352
BIG DATA ANALYTICS LAB

Course Category	Engineering Science	Credits	1.5
Course Type	Laboratory	L-T-P	0-0-3
Prerequisites	23AI&ML3353 Object Oriented Programming Through Java Lab	Continuous Eval Semester End Eval Total Marks	30 70 100

COURSE OUTCOMES

1. Apply Hadoop to configure and manage distributed file systems using HDFS.
2. Analyze and optimize MapReduce programs for large-scale data analysis.
3. Apply Hadoop ecosystem for analyzing data.
4. Analyze Pig and Hive for efficient data querying management.

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									3	2	3	1.7.1, 2.5.1, 2.5.2, 4.4.2
2	1		2		3								3	3	4	1.7.1, 3.6.1, 3.8.2, 5.5.2
3		1		2	3								3	3	3	2.6.3, 2.8.1, 4.6.1, 5.4.1
4		1		2	3								3	3	4	2.7.1, 4.6.2, 5.5.1, 5.6.1

COURSE CONTENT

Task 1: Hadoop Installation and shell commands.
Task 2: File management operations in Hadoop.
Task 3: Data import and export operations between HDFS and local file system.
Task 4: Word Count application: Implementation of Word Count Program using MapReduce Paradigm.
Task 5: Weather Data Analysis: Implementation of MapReduce algorithm for analyzing hot and cold days.
Task 6: MapReduce Application: Implement a MapReduce program to identify "common friends" among all pairs of users.
Task 7: Develop Pig scripts for data processing.
Task 8: Apache Spark transformations on RDD- Resilient Distributed Dataset.
Task 9: Database manipulation using Hive: To create, alter, drop databases and views.
Task 10: Functions and indexes in Hive: To create functions and indexes in Hive.

TEXTBOOKS

1. White, T., Hadoop: The Definitive Guide, 3rd Edition, O'Reilly Media, 2012

Reference Books:

1. Hadoop in Action by Chuck Lam, MANNING Publ.
2. Hadoop for Dummies by Dirk de Roos, Paul C. Zikopoulos, Roman B. Melnyk, Bruce Brown, Rafael Coss.
3. Hadoop in Practice by Alex Holmes, MANNING Publ.
4. Big Data Analytics by Dr. A. Krishna Mohan and Dr. E. Laxmi Lydia.
5. Hadoop MapReduce Cookbook by Srinath Perera and Thilina Gunarathne.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Prof. Rajiv Misra,Big Data Computing IIT Patna https://onlinecourses.nptel.ac.in/noc20_cs92/preview, last accessed on 12-11-2022.
2. Dr.Rajiv Misra, Cloud Computing and Distributed Systems IIT Patna https://nptel.ac.in/courses/106104182, last accessed on 12-11-2022.

23TP6107
QUANTITATIVE APTITUDE

Course Category	SS - 4	Credits	1
Course Type	Learning by Doing	L-T-P	0-0-2
Prerequisites	–	Continuous Eval Semester End Eval Total Marks	100 – 100

COURSE OUTCOMES

1. Solve various Basic Mathematics problems by following different methods
2. Follow strategies in minimizing time consumption in problem solving Apply short-cut methods to solve problems
3. Confidently solve any mathematical problems and utilize these mathematical skills both in their professional as well as personal life.
4. Analyze, summarize and present information in quantitative forms including table, graphs and formulas

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

CO	PO												PSO		RTL	POI
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
1	2															
2		2														
3	2															
4				2												

COURSE CONTENT

UNIT I

Numerical ability l:
Number system, HCF & LCM, Average, Ratio & Proportion
Numerical ability II:
Problems on ages, Partnership, Percentages, Profit & Loss, Allegation

UNIT II

Arithmetical ability l:
Time & Work, Pipes & Cistern, Chain Rule
Arithmetical ability ll:
Time & Distance, Problems on Trains, Boats & Steams

UNIT III

Arithmetical ability lll:
Simple interest and compound interest, Calendar and Clock
Logical ability:
Permutations and Combination, and Probability, Cubes

UNIT IV

Mensuration:
Areas, Volumes
Data interpretation:
Tabulation, Bar graphs, Pie charts, line graphs

