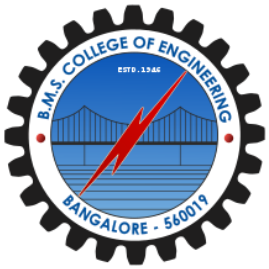


B.M.S. COLLEGE OF ENGINEERING, BENGALURU-19

(Autonomous Institute, Affiliated to VTU)

DEPARTMENT OF MACHINE LEARNING

BACHELOR OF ENGINEERING

IN

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

SCHEME & SYLLABUS

III - VIII SEMESTERS

From 2021-22 Admitted Batch Onwards

INSTITUTE VISION

Promoting Prosperity of mankind by augmenting Human Resource Capital through Quality Technical Education & Training**.**

INSTITUTE MISSION

Accomplish Excellence in the field of Technical Education through Education, Research and Service needs of society.

DEPARTMENT VISION

To achieve excellent standards of quality education in the field of Artificial Intelligence and Machine Learning.

DEPARTMENT MISSION

To nurture the students with strong fundamentals for a successful career in the field of Artificial Intelligence and Machine Learning.

To motivate the students for post-graduation and research.

To create impact in the society with continuous research and innovations.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Acquire fundamentals and expertise data engineering skills for professional career in industry, government, academia as innovative engineers.

PEO2: Pursue higher studies with research potential.

PEO3: Demonstrate professional ethics and attitude as an individual or team member at workplace and function professionally in a global competent world.

PROGRAMME OUTCOMES (POs)

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: Life-Long 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

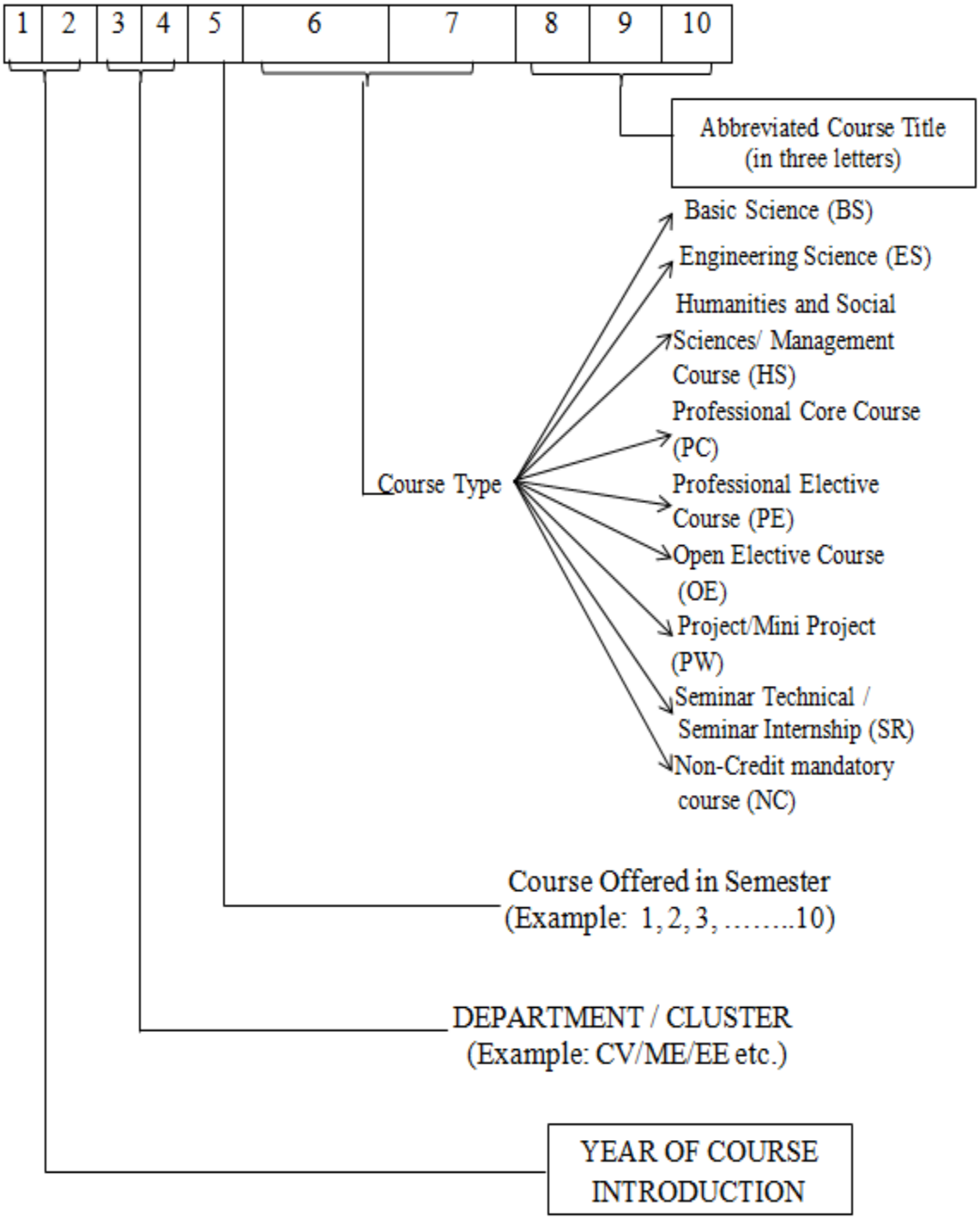
PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO1: **Software Systems:** Apply the skills of cognitive computing, artificial intelligence and machine learning in the field of data engineering to develop intelligent systems.

PSO2: **Recommendation Systems**: Demonstrate Computational knowledge, practical competency and innovative ideas in Artificial Intelligence & Machine Learning.

PSO3: Data Driven Systems: Use modern tools and techniques to solve problems in Machine Learning, Deep Learning, Computer Vision and Natural Language Processing.

NOMENCLATURE FOR THE COURSE CODE



B.M.S. College of Engineering, Bengaluru - 19
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Scheme of Instructions Semester - III (With effect from the Academic Year 2021-22: admitted batches and onwards)

Sl. #	Course Type	Course Code	Course Title	Teaching Hours In Credits/Week			Total Credits	Examination			
				Theory Lecture	Tutorial	Practical		Duration in hours	CIE Marks	SEE Marks	Total Marks
				L	T	P					
1	BS - 7	22MA3BSMML	Mathematical Foundations for Machine Learning	2	1	0	3	04	50	50	100
2	ES - 9	22AM3ESLDA	Logic Design and Computer Architecture	2	1	0	3	04	50	50	100
3	PC - 1	22AM3PCTFC	Theoretical Foundations of Computations	3	0	0	3	03	50	50	100
4	PC - 2	22AM3PCDST	Data Structures	3	0	1	4	05	50	50	100
5	PC - 3	22AM3PCDBM	Database Management Systems	3	0	1	4	05	50	50	100
6	PC - 4	22AM3PCCNS	Computer Networks	0	2	0	2	04	50	50	100
7	AE - 3	22AM3AEWAD	Web Application Development	0	0	1	1	02	50	50	100
8	HS - 3	22CV3HSEVS	Environmental Studies	1	0	0	1	01	50	50	100
9	HS - 4	22MA3HSCPH	Constitutions of India, Professional Ethics and Human Rights	1	0	0	1	01	50	50	100
10	NCMC - 1	22AM3NCPYA	Physical Activity	Non-Credit Mandatory Course				01	-	-	-
			Total	15	4	3	22	30	450	450	900

Note: HS: Humanities and Social Sciences/Management Course, BS: Basic Science Course, ES: Engineering Science Course, PC: Professional Core Course, PE: Professional Elective Course, OE: Open Elective Course; PW: Project/Mini Project Work, INT: Seminar on Internship, AE: Ability Enhancement Course / Mandatory Course, NCMC: Non-credit mandatory course

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Scheme of Instructions Semester – IV (With effect from the Academic Year 2021-22: admitted batches and onwards)

Sl. #	Course Type	Course Code	Course Title	Teaching Hours In Credits/Week			Total Credits	Examination			
				Theory Lecture	Tutorial	Practical		Duration in hours	CIE Marks	SEE Marks	Total Marks
				L	T	P					
1	BS - 8	22MA4BSLIA	Linear Algebra	2	1	0	3	04	50	50	100
2	PC - 5	22AM4PCPSM	Probability and Statistics for Machine Learning	3	1	0	4	05	50	50	100
3	PC - 6	22AM4PCOPS	Operating Systems	3	0	0	3	03	50	50	100
4	PC - 7	22AM4PCDAA	Design and Analysis of Algorithms	3	0	1	4	05	50	50	100
5	PC - 8	22AM4PCIAI	Introduction to Artificial Intelligence	3	0	1	4	05	50	50	100
6	INT - 1	22AM4SRIN1	Seminar - Internship involving Social Activity	0	0	1	1	02	50	50	100
7	AE - 4	22MA4AEUHV	Universal Human Values	0	1	0	1	02	50	50	100
8	AE - 5	22AM4AEPPM	Python Programming	0	0	1	1	02	50	50	100
9	HS - 5	22MA4HSKN / 22MA4HBKN	Samskrutika Kannada / Balake Kannada	1	0	0	1	01	50	50	100
10	NCMC - 2	22AM4NCCLA	Cultural Activity	Non-Credit Mandatory Course				01	-	-	-
			Total	15	3	4	22	30	450	450	900

Note: HS: Humanities and Social Sciences/Management Course, BS: Basic Science Course, ES: Engineering Science Course, PC: Professional Core Course, PE: Professional Elective Course, OE: Open Elective Course; PW: Project/Mini Project Work, INT: Seminar on Internship, AE: Ability Enhancement Course / Mandatory Course, NCMC: Non-credit mandatory course

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Scheme of Instructions Semester – V (With effect from the Academic Year 2021-22: admitted batches and onwards)

Sl.#	Course Type	Course Code	Course Title	Teaching Hours in Credits/Week			Total Credits	Examination			
				Theory Lecture	Tutorial	Practical		Duration in hours	CIE Marks	SEE Marks	Total Marks
				L	T	P					
1	PC-9	23AM5PCSED	Software Engineering & Design Patterns	3	0	0	3	03	50	50	100
2	PC-10	23AM5PCOOP	Object Oriented Programming	3	0	1	4	05	50	50	100
3	PC-11	23AM5PCIML	Introduction to Machine Learning	2	0	1	3	04	50	50	100
4	PC-12	23AM5PCINN	Introduction to Neural Networks	2	0	1	3	04	50	50	100
5	HS-6	23AM5HSCSM	Calculus and Statistics for Machine Intelligence	2	0	1	3	04	50	50	100
6	PE-1	23AM5PEABI	AI in Business Intelligence	3	0	0	3	03	50	50	100
		23AM5PEKDI	Knowledge Discovery								
		23AM5PEDIP	Digital Image Processing								
7	AE-6	23AM5AEDVA	Data visualization and Analysis	2	0	1	3	04	50	50	100
8	NCMC-3	23AM5NCCSE	Communication Skills Enhancement	Non-credit mandatory Course							
			Total	17	0	5	22	27	350	350	900

Note: HS: Humanities and Social Sciences/Management Course, BS: Basic Science Course, ES: Engineering Science Course, PC: Professional Core Course, PE: Professional Elective Course, OE: Open Elective Course; PW: Project/Mini Project Work, SR: Seminar Technical / Seminar Internship, NC: Non-credit mandatory course

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Scheme of Instructions Semester – VI (With effect from the Academic Year 2021-22: admitted batches and onwards)

Sl. #	Course Type	Course Code	Course Title	Teaching Hours In Credits/Week			Total Credits	Examination			
				Theory Lecture	Tutorial	Practical		Duration in hours	CIE Marks	SEE Marks	Total Marks
				L	T	P					
1	PC-13	24AM6PCPAP	Parallel Architectures and Programming	2	1	0	3	04	50	50	100
2	PC-14	24AM6PCTFM	Time Series and Financial Mathematics	2	0	1	3	04	50	50	100
3	PC-15	24AM6PCDEL	Deep Learning	3	0	0	3	03	50	50	100
4	PC-16	24AM6PCBDA	Big Data Analytics	2	0	0	2	02	50	50	100
5	PC-17	24AM6PCDLL	Deep Learning Laboratory	0	0	1	1	02	50	50	100
6	PE-2	24AM6PESNA	Social Network Analysis	3	0	0	3	03	50	50	100
		24AM6PENLP	Natural Language Processing								
		24AM6PEVCV	Video Analytics using Open CV								
7	OE-1	24AM6OEIAI	Introduction to AI	3	0	0	3	03	50	50	100
		24AM6OEIML	Introduction to Machine Learning								
8	HS-7	24AM6HSSMM	Stochastic Modelling for Machine Learning	2	0	0	2	02	50	50	100
9	PW-1	24AM6PWMIP	Mini Project	0	0	2	2	04	50	50	100
			Total	17	1	4	22	27	450	450	900

Note: HS: Humanities and Social Sciences/Management Course, BS: Basic Science Course, ES: Engineering Science Course, PC: Professional Core Course, PE: Professional Elective Course, OE: Open Elective Course; PW: Project/Mini Project Work, INT: Seminar on Internship, AE: Ability Enhancement Course / Mandatory Course, NCMC: Non-credit mandatory course

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Scheme of Instructions Semester – VII (With effect from the Academic Year 2021-22: admitted batches and onwards)

Sl.#	Course Type	Course Code	Course Title	Teaching Hours in Credits/Week			Total Credits	Examination			
				Theory Lecture	Tutorial	Practical		Duration in hours	CIE Marks	SEE Marks	Total Marks
				L	T	P					
1	PC-18	24AM7PCRMD	Research Methodology	2	0	0	2	02	50	50	100
2	PC-19	24AM7PCGAL	Generative AI With Large Language Models	3	0	0	3	03	50	50	100
3	PE-3	24AM7PERPA	Robotic Process Automation	3	0	0	3	03	50	50	100
		24AM7PEACY	AI for Cyber Security								
		24AM7PEHCI	Human Computer Interaction								
4	PE-4	24AM7PEIOT	Internet Of Things	3	0	0	3	03	50	50	100
		24AM7PECPS	Cyber Physical Systems								
		24AM7PEPRN	Pattern Recognition								
5	OE-2	24AM7OEIAI	Introduction to AI	3	0	0	3	03	50	50	100
		24AM7OEIML	Introduction to Machine Learning								
6	PW-2	24AM7PWCP1	Capstone Project – Phase I	0	0	2	2	04	50	50	100
Total				14	0	2	16	18	300	300	600

Note: HS: Humanities and Social Sciences/Management Course, BS: Basic Science Course, ES: Engineering Science Course, PC: Professional Core Course, PE: Professional Elective Course, OE: Open Elective Course; PW: Project/Mini Project Work, SR: Seminar Technical / Seminar Internship, NC: Non-credit mandatory course

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Scheme of Instructions Semester – VIII (With effect from the Academic Year 2021-22: admitted batches and onwards)

Sl.#	Course Type	Course Code	Course Title	Teaching Hours in Credits/Week			Total Credits	Examination			
				Theory Lecture	Tutorial	Practical		Duration in hours	CIE Marks	SEE Marks	Total Marks
				L	T	P					
1	HS-8	24AM8HSNIC	Nature Inspired Computing	1	0	0	1	01	50	50	100
2	HS-9	24AM8HSMEI	Management, Entrepreneurship and IPR	2	0	0	2	02	50	50	100
3	PC-20	24AM8PCEAI	Ethical AI	2	0	0	2	02	50	50	100
4	OE-3	24AM8OEBDS	Big Data Analytics	3	0	0	3	03	50	50	100
		24AM8OEPPG	Python Programming								
5	PW-6	24AM8PWCP2	Capstone Project – Phase II	0	0	7	7	14	50	50	100
6	SR-4	24AM8SRINP	Internship	0	0	1	1	02	50	50	100
7	NC-8	24AM8NCPCM	Competitive Exam / MOOC Course	Non-credit mandatory Course							
			Total	8	0	8	16	24	200	200	600

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Scheme of Instructions Semester - III (With effect from the Academic Year 2021-22: admitted batches and onwards)

Sl. #	Course Type	Course Code	Course Title	Teaching Hours In Credits/Week			Total Credits	Examination			
				Theory Lecture	Tutorial	Practical		Duration in hours	CIE Marks	SEE Marks	Total Marks
				L	T	P					
1	BS - 7	22MA3BSMML	Mathematical Foundations for Machine Learning	2	1	0	3	04	50	50	100
2	ES - 9	22AM3ESLDA	Logic Design and Computer Architecture	2	1	0	3	04	50	50	100
3	PC - 1	22AM3PCTFC	Theoretical Foundations of Computations	3	0	0	3	03	50	50	100
4	PC - 2	22AM3PCDST	Data Structures	3	0	1	4	05	50	50	100
5	PC - 3	22AM3PCDBM	Database Management Systems	3	0	1	4	05	50	50	100
6	PC - 4	22AM3PCCNS	Computer Networks	0	2	0	2	04	50	50	100
7	AE - 3	22AM3AEWAD	Web Application Development	0	0	1	1	02	50	50	100
8	HS - 3	22CV3HSEVS	Environmental Studies	1	0	0	1	01	50	50	100
9	HS - 4	22MA3HSCPH	Constitutions of India, Professional Ethics and Human Rights	1	0	0	1	01	50	50	100
10	NCMC - 1	22AM3NCPYA	Physical Activity	Non-Credit Mandatory Course				01	-	-	-
			Total	15	4	3	22	30	450	450	900

Note: HS: Humanities and Social Sciences/Management Course, BS: Basic Science Course, ES: Engineering Science Course, PC: Professional Core Course, PE: Professional Elective Course, OE: Open Elective Course; PW: Project/Mini Project Work, INT: Seminar on Internship, AE: Ability Enhancement Course / Mandatory Course, NCMC: Non-credit mandatory course

Course Title	Mathematical Foundations for Machine Learning	Course Code	22MA3BSMML
Credits	03	L – T– P	2 – 1– 0
Contact hours	40 hours		

Prerequisites: Basic concepts of Permutations, Combinations, Mathematical Induction,G.C.D., L.C.D., divisors and primes.

Course Objectives:

The objectives of the course are to facilitate the learners to

- Appreciate the importance of Discrete Mathematical structures in Machine learningapplications.
- Gain the knowledge of Discrete Mathematical tools and concepts to implement them in theircore domain.
- Improve their mathematical thinking and acquire skills required for sustained lifelonglearning.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the variouscourse outcomes.

- Lecture method (L) does not mean only traditional lecture method, but different type ofteaching methods may be adopted to develop the outcomes.
- Show Video/animation films to explain functioning of various concepts.
- Encourage collaborative (Group Learning) Learning in the class.
- Ask at least three HOT (Higher order Thinking) questions in the class, which promotescritical thinking.
- Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather thansimply recall it.
- Topics will be introduced in a multiple representation.
- Show the different ways to solve the same problem and encourage the students to come upwith their own creative ways to solve them.
- Discuss how every concept can be applied to the real world and when that's possible, it helpsto improve the students' understanding.

UNIT-1

CONGRUENCES AND ITS APPLICATIONS: **[08 hours]**

Introduction to Congruences, Linear Congruences, Applications of The Chinese Remainder Theorem (without proof), Solving Polynomials, Euler's Theorem, Wilson's Theorem and Fermat's little Theorem (Only statements)-Problems, Applications of Congruences – RSA algorithm.

UNIT-2

GRAPH THEORY-1: **[08 hours]**

Basic concepts: Types of graphs, order and size of a graph, in-degree and out-degree, connected and disconnected graphs, Eulerian graph, Hamiltonian graphs, subgraphs, isomorphic graphs. Matrix representation of graphs: adjacency matrix, incidence matrix.

UNIT-3

GRAPH THEORY-2: **[08 hours]**

Trees, spanning and minimal spanning tree, Kruskal's algorithm, Prim's algorithm, Network flows, Shortest path Algorithm - Dijkstra's algorithm.

UNIT-4

COMBINATORICS: **[08 hours]**

Introduction, Binomial and multinomial theorems, Catalan numbers, the principle of inclusion and exclusion, Derangements, Rook Polynomials.

UNIT-5

INDUCTION AND RECURRENCE RELATIONS: **[08 hours]**

Mathematical Induction, Strong Induction, Recursive Definitions and Structural Induction, First order recurrence relations, second-order homogeneous recurrence relations, Generating functions.

On completion of the course, student will have the ability to:

Course Code	CO#	COURSE OUTCOME(CO)	PO	Strength
22MA3BSMML	CO1	Apply Discrete mathematical tools and concepts in Machine learning algorithms	1	3
	CO2	Analyze the machine learning application using Discrete mathematical tools.	1	2
	CO3	Demonstrate the applications of machine learning concepts using the Discrete mathematical tools.	1, 5, 9, 10	2

Assessment Details (both CIE and SEE)

Component	Type of assessment	Max. Marks	Total	50 % Weightage	Total
CIE – Theory	Quiz	10	100	5	50
	AAT	10		5	
	Test 1	40		20	
	Test 2	40		20	
	Test 3	40		20	
SEE	End Exam	100		50	

Two best scores out of the three tests will be considered for CIE.

CIE methods/question paper is designed to attain the different levels of Bloom's taxonomyas per the outcome defined for the course.

SEMESTER END EXAMINATION:

- Each unit consists of one full question.
- Five full questions to be answered.
- To set one question in Units 1, 3, 4 and two questions each in unit 2 and unit 5.

Text Books:

1. Kenneth H. Rosen, Discrete Mathematics and its applications, 7th edition, McGraw Hill Publishers.
2. Discrete Mathematics, Kolman, Busby Ross, 5th edition, 2004, Prentice Hall

Reference Books:

1. Kenneth H. Rosen, Elementary number theory and its applications, 5th edition, Pearson publications.
2. Graph Theory with Applications to Engineering and Computer Science, Narsingh Deo,Eastern Economy Edition, PHIL earning Pvt., Ltd.
3. Graph Theory and Combinatorics, S. Chandrashekariah, 4th edition, Prism engineering education series.
4. Mathematics for Machine learning, Marc Peter Deisennroth, A. Aldo Faisal, ChengSoon Ong, 2020, Cambridge University Press.

E books and online course materials:

1. http://jlmartin.faculty.ku.edu/~jlmartin/courses/math725-S16/
2. https://www.whitman.edu/mathematics/cgt_online/cgt.pdf

Online Courses and Video Lectures:

1. https://www.coursera.org/learn/probability-intro
2. https://nptel.ac.in/courses/111104026/(DiscreteMathematics)
3. https://nptel.ac.in/courses/111106086/(Combinatorics)

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Course Title	LOGIC DESIGN AND COMPUTER ARCHITECTURE				
Course Code	22AM3ESLDA	Credits	3	L-T-P	2-1-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours /Week	4	Total Lecture Hours			26

UNIT - 1	5 Hrs
Basics of Gates: Review of Basic Logic gates, Positive and Negative Logic. Combinational Logic Circuits: Sum-of-Products Method, Truth Table to Karnaugh Map, Pairs, Quads,and Octets, Karnaugh Simplifications, Don't-care Conditions, Product-of-Sums Method, Product-of-Sums simplifications, Simplification by Quine-McClusky Method. **Data-Processing Circuits**: Multiplexers, Demultiplexers, 1-of-16 Decoder, Exclusive-or Gates, Encoders, Parity Generators.	
UNIT - 2	**5 Hrs**
Flip- Flops: RS Flip-Flops, Gated Flip-Flops, Edge-triggered Flip-Flops, Flip-Flop Timing, JK Master-Slave Flip-Flop, Various Representation of Flip-Flops, Analysis of Sequential Circuits. **Registers:** Types of Registers, Applications of Shift Registers. **Counters:** Asynchronous Counters, Synchronous Counters, Changing the Counter Modulus, Counter Design as a Synthesis problem.	
UNIT - 3	**5 Hrs**
Basic Concepts and Computer Evolution: Organization and Architecture, Structure and Function, A Brief History of Computers, The Evolution of the Intel x86 Architecture. **The Computer System:** Computer Components, Computer Function, Interconnection Structures, Bus Interconnection.	
UNIT - 4	**5 Hrs**
Cache Memory: Memory Hierarchy, Cache mapping techniques. **Input/output Organization**: Accessing I/O Devices, Interrupts. **Arithmetic:** Addition and Subtraction of Signed Numbers, Design of Fast adders, Multiplication of positive Numbers, Signed-Operand Multiplication.	
UNIT – 5	**6 Hrs**
The Central Processing Unit: Instruction sets: Machine Instruction Characteristics, Types of Operands, Types of Operations, Addressing Modes, Instruction Formats, Assembly Language. **Control Unit:** Hardwired and Microprogrammed Control unit.	

Text Books:

1. *Digital Principles and Applications*, Donald P Leach, Albert Paul Malvino & Goutam Saha, 8th Edition, Tata McGraw Hill, 2015.
2. *Computer Organization & Architecture*, William Stallings, 10th Edition, Pearson, 2015.

Reference Books:

1. *Illustrative Approach to Logic Design*, R D Sudhaker Samuel, Sanguine-Pearson, 2010.
2. *Computer Organization*, Carl Hamacher, 5th Edition, McGraw Hill Publishers.
3. *Computer System and Architecture*, Morris Mano, 3rd Edition, Pearson Education.

Course Outcomes	
CO1	Analyze the functionality of digital circuits and design efficient synchronous logic circuit from the functional description of digital systems.
CO2	Ability to analyze and design tradeoff in the development of processor and other components to articulate improvement in computer design.
CO3	Use design tools to simulate and verify logic circuits and computer architecture concepts.

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**1**												**1**		
CO2			**2**										**1**		
CO3					**1**				**1**	**2**			**1**		

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Digital System Design	NPTEL	https://nptel.ac.in/courses/108106177
2.	Digital Circuits	NPTEL	https://nptel.ac.in/courses/108105113
3.	Computer architecture and organization	NPTEL	https://nptel.ac.in/courses/106105163
4.	Digital Systems: From Logic Gates to Processors	Coursera	https://in.coursera.org/learn/digital-systems

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice / Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks
Unit 2	Internal Choice	Two questions to be asked for 20 marks each
Unit 3	Mandatory	One question to be asked for 20 marks
Unit 4	Internal Choice	Two questions to be asked for 20 marks each
Unit 5	Mandatory	One question to be asked for 20 marks

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	25%
Apply / Analyze	50%
Create / Evaluate	25%

Assessment Pattern:

Category			Score Split up	Total
Continuous Internal Evaluation (CIE)	**Theory**	CIE - 1	20M (Best of Two)	**25M**
		CIE – 2		
		CIE - 3		
		AAT/Quiz	10M	
Semester End Examination (SEE)	100M (50% weightage)			**50M**
Total				**100M**

Course Title	THEORETICAL FOUNDATIONS OF COMPUTATIONS				
Course Code	22AM3PCTFC	Credits	3	L-T-P	3-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	3	Total Lecture Hours			36

UNIT - 1	8 Hrs
Introduction to Finite Automata (FA): Introduction to Finite Automata, Central Concepts of Automata Theory – Languages, Grammars, Automata and applications; Deterministic Finite Automata (DFA), Nondeterministic Finite Automata (NFA), Equivalence of DFA and NFA, FA State Reductions, Finite Automata with Epsilon Transition.	
UNIT - 2	**6 Hrs**
Regular Languages and Expressions: Regular Expressions, Finite Automata and Regular Expressions, Applications of Regular Expressions, Proving Languages Not to Be Regular, Closure Properties of Regular Languages, Equivalence and Minimization ofAutomata.	
UNIT - 3	**8 Hrs**
Context Free Grammars and Languages: Context Free Grammars (CFG) - Left Most Derivation, Right Most Derivation, Parse trees; Applications of Context Free Grammars, Parsing and Ambiguity in Grammars and Languages. **CFG Simplification and Normal Forms:** Eliminating Useless Symbols, Computing the Generating and Reachable Symbols, Eliminating Epsilon Productions, Eliminating Unit Productions, Chomsky Normal Form (CNF), Greibach Normal Form (GNF). **Properties of Context Free Languages:** The Pumping Lemma for Context Free Languages, Closure Properties of Context Free Languages (CFL).	
UNIT - 4	**7 Hrs**
Pushdown Automata (PDA): Introduction, Non-Deterministic Pushdown Automaton, The Languages accepted by a Pushdown Automaton, Deterministic Pushdown Automata, Applications. **Pushdown Automata and Context Free Languages:** PDA for CFL, Equivalence of PDA's and CFG's.	
UNIT - 5	**7 Hrs**
Turing Machines: The Standard Turing Machine (TM) – Definition, TM as Language Accepters and Transducers; Combining TM for complicated Task, Turing's Thesis. **Turing Machine other Models:** Minor variations - TM with Stay Option & Semi-Infinite Tape, Offline TM; Complex Storage – Multitape & Multidimensional TM, Nondeterministic TM, Universal TM, Linear Bounded Automata. **Limitations of Algorithmic Computation:**Problems that cannot be solved by TMs, Post Correspondence Problem, Undecidable Problems.	

Text Books:

1. *An Introduction to Formal Languages and Automata*, Peter Linz, 6th Edition, Jones & Bartlett Learning, 2017.

Reference Books:

1. *Introduction to Automata Theory, Languages and Computation,* John E. Hop croft, Rajeev Motwani, Jeffrey D. Ullman, 3rd Edition, Pearson, 2007.
2. *Introduction to Languages and the Theory of Computation,* John C Martin, 4th Edition, TataMcGraw-Hill, 2011.
3. *Introduction to Computer Theory*, Daniel I.A. Cohen, John Willy & Son Inc, 2nd Edition, 2000.

Course Outcomes	
CO1	Apply formal notations with related concepts to provide basic construct of computation.
CO2	Analyze the constructs of a machine representation of formal languages and implement solutions towards designing of system software.
CO3	Design Formal machines that can recognize the patterns and syntaxes of mathematical models.

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**1**												**1**		
CO2		**2**											**1**		
CO3			**2**										**1**		

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Formal Languages and Automata Theory	NPTEL	https://nptel.ac.in/courses/111103016
2.	Introduction to Automata , Languages and Computation	NPTEL	https://nptel.ac.in/courses/106105196

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice / Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks
Unit 2	Internal Choice	Two questions to be asked for 20 marks each
Unit 3	Mandatory	One question to be asked for 20 marks
Unit 4	Mandatory	One question to be asked for 20 marks
Unit 5	Internal Choice	Two questions to be asked for 20 marks each

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	25%
Apply / Analyze	50%
Create / Evaluate	25%

Assessment Pattern:

Category			Score Split up	Total
Continuous Internal Evaluation (CIE)	**Theory**	CIE - 1	40M (Best of Two)	**50M**
		CIE – 2		
		CIE - 3		
		Quiz	05M	
		AAT	05M	
Semester End Examination (SEE)	100M (50% weightage)			**50M**
			Total	**100M**

Course Title	DATA STRUCTURES				
Course Code	22AM3PCDST	Credits	4	L-T-P	3-0-1
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	5	Total Lecture Hours			36

UNIT - 1	8 Hrs
Introduction to Data Structures: Definition and its classification, Dynamic Memory allocation. **Linked Lists:** Definition, Basic Operations on Singly Linked List, Singly linked List with Header Nodes, Applications of Singly Linked Lists.	
UNIT - 2	**7 Hrs**
Linked List: Doubly Linked Lists, Circular Linked List – Implementation and Applications **Stacks:** Definition, Operations, Implementation using Arrays and Linked list, Applications of Stack – Infix to postfix conversion, Evaluation of postfix expression, Parenthesis matching, reversing a string.	
UNIT - 3	**6 Hrs**
Recursion: Definition, Writing recursive programs, Efficiency and Applications of Recursion. **Queues:** Definition, Operations, Implementation using Arrays and Linked list, Types of queues – Circular queue, Deque and priority queue, Applications of queues.	
UNIT - 4	**7 Hrs**
Binary Trees: Binary Tree properties and representations, traversals and other operations. **Binary Search Trees:** Definition, Operations on BST, Threaded binary trees, Applications.	
UNIT - 5	**8 Hrs**
Balanced Trees: AVL Trees, Splay trees, Red- Black Trees – Definitions, Rotation and other basic operations.	

Text Books:

1. *Data Structures using C and C++,* Yedidyah, Augenstein, Tannenbaum, 2nd Edition, Pearson Education, 2007.
2. *Data Structures using C*, Reema Thareja, 2nd Edition, Oxford University Press, 2011

Reference Books:

1. *Fundamentals of Data Structures in C*, by Horowitz, Sahni, Anderson-Freed, 2nd Edition, Universities Press, 2007.
2. *Data Structures A Pseudocode Approach with C*, Richard F. Gilberg and Behrouz A. Forouzan, Cengage Learning, 2005.

Course Outcomes	
CO1	Design various methodology for organizing data and solving basic programming challenges using Linear Data Structures.
CO2	Apply the concepts of Linear Data Structures and Recursive techniques to handle problems in real time applications through programming.
CO3	Analyze and implement application based real time solutions using Non-linear Data structures.

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		**2**											**1**		
CO2			**2**										**1**		
CO3				**1**					**1**	**1**			**1**		

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Introduction to Data Structures	NPTEL	https://nptel.ac.in/courses/106102064
2.	Data Structures and Algorithms Specialization	Coursera	https://in.coursera.org/specializations/data-structures-algorithms
3.	Data Structures and Algorithms using Java	NPTEL	https://onlinecourses.nptel.ac.in/noc22_cs92/preview
4.	Data Structures and Algorithms in Python	GeeksforGeeks	https://practice.geeksforgeeks.org/courses/Data-Structures-With-Python

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice / Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks
Unit 2	Internal Choice	Two questions to be asked for 20 marks each
Unit 3	Mandatory	One question to be asked for 20 marks
Unit 4	Mandatory	One question to be asked for 20 marks
Unit 5	Internal Choice	Two questions to be asked for 20 marks each

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	25%
Apply / Analyze	50%
Create / Evaluate	25%

Assessment Pattern:

Category			Score Split up	Total
Continuous Internal Evaluation (CIE)	**Theory**	CIE - 1	20M (Best of Two)	**25M**
		CIE – 2		
		CIE - 3		
		AAT/Quiz	05M	
	Lab	CIE - 1	10M	**25M**
		CIE – 2	10M	
		AAT	05M	
Semester End Examination (SEE)	100M (50% weightage)			**50M**
			Total	**100M**

Course Title	DATABASE MANAGEMENT SYSTEMS				
Course Code	22AM3PCDBM	Credits	4	L-T-P	3-0-1
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	5	Total Lecture Hours			36

UNIT – 1	7 Hrs
Introduction to Databases: Characteristics of Database approach, Advantages. **Database Architecture:** Data models, Schemas and instances, Three schema architecture and data independence Database languages and interfaces, The database system environment, **SQL:** SQL Data Definition and Data Types specifying basic constraints in SQL, Basic retrieval queries in SQL, Insert, Delete and Update statements in SQL, Additional features of SQL, More complex SQL Queries, Specifying Constraints as Assertions and Triggers, Views (Virtual Tables) in SQL, Schema Change Statement in SQL.	
UNIT – 2	**7 Hrs**
Entity-Relationship(ER) model: Using High-Level conceptual Data Models for Database Design, A sample Database Application, Entity types, Entity Sets, Attributes and Keys, Relationship Types, Relationship Sets, Roles and Structural Constraints, Weak Entity types, Refining the ER Design, ER Diagrams, Naming Conventions and Design Issues, Relationship Types of Degree Higher than two, Relational Database Design using ER-to Relational Mapping.	
UNIT – 3	**7 Hrs**
Relational Data Model and Relational Database Constraints: Relational Model Concepts, Relational Model Constraints and Relational Database Schemas, Update Operations, Transactions and Dealing with Constraint Violations. **Relational Algebra:** Unary Relational Operations, SELECT and PROJECT, Relational Algebra Operations from Set Theory Binary Relational Operations: JOIN and DIVISION, Additional Relational Operations	
UNIT – 4	**7 Hrs**
Database Design Theory and Normalization: Informal Design Guidelines for Relation Schemas, Functional Dependencies, Normal Forms Based on Primary Keys, General Definitions of Second and Third Normal Forms, Boyce-Codd Normal Form, Multi-valued Dependencies and a Fourth Normal Form, Join Dependencies, Fifth Normal Form.	
UNIT – 5	**8 Hrs**
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.	

Text Books:

1. *Fundamental of Database Systems,* Elmasri and Navathe, 7th Edition, Pearson, 2016.
2. *Getting Started with NoSQL,* Gaurav Vaish, 2nd Edition, Packt Publishing, 2014.

Reference Books:

1. *Database Systems: The Complete Book*, Hector Garcia-Molina Jeffrey D. Ullman Jennifer Widom, 3rd Edition, Pearson, 2008.

Course Outcomes	
CO1	Apply the concepts of database management system for various applications to its correctness.
CO2	Analyse conceptual, logical, and physical database design principles for the given scenario.
CO3	Demonstrate a rudimentary understanding of programmatic interfaces to a database and be able to use the basic functions of one such interface.

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2												2		
CO2		2											2		
CO3			1		2						1		2		

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Introduction to Database Systems	NPTEL	https://nptel.ac.in/courses/106106220
2.	Fundamentals of Database Systems	NPTEL	https://nptel.ac.in/courses/106104135
3.	Data Structures and Algorithms using Java	Coursera	https://in.coursera.org/projects/fundamentals-database-systems

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice / Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks
Unit 2	Internal Choice	Two questions to be asked for 20 marks each
Unit 3	Mandatory	One question to be asked for 20 marks
Unit 4	Mandatory	One question to be asked for 20 marks
Unit 5	Internal Choice	Two questions to be asked for 20 marks each

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	25%
Apply / Analyze	50%
Create / Evaluate	25%

Assessment Pattern:

Category			Score Split up	Total
Continuous Internal Evaluation (CIE)	Theory	CIE - 1	20M (Best of Two)	25M
		CIE – 2		
		CIE - 3		
		AAT/Quiz	05M	
	Lab	CIE - 1	10M	25M
		CIE – 2	10M	
		AAT	05M	
Semester End Examination (SEE)	100M (50% weightage)			50M
			Total	100M

Course Title	COMPUTER NETWORKS				
Course Code	22AM3PCCNS	Credits	2	L-T-P	0-2-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	4				

UNIT - 1
Introduction to Computer Network: Problem: Building a Network: Application, Network Requirement Network Architecture, Implementation of Network software, performance measures.
UNIT - 2
Connecting to Network: Perspective on connecting, Encoding, Framing, Error Detection, Reliable transmission, 802.XX protocols.
UNIT - 3
Internetworking: Switching and bridging, Basic Internetworking, **Routing:** Distance Vector routing, Link state routing, **GlobalInternet:** BGP protocol, Routing in mobile device and Deployment of IPv6.
UNIT - 4
End to End Protocols: Simple De-multiplexer (UDP), Reliable Byte stream (TCP): Connection establishment and termination, silly window syndrome. **Congestion control and Resource Allocation:** Issues in resource allocation, Queuing Disciplines, TCPcongestion control.
UNIT - 5
Network Security: Building blocks of cryptography, key pre-distribution. **Network Applications:** Traditional Applications, Multimedia Applications.

Text Books:

1. *Computer Networks: A Systems Approach*, Larry L Peterson and Bruce S Davie,5th Edition, Morgan Kufmann, 2011.

Reference Books:

1. *Computer Networking: A Top-Down Approach Featuring the Internet*, JamesKurose and Keith Ross, 8th Edition, Pearson, 2021.
2. *Computer Networks, Andrew S Tannenbaum and David J Wetherall,* 5th Edition, Pearson, 2015.

Course Outcomes	
CO1	Analyze and Apply the need of network requirements for building a secure and robust network.
CO2	Design a network using internetworking concepts and protocols.
CO3	Apply the knowledge of security concepts for secure data transmission.

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1												1		
CO2		2											1		
CO3			2										1		

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Computer Networks	NPTEL	https://nptel.ac.in/courses/106105080
2.	Computer Networks and Internet Protocol	NPTEL	https://onlinecourses.nptel.ac.in/noc22_cs19/preview
3.	Computer Communications Specialization	Coursera	https://in.coursera.org/specializations/computer-communications

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice / Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks
Unit 2	Internal Choice	Two questions to be asked for 20 marks each
Unit 3	Mandatory	One question to be asked for 20 marks
Unit 4	Mandatory	One question to be asked for 20 marks
Unit 5	Internal Choice	Two questions to be asked for 20 marks each

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	25%
Apply / Analyze	50%
Create / Evaluate	25%

Assessment Pattern:

Category			Score Split up	Total
Continuous Internal Evaluation (CIE)	**Theory**	CIE - 1	40M (Best of Two)	**50M**
		CIE – 2		
		CIE - 3		
		AAT/Quiz	10M	
Semester End Examination (SEE)	100M (50% weightage)			**50M**
Total				**100M**

Course Title	WEB APPLICATION DEVELOPMENT				
Course Code	22AM3AEWAD	Credits	1	L-T-P	0-0-1
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	2				

About the Course: The students should develop websites using modern web technologies. The course will be executed in two cycles and a project work. During this project phase, the students would be able to design responsive web portals usingHTML, CSS and JS functionality. The student will design and develop complete end to end web portals based on requirements and design considerations.

Text Books:

1. *Responsive Web Design with HTML5 and CSS3*, Ben Frain, 2nd Edition,Packt Publishing Limited, 2015.
2. *Learning JavaScript,* Ethan Brown, 3rd Edition, Oreilly Publishers,2016.
3. *PHP and MySQL Development*, Laura Thomson, Luke Welling, 5th Edition, Pearson Education, 2016.

Reference Books:

1. *Internet & World Wide WebHow to Program*, Paul J. Deitel, Harvey M. Deitel, Abbey Deitel, 5th Edition, Prentice Hall, 2013.
2. *Head First Java Script Programming: A Brain- friendly Guide,* Elisabeth Robson, Eric Freeman, Oreilly Publishers, 2014.

Course Outcomes	
CO1	Apply the knowledge of modern web languages and latest web frameworks to develop interactive web applications.
CO2	Analyze front-end web coding languages to add dynamic content and discover the various ways of passing information from client to server.
CO3	Design an interactive website(s) in team using modern integrated tools.

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1					2							1		
CO2		2											1		
CO3			2		1		1		1	1		1	1		

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Modern Application Development	NPTEL	https://onlinecourses.nptel.ac.in/noc20_cs52/preview
2.	Introduction to Web Development with HTML,CSS,Javascript	Coursera	https://in.coursera.org/learn/introduction-to-web-development-with-html-css-javacript
3.	Introduction to Web Development	Coursera	https://www.coursera.org/learn/web-development

Assessment Pattern:

<table>
<tr><th colspan="3">Category</th><th>Score Split up</th><th>Total</th></tr>
<tr><td rowspan="4">Continuous Internal Evaluation (CIE)</td><td rowspan="2">Presentation 1</td><td>CIE - 1</td><td>20M</td><td rowspan="2">25M</td></tr>
<tr><td>AAT</td><td>05M</td></tr>
<tr><td rowspan="2">Presentation 2</td><td>CIE – 2</td><td>20M</td><td rowspan="2">25M</td></tr>
<tr><td>AAT</td><td>05M</td></tr>
<tr><td>Semester End Examination (SEE)</td><td colspan="3">100M (50% weightage)</td><td>50M</td></tr>
<tr><td colspan="4">Total</td><td>100M</td></tr>
</table>

Course	Environmental Studies	Course Code	22CV3HSEVS	SEE, QP Duration	1Hr,30 Min
Credits	01	L-T-P	1 : 0 : 0	SEE marks	50

COURSE OBJECTIVE: The students will be able to develop a sense of responsibility about the environment, natural resources, their conservation and Understand the concept, structure and function of different ecosystems and the ill effects of environmental pollution and other environmental issues like population growth, Acid rain, global warming etc.,

COURSE OUTCOME : Student can an ability to

CO1: Discuss the components and impacts of human activities on environment.
CO2: Apply the environmental concepts for conservation and protection of natural resources.
CO3: Identify and establish relationship between social, economic and ethical values from environmental perspectives.