TEXTBOOKS

1. R. S. Aggarwal, Quantitative Aptitude, Revised Edition, S. Chand Publications, 2017, ISBN: 8121924987.

MINORS

DATABASE MANAGEMENT SYSTEMS

Course Category	Minors	Credits	4.5
Course Type	Theory	L-T-P	3-0-3
Prerequisites	–	Continuous Eval Semester End Eval Total Marks	30 70 100

COURSE OUTCOMES

1. Understand the concepts of database systems.
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, 3^{rd} Edition. (For Chapters 2, 3, 4)
2. Silberschatz, Korth, Sudarsan, TMH, Database System Concepts, 5^{th} Edition, (For Chapter 1 and Chapter 5)

REFERENCE BOOKS

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

OPERATING SYSTEMS

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

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, 10^{th} Edition, 2018.
2. Tanenbaum A S, Modern Operating Systems, Galgotia Publications Pvt. Ltd, 4^{th} Edition, 2016.

REFERENCE BOOKS

1. Stallings W, Operating Systems -Internals and Design Principles, Pearson, 9^{th} Edition, 2018.
2. D.M Dhamdhere, Operating Systems: A Concept Based Approach, McGraw- Hill, 3^{rd} 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: 28/10/2024.
2. Stanford University - Lecture Notes on Operating Systems, https://www.scs.stanford.edu/21wi-cs140/notes, Last Accessed on: 28/10/2024.
3. IIT Bombay – Lecture Notes on Operating Systems , https://www.cse.iitb.a

c.in/~mythili/os/, Last Accessed on: 28/10/2024.

DATA VISUALIZATION

Course Category	Minors	Credits	4.5
Course Type	Theory	L-T-P	3-0-0
Prerequisites	–	Continuous Eval Semester End Eval Total Marks	30 70 100

COURSE OUTCOMES

1. Understand the foundational concepts of data visualization, including its history, perceptual principles, and connections to AI and ML.
2. Apply visualization reference models, visual mappings, and analytic strategies to design effective visualization applications for AI and ML tasks.
3. Understand various visualization systems, interaction techniques, and methods for representing multidimensional, textual, hierarchical, and network data.
4. Apply suitable visualization techniques for volumetric, vector, simulation, and GIS data, and understand the use of data structures in modern visualization environments.

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

Fundamentals of Data Visualization What Is Visualization? History of Visualization, Relationship between Visualization and Other Fields. The Visualization Process, Introduction of visual perception, visual representation of data, Gestalt principles, information overloads.

UNIT II

Visual Representation and Analytics Design: Creating visual representations, visualization reference model, visual mapping, visual analytics, Design of visualization applications.

UNIT III

Visualization Systems and Techniques: Classification of visualization systems, Interaction and visualization techniques misleading, Visualization of one, two and multi-dimensional data, text and text documents. Visualization of groups, trees, graphs, clusters, networks, software, Metaphorical visualization.

UNIT IV

Advanced Visualization Methods and Applications:Visualization of volumetric data, vector fields, processes and simulations, Visualization of maps, geographic information, GIS systems, collaborative visualizations, Evaluating visualizations.
Recent trends in various perception techniques, various visualization techniques, data structures used in data visualization.

TEXTBOOKS

1. Ward, Grinstein, Keim, Interactive Data Visualization: Foundations, Techniques, and Applications, 2nd Edition, 2015.
2. Edward R. Tufte, The Visual Display of Quantitative Information, 2nd Edition, 2001.

REFERENCE BOOKS

1. Tamara Munzner, Visualization Analysis and Design, 1st Edition, 2014.
2. Colin Ware, Information Visualization: Perception for Design, 3rd Edition, 2013.

E-RESOURCES AND OTHER DIGITAL MATERIALS

1. Prof. Nandan Sudarsanam, Introduction to Data Analytics, IIT Madras, https://nptel.ac.in/courses/110106072, Last Accessed on 08/12/2025
2. Prof. Ramkumar Rajendran, Learning Analytics Tools, IIT Bombay, https://nptel.ac.in/courses/106101224, Last Accessed on 08/12/2025