Unit – 1 : Introduction to Environment

- Definition, about the Earth, Earth's Structure i.e. Atmosphere and its parts, Hydrosphere, Lithosphere and Biosphere.
- Ecology & Ecosystem, Balanced ecosystem, types of Ecosystem.
- Human activities - Food, Shelter, Economic & Social Security.
- Effects of Human activities on Environment: Agriculture, Housing, Industries, Mining and Transportation activities.
- Environmental Impact Assessment (E I A)

05 Hrs

Unit – 2: Natural Resources

- Definition, Renewable and Non-Renewable sources.
- Major Natural Resources are -
  - Water resources, its availability, quality, water borne & water induced diseases,
  - Mineral resources, classification, uses in various Industries as byproducts.
  - Forest resources – causes & consequences of deforestation, various afforestation programs.
- Conventional and Non-conventional energy resources -
  - Hydroelectric, Wind power, Solar, Biogas, geothermal energy.
  - Fossil fuel based energy resources – Coal, Oil & Gas, Nuclear power
  - Hydrogen as an alternate future sources of energy.

04 Hrs

Unit-3 : Environmental pollution

Introduction, following are few types of pollutions to study -

- Water pollution - definition, types, sources, effects and control of water pollution.
- Land pollution - definition, types, sources, effects, Solid waste management.
- Noise pollution - definition, sources, effects & control of noise pollution.
- Air pollution - definition, sources, effects & control of air pollution.

03 Hrs

Unit-4 :<u>Current environmental issues & importance</u>

- Population growth, effects & Control, Climatic changes,
- Global warming, Acid rain, Ozone layer depletion and its effects.
- Environmental protection – initiatives by Government and non–Govt. Organizations (NGO's), Role of Legal aspects.
- Environmental Education, Women education.

03 Hrs

Total contact hours = 15 (Weekly 1 Hr.)

<u>C I E Marks</u>: Conducted 3 Tests, considered best of 2, The pattern of Test paper consists of two parts, Part-A, 20 mcqs, 1 mark each, Part-B Consists of 3 descriptive questions, 10 marks each, student should answer 2 full questions from part-B. Two quiz's, each quiz is 5 marks covering full syllabus.

TOTAL C I E MARKS: 20+20+10=50 MARKS

<u>SEE QUESTION PAPER PATTERN</u>

<u>PART-A</u>

- 20 Multiple Choice Questions Covering Full Syllabus
- 1 Mark Each, attend all questions 20 marks

<u>PART-B</u>

- Consist of 4 Main Questions, It May be Subdivisions of 3 or 4.
- Each Question Consists of 10 Marks, Covering Full Syllabus
- Student Should Answer only 3 Full Questions Only.

30 marks

SEE TOTAL MARKS : 20+30=50 MARKS

<u>TEXT BOOKS:</u>

1. Environmental studies by - Dr. Geetha balakrishanan (Revised Edition)

2. Ecology by – Subramanyam (Tata McGraw Hill Publication)

3. Environmental studies by – Dr. J.P.Sharma (Fourth edition)

4. Environmental studies by – Smriti Srivastav

<u>REFERENCES:</u>

1. Environmental studies by – Benny Joseph

2. Environmental studies by – Dr. D.L.Manjunath

<u>LEARNING RESOURCES:</u>

1. NPTEL (Open Sources / power point and visuals)

2. Ecological studies / IITR / Open Sources

3. Ministry of Environment and forest & wildlife.

MOOC's:

MOOCS – https://www.coursera.org / course / sustain

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E V S CO-PO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**2**										
CO2	**2**	**2**										
CO3	**1**	**1**										

Indicate strength of mapping (1/2/3)
Justify the strength of mapping
Include a similar mapping Table for CO-PSO if applicable

Course Title	Constitution of India, Professional Ethics and Human Rights	Course Code	22MA3HSCPH / 22MA4HSCPH
Credits	01	L-T-P-S	1-0-0-0

Course Objectives:

- To educate students about the country's highest law.
- To respect human dignity and protect people's rights from discrimination.
- To discuss about risk management, workplace safety, and increase understanding of concerns pertaining to the profession.

Teaching-Learning Process (General Instructions):

These are sample strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Innovative lecture methodologies to be adapted to improve the teaching and learning process.
- Short videos for better understanding and group discussion.
- Encourage collaborative (Group Learning) learning in the class.
- Ask Higher Order Thinking (HOT) questions in the class, which promotes critical thinking.
- Classroom discussions focused on case studies help students strengthen their analytical skills and thinking abilities, such as the capacity to assess, generalise, and analyse knowledge rather than just recollect it.

UNIT-1

[03 hours]

Introduction to Indian Constitution

Framing of the Indian constitution: Role of the Constituent Assembly - Preamble and Salient features of the Constitution of India, Fundamental Rights and its limitations. Fundamental Duties and their significance. Directive Principles of State Policy: Importance and its relevance.
Case Studies.

Teaching-Learning Process	Chalk and talk method / Power Point Presentation

UNIT -2

[03 hours]

Union Executive and State Executive

The Union Executive – The President and the Vice President, the Prime Minister and
The Council of Ministers. The Union Parliament – Lok Sabha & Rajya Sabha.
The Supreme Court of India.
State Executive – The Governors, the Chief Ministers and the Council of Ministers. The State Legislature – Legislative Assembly and Legislative Council. State High Courts.

Teaching-Learning Process	Chalk and talk method / Power Point Presentation

UNIT -3

[03 hours]

Election Commission of India, Amendments and Emergency Provisions

Election Commission of India – Powers & Functions – Electoral Process in India.
Methods of Constitutional Amendments and their Limitations.
Important Constitutional Amendments – 42nd, 44th, 61st, 74th, 76th, 77th, 86th and 91st.
Emergency Provisions. Case Studies.

Teaching-Learning Process	Chalk and talk method / Power Point Presentation

UNIT-4

[03 hours]

Human Rights

Human Rights – Meaning and significance, Types Human Rights, Powers and Functions of National and State Human Rights Commission of India. Human rights in constitution of India.

Teaching-Learning Process	Chalk and talk method / Power Point Presentation

UNIT-5

[03 hours]

Professional Ethics

Scope and Aims of Engineering Ethics, Responsibilities of Engineers and impediments to Responsibilities. Honesty, Integrity and Reliability; Risks – Safety and Liability in Engineering. Case Studies.

Teaching-Learning Process	Chalk and talk method / Power Point Presentation

Course outcomes (Course Skills Set)

At the end of the course, the student will have the ability to

COURSE CODE	CO	COURSE OUTCOME (CO)	PO	Strength
22MA3HSCPH / 22MA4HSCPH	CO1	Recognize the significance of the Indian Constitution as the supreme legal authority.	PO6, PO12	3
	CO2	Analyse human rights theories and concepts.	PO6, PO12	3
	CO3	Apply the principles of moral obligations and duties to safeguard the public's welfare and safety.	PO8, PO12	2

Assessment Details (both CIE and SEE)

Component	Type of assessment	Max. Marks	Total	50 % Weightage	Total
CIE – Theory	AAT	10	100	5	50
	AAT	10		5	
	Test 1	40		20	
	Test 2	40		20	
	Test 3	40		20	
SEE	End Exam	100		50	

Two best scores out of the three tests will be considered for CIE.

CIE methods/question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Text Books:

1. "An Introduction to Constitution of India and Professional Ethics" by Merunandan K.B. and B.R. Venkatesh, Meragu Publications, 3rd edition, 2011.
2. "Constitution of India & Professional Ethics & Human Rights" by Phaneesh K. R., Sudha Publications, 10th edition, 2016.

Reference Books:

1. "V.N. Shukla's Constitution of India" by Prof (Dr.) Mahendra Pal Singh (Revised), Eastern Book Company, Edition: 13th Edition, 2017, Reprint 2019.
2. "Ethics in Engineering" by Martin, W. Mike.,Schinzinger, Roland., McGraw-Hill Education; 4th edition (February 6, 2004) .

E books and online course materials:

1. https://www.smartzworld.com/notes/constitution-of-india-and-professional-ethics-notes-vtu-cip-pdf/
2. https://legalstudymaterial.com/constitution-of-india/

Question Paper Pattern:

SEE Multiple Choice Questions (Online Examination)

B.M.S. College of Engineering, Bengaluru – 19
(Autonomous Institute, Affiliated to VTU | Approved by AICTE)

Scheme of Instructions Semester – IV (With effect from the Academic Year 2021-22: admitted batches and onwards)

Sl. #	Course Type	Course Code	Course Title	Teaching Hours In Credits/Week			Total Credits	Examination			
				Theory Lecture	Tutorial	Practical		Duration in hours	CIE Marks	SEE Marks	Total Marks
				L	T	P					
1	BS - 8	22MA4BSLIA	Linear Algebra	2	1	0	3	04	50	50	100
2	PC - 5	22AM4PCPSM	Probability and Statistics for Machine Learning	3	1	0	4	05	50	50	100
3	PC - 6	22AM4PCOPS	Operating Systems	3	0	0	3	03	50	50	100
4	PC - 7	22AM4PCDAA	Design and Analysis of Algorithms	3	0	1	4	05	50	50	100
5	PC - 8	22AM4PCIAI	Introduction to Artificial Intelligence	3	0	1	4	05	50	50	100
6	INT - 1	22AM4SRIN1	Seminar - Internship involving Social Activity	0	0	1	1	02	50	50	100
7	AE - 4	22MA4AEUHV	Universal Human Values	0	1	0	1	02	50	50	100
8	AE - 5	22AM4AEPPM	Python Programming	0	0	1	1	02	50	50	100
9	HS - 5	22MA4HSKN / 22MA4HBKN	Samskrutika Kannada / Balake Kannada	1	0	0	1	01	50	50	100
10	NCMC - 2	22AM4NCCLA	Cultural Activity	Non-Credit Mandatory Course				01	-	-	-
			Total	15	3	4	22	30	450	450	900

Note: HS: Humanities and Social Sciences/Management Course, BS: Basic Science Course, ES: Engineering Science Course, PC: Professional Core Course, PE: Professional Elective Course, OE: Open Elective Course; PW: Project/Mini Project Work, INT: Seminar on Internship, AE: Ability Enhancement Course / Mandatory Course, NCMC: Non-credit mandatory course

SYLLABUS (2022-2023)

FOURTH SEMESTER B.E. COURSE

(CS/IS/AI&ML)

Course Title	**LINEAR ALGEBRA**	**Course Code**	**22MA4BSLIA**
Credits	**03**	**L – T – P**	**2-1-0**
Contact hours	**40**		

Course Objectives:

The objectives of the course are to facilitate the learners to

- Appreciate the importance of linear algebra in computer and allied engineering science.
- Gain the knowledge of linear algebra tools and concepts to implement them in their core domain.
- Improve their mathematical thinking and acquire skills required for sustained lifelong learning.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

- Lecture method(L) does not mean only traditional lecture method, but different type ofteaching methods may be adopted to develop the outcomes.
- Show Video/animation films to explain functioning of various concepts.
- Encourage collaborative (Group Learning) Learning in the class.
- Ask at least three HOT (Higher order Thinking) questions in the class, which promotes criticalthinking.
- Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather thansimply recall it.
- Show the different ways to solve the same problem and encourage the students to come upwith their own creative ways to solve them.
- Discuss how every concept can be applied to the real world and when that's possible, it helps toimprove the students' understanding.

UNIT-1

VECTOR SPACES **[8 hours]**

Introduction, Vector spaces, Subspaces, Linear Combinations, Linear Spans, row space and columnspace of a Matrix, Linear Dependence and Independence, Basis and Dimension, Coordinates.

Teaching-Learning Process: Chalk and Board, Problem based learning.

UNIT-2

LINEAR TRANSFORMATIONS **[8 hours]**

Introduction, Linear Mappings, Geometric linear transformation of $\mathbb{R}^2$, Kernel and Image of a linear transformations, Rank-Nullity Theorem (No proof), Matrix representation of linear transformations, Singular and Non-singular linear transformations, Invertible linear transformations.

Teaching-Learning Process: Chalk and Board, Problem based learning.

UNIT-3

EIGENVALUES AND EIGENVECTORS **[8 hours]**

Introduction, Polynomials of Matrices, Applications of Cayley-Hamilton Theorem, eigen spaces ofa linear transformation, Characteristic and Minimal Polynomials of Block Matrices, Jordan Canonical form.

Teaching-Learning Process: Chalk and Board, Problem based learning.

UNIT-4

INNER PRODUCT SPACES **[8 hours]**

Inner products, inner product spaces, length and orthogonality, orthogonal sets and Bases, projections, Gram-Schmidt process, QR-factorization, least squares problem and least square error.

Teaching-Learning Process: Chalk and Board, Problem based learning.

UNIT-5

OPTIMIZATION TECHNIQUES IN LINEAR ALGEBRA **[8 hours]**

Diagonalization and Orthogonal diagonalization of real symmetric matrices, quadratic forms and its classifications, Hessian Matrix, Method of steepest descent, Singular value decomposition. Dimensionality reduction – Principal component analysis.

Teaching-Learning Process: Chalk and Board, Problem based learning.

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Course outcomes (Course Skills Set)

After successfully completing the course, the student will be able to understand the topics:

Course Code	CO	COURSE OUTCOME (CO)	PO	Strength
22MA4BSLIA	CO 1	Apply the concepts of linear algebra in Computer and allied Engineering Sciences.	1	3
	CO 2	Analyze the computer science and allied engineering Sciences applications using Linear algebra.	1	2
	CO 3	Demonstrate the applications of computer science and allied engineering Science applications using Linear algebra tools.	1, 5, 9, 10	1

Assessment Details (both CIE and SEE)

Component	Type of assessment	Max. Marks	Total	50 % Weightage	Total
CIE – Theory	Quiz	10	100	5	50
	AAT	10		5	
	Test 1	40		20	
	Test 2	40		20	
	Test 3	40		20	
SEE	End Exam	100		50	

Two best scores out of the three tests will be considered for CIE.

CIE methods/question paper is designed to attain the different levels of Bloom's taxonomy asper the outcome defined for the course.

SEMESTER END EXAMINATION:

- Each unit consists of one full question.
- Five full questions to be answered.
- To set one question each from Units 1, 4 and 5 and two questions each from Unit 2 and Unit 3.

SUGGESTED LEARNING RESOURCES:

Text Books:

1. Linear Algebra and its applications, David C. Lay, Steven R. Lay, Judi J Mc. Donald, 6thEdition, 2021, Pearson Education.
2. Linear Algebra and its applications, Gilbert Strang, 4th edition, 2005, Brooks Cole.
3. Linear Algebra: An Introduction, Richard Bronson & Gabriel B. Costa, 2nd edition.

Reference Books:

1. Schaum's outline series -Theory and problems of linear algebra, Seymour Lipschutz, MarcLipson, 6th edition, 2017, McGraw-Hill Education.
2. Mathematics for Machine learning, Marc Peter Deisennroth, A. Aldo Faisal, Cheng SoonOng, 2020, Cambridge University Press.

E books and online course materials:

1. https://ocw.mit.edu/courses/mathematics/18-06sc-linear-algebra-fall-2011/index.htm
2. https://www.math.ucdavis.edu/~linear/linear.pdf

Online Courses and Video Lectures:

1. https://www.coursera.org/learn/linear-algebra-machine-learning
2. https://nptel.ac.in/syllabus/111106051/

Course Title	PROBABILITY AND STATISTICS FOR MACHINE LEARNING				
Course Code	22AM4PCPSM	Credits	4	L-T-P	3-1-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	5	Total Lecture Hours			36

UNIT – 1	6 Hrs
Probability and Random Variables: Events and their probabilities, outcomes, sample space, set operations, rules of Probability, Axioms of Probability, Computing probabilities of events, Combinatorics.	
UNIT – 2	**10 Hrs**
Discrete Random Variables: Distribution of a random variable, Types of random variables, Joint and marginal distribution, Independence of random variables Expectation and variance, function , properties, standard deviation, Covariance and correlation, Properties of discrete Random variables, Bernoulli distribution, Binomial distribution, Geometric distribution Poisson distribution. **Continuous Random variables:** Probability density, Union, Exponential, Normal distributions and Central Limit Theorem.	
UNIT – 3	**6 Hrs**
Introduction to statistics: Population and sample, parameters and statistics Descriptive statistics, Mean, Median, Quantiles, Percentiles, Quartiles, Variance, Standard Deviation, Standard Errors of Estimates.	
UNIT – 4	**7 Hrs**
Statistical Inference: Parameter estimation, Method of moments, Method of maximum likelihood, Estimation of standard errors, Confidence intervals, Construction of confidence intervals: a general method, Confidence interval for the population mean, Confidence interval for the difference between two means, Selection of a sample size, Estimating means with a given precision, Hypothesis Testing, Type I and Type II errors: level of significance, Rejection regions, Z-tests for means and proportions, T-tests, Duality: two-sided tests and two-sided confidence intervals.	
UNIT – 5	**7 Hrs**
Regression: Linear regression, Regression and correlation, Overfitting a model, Analysis of variance, prediction, and further inference, ANOVA and R-square, Tests and confidence intervals Prediction, Multivariate regression, Logistic regression, Dimensionality reduction.	

Text Books:

1. *Probability and Statistics for Computer Scientists,* Michael Baron, 3rd Edition, CRC press, 2019.

Reference Books:

1. *Probability and Statistics with Reliability, Queuing theory and Computer Science Applications,* Kishore S Trivedi, 2nd Edition, Willey Publishers, 2016.

Course Outcomes	
CO1	Apply properties of commonly used probability distributions in machine learning to solve given problems.
CO2	Analyze uncertainty inherent in predictions made by machine learning models using statistical knowledge.
CO3	Devise the relationship between the features to develop prediction model and report the findings with reasoning.

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2												1		
CO2		2											1		
CO3				1					1	1			1		

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Probability and Statistics	NPTEL	https://nptel.ac.in/courses/111105041
2.	Probability and Statistics for Machine Learning and Data Science	Coursera	https://in.coursera.org/learn/machine-learning-probability-and-statistics

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice / Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks
Unit 2	Internal Choice	Two questions to be asked for 20 marks each
Unit 3	Mandatory	One question to be asked for 20 marks
Unit 4	Mandatory	One question to be asked for 20 marks
Unit 5	Internal Choice	Two questions to be asked for 20 marks each

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	25%
Apply / Analyze	50%
Create / Evaluate	25%

Assessment Pattern:

Category			Score Split up	Total
Continuous Internal Evaluation (CIE)	Theory	CIE - 1	40M (Best of Two)	50M
		CIE – 2		
		CIE - 3		
		AAT/Quiz	10M	
Semester End Examination (SEE)	100M (50% weightage)			50M
			Total	100M

Course Title	OPERATING SYSTEMS				
Course Code	22AM4PCOPS	Credits	3	L-T-P	3-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours /Week	3	Total Lecture Hours			36

UNIT - 1	7 Hrs
Introductions: What Is An Operating System? The Operating System Zoo, Operating System Concepts: Processes, Address Spaces, Files, Input/Output, Protection, The Shell. System Calls: System Calls for Process Management, System Calls for File Management, System Calls for Directory Management. Operating System Structure. **Processes and Threads:** The Process Model, Process Creation, Process Termination, Process Hierarchies, Process States, Thread Usage, The Classical Thread Model, Implementing Threads In User Space, Implementing Threads In The Kernel.	
UNIT - 2	**7 Hrs**
Interprocess Communication: Race Conditions, Critical Regions Mutual Exclusion with Busy Waiting Semaphores Mutexes Monitors, Message Passing, Avoiding Locks: Read-Copy-Update, The Dining Philosophers Problem, The Readers and Writers Problem. Introduction to Scheduling, Scheduling in Batch Systems, Scheduling in Interactive Systems, Scheduling in Real-Time Systems.	
UNIT - 3	**8 Hrs**
Memory Management: A Memory Abstraction: Address Space, Virtual Memory, Page Replacement Algorithms, Local Versus Global Allocation Policies, Shared Pages, Page Fault Handling, Implementation of Pure Segmentation.	
UNIT - 4	**8 Hrs**
Disk performance optimization: Disk Hardware, Disk Formatting, Disk Arm Scheduling Algorithms, Error Handling. **File Systems:** Files, Directories, File-System Layout, Implementing Files, Implementing Directories.	
UNIT - 5	**6 Hrs**
Deadlocks: Resources, Introduction to Deadlocks, The Ostrich Algorithm, Deadlock Detection and Recovery, Deadlock Avoidance, Deadlock Prevention, Other Issues. **Multiple Processor Systems:** Multiprocessor Operating System Types, Multiprocessor Synchronization, Multiprocessor Scheduling.	

Text Books:

1. *Modern operating systems,* Tanenbaum, Andrew, 4th Edition, Pearson Education, 2009.

Reference Books:

1. *Operating System Concepts*, Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, 9th Edition, Wiley India, 2012.

Course Outcomes	
CO1	Apply the fundamental concepts of modern operating systems to demonstrate proficiency in optimizing system performance and resource utilization.
CO2	Analyze the impact of Concurrency and synchronization on system performance, considering trade-offs and making informed decisions to address identified issues.
CO3	Evaluate the effectiveness of different algorithms and strategies in solving specific operating system problems and propose optimized solutions based on critical analysis.

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2												2		
CO2		2											2		
CO3			2										2		

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Operating System Fundamentals	NPTEL	https://nptel.ac.in/courses/106105214
2.	Introduction to Operating Systems Specialization	Coursera	https://in.coursera.org/specializations/codio-introduction-operating-systems

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice / Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks
Unit 2	Internal Choice	Two questions to be asked for 20 marks each
Unit 3	Mandatory	One question to be asked for 20 marks
Unit 4	Mandatory	One question to be asked for 20 marks
Unit 5	Internal Choice	Two questions to be asked for 20 marks each

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	25%
Apply / Analyze	50%
Create / Evaluate	25%

Assessment Pattern:

Category			Score Split up	Total
Continuous Internal Evaluation (CIE)	Theory	CIE - 1	40M (Best of Two)	50M
		CIE – 2		
		CIE - 3		
		AAT/Quiz	10M	
Semester End Examination (SEE)	100M (50% weightage)			50M
			Total	100M

Course Title	DESIGN AND ANALYSIS OF ALGORITHMS				
Course Code	22AM4PCDAA	Credits	4	L-T-P	3-0-1
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	5	Total Lecture Hours			36

UNIT – 1	7 Hrs
Fundamentals of Algorithm Analysis: Definition of algorithm, Algorithmic Problem Solving, Framework for Analysis of algorithm efficiency, Asymptotic Notations, Mathematical Analysis of Non recursive algorithms and Recursive algorithms.	
UNIT – 2	**7 Hrs**
Brute Force: Sorting techniques, String Matching, Exhaustive search **Divide and Conquer:** Master Theorem, Merge sort, Quicksort. **Greedy Technique:** Minimum Spanning tree and its applications - Dijkstra's Algorithm, Prim's Algorithm, Kruskal's Algorithm.	
UNIT – 3	**8 Hrs**
Decrease and conquer: Depth First Search (DFS), Breadth First Search (BFS), Applications of DFS and BFS, Topological Sorting, Algorithms for Generating Combinatorial Objects. **Space and Time Trade-offs:** Horspool Algorithm, Hashing.	
UNIT – 4	**7 Hrs**
Transform and Conquer: Pre-sorting, 2-3 Trees, Heaps and Heapsort **Dynamic Programming:** Computing a Binomial Coefficient, Floyd's Algorithm, Warshall's Algorithm, Knapsack Problem and Memory functions.	
UNIT – 5	**7 Hrs**
Limitations of Algorithm Power: Decision Trees, P, NP and NP-Complete Problems. **Backtracking:** N queens problem, Sum of subset problem **Branch and bound:** Travelling Salesman problem, Assignment problem	

Text Books:

1. *Introduction to the design and analysis of algorithms,* Anany Levitin, 3rd Edition, Pearson Education, 2011.
2. *Computer Algorithms*, Horowitz E., Sahani S., Rajasekharan S., 2nd Edition, Universities Press, 2008.

Reference Books:

1. *Introduction to Algorithms,* Cormen T.H, Leiserson C. E, Rivest R.L, Stein C, 3rd Edition, PHI 2010.
2. *Data Structures and Algorithm Analysis in C++,* Mark Allen Weiss, PHI, 2013.

Course Outcomes

CO1	Apply algorithmic design paradigms to basic computing problems.
CO2	Analyze the time complexity of different algorithms and design efficient algorithms using appropriate algorithm design techniques.
CO3	Conduct experiments to implement real world problems using algorithmic design techniques through modern tools.

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2												2		
CO2		2											2		
CO3				1	2								2		

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Design And Analysis Of Algorithms	NPTEL	https://nptel.ac.in/courses/106106131
2.	Algorithms Specialization	Coursera	https://in.coursera.org/specializations/algorithms

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice / Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks
Unit 2	Internal Choice	Two questions to be asked for 20 marks each
Unit 3	Internal Choice	Two questions to be asked for 20 marks each
Unit 4	Mandatory	One question to be asked for 20 marks
Unit 5	Mandatory	One question to be asked for 20 marks

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	25%
Apply / Analyze	50%
Create / Evaluate	25%

Assessment Pattern:

Category			Score Split up	Total
Continuous Internal Evaluation (CIE)	Theory	CIE - 1	20M (Best of Two)	25M
		CIE – 2		
		CIE - 3		
		AAT/Quiz	05M	
	Lab	CIE - 1	10M	25M
		CIE – 2	10M	
		AAT	05M	
Semester End Examination (SEE)	100M (50% weightage)			50M
			Total	100M

Course Title	INTRODUCTION TO ARTIFICIAL INTELLIGENCE				
Course Code	22AM4PCIAI	Credits	4	L-T-P	3-0-1
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours /Week	5	Total Lecture Hours			36

UNIT - 1	6 Hrs
Introduction: What is AI? **Intelligent Agents**: How agent should act, Structure of Intelligent Agents, Environments Problem Solving: Formulating problems, Example problems **Uniformed-search strategies:** Breadth-First Search, Uniform Cost Search, Depth-First Search, Depth Limited Search, Iterative Deepening Search.	
UNIT - 2	**8 Hrs**
Heuristic Search Strategies: Generate-and-Test, Hill Climbing, Best-first Search, Problem Reduction, Constraint Satisfaction, Means-ends Analysis.	
UNIT - 3	**8 Hrs**
Knowledge Representation: Propositional Logic – Syntax and Semantics, Using Propositional Logic, First-Order Logic – Syntax and Semantics, Using First-Order Logic **Representing Knowledge using Rules**: Procedural Versus Declarative Knowledge, Forward Versus Backward Reasoning, Semantic Knowledge, Ontology Based representation.	
UNIT - 4	**8 Hrs**
Uncertain Knowledge & Reasoning: Acting under Uncertainty, The Wumpus World Revisited, Representing Knowledge in an Uncertain Domain, The Semantics of Belief Networks, Efficient Representation of Conditional Distributions, Exact Inference in Bayesian Networks, Approximate Inference in Bayesian Networks, Relational and First-Order Probability Models, Other Approaches to Uncertain Reasoning.	
UNIT - 5	**6 Hrs**
Introduction to Expert Systems: Definition, Features of an Expert System, Organization, Characteristics, Prospector, Knowledge Representation in Expert Systems, Expert System tools – MYCIN, EMYCIN.	

Text Books:

1. *Artificial Intelligence - A Modern Approach,* Stuart Russell and Peter Norvig, 3rd Edition, Pearson, 2014.

Reference Books:

1. *Artificial Intelligence, Elaine* Rich, Kevin Knight and Shivashankar B Nair, 3rd Edition, McGraw-Hill Education, 2015.
2. *Introduction to Artificial Intelligence and Expert Systems,* Dan W Patterson, Pearson, 2015.

Course Outcomes	
CO1	Apply the principles of Intelligent Agents to address problem-solving challenges through search strategies.
CO2	Construct procedural and declarative knowledge through the implementation of agent-based rules, facilitating a logic-based analysis.
CO3	Assess the probabilities associated with managing uncertain knowledge and utilize the principles of expert systems effectively.

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		2												2	
CO2			3											2	
CO3				1	1									2	

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Introduction to Artificial Intelligence	NPTEL	https://nptel.ac.in/courses/106105077
2.	Introduction to Artificial Intelligence	Coursera	https://in.coursera.org/learn/introduction-to-ai
3.	Artificial Intelligence : Knowledge Representation and Reasoning	NPTEL	https://nptel.ac.in/courses/106106140

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice / Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks
Unit 2	Internal Choice	Two questions to be asked for 20 marks each
Unit 3	Internal Choice	Two questions to be asked for 20 marks each
Unit 4	Mandatory	One question to be asked for 20 marks
Unit 5	Mandatory	One question to be asked for 20 marks

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	25%
Apply / Analyze	50%
Create / Evaluate	25%

Assessment Pattern:

Category			Score Split up	Total
Continuous Internal Evaluation (CIE)	**Theory**	CIE - 1	40M (Best of Two)	**50M**
		CIE – 2		
		CIE - 3		
		AAT/Quiz	01M	
Semester End Examination (SEE)	100M (50% weightage)			**50M**
			Total	**100M**

Course Title	SEMINAR - INTERNSHIP INVOLVING SOCIAL ACTIVITY				
Course Code	22AM4SRIN1	Credits	1	L-T-P	0-0-1
CIE	50	SEE	50 Marks (50% Weightage)		
Contact Hours / Week	02	Total Lecture Hours			NA

The internship in Social Activity and Community Engagement is designed to provide students with practical exposure to the field of social work, community development. Interns are expected to contribute to projects that aim to enhance the quality of life for individuals and communities, fostering a sense of social responsibility and community empowerment. Students are expected to get exposure to diverse community challenges and chance to contribute to meaningful solutions.

Course Outcomes	
CO1	Build a professional network within the social sector, connecting with professionals and organizations, and gaining insights into potential career paths and opportunities.
CO2	Develop a keen sense of ethical responsibility and social consciousness, understanding the importance of ethical considerations in social work and community development.
CO3	Demonstrate leadership skills by taking initiative, exhibiting problem-solving abilities, and adapting to dynamic community environments.

CO – PO - PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO 1										1		1	1		
CO 2							1	1					1		
CO 3									2		1		1		

Assessment Pattern:

Evaluation Components	Marks
CIE – Presentation (Review)	50
SEE – Presentation	50
Total	100

Course Title	PYTHON PROGRAMMING				
Course Code	22AM4AEPPM	Credits	1	L-T-P	0-0-1
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	2				

About the Course: The students will be exploring fundamentals to advanced features of python programming that are necessary for AI and ML applications. The students also will explore various tools like anaconda, pytorch to conduct various experiments. At the end of the course project work have to demonstrated in groups.

Text Books:

1. *Python Crash Course: A Hands-On, Project-Based Introduction to Programming,* Eric Matthes, 2nd Edition, No Starch Press, 2019.
2. *Learn Python the Hardway,* Zeo A Shaw, 3rd Edition, Addison Wesley, 2013.

Reference Books:

1. *Introducing Python,* Bill Lubanovic, 2nd Edition, O'Reilly Media, 2014.
2. *Learning with Python: How to Think Like a Computer Scientist,* Allen Downey, Jeffrey Elkner and Chris Meyers, Dreamtech Press, 2015.
3. *Learning to Program using Python,* Cody Jackson, 2nd Edition, 2014.
4. *Programming Python,* Mark Lutz, O'reilly Media, 2015.

Detailed Syllabus to cover Python Basics (will be taught in parallel with lab programs):

UNIT – 1

Why should you learn to write programs, Variables, expressions and statements, Conditional execution, Functions, Iteration, Strings, Lists, Dictionaries, Tuples, Regular Expressions.

UNIT – 2

Files: File Operations, Files and Streams, Creating a File, Reading From a File, Iterating Through Files, Seeking, Serialization.

Databases: How to Use a Database, Working With a Database, Using SQL to Query a Database, Python and SQLite, Creating an SQLite DB, Pulling Data from a DB, SQLite Database Files.

UNIT – 3

NumPy: The Basics of NumPy Arrays, Computation on NumPy Arrays: Universal Functions, Aggregations: Min, Max, and Everything In Between, Computation on Arrays: Broadcasting, Comparisons, Masks, and Boolean Logic, Fancy Indexing, Sorting Arrays.

Data visualization: Scatter plot, Line plot, Bar plot, Histogram, Box plot, Pair plot

UNIT – 4

Introduction to Pandas: Loading your first data set, Looking at columns, rows, and cells, Creating your own data, The Series, The DataFrame.

Data Manipulation with Pandas: Operating on Data in Pandas, Handling Missing Data, Combining Datasets: Concat and Append, Merge and Join, Aggregation and Grouping.

UNIT – 5

GUI development – examining GUI, understanding event driven programming, root window, labels, buttons, creating a GUI using a class, binding widgets and event handlers, text and entry widgets and Grid layout manager, check buttons, radio buttons, mad lib program

CASE STUDY

- **Regression:** Predicting price of pre-owned cars
- **Classification:** Classifying personal income

List of Text Books:

1. *Learning to Program using Python,* Cody Jackson, 2nd Edition, 2014.
2. *Pandas for Everyone: Python Data Analysis,* Daniel Y. Chen, 1st Edition, Pearson, 2018.
3. *Python Data Science Handbook,* Jake VanderPlas, O'Reilly, 2017.

Course Outcomes:

CO1	Implement different algorithms using control structures such as loops and conditional statements in python.
CO2	Implement solutions to programs involving file handling concepts using Python.
CO3	Apply python libraries and modules and work collaboratively on programming tasks.

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**1**													**2**	
CO2		**1**												**2**	
CO3			**1**		**2**			**1**	**1**			**1**		**2**	

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Python for Data Science	NPTEL	https://onlinecourses.nptel.ac.in/noc22_cs32/preview
2.	The Joy of Computing using Python	NPTEL	https://onlinecourses.nptel.ac.in/noc19_cs41/preview
3.	Python for Everybody Specialization	Coursera	https://in.coursera.org/specializations/python

Assessment Pattern:

Category			Score Split up	Total
Continuous Internal Evaluation (CIE)	**Presentation 1**	CIE - 1	20M	**25M**
		AAT	05M	
	Presentation 2	CIE – 2	20M	**25M**
		AAT	05M	
Semester End Examination (SEE)	100M (50% weightage)			**50M**
Total				**100M**

B.M.S. College of Engineering, Bengaluru – 19
(Autonomous Institute, Affiliated to VTU | Approved by AICTE)

Scheme of Instructions Semester – V (With effect from the Academic Year 2021-22: admitted batches and onwards)

Sl.#	Course Type	Course Code	Course Title	Teaching Hours in Credits/Week			Total Credits	Examination			
				Theory Lecture	Tutorial	Practical		Duration in hours	CIE Marks	SEE Marks	Total Marks
				L	T	P					
1	PC-9	23AM5PCSED	Software Engineering & Design Patterns	3	0	0	3	03	50	50	100
2	PC-10	23AM5PCOOP	Object Oriented Programming	3	0	1	4	05	50	50	100
3	PC-11	23AM5PCIML	Introduction to Machine Learning	2	0	1	3	04	50	50	100
4	PC-12	23AM5PCINN	Introduction to Neural Networks	2	0	1	3	04	50	50	100
5	HS-6	23AM5HSCSM	Calculus and Statistics for Machine Intelligence	2	0	1	3	04	50	50	100
6	PE-1	23AM5PEABI	AI in Business Intelligence	3	0	0	3	03	50	50	100
		23AM5PEKDI	Knowledge Discovery								
		23AM5PEDIP	Digital Image Processing								
7	AE-6	23AM5AEDVA	Data visualization and Analysis	2	0	1	3	04	50	50	100
8	NCMC-3	23AM5NCCSE	Communication Skills Enhancement	Non-credit mandatory Course							
			Total	17	0	5	22	27	350	350	900

Note: HS: Humanities and Social Sciences/Management Course, BS: Basic Science Course, ES: Engineering Science Course, PC: Professional Core Course, PE: Professional Elective Course, OE: Open Elective Course; PW: Project/Mini Project Work, SR: Seminar Technical / Seminar Internship, NC: Non-credit mandatory course

Course Title	SOFTWARE ENGINEERING AND DESIGN PATTERNS				
Course Code	23AM5PCSED	Credits	3	L-T-P	3-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	3	Total Lecture Hours			36

UNIT - 1	8 Hours
Overview of Software Engineering: Nature of Software, Application Domains, Software Engineering, Software Process & Principles. **Process Models**: Waterfall, V-Model, Iterative, Spiral, Agile Development, Scrum. Modeling Requirements: Requirements Engineering, Requirement Elicitation, SRS Document, Functional and Non-Functional Requirements, Software Quality Assurance: Quality Standards Models ISO.	
UNIT - 2	**7 Hours**
Software Metrics: Size-Oriented Metrics, Halsted Metrics, Cyclomatic Complexity Metrics. **Software Modelling**: Unified Modeling Language, Use Cases, Class, Sequence, Activity, State Diagrams. **Software Design:** Software Quality Guidelines and Design Principles, Design concepts and principles – Abstraction – Modularity, Types of Cohesion and Coupling, Functional Independence. Case study- Six-Sigma.	
UNIT – 3	**6 Hours**
Software Testing: Verification and Validation, Unit Testing, Integration Testing, Testing Strategies for Web Apps. White Box-Testing: Basis Path Testing, Flow Graph Notation, Graph Matrices, Control Flow Testing, Black Box Testing: Graph Based Testing, Equivalence Partitioning, Boundary Value Analysis.	
UNIT – 4	**8 Hours**
Patterns: What is a Pattern? What Makes a Pattern? Relationships between Patterns. **Architectural Patterns:** Introduction, From Mud to Structure, Layers, Pipes and Filters. Distributed Systems: Broker. **Interactive Systems**: Model-View-Controller, Presentation-Abstraction-Control. Adaptable Systems: Microkernel.	
UNIT – 5	**7 Hours**
Design Patterns: Introduction, Structural Patterns-Adapter, Bridge, Composite, Decorator, Facade, Proxy.	

Text Books:

1. *Software engineering: a practitioner's approach*, Roger S. Pressman, Palgrave macmillan, 7th Edition, 2017.
2. *Pattern-Oriented Software Architecture A System of Patterns*, Frank Buschmann, Regine Meunier, Hans Rohnert, Peter Sommerlad and Michael Stal, Volume 1, Wiley series in Software Design Patterns, 1996.

Reference Books:

1. *The Essentials of Modern Software Engineering: Free the Practices from the Method, Prisons,* Ivar Jacobson, Harold "Bud" Lawson, Pan-Wei Ng, Paul E. McMahon and Michael Goedicke, 1st Edition, 2019.
2. *Software Engineering, Sommerville*, I., Pearson Education Limited, 10th Edition, 2017.
3. *Design Patterns: Elements of Reusable Object-Oriented Software*, Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides, Addison-Wesley, 1995.

Course Outcomes

CO1	Analyze software requirements, models and metrics for developing quality software.
CO2	Apply techniques, principles and practices for designing, implementing and testing software systems.
CO3	Analyze and Implement design patterns for given software requirements.

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**1**												**1**		
CO2		**2**											**1**		
CO3			**2**		**1**				**1**	**1**	**1**		**1**		

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Software Engineering	NPTEL	https://nptel.ac.in/courses/106105182
2.	Software Engineering Specialization	Coursera	https://in.coursera.org/specializations/software-engineering#courses
3.	Software Testing	NPTEL	https://onlinecourses.nptel.ac.in/noc22_cs61/preview

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice / Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks
Unit 2	Internal Choice	Two questions to be asked for 20 marks each
Unit 3	Mandatory	One question to be asked for 20 marks
Unit 4	Internal Choice	Two questions to be asked for 20 marks each
Unit 5	Mandatory	One question to be asked for 20 marks

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	25%
Apply / Analyze	50%
Create / Evaluate	25%

Assessment Pattern:

Category			Score Split up	Total
Continuous Internal Evaluation (CIE)	**Theory**	CIE - 1	40M (Best of Two)	**50M**
		CIE – 2		
		CIE - 3		
		Quiz	05M	
		AAT	05M	
Semester End Examination (SEE)	100M (50% weightage)			**50M**
Total				**100M**

Course Title	OBJECT ORIENTED PROGRAMMING				
Course Code	23AM5PCOOP	Credits	4	L-T-P	3-0-1
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	3	Total Lecture Hours			36

UNIT - 1	6 Hours
Introduction: The Concepts of Abstract Machine and Interpreter, Influences on language design, Implementation methods, Programming environments, Language categories and examples. **Modeling physical objects with object programming**: Procedural Python examples, OOP principles, classes, objects and instantiation.	
UNIT - 2	**7 Hours**
Functions: Defining functions in classes, calling functions in classes, Attributes, Passing Arguments to a Method, creating multiple instances, Initializing parameters. **Encapsulation:** Encapsulations with functions, Encapsulations with objects, Making Instance Variables More Private.	
UNIT - 3	**6 Hours**
Abstraction: Abstract base classes, Creation of abstract base class. **Inheritance:** Extending built-ins, overriding and super keyword, Multiple Inheritance, Diamond problem, Real-World Examples of Inheritance.	
UNIT - 4	**7 Hours**
Polymorphism: Sending messages to objects, Pygame shapes, Polymorphism in pywidgets , Polymorphism for operators, Magic methods. **Better error handling with Exceptions in python:** Try and except, Raise statement and custom exceptions.	
UNIT - 5	**8 Hours**
Managing Memory used by objects: Object lifetime, Reference count, Garbage collection, Class variables and constants, Managing memory slots. **Concurrency:** Threads, Multithreading, Multiprocessing. **Timers in python:** Approaches for implementing timers, Displaying time.	

Text Books:

1. *Programming Languages: Principles and Paradigms*, springer, Maurizio Gabbrielli, Simone Martini, 2023.
2. *Python 3 object-oriented programming*, Second edition, Dusty Phillips, 2015.

Reference Books:

1. *Object oriented python*, Irv Kalb, 2022.
2. *Concepts of programming languages*, Tenth Edition, Robert W. Sebesta, 2012.

Course Outcomes	
CO1	Design various methodology for organizing data and solving basic programming challenges using Linear Data Structures.
CO2	Apply the concepts of Linear Data Structures and Recursive techniques to handle problems in real time applications through programming.
CO3	Analyze and implement application based real time solutions using Non-linear Data structures.

Course Outcomes	
CO1	Analyze and interpret the principles of Object-Oriented Programming (OOP) to assess its impact on code reusability and maintainability.
CO2	Design event driven GUI and web related applications which mimic the real-world scenarios by integrating concurrent programming principles.
CO3	Develop hands-on skills through practical assignments, enabling to implement and troubleshoot key object-oriented functionalities using relevant programming languages and tools.

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		**3**											**1**		
CO2			**2**										**1**		
CO3					**1**				**1**	**2**			**1**		

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Programming in Java	NPTEL	https://nptel.ac.in/courses/106105191
2.	Object Oriented Programming in Java	Coursera	https://www.coursera.org/learn/object-oriented-java

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice / Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks
Unit 2	Internal Choice	Two questions to be asked for 20 marks each
Unit 3	Mandatory	One question to be asked for 20 marks
Unit 4	Internal Choice	Two questions to be asked for 20 marks each
Unit 5	Mandatory	One question to be asked for 20 marks

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	25%
Apply / Analyze	50%
Create / Evaluate	25%

Assessment Pattern:

Category			Score Split up	Total
Continuous Internal Evaluation (CIE)	**Theory**	CIE - 1	20M (Best of Two)	**25M**
		CIE – 2		
		CIE - 3		
		AAT/Quiz	05M	
	Lab	CIE - 1	10M	**25M**

		CIE – 2	10M	
		AAT	05M	
Semester End Examination (SEE)	100M (50% weightage)			**50M**
			Total	**100M**

Course Title	INTRODUCTION TO MACHINE LEARNING				
Course Code	23AM5PCIML	Credits	3	L-T-P	2-0-1
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	2	Total Lecture Hours			26

UNIT - 1	4 Hours
Introduction: What Is Machine Learning (ML)? Uses and Applications with examples, Types of Machine Learning, Main Challenges, Testing and Validating. Well posed learning problems, Designing a Learning system, Perspectives and Issues in Machine learning. **Concept Learning:** Concept learning task, search, Find-S algorithm, Version space, Candidate Elimination algorithm, Inductive Bias.	
UNIT - 2	**6 Hours**
Supervised Machine Learning: Decision Trees: Introduction, Decision Tree Representation, Appropriate Problems for decision Tree Algorithm, Hypothesis Space Search, Inductive Bias in Decision Tree Learning, Issues. **Instance- Based Learning:** Introduction, Support Vector Machines: Linear and Non-Linear, Kernel Functions, k- Nearest Neighbor Learning, Locally Weighted Regression.	
UNIT - 3	**6 Hours**
Supervised Learning Techniques: Bayesian Learning: Concept Learning – Maximum Likelihood – Minimum Description Length Principle – Bayes Optimal Classifier – Naïve Bayes Classifier– example-Bayesian Belief Network – EM Algorithm. **Ensemble and Probabilistic Learning Model:** Voting classifiers, Bagging and pasting, Random patches, Random forests, Boosting, stacking.	
UNIT - 4	**5 Hours**
Unsupervised Machine Learning: Clustering – K means, Spectral, Hierarchical, Association rule mining, Anomaly detection.	
UNIT - 5	**5 Hours**
Unsupervised Learning Techniques: Dimensionality Reduction: The Curse of Dimensionality, Main Approaches for Dimensionality, PCA, Kernel PCA, LLE, Linear Discriminant Analysis (LDA).	

Text Books:

1. *Machine Learning,* Tom Mitchell, , McGraw Hill, 3rdEdition, 1997.
2. *Introduction to Machine Learning with Python*, A Guide for Data Scientists, Andreas C. Miller and Sarah Guido, O'Reilly Media, 2017.
3. *Introduction to Machine Learning* ,Ethem Alpaydın, Third edition, MIT press.

Reference Books:

1. *MACHINE LEARNING - An Algorithmic Perspective*, Second Edition, Stephen Marsland, 2015.
2. *Hands-on machine learning with Scikit-Learn and TensorFlow: concepts, tools, and techniques to build intelligent systems,* Aurelien Geron, O'Reilly Media, 2019.

Course Outcomes	
CO1	Analyze the existing data, discover patterns and prepare the data through transformations to suit the requirement of learning models.
CO2	Design optimized models to solve real time problems and evaluate their efficacy using mathematical tools.
CO3	Construct rule based and hybrid models to automate the complex learning process for accomplishing the task of classification and clustering.

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		**2**												**2**	
CO2			**3**											**2**	
CO3					**3**				**1**	**1**				**2**	

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Introduction to Machine Learning	NPTEL	https://onlinecourses.nptel.ac.in/noc23_cs18/preview
2.	Introduction to Machine Learning	NPTEL	https://nptel.ac.in/courses/106105152
3.	Introduction to Machine Learning	Coursera	https://in.coursera.org/learn/machine-learning-duke
4.	Machine Learning Specialization	Coursera	https://in.coursera.org/specializations/machine-learning-introduction

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice / Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks
Unit 2	Mandatory	One question to be asked for 20 marks
Unit 3	Mandatory	One question to be asked for 20 marks
Unit 4	Internal Choice	Two questions to be asked for 20 marks each
Unit 5	Internal Choice	Two questions to be asked for 20 marks each

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	25%
Apply / Analyze	50%
Create / Evaluate	25%

Assessment Pattern:

Category			Score Split up	Total
Continuous Internal Evaluation (CIE)	**Theory**	CIE - 1	40M (Best of Two)	**50M**
		CIE – 2		
		CIE - 3		
		AAT/Quiz	10M	
Semester End Examination (SEE)	100M (50% weightage)			**50M**
Total				**100M**

Course Title	INTRODUCTION TO NEURAL NETWORKS				
Course Code	23AM5PCINN	Credits	3	L-T-P	2-0-1
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours /Week	4	Total Lecture Hours			26

UNIT – 1	5 Hours
Introduction: What is a Neural Network? , Models of a Neuron , Neural Networks Viewed As Directed Graphs, Feedback, Network Architectures, Knowledge Representation.**Rosenblatt's Perceptron**: Introduction, Perceptron , The Perceptron Convergence Theorem , Relation Between the Perceptron and Bayes Classifier for a Gaussian ,The Batch Perceptron Algorithm, Filtering structure of the LMS Algorithm, Unconstrained Optimization: a Review.	
UNIT – 2	**6 Hours**
Multilayer Perceptron's-1 : Introduction , Some Preliminaries , Batch Learning and On-Line Learning, The Back-Propagation Algorithm , XOR Problem , Heuristics for Making the Back-Propagation Algorithm Perform Better, Back Propagation and Differentiation, The Hessian and Its Role in On-Line Learning, Optimal Annealing and Adaptive Control of the Learning Rate.	
UNIT – 3	**5 Hours**
Multilayer Perceptron's-2 : Generalization Approximations of Functions, Cross-Validation, Complexity Regularization and Network Pruning, Virtues and Limitations of Back-Propagation Learning, Supervised Learning Viewed as an Optimization Problem.	
UNIT – 4	**5 Hours**
Radial-Basis Function Networks: Introduction , Cover's Theorem on the Separability of Patterns , The Interpolation Problem , Radial-Basis-Function Networks, Recursive Least-Squares Estimation of the Weight Vector, Hybrid Learning Procedure for RBF Networks.	
UNIT – 5	**5 Hours**
Self-Organizing Maps : Introduction ,Two Basic Feature-Mapping Models , Self-Organizing Map , Properties of the Feature Map, Contextual Maps ,Hierarchical Vector Quantization, Kernel Self-Organizing Map, Relationship Between Kernel SOM and Kullback–Leibler Divergence.	

Text Books:

1. *Neural Networks and Learning Machines*, Simon Haykin, PHI, 3rd Edition, 2016.

Reference Books:

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

Course Outcomes	
CO1	Apply the basic principles of neural networks to build and train neural networks models using various frameworks.
CO2	Assess and Enhance Model Effectiveness through Metric Analysis and Performance Optimization Techniques.
CO3	Demonstrate the practical implementation of neural networks in addressing real-world challenges across diverse domains.

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		**1**												**2**	
CO2				**2**										**2**	
CO3					**2**				**1**					**2**	

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Neural Networks and Applications	NPTEL	https://archive.nptel.ac.in/courses/117/105/117105084/
2.	Neural Networks and Deep Learning	Coursera	https://in.coursera.org/learn/neural-networks-deep-learning
3.	Neural Networks for Signal Processing - I	NPTEL	https://onlinecourses.nptel.ac.in/noc22_cs92/preview

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice / Mandatory	Unit Wise Marks Distribution
Unit 1	Internal Choice	Two questions to be asked for 20 marks each
Unit 2	Mandatory	One question to be asked for 20 marks
Unit 3	Internal Choice	Two questions to be asked for 20 marks each
Unit 4	Mandatory	One question to be asked for 20 marks
Unit 5	Mandatory	One question to be asked for 20 marks

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	25%
Apply / Analyze	50%
Create / Evaluate	25%

Assessment Pattern:

Category			Score Split up	Total
Continuous Internal Evaluation (CIE)	**Theory**	CIE - 1	40M (Best of Two)	**50M**
		CIE – 2		
		CIE - 3		
		AAT	05M	
		Quiz	05M	
Semester End Examination (SEE)	100M (50% weightage)			**50M**
			Total	**100M**

Course Title	CALCULUS AND STATISTICS FOR MACHINE INTELLIGENCE				
Course Code	23AM5HSCSM	Credits	3	L-T-P	2-0-1
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	2	Total Lecture Hours			26

UNIT - 1	5 Hours
Differential Calculus: Gradient of a Straight Line, and Curve, Derivatives of First Principle, Second Derivative, partial derivatives, Differentiation by chain rule and product rule. **Integral Calculus:** Integral Calculus rules, indefinite and definite integrals.	
UNIT - 2	**5 Hours**
Linear Model Selection: Subset Selection: Best-Subset Selection, Forward- and Backward-Stepwise Selection, Forward-Stagewise Regression, Shrinkage Methods: Ridge Regression, The Lasso, Selecting the Tuning Parameter.	
UNIT - 3	**5 Hours**
Regularization: Logistic regression: Fitting Logistic Regression Models, Quadratic Approximations and Inference, L1 Regularized Logistic Regression.	
UNIT - 4	**6 Hours**
Optimization and Metrics: Introduction, Graphical approaches – Identification of optimal solution, Influence of inequality and equality constraints. **Unconstrained Optimization:** Single & Multivariable. **Constrained Optimization:** Augmented Lagrangian, Sequential Quadratic Programming Method. Metrics: MAE, MSE, RMSE, R^2, Confusion Matrix, AU-ROC.	
UNIT - 5	**5 Hours**
Similar Measures: Applications of Near-Neighbor Search, Jaccard Similarity of Sets, Similarity of Documents, Collaborative Filtering as a Similar-Sets Problem, Distance Measures: Definition of a Distance Measure, Euclidean Distances, Jaccard Distance, Cosine Distance, Edit Distance, Hamming Distance.	

Text Books:

1. *Calculus for Machine Learning Understanding the Language of Mathematics*, Jason Brownlee.
2. *The Elements of Statistical Learning Data Mining, Inference, and Prediction*, Trevor Hastie ,Robert Tibshirani ,Jerome Friedman, 2nd Edition, Springer.
3. *Optimization for machine learning Finding function Optima with Python*, Jason Brownlee.
4. *Mining of Massive Datasets*, Jure Leskovec, Anand Rajaraman, Jeffrey D. Ullman.

Reference Books:

1. *An Introduction to Statistical Learning with Applications in R*, Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshiran.

Course Outcomes	
CO1	Apply concepts of differential calculus, Integral calculus for functional optimization and different types of linear model methods such as subset selection, shrinkage methods, logistic regression for a given problem
CO2	Solve various constrained and unconstrained problems with single variable and multivariable.
CO3	Assess the performance of different similarity measure methods and metrics.

Course Title	AI IN BUSINESS INTELLIGENCE				
Course Code	23AM5PEABI	Credits	3	L-T-P	3-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	3	Total Lecture Hours			36

UNIT - 1	8 Hours
Business Intelligence, Data Analytics and Decision Support: Opening Vignette, Changing Business Environments and Computerized Decision Support, Managerial Decision Making, Information systems Support for Decision Making, An Early Framework for Computerized Decision Support, The Concept of Decision Support Systems (DSS), A framework for Business Intelligence (BI), A Work System View of Decision Support, Overview of Business Analytics, Introduction to Big Data Analytics	
UNIT - 2	**7 Hours**
Decision Making Technologies: Decision Making, Models, Phases of the Decision-Making Process, The Intelligence Phase, The Design Phase, The Choice Phase, The Implementation Phase, How Decisions Are Supported, DSS - Capabilities, Classifications and Components. **Modeling and Analysis:** Structure of Mathematical Models for Decision Support, Certainty, Uncertainty, and Risk, Management Support Systems.	
UNIT - 3	**6 Hours**
Data Warehousing: Data Warehousing Definitions and Concepts, Data Warehousing Process Overview, Data Warehousing Architectures, Data Integration and the Extraction, Transformation, and Load (ETL) Processes, Data Warehouse - Development, Implementation Issues, Administration, Security Issues and Future Trends.	
UNIT - 4	**7 Hours**
Knowledge Management and Collaborative Systems: Introduction to Knowledge Management, Organizational Learning and Transformation, Knowledge Management Activities, Approaches to Knowledge Management, Information Technology (IT) In Knowledge Management, Knowledge Management Systems Implementation, Making Decisions in Groups, Supporting Group work with Computerized Systems, Tools for indirect support of Decision Making, Direct Computerized Support for Decision Making	
UNIT - 5	**8 Hours**
Business Analytics for Emerging Trends and Future Impacts: Location based Analytics for Organizations, Analytics Applications for Consumers, Recommendation Engines, Web 2.0 and Online Social Networking, Cloud computing and BI, Impact of Analytics in Organizations, Issues of - Legacy, Privacy and Ethics; An Overview of Analytics Ecosystem.	

Text Books:

1. *Business Intelligence, A managerial Perspective on Analytics, Sharda, R, Delen D, Tur*ban E, 10th Edition, Pearson, 2015.

Reference Books:

1. *Data Mining Techniques. For Marketing, Sales and Customer Relationship Management*, Berry M. & Linoff G, 2nd Edition, Wiley Publishing Inc., 2004.
2. *Artificial Intelligence in Practice*, Bernard Marr with Matt Ward, Wiley, 2019.
3. *Data Science for Business*, Foster Provost and Tom Fawcett, O'Reilly Media, Inc., 2013.

Course Outcomes	
CO1	Apply tools and techniques to understand real-world datasets and generate insights that are relevant to business decision making
CO2	Ability to analyse the tools and processes of business to gain knowledge on data and support business systems
CO3	Analyse ethical considerations related to the use of AI in Business intelligence

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1													1	
CO2		2												1	
CO3			1											1	

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Power BI for Beginners Introduction to Business Intelligence	Coursera	https://in.coursera.org/projects/power-bi-for-beginners-introduction-to-business-intelligence
2.	Business Analytics Specialization	Coursera	https://in.coursera.org/specializations/analytics

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice / Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks
Unit 2	Internal Choice	Two questions to be asked for 20 marks each
Unit 3	Mandatory	One question to be asked for 20 marks
Unit 4	Internal Choice	Two questions to be asked for 20 marks each
Unit 5	Mandatory	One question to be asked for 20 marks

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	25%
Apply / Analyze	50%
Create / Evaluate	25%

Assessment Pattern:

Category			Score Split up	Total
Continuous Internal Evaluation (CIE)	Theory	CIE - 1	20M (Best of Two)	25M
		CIE – 2		
		CIE - 3		
		AAT/Quiz	05M	
	Lab	CIE - 1	10M	25M
		CIE – 2	10M	
		AAT	05M	
Semester End Examination (SEE)	100M (50% weightage)			50M
			Total	100M

Course Title	KNOWLEDGE DISCOVERY				
Course Code	23AM5PEKDI	Credits	3	L-T-P	3-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	3	Total Lecture Hours			36

UNIT - 1	6 Hours
Introduction and Data Preprocessing: Why data mining, what is data mining, What kinds of data can be mined, What kinds of patterns can be mined, Which Technologies Are used, Which kinds of Applications are targeted, Major issues in data mining.**Data Preprocessing**: An overview, Data cleaning, Data integration, Data reduction, Data transformation and data discretization.	
UNIT - 2	**6 Hours**
Data warehousing and online analytical processing: Data warehousing: Basic concepts- What Is a Data Warehouse, Differences between Operational Database Systems and Data Warehouses, Why Have a Separate Data Warehouse? Data Warehousing: A Multitiered Architecture.**Data Warehouse Models:** Enterprise Warehouse, Data Mart, and Virtual Warehouse Extraction, Transformation, and Loading.	
UNIT - 3	**8 Hours**
Data warehouse modeling: Data Cube: A Multidimensional Data Model Stars, Snowflakes, and Fact Constellations: Schemas for Multidimensional Data Models, **Dimensions:** The Role of Concept Hierarchies, Measures: Their Categorization and Computation, Typical OLAP Operations. A Business Analysis Framework for Data Warehouse Design, Data Warehouse Design Process.	
UNIT - 4	**8 Hours**
Mining Frequent Patterns, Associations, and Correlations: Market Basket Analysis: A Motivating Example, Frequent Itemsets, Closed Itemsets, and Association Rules, **Apriori Algorithm:** Finding Frequent Itemsets by Confined Candidate Generation, Generating Association Rules from Frequent Itemsets, Improving the Efficiency of Apriori, A Pattern Growth Approach for Mining Frequent Itemsets, Mining Frequent Itemsets Using Vertical Data Format, Mining Closed and Max Patterns, Which Patterns Are Interesting? —Pattern Evaluation Methods.	
UNIT - 5	**8 Hours**
Cluster Analysis: What Is Cluster Analysis? Requirements for Cluster Analysis, Partitioning methods: k-Means: A Centroid-Based Technique, k-Medoids.**Hierarchical Methods:** Agglomerative versus Divisive Hierarchical Clustering, BIRCH, Chameleon, Probabilistic Hierarchical Clustering, **Density-based methods:** DBSCAN, OPTICS, DENCLUE	

Text Books:

1. *Data Mining Concepts and Techniques*, Jiawei Han, Micheline Kamber, Jian Pei, 3rd Edition, Elsevier, 2012.

Reference Books:

1. *Introduction to Data Mining*, Pang-Ning Tan, Michael Steinbach, Anuj Karpatne and Vipin Kumar, Pearson Education, 2016**.**

Course Outcomes	
CO1	Apply the basic principles and techniques to discover the knowledge to collect, clean preprocess.
CO2	Analyze different types of data based on dimension by various patterns.
CO3	Design a solution to real world problems for various applications such as healthcare, finance and marketing.

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2													1	
CO2		2												1	
CO3			1											1	

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Data Mining	NPTEL	https://onlinecourses.swayam2.ac.in/cec19_cs01/preview
2.	Data Mining Specialization	Coursera	https://in.coursera.org/specializations/data-mining

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice / Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks
Unit 2	Internal Choice	Two questions to be asked for 20 marks each
Unit 3	Internal Choice	Two questions to be asked for 20 marks each
Unit 4	Mandatory	One question to be asked for 20 marks
Unit 5	Mandatory	One question to be asked for 20 marks

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	25%
Apply / Analyze	50%
Create / Evaluate	25%

Assessment Pattern:

Category			Score Split up	Total
Continuous Internal Evaluation (CIE)	Theory	CIE - 1	20M (Best of Two)	25M
		CIE – 2		
		CIE - 3		
		AAT/Quiz	05M	
	Lab	CIE - 1	10M	25M
		CIE – 2	10M	
		AAT	05M	
Semester End Examination (SEE)	100M (50% weightage)			50M
			Total	100M

Course Title	DIGITAL IMAGE PROCESSING				
Course Code	23AM5PEDIP	Credits	3	L-T-P	3-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours /Week	3	Total Lecture Hours			36

UNIT – 1	8 Hours
Introduction and Digital Image Fundamentals: The origins of Digital Image Processing, Examples of Fields that Use Digital Image Processing, Fundamentals Steps in Image Processing. **Elements of Digital Image Processing Systems** : Image Sampling and Quantization, Some basic relationships like Neighbor's, Connectivity, Distance Measures between pixels, Translation, Scaling, Rotation and Perspective Projection of image, Linear and Non-Linear Operations.	
UNIT – 2	**7 Hours**
Image Enhancement in the Spatial Domain: Some basic Gray Level Transformations, Histogram Processing, Enhancement Using Arithmetic and Logic operations, Combining Spatial Enhancement Methods, Basics of Spatial Filters, Smoothening and Sharpening Spatial Filters, Intensity Transformation Function, Histogram Processing and Function Plotting.	
UNIT – 3	**7 Hours**
Image Enhancement in the Frequency Domain: Introduction to Fourier Transform and the frequency Domain, Computing and Visualizing the 2D DFT, Smoothing Frequency Domain Filters, Sharpening Frequency Domain Filters, Homomorphic Filtering.	
UNIT – 4	**8 Hours**
Image Restoration: A model of The Image Degradation / Restoration Process, Noise Models, Restoration in the presence of Noise Only- Spatial Filtering, Periodic Noise Reduction by Frequency- Domain Filtering, Linear Position-Invariant Degradations, Estimation of Degradation Function, Inverse filtering, Wiener filtering, Geometric Mean Filter, Geometric Transformations. **Image Compression:** Coding, Interpixel and Psychovisual Redundancy, Image Compression models, Compression standards.	
UNIT – 5	**6 Hours**
Image Segmentation: Detection of Discontinuities, Edge linking and boundary detection, Thresholding. **Object Recognition:** Patterns and Pattern Classes, Decision-Theoretic Methods, Structural Methods.	

Text Books:

1. *Digital Image Processing,* Rafael C. Gonzalez and Richard E. Woods, 3rd Edition, Prentice Hall, 2008.

Reference Books:

1. *Fundamentals of Digital Image Processing,* Anil K Jain, Pearson Education, 2015.

Course Outcomes	
CO1	Apply the fundamentals of image processing and acquire knowledge of image acquisition, storage, and display technologies.
CO2	Develop the ability to use tools and techniques to enhance image quality, reduce noise, and extract information from images.
CO3	Acquire knowledge of advanced image processing techniques to design and implement image processing algorithms using software tools.

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		**1**												**2**	
CO2			**2**											**2**	
CO3					**1**	**1**								**2**	

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Digital Image Processing	NPTEL	https://nptel.ac.in/courses/117105079
2.	Fundamentals of Digital Image and Video Processing	Coursera	https://in.coursera.org/learn/digital

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice / Mandatory	Unit Wise Marks Distribution
Unit 1	Internal Choice	Two questions to be asked for 20 marks each
Unit 2	Mandatory	One question to be asked for 20 marks
Unit 3	Mandatory	One question to be asked for 20 marks
Unit 4	Internal Choice	Two questions to be asked for 20 marks each
Unit 5	Mandatory	One question to be asked for 20 marks

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	25%
Apply / Analyze	50%
Create / Evaluate	25%

Assessment Pattern:

Category			Score Split up	Total
Continuous Internal Evaluation (CIE)	**Theory**	CIE - 1	40M (Best of Two)	**50M**
		CIE – 2		
		CIE - 3		
		AAT	05M	
		Quiz	05M	
Semester End Examination (SEE)	100M (50% weightage)			**50M**
Total				**100M**

Course Title	DATA VISUALIZATION AND ANALYSIS				
Course Code	23AM5AEDVA	Credits	3	L-T-P	2-0-1
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	2	Total Lecture Hours			26

UNIT - 1	6 Hours
Introduction of visual perception, visual representation of data, Gestalt principles, information overloads, Statistical charts (Bar Chart-stacked bar Chart -Line Chart-Histogram-pie chart- frequency polygon-Box Plot-Scatter plot	
UNIT - 2	**5 Hours**
Creating visual representations: visualization reference model, visual mapping, visual analytics, Design of visualization applications	
UNIT - 3	**5 Hours**
Classification of visualization systems: Interaction and visualization techniques misleading, Visualization of one, two and multi-dimensional data, text and text documents.	
UNIT - 4	**5 Hours**
Visualization: Groups, trees, graphs, clusters, networks, software, Metaphorical visualization **Case Study:** Interactive Data Visualization in News Media	
UNIT - 5	**5 Hours**
Visualization of volumetric data: vector fields, processes and simulations, Visualization of maps, geographic information, GIS systems, collaborative visualizations, evaluating visualizations.	

Text Books:

1. *Interactive Data Visualization: Foundations, Techniques, and Applications*, Ward, Grinstein Keim,. Natick: A K Peters, Ltd,1st Edition, 2010.
2. *Data Visualization: A Practical Introduction*, Kieran Healy, , 1st Edition, 2018.
3. *Visualizing Graph Data*, Corey Lanum,, 1st Edition, 2016.

Reference Books:

1. *The Visual Display of Quantitative Information* ,E. Tufte, , Graphics Press.2nd Edition, 2001.
2. *Data Visualization: a successful design process* ,Andy Krik , 1st Edition, 2016.

Course Outcomes	
CO1	Utilize data visualization tools to create visually appealing and user-friendly interfaces for displaying complex datasets.
CO2	Apply Tableau Desktop to construct comprehensive dashboards that effectively communicate insights derived from data analysis
CO3	Develop proficiency in crafting visually engaging representations of complex datasets, ensuring clarity and accessibility for diverse audiences.

B.M.S. College of Engineering, Bengaluru – 19
(Autonomous Institute, Affiliated to VTU | Approved by AICTE)

Scheme of Instructions Semester – VI (With effect from the Academic Year 2021-22: admitted batches and onwards)

Sl. #	Course Type	Course Code	Course Title	Teaching Hrs. In Credits/Week			Total Credits	Examination			
				Theory Lecture	Tutorial	Practical		Duration in Hrs.	CIE Marks	SEE Marks	Total Marks
				L	T	P					
1	PC-13	24AM6PCPAP	Parallel Architectures and Programming	2	1	0	3	04	50	50	100
2	PC-14	24AM6PCTFM	Time Series and Financial Mathematics	2	0	1	3	04	50	50	100
3	PC-15	24AM6PCDEL	Deep Learning	3	0	0	3	03	50	50	100
4	PC-16	24AM6PCBDA	Big Data Analytics	2	0	0	2	02	50	50	100
5	PC-17	24AM6PCDLL	Deep Learning Laboratory	0	0	1	1	02	50	50	100
6	PE-2	24AM6PESNA	Social Network Analysis	3	0	0	3	03	50	50	100
		24AM6PENLP	Natural Language Processing								
		24AM6PEVCV	Video Analytics using Open CV								
7	OE-1	24AM6OEIAI	Introduction to AI	3	0	0	3	03	50	50	100
		24AM6OEIML	Introduction to Machine Learning								
8	HS-7	24AM6HSISMM	Stochastic Modelling for Machine Learning	2	0	0	2	02	50	50	100
9	PW-1	24AM6PWMIP	Mini Project	0	0	2	2	04	50	50	100
10	NCMC-4	24AM6NCPDC	Personality Development, Aptitude and Communication Skills	-	-	-	-	01	-	-	-
			Total	17	1	4	22	28	450	450	900

Note: HS: Humanities and Social Sciences/Management Course, BS: Basic Science Course, ES: Engineering Science Course, PC: Professional Core Course, PE: Professional Elective Course, OE: Open Elective Course; PW: Project/Mini Project Work, INT: Seminar on Internship, AE: Ability Enhancement Course / Mandatory Course, NCMC: Non-credit mandatory course

Course Title	PARALLEL ARCHITECTURES AND PROGRAMMING				
Course Code	24AM6PCPAP	Credits	3	L-T-P	2-1-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hrs./Week	3	Total Lecture Hrs.			26

UNIT - 1	**5 Hrs.**
Introduction to Parallel Computer Architecture: Computer Architecture, Parallel Computer Architecture, Performance Measurement in Parallel Computing.	
UNIT - 2	**5 Hrs.**
Memory and Input-Output Subsystems: Virtual memory system, memory allocation and management, cache memories and management, Input-Output subsystems.	
UNIT - 3	**6 Hrs.**
Principles of pipelining and vector processing: An overlapped parallelism, Instruction and arithmetic pipelines, vector processing requirements.	
UNIT - 4	**5 Hrs.**
GPU Programming: The rise of GPU computing, GPU Architecture, CPU/GPU architecture comparison, Programming Models: CUDA, Basic Concepts: Threads, Blocks, Grids, GPU memory hierarchy.	
UNIT - 5	**5 Hrs.**
Computer unified device architecture: Architecture of CUDA, Parallelism and program structure of CUDA, Applications of CUDA.	

Text Books:

1. *Computer architecture and Parallel processing,* Kai Hwang and Briggs, McGraw-Hill Series in computer organization and architecture.
2. *Parallel and high-performance programming with python*, Fabio Nelli, Orange Education Pvt Ltd, April 2023.
3. *Parallel Computers Architecture and Programming*, V. Rajaraman, C. Siva Ram Murthy,PHI.
4. *CUDA By Example*, Jason Sanders, Edward Kandrot, Addison_Wesley.

Reference Books:

1. *Introduction to Parallel Computing*, Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, Pearson Education.
2. *Parallel Computing Theory and Practice*, Michel j.Quinn

Course Outcomes	
CO1	Interpret the metrics and measures for improving computation efficiency.
CO2	Analyze the need of parallel programming architectures for high performance computing.
CO3	Demonstrate proficiency in Parallel Programming through modern tools.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PS01	PS02	PS03
CO1	3												2	
CO2		3											2	
CO3	3				3								2	

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1	Parallel Computer Architecture	NPTEL, IIT Kanpur	https://archive.nptel.ac.in/courses/106/104/106104024/

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice/ Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks each
Unit 2	Internal Choice	Two questions to be asked for 20 marks each
Unit 3	Internal Choice	Two questions to be asked for 20 marks each
Unit 4	Mandatory	One question to be asked for 20 marks each
Unit 5	Mandatory	One question to be asked for 20 marks each

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	30%
Apply / Analyse	60%
Create / Evaluate	10%

Assessment Pattern

Category			Score Split up	Total
Continuous Internal Assessment (CIE)	**Theory**	CIE – 1	40 M (Best of Two)	**50M**
		CIE – 2		
		CIE – 3		
		AAT	05M	
		Quiz	05M	
Semester End Examination (SEE)	**100M (50% weightage)**			**50M**
Total				**100M**

Course Title	TIME SERIES AND FINANCIAL MATHEMATICS				
Course Code	24AM6PCTFM	Credits	3	L-T-P	2-0-1
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hrs./Week	4	Total Lecture Hrs.			26

UNIT - 1	6 Hrs.
Introduction to Time Series: Additive and Multiplicative Models, Components of Time Series – Trend, Seasonal, Cyclical and Random Variations. **Measuring Trend**: Graphic, Semi-Averages, Moving Average and Least Squares Method. **Measuring Seasonal Variations** - Simple Averages, Ratio-Trend Method, Ratio-Moving Average Method and Link Relative Method	
UNIT - 2	**5 Hrs.**
Forecasting Techniques: Simple Exponential Smoothing (SES), Simple Moving Average (SMA), Exponential Weighted Moving Average (EWMA), Holt-Winter's Smoothing.	
UNIT - 3	**5 Hrs.**
Time Series Models: Stationary Time Series, Invertible Time Series, White Noise Sequence, Random Walk, ACF and PACF, ARMA (p, q), ARIMA (p, d, q), SARIMA (p, d, q, P, D, Q, S)	
UNIT - 4	**5 Hrs.**
Basics of Financial Market: Basics of Stocks, Risky and Non-Risky Assets, Portfolio Analysis, Volatility, **Options:** Call and Put Options, Strike Price, Exercise Price, **Futures and Derivatives**: Forward and Future Contract, Hedging, Arbitrage, Financial Ratios, Market Indicators, Value at Risk.	
UNIT - 5	**5 Hrs.**
Time Series Models of Heteroscedasticity: Some common features of Financial Time Series, The ARCH (1) Model, GARCH (1,1) Model, Identifying an ARCH/GARCH Model in practice, Maximum Likelihood Estimation.	

Text Books:

1. *Introduction to Time Series Analysis and Forecasting,* Douglas C. Montgomery, Cheryl L. Jennings, Murat Kulahci, 2nd Edition, Wiley, 2015.
2. *An Elementary Introduction to Mathematical Finance*, Sheldon M. Ross, 3rd Edition, Cambridge University Press, 2011.

Reference Books:

1. *The Statistical Analysis of Time Series*, Theodore W. Anderson, Wiley, 1994
2. *Time Series Analysis - Forecasting and Control*, George E. P. Box, Gwilym M. Jenkins, Gregory C. Reinsel, 4th Edition, Wiley, 2013
3. *Option valuation: A first course in financial mathematics, Chapman and Hall/CRC Financial Mathematics Series*, Hugo. D. Junghenn, Chapman and Hall/CRC, 2011.
4. *Time Series*, Maurice George Kendall, J. K. Ord, 3rd Edition, Edward Arnold 1990.

Course Outcomes	
CO1	Apply effective techniques on time-dependent information to construct predictive models and facilitate decision-making processes.
CO2	Examine the stochastic behavior of financial time series data for effectively managing risks associated with it.
CO3	Develop time series and financial models tailored for real-time applications.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PS01	PS02	PS03
CO1					1								2	
CO2		2												
CO3				2	1						2			2

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1	Applied Time-Series Analysis	IIT Madras	https://nptel.ac.in/courses/103106123
2	Practical Time Series Analysis	Coursera	https://www.coursera.org/learn/practical-time-series-analysis

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice/ Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks each
Unit 2	Mandatory	One question to be asked for 20 marks each
Unit 3	Mandatory	One question to be asked for 20 marks each
Unit 4	Internal Choice	Two questions to be asked for 20 marks each
Unit 5	Internal Choice	Two questions to be asked for 20 marks each

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	25%
Apply / Analyse	55%
Create / Evaluate	20%

Assessment Pattern

Category			Score Split up	Total
Continuous Internal Assessment (CIE)	**Theory**	CIE – 1	40 M (Best of Two)	**50M**
		CIE – 2		
		CIE – 3		
		AAT	05M	
		Quiz	05M	
Semester End Examination (SEE)	**100M (50% weightage)**			**50M**
			Total	**100M**

Lab Programs

Course Title	TIME SERIES AND FINANCIAL MATHEMATICS				
Course Code	24AM6PCTFM	Credits	3	L-T-P	2-0-1
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hrs./Week	2	Total Lab Hrs.			12

Sl. No.	Topics
1.	Introduction to Time Series in Python: Loading the data, Examining the data, and Plotting the Data.
2.	Forecasting Techniques
3.	White Noise, Random Walk, Stationarity: Determining Weak Form of Stationarity.
4.	Determining Trend, Seasonality, ACF and PACF Plot
5.	The AR Model- Examining the ACF and PACF plots, Fitting AR (1) Model, Fitting Higher Lag AR Models
6.	The MA Model- Examining the ACF and PACF plots, Fitting MA (1) Model, Fitting Higher Lag MA Models
7.	The ARMA Model: Examining the ACF and PACF plots, Fitting ARMA (1,1) Model, Fitting Higher Lag ARMA Models
8.	The ARIMA Model: Fitting ARIMA Model.
9.	The ARCH Model
10.	The GARCH Model

Course Title	DEEP LEARNING				
Course Code	24AM6PCDEL	Credits	3	L-T-P	3-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hrs. / Week	3	Total Lecture Hrs.			36

UNIT – 1	7 Hrs.
Deep Feed forwarded Networks: Gradient-Based Learning, Hidden Units, Architecture, Unit saturation, vanishing gradient, ways to mitigate it, ReLU Heuristics for avoiding bad local minima, Heuristics for faster training, Nesterov accelerated gradient descent, Dataset Augmentation, Noise Robustness.	
UNIT – 2	**6 Hrs.**
Training Deep Neural Networks: Semi-Supervised & Multi-Task Learning, Early Stopping, Parameter Tying and Sharing, Sparse Representations, Dropout, Parameter-Specific Learning Rates, Gradient Clipping.	
UNIT – 3	
Recurrent Neural Networks (RNN): Introduction – Expressiveness; Architecture – Language Modeling, Bidirectional RNN, Encoder Decoder architectures, Multilayer RNN; Exploding gradient problem, Challenges of Training RNNs - Layer Normalization, RRBF, LSTM, GRUs.	**8 Hrs.**
UNIT – 4	**8 Hrs.**
Convolutional Networks: Convolution Operation, Motivation, Pooling, Convolution and Pooling as an Infinitely Strong Prior, Variants of the basic convolution function, Structured Outputs, Data types, Efficient Convolution Algorithms, Random or Unsupervised features, Adversarial Training, Tangent Distance, Tangent Prop and Manifold Tangent Classifier.	
UNIT – 5	**7 Hrs.**
Restricted Boltzmann Machines: Introduction, Hopfield Networks, The Boltzmann Machine, Restricted Boltzmann Machines, RBMs Beyond Binary Data Types, Stacking Restricted Boltzmann Machines.	

Text Books:

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

Reference Books:

1. Deep Learning with Tensor Flow and Keras 3rd Edition, Packt Publishing Limited; November 2022.
2. Learning Deep Learning: Theory and Practice of Neural Networks, Computer Vision, Natural Language Processing, and Transformers Using TensorFlow, Addison-Wesley Professional, October 2021

Course Outcomes	
CO1	Apply the concepts of deep learning such as CNN, RNN, RBM for the given problem statement.
CO2	Analyze various deep learning techniques and their applications across various methods
CO3	Design an application to solve real world problems using deep learning concepts

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PS01	PS02	PS03
CO1		**3**												**1**
CO2			**3**											**2**
CO3				**2**										**1**

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1	Deep learning – IIT Ropar	NPTEL	https://onlinecourses.nptel.ac.in/noc21_cs76/preview
2	Neural Networks and Deep Learning	Coursera	https://www.coursera.org/learn/neural-networks-deep-learning?specialization=deep-learning
3	Improving Deep Neural Networks: Hyperparameter Tuning, Regularization and Optimization	Coursera	https://www.coursera.org/learn/deep-neural-network?specialization=deep-learning

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice/ Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks each
Unit 2	Mandatory	One question to be asked for 20 marks each
Unit 3	Internal Choice	Two questions to be asked for 20 marks each
Unit 4	Internal Choice	Two questions to be asked for 20 marks each
Unit 5	Mandatory	One question to be asked for 20 marks each

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	25%
Apply / Analyse	55%
Create / Evaluate	20%

Assessment Pattern

<table>
<tr><th colspan="3">Category</th><th>Score Split up</th><th>Total</th></tr>
<tr><td rowspan="5">Continuous Internal Assessment (CIE)</td><td rowspan="3">Theory</td><td>CIE – 1</td><td rowspan="3">40 M
(Best of Two)</td><td rowspan="3">50M</td></tr>
<tr><td>CIE – 2</td></tr>
<tr><td>CIE – 3</td></tr>
<tr><td>Quiz-1</td><td>05M</td><td rowspan="2">10M</td></tr>
<tr><td>Quiz-2</td><td>05M</td></tr>
<tr><td>Semester End Examination (SEE)</td><td colspan="3">100M (50% weightage)</td><td>50M</td></tr>
<tr><td colspan="4">Total</td><td>100M</td></tr>
</table>

Course Title	BIG DATA ANALYTICS				
Course Code	24AM6PCBDA	Credits	2	L-T-P	2-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours /Week	2	Total Lecture Hours			26

UNIT - 1	5 Hrs
Introduction to Big Data Analytics: what is Big Data? Sources of Big Data, Big Data Characteristics, Types of Big Data, Tools and Technologies Available for Big Data, Infrastructure for Big Data,Types of Big Data Analytics, Uses of Big Data Analytics, Big Data Challenges, Big Data Case Studies.	
UNIT - 2	**5 Hrs**
Big Data File Formats and Compression Techniques: Various file formats supported by Big Data, Difference between Row oriented and Column oriented file formats and use cases, Understanding RC, ORC, Avro, Parquet, Sequence, Text File Formats and associated Compression techniques of zip, gzip, bzip,bzip2, lz4, snappy to optimize processing.	
UNIT - 3	**6 Hrs**
Introduction to Hadoop and Hadoop Architecture: What is Hadoop?, Modules of Hadoop- HDFS, Features of HDFS, Yarn, Hadoop Architecture, Hadoop MapReduce- Data Flow in MapReduce, MapReduce API, Examples, Moving Data in and out of Hadoop – Understanding inputs and outputs of MapReduce, Data Serialization and Deserialization.	
UNIT - 4	**5 Hrs**
HDFS and HIVE: Java API, Hive Architecture, HiveQL Querying Data, Sorting and Aggregating, Map Reduce Scripts, Joins & Sub queries.	
UNIT - 5	**5 Hrs**
HBase and client-server Architecture: Advanced Usage, Schema Design, Advance Indexing, PIG, Zookeeper, how it helps in monitoring a cluster, HBase uses Zookeeper and how to Build Applications with Zookeeper, Apache spark features, architecture and programming examples.	

Text Books:

1. Bart Baesens , Analytics in a Big Data World: The Essential Guide to Data Science and its Applications, ,Wiley, 2014
2. Xyz Dirk Deroos et al., Hadoop for Dummies, Dreamtech Press, 2014.

Reference Books:

1. Tom White, Hadoop: The Definitive Guide:by ,June 2009, Publisher(s): O'Reilly Media, Inc.
2. Chuck Lam, Hadoop in Action, December, 2010.
3. Leskovec, Rajaraman, Ullman, Mining of Massive Datasets, Cambridge University Press.
4. I.H. Witten and E. Frank, Data Mining: Practical Machine learning tools and techniques.

Course Outcomes	
CO1	Apply key data processing techniques, such as data cleaning, data integration, and data transformation
CO2	Analyze different data storage and retrieval technologies and select the appropriate technology based on specific use cases.
CO3	Attain proficiency in the use of a variety of tools for comprehensive data analysis.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PS01	PS02	PS03
CO1	1												2	
CO2		2											2	
CO3					2						2		2	

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1	Introduction to Big Data	Coursera	https://www.coursera.org/learn/big-data-introduction
2	Introduction to Big Data with Spark and Hadoop	Coursera	https://www.coursera.org/learn/introduction-to-big-data-with-spark-hadoop

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice/ Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks each
Unit 2	Mandatory	One question to be asked for 20 marks each
Unit 3	Internal Choice	Two questions to be asked for 20 marks each
Unit 4	Mandatory	One question to be asked for 20 marks each
Unit 5	Internal Choice	Two questions to be asked for 20 marks each

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	30%
Apply / Analyse	40%
Create / Evaluate	30%

Assessment Pattern

<table>
<tr><th colspan="3">Category</th><th>Score Split up</th><th>Total</th></tr>
<tr><td rowspan="4">Continuous Internal Assessment (CIE)</td><td rowspan="3">Theory</td><td>CIE – 1</td><td rowspan="3">40 M
(Best of Two)</td><td rowspan="3">50M</td></tr>
<tr><td>CIE – 2</td></tr>
<tr><td>CIE – 3</td></tr>
<tr><td></td><td>AAT</td><td>10M</td><td></td></tr>
<tr><td>Semester End Examination (SEE)</td><td colspan="3">100M (50% weightage)</td><td>50M</td></tr>
<tr><td colspan="4">Total</td><td>100M</td></tr>
</table>

Course Title	DEEP LEARNING LABORATORY				
Course Code	24AM6PCDLL	Credits	1	L-T-P	0-0-1
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hrs. / Week	2	Total Lecture Hrs.			-

Lab component programs

SI No.	Topics
1.	Design a multilayer deep neural network with a linear input layer, Tanh or ReLU activation for the hidden layers, and sigmoid or softmax activation for the output layer
2.	Design a deep NN and optimize the network with Gradient Descent and optimize the same with Stochastic gradient descent (SGD)
3.	Demonstrate the usage of dropout and gradient clipping in a neural network training scenario
4.	Implement a program showcasing multitask learning with early stopping
5.	Sentiment Analysis using Recurrent Neural Networks (RNN)
6.	Write a program to predict a caption for a sample image using LSTM.
7.	Develop a GRU based term stock price prediction model for tickers in yahoo finance
8.	Classification of MNIST Dataset using CNN
9.	Implement a program on Adversarial training ,tangent distance, tangent prop and tangent classifier
10.	Implementation of a Restricted Boltzmann Machine (RBM) that demonstrates stacking

Course Outcomes	
CO1	Analyze appropriate deep learning concepts based on the characteristics of the problem and the data.
CO2	Design the models using Advanced Training Techniques in Deep Learning on various datasets
CO3	Implementation of Deep Learning Models for Real-world Applications

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PS01	PS02	PS03
CO1		**3**										3		
CO2			**2**										3	
CO3				**2**	**3**				**3**	**3**				**3**

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1	Deep learning – IIT Ropar	NPTEL	https://onlinecourses.nptel.ac.in/noc21_cs76/preview
2	Neural Networks and Deep Learning	Coursera	https://www.coursera.org/learn/neural-networks-deep-learning?specialization=deep-learning
3	Improving Deep Neural Networks: Hyperparameter Tuning, Regularization and Optimization	Coursera	https://www.coursera.org/learn/deep-neural-network?specialization=deep-learning

Assessment Pattern:

Category		Score Split up	Total
Continuous Internal Evaluation (CIE) Lab	CIE - 1	20M	**50M**
	CIE – 2	20M	
	AAT	10M	
Semester End Examination (SEE)	100M (50% weightage)		**50M**
Total			**100M**

Course Title	SOCIAL NETWORK ANALYSIS				
Course Code	24AM6PESNA	Credits	3	L-T-P	3-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hrs. /Week	3	Total Lecture Hrs.			36

UNIT - 1	6 Hrs.

Introduction: The Social Networks Perspective, Historical and Theoretical Foundations, Fundamental Concepts in Network Analysis, Distinctive Features.

Social Network Data: What are Network Data? Boundary Specification and Sampling, Types of Networks, Network Data, Measurement and Collection.

Graph Theory and Social Networks: Graphs: Basic Definitions, Paths and Connectivity, Distance and Breadth-First Search.

UNIT – 2	8 Hrs.

Strong and Weak Ties: Triadic Closure, The Strength of Weak Ties, Tie Strength and Network Structure in Large-Scale Data, Tie Strength, Social Media, and Passive Engagement, Closure, Structural Holes, and Social Capital.

Networks in Their Surrounding Contexts: Homophily, Mechanisms Underlying Homophily: Selection and Social Influence, Affiliation.

Positive and Negative Relationships: Structural Balance, Characterizing the Structure of Balanced Networks.

UNIT – 3	7 Hrs.

Information Networks and the World Wide Web: The Structure of the web: The World Wide Web, Information Networks, Hypertext, and Associative Memory, The Web as a Directed Graph, The Bow-Tie Structure of the Web.

Link Analysis and Web Search: Searching the Web: The Problem of Ranking, Link Analysis using Hubs and Authorities, PageRank.

UNIT – 4	7 Hrs.

Network Dynamics: Information Cascades, Following the Crowd, A Simple Herding Experiment, Bayes' Rule: A Model of Decision-Making Under Uncertainty, Bayes' Rule in the Herding Experiment, A Simple, General Cascade Model, Sequential Decision-Making and Cascades.

Structural Models: Cascading Behavior in Networks: Diffusion in Networks, Modeling Diffusion through a Network, Cascades and Clusters, Diffusion, Thresholds, and the Role of Weak Ties.

UNIT – 5	8 Hrs.

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

Text Books:

1. Social Network Analysis: Methods and Applications, Stanley Wasserman, Katherine Faust, Cambridge University Press, 2012.
2. Peter Mika, ―Social Networks and the Semantic Web, First Edition, Springer 2007.

Reference Books:

1. Social Network Analysis by John Scott, 3rd edition, SAGE publications Ltd, 2012.
2. Networks, Crowds, and Markets: Reasoning about a Highly Connected World: David Easley, Jon Kleinberg.
3. Understanding-Social-Networks-Theories-Concepts-and findings by Charles Kadushin, Oxford university press, 2012.

Course Outcome:

CO1	Analyze the functionality and capabilities of social network analysis tools and software to effectively extract insights from network data, enabling informed decision-making and strategic planning based on network dynamics and structural patterns.
CO2	Explore structural models of cascading behavior in networks, including diffusion processes and the role of weak ties, to analyze how information spreads and influences decision-making within interconnected systems.
CO3	Evaluate the appropriateness of ontology-based modeling choices in different social network contexts.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1		**3**												**2**	
CO2			**3**											**2**	
CO3				**3**	**2**									**2**	

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1	Social Networks	IIT Ropar, Mahindra University, Hyderabad	https://onlinecourses.nptel.ac.in/noc24_cs56/preview
2	Social Network Analysis	Coursera	https://www.coursera.org/learn/social-network-analysis

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice/ Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks each
Unit 2	Internal Choice	Two questions to be asked for 20 marks each
Unit 3	Mandatory	One question to be asked for 20 marks each
Unit 4	Internal Choice	Two questions to be asked for 20 marks each
Unit 5	Mandatory	One question to be asked for 20 marks each

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	30%
Apply / Analyse	40%
Create / Evaluate	30%

Assessment Pattern

Category			Score Split up	Total
Continuous Internal Assessment (CIE)	**Theory**	CIE – 1	40 M (Best of Two)	**50M**
		CIE – 2		
		CIE – 3		
		AAT	05M	
		Quiz	05M	
Semester End Examination (SEE)	**100M (50% weightage)**			**50M**
Total				**100M**

Course Title	NATURAL LANGUAGE PROCESSING				
Course Code	24AM5PENLP	Credits	3	L-T-P	3-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hrs. / Week	3	Total Lecture Hrs.			36

UNIT – 1	6 Hrs.

Introduction: What is Natural Language Processing (NLP), Origins of NLP, Phases of NLP, The Challenges of NLP- Why is NLP hard? Language and Grammar, Applications of NLP.
Case studies: Machine Translation and Information retrieval.
Word Level Analysis: Regular Expressions, Words, Corpora, Text Normalization, Tokenization, Lemmatization, Stemming.

UNIT – 2	8 Hrs.

Language Modeling: Types of language models, Statistical Language Model: N-grams, evaluating language model: Training, Test Sets Perplexity, Sampling sentences from a language model, Generalization and Zeros, Smoothing.
Sequence Labeling: POS tagging, **HMM** Part-of-Speech Tagging, Conditional Random Fields (CRFs), Evaluation of Named Entity Recognition.

UNIT – 3	7 Hrs.

Constituency Parsing: Constituency, Context-Free Grammars, Treebanks, Grammar Equivalence and Normal Form, Ambiguity, CKY Parsing: A Dynamic Programming Approach.
Dependency Parsing: Dependency Relations, Transition-Based Dependency Parsing, Graph-Based Dependency Parsing.

UNIT – 4	8 Hrs.

Semantic Analysis: Lexical Semantics, Vector Semantics, Words and Vectors, Cosine for measuring similarity, TF-IDF: Weighing terms in the vector, Pointwise Mutual Information (PMI), Applications of the TF-IDF or PPMI vector models, Word2vec, Visualizing Embeddings, Semantic properties of embeddings, Bias and Embeddings, Evaluating Vector Models.
Contextual Embeddings: Contextual Embeddings and Word Sense, Word Similarity.

UNIT – 5	7 Hrs.

Coreference Resolution: Coreference Phenomena: Linguistic Background, Coreference Tasks and Datasets, Mention Detection, Architectures for Coreference Algorithms, Classifiers using hand-built features, Entity Linking, Evaluation of Coreference Resolution, Winograd Schema problems, Gender Bias in Coreference.
Introduction to NLP pre trained Language Models: BERT, RoBERTa, ALBERT, ELECTRA, XLNet.

Text Books:

1. Speech and Language Processing: An introduction to Natural Language Processing, Computational Linguistics and Speech Recognition, Daniel Jurafsky, James H Martin, 3rd Edition, Prentice Hall, 2024.
2. Natural Language Processing: An information Access Perspective, Kavi Narayana Murthy, Ess Ess Publications, 2006.

Reference Books:

1. Natural Language Processing and Information Retrieval, Tanveer Siddiqui, U.S. Tiwary, 1st Edition Oxford University press, 2008.

2. Applied Text Analysis with Python, Benjamin Bengfort, Tony Ojeda, Rebecca Bilbro, O'Reilly Media, 2018.

Course Outcomes	
CO1	Apply foundations of natural language processing in linguistics and formal language theory to build NLP applications.
CO2	Analyse NLP tasks using existing algorithms.
CO3	Conduct experiments to implement building blocks of statistical NLP.

CO – PO - PSO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**2**														**2**
CO2		**3**							**2**						**2**
CO3			**2**		**3**										**2**

Massive Open Online Course (MOOC):

Sl. No.	**Course**	**Offered by**	**Course Link**
1.	Applied Natural Language Processing	By Prof. Ramaseshan R Indian Institute of Technology, Madras	https://archive.nptel.ac.in/courses/106/106/106106211/
2.	Natural Language Processing	Prof Pawan Goyal, IIT Kharagpur	https://onlinecourses.nptel.ac.in/noc23_cs45/preview

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice/ Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks each
Unit 2	Internal Choice	Two questions to be asked for 20 marks each
Unit 3	Mandatory	One question to be asked for 20 marks each
Unit 4	Internal Choice	Two questions to be asked for 20 marks each
Unit 5	Mandatory	One question to be asked for 20 marks each

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	25%
Apply / Analyse	55%
Create / Evaluate	20%

Assessment Pattern:

Category		Score Split up	Total
Continuous Internal Evaluation (CIE) Theory	CIE - 1	40M	**40M**
	CIE – 2	40M	
	AAT	10M	**10M**
Semester End Examination (SEE)	100M (50% weightage)		**50M**
Total			**100M**

Course Title	VIDEO ANALYTICS USING OPENCV				
Course Code	24AM6PEVCV	Credits		L-T-P	3-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hrs. /Week	3	Total Lecture Hrs.			36

UNIT – 1	7 Hrs.
Getting Started with OpenCV : Introduction to computer vision, Introduction to images, Basic image operations, Mathematical operations on images, Sunglass filter : A simple application, Bitwise operations, Image Annotation. **Video IO and GUI:** Video IO using HighGUI, Callback functions, Keyboard as input device.	
UNIT – 2	**7 Hrs.**
Binary Image Processing: Thresholding, Erosion / Dilation, Opening and Closing, Connected Component Analysis, Contour Analysis, Blob Detection. **Image Enhancement and Filtering**: Color Spaces, Color Transforms, Image Filtering, Image Smoothing, Image Gradients.	
UNIT – 3	**7 Hrs.**
Advanced Image Processing and Computational Photography: Hough Transforms, High Dynamic Range Imaging, Seamless Cloning, Image Inpainting. **Geometric Transforms and Image Features**: Geometric Transforms, Image Features, Feature Matching, **Application**: Image Alignment, Application: Creating Panorama, Application: Finding Known Objects using OpenCV.	
UNIT – 4	**7 Hrs.**
Image Segmentation and Recognition: Image segmentation using GrabCut, Image Classification, Object Detection. **Video Analysis:** Motion Estimation using Optical Flow, Application: Video Stabilization, Object Tracking, Object Trackers in OpenCV, Multiple Object Tracking using OpenCV, Kalman Filter, MeanShift and CamShift.	
UNIT – 5	**8 Hrs.**
Deep Learning with OpenCV: Image Classification- Image Classification using Caffe and Tensorflow ,Object Detection - Single Shot Multibox Detector(SSD) , You Only Look Once Detector(YOLO), Face Detection- SSD based Face Detector , Human Pose Estimation- OpenPose.	

Reference Materials:

1. *Computer Vision: Algorithms and Applications,* Richard Szeliski. A free electronic copy is available online (Link).
2. *Introductory techniques for 3-D Computer Vision,* Emanuele Trucco and Alessandro Verri.
3. *Multiple View Geometry in Computer Vision,* Richard hartley and Andrew Zisserman, 2nd Edition.
4. *Computer Vision: A Modern Approach,* David Forsyth and Jean Ponce.
5. *Digital Image Processing,* Rafael Gonzalez, Richard Woods

Course Outcomes	
CO1	Apply the basic concepts of computer vision and video analytics in processing images and videos.
CO2	Analyze the key features of OpenCV library to perform video input/output operations.
CO3	Develop video analytics techniques to real-world problems such as surveillance, traffic analysis, and activity recognition.

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		1													2
CO2			2												2
CO3					2										2

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	OpenCV CrashCourse	OpenCV	https://opencv.org/opencv-free-course/
2.	Computer Vision	NPTEL	https://onlinecourses.nptel.ac.in/noc19_cs58/preview

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice / Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks
Unit 2	Mandatory	One question to be asked for 20 marks
Unit 3	Mandatory	One question to be asked for 20 marks
Unit 4	Internal Choice	Two questions to be asked for 20 marks each
Unit 5	Internal Choice	Two questions to be asked for 20 marks each

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	25%
Apply / Analyze	50%
Create / Evaluate	25%

Assessment Pattern:

Category			Score Split up	Total
Continuous Internal Evaluation (CIE)	**Theory**	CIE - 1	40M (Best of Two)	**50M**
		CIE – 2		
		CIE - 3		
		AAT/Quiz	10M	
Semester End Examination (SEE)	100M (50% weightage)			**50M**
Total				**100M**

Course Title	INTRODUCTION TO ARTIFICIAL INTELLIGENCE				
Course Code	24AM6OEIAI	Credits	3	L-T-P	2-0-1
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hrs. /Week	3	Total Lecture Hrs.			26

UNIT - 1	6 Hrs.
Introduction: What is AI? **Intelligent Agents**: How agent should act, Structure of Intelligent Agents, Environments Problem Solving: Formulating problems, Example problems **Uniformed-search strategies:** Breadth-First Search, Uniform Cost Search, Depth-First Search, Depth Limited Search, Iterative Deepening Search.	
UNIT - 2	**8 Hrs.**
Heuristic Search Strategies: Generate-and-Test, Hill Climbing, Best-first Search, Problem Reduction, Constraint Satisfaction, Means-ends Analysis.	
UNIT - 3	**8 Hrs.**
Knowledge Representation: Propositional Logic – Syntax and Semantics, Using Propositional Logic, **Adversarial Search and Games:** Game theory optimal decision in games, heuristic alpha beta tree search **Representing Knowledge using Rules**: Procedural Versus Declarative Knowledge, Forward Versus Backward Reasoning.	
UNIT - 4	**8 Hrs.**
Uncertain Knowledge & Reasoning: Acting under Uncertainty, The Wumpus World Revisited, Representing Knowledge in an Uncertain Domain, The Semantics of Belief Networks, Efficient Representation of Conditional Distributions, Exact Inference in Bayesian Networks.	
UNIT - 5	**6 Hrs.**
Introduction to Expert Systems: Definition, Features of an Expert System, Organization, Characteristics, Prospector, Knowledge Representation in Expert Systems, Ethics of AI	

Text Books:

1. *Artificial Intelligence - A Modern Approach,* Stuart Russell and Peter Norvig, 3rd Edition, Pearson, 2014.

Reference Books:

1. *Artificial Intelligence, Elaine* Rich, Kevin Knight and Shivashankar B Nair, 3rd Edition, McGraw-Hill Education, 2015.
2. *Introduction to Artificial Intelligence and Expert Systems,* Dan W Patterson, Pearson, 2015.

Course Outcomes	
CO1	Apply the principles of Intelligent Agents to address problem-solving challenges through both uninformed and informed search strategies.
CO2	Evaluate and construct procedural and declarative knowledge through the implementation of agent-based rules, facilitating a logic-based analysis for question and answering techniques.
CO3	Assess the probabilities associated with managing uncertain knowledge and utilize the principles of expert systems to effectively address such uncertainties.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PS01	PS02	PS03
CO1		2												
CO2			3									1		
CO3				1	1									

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1	An Introduction to Artificial Intelligence	IIT Delhi	https://onlinecourses.nptel.ac.in/noc22_cs56/preview
2	Introduction to Artificial Intelligence	Coursera	https://www.coursera.org/learn/introduction-to-ai

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice/ Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks each
Unit 2	Mandatory	One question to be asked for 20 marks each
Unit 3	Internal Choice	Two questions to be asked for 20 marks each
Unit 4	Internal Choice	Two questions to be asked for 20 marks each
Unit 5	Mandatory	One question to be asked for 20 marks each

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	25%
Apply / Analyse	55%
Create / Evaluate	20%

Assessment Pattern

Category			Score Split up	Total
Continuous Internal Assessment (CIE)	**Theory**	CIE – 1	40 M (Best of Two)	**50M**
		CIE – 2		
		CIE – 3		
		AAT	05M	
		Quiz	05M	
Semester End Examination (SEE)	**100M (50% weightage)**			**50M**
			Total	**100M**

Course Title	INTRODUCTION TO MACHINE LEARNING				
Course Code	24AM6OEIML	Credits	3	L-T-P	3-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours/Week	3	Total Lecture Hours			36

UNIT - 1	7 Hrs
Introduction: What Is Machine Learning (ML)? Uses and Applications with examples, Types of Machine Learning, Main Challenges, Testing and Validating. Well posed learning problems, Designing a Learning system, Perspectives and Issues in Machine learning.	
UNIT - 2	**6 Hrs**
Concept Learning: Concept learning task, search, Find-S algorithm, Version space, Candidate Elimination algorithm	
UNIT - 3	**8 Hrs**
Supervised Learning: Instance- Based Learning: Introduction, Support Vector Machines: Linear and Non-Linear, Kernel Functions, k- Nearest Neighbor Learning Linear Models-linear and logistic.	
UNIT - 4	**8 Hrs**
Unsupervised Learning: Types of Unsupervised Learning, Challenges in Unsupervised Learning, Clustering – K means, DBSCAN, Hierarchical, anomaly detection.	
UNIT - 5	**7 Hrs**
Decision Tree Learning: Introduction, Decision tree representation, Appropriate problems, ID3 algorithm. Reinforcement Learning: Introduction, The learning task.	

Text Books:

1. Tom Mitchell, *"Machine Learning",* McGraw Hill, 3rdEdition, 1997.
2. *Ethem Alpaydın, Introduction to machine learning, third edition, MIT press*.

Reference Books:

1. *MACHINE LEARNING - An Algorithmic Perspective, Second Edition, Stephen Marsland, 2015.*
2. *Introduction to Machine Learning with Python, A Guide for Data Scientists, Andreas C.Miller and Sarah Guido, O'Reilly Media, 2017.*
3. *Hands-on machine learning with Scikit-Learn and TensorFlow: concepts, tools, and techniques to build intelligent systems, AurelienGeron, O'Reilly Media, 2019*.

Course Outcomes

CO1	Apply Supervised Learning and Unsupervised Machine Learning techniques to solve the real time problems.
CO2	Analyze different Machine Learning algorithms for given data.
CO3	Demonstrate various applications of Machine Learning algorithms.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PS01	PS02	PS03
CO1	3													3
CO2		3												3
CO3					3									3

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1	Machine Learning – Introduction to everyone	Coursera	https://www.coursera.org/learn/machine-learning-introduction-for-everyone
2	Introduction to Machine Learning	NPTEL	https://archive.nptel.ac.in/courses/106/106/106106139/

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice/ Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks each
Unit 2	Mandatory	One question to be asked for 20 marks each
Unit 3	Internal Choice	Two questions to be asked for 20 marks each
Unit 4	Internal Choice	Two questions to be asked for 20 marks each
Unit 5	Mandatory	One question to be asked for 20 marks each

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	30%
Apply / Analyze	60%
Create / Evaluate	10%

Assessment Pattern

Category			Score Split up	Total
Continuous Internal Assessment (CIE)	**Theory**	CIE – 1	40 M (Best of Two)	**50M**
		CIE – 2		
		CIE – 3		
		AAT	05M	
		Quiz	05M	
Semester End Examination (SEE)	**100M (50% weightage)**			**50M**

Course Title	STOCHASTIC MODELLING FOR MACHINE LEARNING				
Course Code	24AM6HSSMM	Credits	2	L-T-P	2-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hrs./Week	2	Total Lecture Hrs.			26

UNIT - 1	5 Hrs.
Stochastic Process: Introduction to Stochastic Processes, Brownian Motion, Geometric Brownian Motion, Interest rate analysis and Rate of Returns.	
UNIT - 2	**5 Hrs.**
Markov Analysis I: Random process, Markov Chain, Transition Probability Matrix, Steady State Condition, First and Higher Order Markov Process, n-step Transition Probability.	
UNIT - 3	**6 Hrs.**
Markov Analysis II: Classification of States**,** Mean Time Spent in Transient States, Markov Decision Process, Hidden Markov Chains, Predicting the States, The Basic Limit Theorem of Markov Chains.	
UNIT - 4	**5 Hrs.**
Q-Learning: Exploration vs. Exploitation trade-off, The Q-function, The Q-Learning Update Rule, Temporal Difference Learning, TD Errors, Connection to Q-Learning.	
UNIT - 5	**5 Hrs.**
Actor Critic Algorithm: Actor-Critic Architecture, Policy Gradient, Updation Rules, Example Problems Implementing Actor-Critic Algorithm.	

Text Books:

1. *Operations Research*, Dr. S. D. Sharma, Kedar Nath Ram Nath & Co. 1995,
2. *Reinforcement Learning, An Introduction*, 2nd Edition, Richard S Sutton, Andrew G. Barto, 2018
3. *An Introduction to Stochastic Modelling,* 3rd Edition, Howard M.Taylor, Samuel Karlin

Reference Books:

1. *An Introduction to Probability Models*, 10th Edition, Sheldon M. Ross.
2. *Introduction to Stochastic Processes*, Paul G. Hoel, Sidney C. Port, Charles J. Stone.
3. *Grokking Deep Reinforcement Learning*, Miguel Morales

Course Outcomes	
CO1	Apply relevant mathematical tools to solve problems involving stochasticity.
CO2	Develop the ability to analyze problems through stochastic process and reinforcement learning.
CO3	Evaluate the performance of reinforcement learning algorithms under different conditions.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PS01	PS02	PS03
CO1		2												
CO2			2									1	2	
CO3				2										

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1	Introduction of Stochastic Processes.	IIT Delhi	https://archive.nptel.ac.in/courses/111/102/111102098/
2	Reinforcement Learning	IIT Madras	https://archive.nptel.ac.in/courses/106/106/106106143/

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice/ Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks each
Unit 2	Mandatory	One question to be asked for 20 marks each
Unit 3	Internal Choice	Two questions to be asked for 20 marks each
Unit 4	Internal Choice	Two questions to be asked for 20 marks each
Unit 5	Mandatory	One question to be asked for 20 marks each

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	20%
Apply / Analyse	55%
Create / Evaluate	25%

Assessment Pattern

Category			Score Split up	Total
Continuous Internal Assessment (CIE)	**Theory**	CIE – 1	40 M (Best of Two)	**50M**
		CIE – 2		
		CIE – 3		
		AAT	05M	
		Quiz	05M	
Semester End Examination (SEE)	**100M (50% weightage)**			**50M**
			Total	**100M**

Course Title	MINI PROJECT				
Course Code	24AM6PWMIP	Credits	2	L-T-P	0-0-2
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hrs. / Week	4	Total Lecture Hrs.			48

Rules and regulation:

A team should comprise of two or three members.

Each team has to do a mini project.

Internship projects are not allowed.

Mobile / web apps or database projects are not considered.

About the Course: The students should develop machine learning/deep learning projects by adopting various technologies. The project is evaluated in two phases. The evaluation for Review-1 will be conducted for 20 marks and Review-2 will be conducted for 30 marks.

Review -1 will be conducted based on the following parameters: Preliminary study, Literature survey, problem formulation and learning necessary modern tools, Software Requirement Specification, functional and non-functional requirements, high level design, documentation and presentation.

Review-2 will be conducted based on the parameters: Low level design, implementation, testing, experiment results and analysis, environmental and social context, documentation and presentation.

During the project phase, the students would be able to design responsive models by using python programming, various tools and techniques. The student will design and develop a complete project based on the requirements and design considerations.

	Course Outcomes
CO1	Identify an engineering problem and perform thorough literature review from the identified latest research.
CO2	Analyze and Design feasible and practical solutions addressing societal or engineering challenges through modern tools and technologies.
CO3	Demonstrate effective team spirit, communication skills through effective oral and written articulations.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		3											3	3	3
CO2			3		3	2							3	3	3
CO3								3	3	3			3	3	3

B.M.S. College of Engineering, Bengaluru – 19
(Autonomous Institute, Affiliated to VTU | Approved by AICTE)

Scheme of Instructions Semester – VII (With effect from the Academic Year 2021-22: admitted batches and onwards)

Sl.#	Course Type	Course Code	Course Title	Teaching Hours in Credits/Week			Total Credits	Examination			
				Theory Lecture	Tutorial	Practical		Duration in hours	CIE Marks	SEE Marks	Total Marks
				L	T	P					
1	PC-18	24AM7PCRMD	Research Methodology	2	0	0	2	02	50	50	100
2	PC-19	24AM7PCGAL	Generative AI With Large Language Models	3	0	0	3	03	50	50	100
3	PE-3	24AM7PERPA	Robotic Process Automation	3	0	0	3	03	50	50	100
		24AM7PEACY	AI for Cyber Security								
		24AM7PEHCI	Human Computer Interaction								
4	PE-4	24AM7PEIOT	Internet Of Things	3	0	0	3	03	50	50	100
		24AM7PECPS	Cyber Physical Systems								
		24AM7PEPRN	Pattern Recognition								
5	OE-2	24AM7OEIAI	Introduction to AI	3	0	0	3	03	50	50	100
		24AM7OEIML	Introduction to Machine Learning								
6	PW-2	24AM7PWCP1	Capstone Project – Phase I	0	0	2	2	04	50	50	100
Total				14	0	2	16	18	300	300	600

Note: HS: Humanities and Social Sciences/Management Course, BS: Basic Science Course, ES: Engineering Science Course, PC: Professional Core Course, PE: Professional Elective Course, OE: Open Elective Course; PW: Project/Mini Project Work, SR: Seminar Technical / Seminar Internship, NC: Non-credit mandatory course

Course Title	RESEARCH METHODOLOGY				
Course Code	24AM7PCRMD	Credits	2	L-T-P	2-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	2	Total Lecture Hours			26

UNIT – 1	5 Hrs
Research Methodology: Introduction, Meaning of Research, Objectives of Research, Types of Research, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India. **Defining the Research Problem**: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration.	
UNIT – 2	**6 Hrs**
Reviewing the literature: Literature overview, searching the existing literature, reviewing the selected literature, developing a theoretical framework, developing a conceptual framework. **Research Design**: Meaning of Research Design, Need for Research Design, features of a Good Design, Different Research Designs.	
UNIT – 3	**5 Hrs**
Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement, Techniques of Developing Measurement Tools, Scaling, Scale Classification Bases, Scaling Technics, Multidimensional Scaling, Deciding the Scale.	
UNIT – 4	**5 Hrs**
Data Collection: Introduction, Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method.	
UNIT – 5	**5 Hrs**
Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.	
Text Books: *Research Methodology: Methods and Techniques,* C.R. Kothari and Gaurav Garg, 4th Edition, New Age International, 2018.	
Reference Books: *Research Methodology a step-by step guide for beginners,* Ranjit Kumar, 3rd Edition, SAGE Publications, 2011.	

Course Outcomes	
CO1	Analyze and apply relevant research methods and techniques appropriate to identified research study.
CO2	Distinguishing qualitative and quantitative research types
CO3	Demonstrate enhanced research writing skills using modern tools like LaTeX, EndNote and alike.

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**3**														
CO2		**3**													
CO3					**3**			**2**	**2**	**2**					

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Research Methodology	NPTEL	https://onlinecourses.nptel.ac.in/noc23_ge36
2.	Research Methodology	NPTEL	https://onlinecourses.nptel.ac.in/noc22_ge08/preview

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice / Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks
Unit 2	Internal Choice	Two questions to be asked for 20 marks each
Unit 3	Internal Choice	Two questions to be asked for 20 marks each
Unit 4	Mandatory	One question to be asked for 20 marks
Unit 5	Mandatory	One question to be asked for 20 marks

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	25%
Apply / Analyze	60%
Create / Evaluate	15%

Assessment Pattern:

Category			Score Split up	Total
Continuous Internal Evaluation (CIE)	**Theory**	CIE - 1	40M (Best of Two)	**50M**
		CIE – 2		
		CIE - 3		
		AAT	10M	
Semester End Examination (SEE)	100M (50% weightage)			**50M**
Total				**100M**

Course Title	GENERATIVE AI WITH LARGE LANGUAGE MODELS				
Course Code	24AM7PCGAL	Credits	3	L-T-P	3-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	3	Total Lecture Hours			36

UNIT – 1	8 Hrs
Introduction to Generative AI: Overview of generative AI and its applications, Introduction to generative models, Key concepts: generative models vs. discriminative models, probability distributions, Convolutional Neural Networks (CNNs) for generative tasks. **Variational Autoencoders (VAEs)**:Introduction to autoencoders, Understanding VAEs: encoder, decoder, and latent space, Variational inference and the reparameterization trick , Applications of VAEs: image generation, data compression.	
UNIT – 2	**7 Hrs**
Generative AI & LLMs: LLM use cases and tasks, Text generation before transformers, Transformers architecture, Generating text with transformers, Prompting and prompt engineering, Generative configuration, Generative AI project lifecycle. **Large Language Models**: Pre-training large language models, Computational challenges of training LLMs, Efficient multi-GPU compute strategies, Scaling laws and compute-optimal models, Pre-training for domain adaptation, Domain-specific training: BloombergGPT.	
UNIT – 3	**7 Hrs**
Fine-tuning and evaluating large language models: Introduction, Instruction fine-tuning, Fine-tuning on a single task, Multi-task instruction fine-tuning, Model evaluation, Benchmarks, Parameter efficient fine-tuning (PEFT),**PEFT techniques** 1: LoRA , PEFT techniques 2: Soft prompts, Scaling instruct models. Reinforcement learning and LLM-powered applications: Introduction, Aligning models with human values, **Reinforcement learning from human feedback** (RLHF),RLHF: Obtaining feedback from humans.	
UNIT – 4	**7 Hrs**
Reinforcement learning from human feedback : Reward model, RLHF: Fine-tuning with reinforcement learning. Proximal policy optimization, RLHF: Reward hacking, Scaling human feedback. **Model optimizations for deployment**: Generative AI Project Lifecycle: Revisited, Using the LLM in applications, Interacting with external applications, Helping LLMs reason and plan with chain-of-thought, Program-aided language models (PAL), ReAct : Combining reasoning and action, LLM application architectures, Responsible AI ,KL divergence, ReAct: Reasoning and action.	
UNIT – 5	**7 Hrs**
Generative Adversarial Networks (GANs): Introduction to GANs and their components (generator, discriminator),GAN training process: minimax game, adversarial loss, Architectural variations: DCGAN, WGAN, CGAN, etc. GAN applications: image synthesis, style transfer.	

Text Books:

1. **Deep Learning,** Ian Goodfellow, Yoshua Bengio, and Aaron Courville, 1st Edition, MIT Press, 2016.
2. **Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play**, David Foster, 1st Edition, O'Reilly Media, 2019.
3. **Generative Adversarial Networks Cookbook**, Josh Kalin, 1st Edition, Packt Publishing, 2018.
4. **Natural Language Processing with Transformers**: Building Language Applications with Hugging Face, Lewis Tunstall, Leandro von Werra, and Thomas Wolf, O'Reilly Media,2022.

Reference Books:

1. **Hands-On Generative Adversarial Networks with Keras**, Rafael Valle, 1st Edition, Packt Publishing, 2019.
2. **Probabilistic Machine Learning: Advanced Topics**, Kevin P. Murphy, 1st Edition, MIT Press, 2023.
3. **The GAN Handbook**, Phil Wang, 1st Edition, Independently Published, 2022.

4. **Transformers for Natural Language Processing**, by Denis Rothman,2021.	
Course Outcomes	
CO1	Explore the underlying architecture, training processes and key components that enable the models to generate and creative content.
CO2	Asses the strategies for responsible AI development in AI-generated content.
CO3	Implement and fine-tuning large language models for various domain specific problems.

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1			3											3	
CO2			3											3	
CO3	3													3	

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Leveraging Generative AI for Teaching Programming Courses	NPTEL	https://elearn.nptel.ac.in/shop/iit-workshops/completed/leveraging-generative-ai-for-teaching-programming-courses/?v=c86ee0d9d7ed
2.	Generative AI and Large Language Models	NPTEL	https://onlinecourses.swayam2.ac.in/imb24_mg116/preview
3.	Generative AI Fundamentals (Online)	National Institute of Electronics & Information Technology, Calicut	https://nielit.gov.in/calicut/content/genai
4.	Applications of Generative AI	IIT Kanpur	https://ifacet.iitk.ac.in/product/applications-of-generative-ai/

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice / Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks
Unit 2	Mandatory	One question to be asked for 20 marks
Unit 3	Mandatory	One question to be asked for 20 marks
Unit 4	Internal Choice	Two questions to be asked for 20 marks each
Unit 5	Internal Choice	Two questions to be asked for 20 marks each

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	**30%**
Apply / Analyze	**45%**
Create / Evaluate	**25%**

Assessment Pattern:

<table>
<tr><th colspan="3">Category</th><th>Score Split up</th><th>Total</th></tr>
<tr><td rowspan="4">Continuous Internal Evaluation (CIE)</td><td rowspan="4">Theory</td><td>CIE - 1</td><td rowspan="3">40M
(Best of Two)</td><td rowspan="4">50M</td></tr>
<tr><td>CIE – 2</td></tr>
<tr><td>CIE - 3</td></tr>
<tr><td>AAT/Quiz</td><td>10M</td></tr>
<tr><td>Semester End Examination (SEE)</td><td colspan="3">100M (50% weightage)</td><td>50M</td></tr>
<tr><td colspan="4">Total</td><td>100M</td></tr>
</table>

Course Title	ROBOTIC PROCESS AUTOMATION				
Course Code	24AM7PERPA	Credits	3	L-T-P	3-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	3	Total Lecture Hours			36

UNIT – 1	6 Hrs
Introduction to Robotic Process Automation: Scope and techniques of automation, Benefits of RPA, Components of RPA, RPA platforms, The future of automation. **RPA Basics**: History of Automation, RPA vs Automation, Programming Constructs in RPA, What Processes can be Automated, Types of Bots – Workloads which can be automated, Risks and Challenges in RPA. **Python Libraries for RPA Developers:** Pyautogui, Openpyxl, Pywinauto, Selenium, Pytesseract, PyPDF2.	
UNIT – 2	**8 Hrs**
Sequence, Flowchart and Control Flow: Sequencing the Workflow, Activities, Control flow, various types of loops, and decision making, how to use a sequence, flowchart, step by step example using sequence and control flow. **Data Manipulation:** Variables and scope, Collections, Arguments-purpose and use, Data table usage with examples, Clipboard management, File operation with step-by-step example. CSV/Excel to data table and vice versa examples.	
UNIT – 3	**8 Hrs**
Taking control of the controls: Finding and attaching windows, control, Techniques for waiting for a control, Act on controls-mouse and keyboard activities, working with UiExplorer, Handling events, Revisit recorder, Screen scraping, when to use OCR? Types of OCR available, how to use OCR? Avoiding typical failure points. **Tame that Application with Plugins:** Mail plugin, PDF plugin, web integration, Excel and Word plugins, Credential management.	
UNIT – 4	**7 Hrs**
Handling User Events and Assistant Bots: What are assistant bots? Monitoring system event triggers, monitoring image and element triggers, Launching an assistant bot on a keyboard event. **Exception Handling, Debugging, and Logging Exception handling:** Common exceptions and ways to handle them, Logging and taking screenshots, debugging techniques, Collecting crash dumps, Error reporting.	
UNIT – 5	**7 Hrs**
Managing and Maintaining the Code: Project Organization, Nesting workflows, Reusability of workflows, commenting techniques, State Machine, when to use Flowcharts? State Machines or sequences, Using config files and examples of a config file. **Deploying and Maintaining the Bot:** Publishing using publish utility, Overview of Orchestration Server, Using Orchestration Server to control bots, Using Orchestration Server to deploy bots.	

Text Books:

1. "*Learning Robotic Process Automation*", Alok Mani Tripathi, Packt Publishing, 2018.
2. *"The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems",* Tom Taulli, APress publications, 2020.

Reference Books:

1. *"Robotic Process Automation: Guide to Building Software Robots, Automate Repetitive Tasks & Become an RPA Consultant"*, Richard Murdoch, Amazon Asia-Pacific Holdings Private Limited, 2018.
2. *"Introduction to Robotic Process Automation": A Primer*, Frank Casale, Rebecca Dilla, Heidi Jaynes, Lauren Livingston, Amazon Asia-Pacific Holdings Private Limited, 2018.

Course Outcomes	
CO1	Apply the concept of Robotic Process Automation (RPA) to automate various applications.
CO2	Analyze the usage of appropriate RPA technique for a given application.
CO3	Design and implement techniques of RPA.

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**3**														
CO2		**2**													
CO3			**2**		**3**				**2**	**2**				**2**	

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	RPA	UiPath	https://www.uipath.com/rpa/academy
2.	Robotic Process Automation (RPA) Specialization	Coursera	https://www.coursera.org/specializations/roboticprocessautomation

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice / Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks
Unit 2	Internal Choice	Two questions to be asked for 20 marks each
Unit 3	Internal Choice	Two questions to be asked for 20 marks each
Unit 4	Mandatory	One question to be asked for 20 marks
Unit 5	Mandatory	One question to be asked for 20 marks

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	20%
Apply / Analyze	70%
Create / Evaluate	10%

Assessment Pattern:

Category			Score Split up	Total
Continuous Internal Evaluation (CIE)	**Theory**	CIE - 1	40M (Best of Two)	**50M**
		CIE – 2		
		CIE - 3		
		Quiz	05M	
		AAT	05M	
Semester End Examination (SEE)	100M (50% weightage)			**50M**
Total				**100M**

Course Title	AI FOR CYBER SECURITY				
Course Code	24AM7PEACY	Credits		L-T-P	3-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	5	Total Lecture Hours			36

UNIT – 1	6 Hrs
Introduction to AI for Cybersecurity Professionals: Applying AI in Cybersecurity, Evolution in AI: from expert systems to data mining, A brief introduction to expert systems, Reflecting the indeterministic nature of reality, Going beyond statistics toward machine learning Mining data for models.	
UNIT – 2	**8 Hrs**
Detecting Cybersecurity Threats with AI: Ham or Spam? Detecting Email Cybersecurity, Threats with AI Detecting spam with Perceptron, Meet NNs at their purest – the Perceptron, Spam filters in a nutshell, Spam filters in action, Detecting spam with linear classifiers, How the Perceptron learns, A simple Perceptron-based spam filter, Pros and cons of Perceptrons. **Spam detection with SVMs:** SVM optimization strategy, SVM spam filter example, Image spam detection with SVMs, Phishing detection with logistic regression and decision trees	
UNIT – 3	**7 Hrs**
Malware Threat Detection: Artificial intelligence for malware detection: Malware goes by many names, Malware analysis tools of the trade, Malware detection strategies Static malware analysis, Static analysis methodology, Difficulties of static malware analysis How to perform static analysis, Hardware requirements for static analysis Dynamic malware analysis, Anti-analysis tricks	
UNIT – 4	**8 Hrs**
Network Anomaly Detection with AI: Network anomaly detection techniques, Anomaly detection rationales, Intrusion Detection Systems, Host Intrusion Detection Systems, Network Intrusion Detection Systems, Anomaly-driven IDS, turning service logs into datasets, **Protecting Sensitive Information and Assets**: Securing User Authentication, Authentication abuse prevention, Are passwords obsolete? Common authentication practices, how to spot fake logins, Fake login management – reactive versus predictive, Predicting the unpredictable, Choosing the right features, Preventing fake account creation	
UNIT – 5	**7Hrs**
Fraud Prevention with Cloud AI Solutions: Introducing fraud detection algorithms, Dealing with credit card fraud, Machine learning for fraud detection and prevention systems, Expert-driven predictive models, Data-driven predictive models, FDPS – the best of both worlds.	

Text Books:

1. Hands-On Artificial Intelligence for Cybersecurity, O'Reilly, August 2019

Reference Books:

1. AI for Cybersecurity A Handbook of Use Cases, Penn state cybersecurity lab
2. Cybersecurity and Artificial Intelligence: Threats and Opportunities, By Steve Wilson (CPO, Contrast Security)

Course Outcomes	
CO1	Gain a comprehensive understanding of the evolution of AI, from expert systems to data mining.
CO2	Apply Perceptron and SVM principles for spam detection, develop spam filters with linear classifiers
CO3	Analyze different malware detection strategies, including static and dynamic analysis and Gain practical knowledge in performing static malware analysis, understanding its methodology, and overcoming its difficulties.

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		**2**													**1**
CO2			**3**												**1**
CO3								**1**							**1**

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Machine Learning for Cyber Security	IIT, Kanpur	https://www.cse.iitk.ac.in/users/e-masters/courses/Machine%20Learning%20for%20Cyber%20Security.html
2.	IBM Generative AI for Cybersecurity Professionals Specialization	Coursera	https://www.coursera.org/specializations/generative-ai-for-cybersecurity-professionals
3.	Cyber Security and Privacy	NPTEL	https://onlinecourses.nptel.ac.in/noc23_cs127/preview

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice / Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks
Unit 2	Internal Choice	Two questions to be asked for 20 marks each
Unit 3	Mandatory	One question to be asked for 20 marks
Unit 4	Internal Choice	Two question to be asked for 20 marks
Unit 5	Mandatory	One questions to be asked for 20 marks each

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	25%
Apply / Analyze	50%
Create / Evaluate	25%

Assessment Pattern:

Category			Score Split up	Total
Continuous Internal Evaluation (CIE)	**Theory**	CIE - 1	40M (Best of Two)	**40M**
		CIE – 2		
		CIE - 3		
		AAT/Quiz	10M	**10M**
Semester End Examination (SEE)	100M (50% weightage)			**50M**
Total				**100M**

Course Title	HUMAN COMPUTER INTERACTION				
Course Code	24AM7PEHCI	Credits	3	L-T-P	3-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	3	Total Lecture Hours			36

UNIT – 1	7 Hrs
Introduction to HCI. What is HCI – Interdisciplinary nature of HCI – History of HCI – Importance of design and HCI – The design process - The double diamond of design. The Interaction: Introduction, Models of Interaction, Frameworks and HCI, Ergonomics, Interaction styles, Elements of the WIMP interface, Interactivity, The context of the Interaction.	
UNIT – 2	**8 Hrs**
Design Process: Basics Interactive design, The process of Design, Scenarios, Navigation design. Design rules: Principles to support usability. Standards, Guidelines, Golden Rules and Heuristics, HCI patterns	
UNIT – 3	**8 Hrs**
Models in HCI: formal models, linguistic models, cognitive models (KLM/GOMS), Fitts' law and Hick-Hyman's law Cognitive architectures, hybrid models.	
UNIT – 4	**6 Hrs**
Communication And Collaboration Models: Introduction, Goals of Collaboration and Participation, Asynchronous Distributed Interfaces: Different Place, Different Time Synchronous Distributed Interfaces: Different Place, Same Time, Face-to-Face Interfaces: Same Place, Same Time	
UNIT – 5	**7 Hrs**
Evaluation Techniques, Goals of evaluation, Evaluation through expert analysis, Evaluation through user participation, Choosing an evaluation method. Task Analysis: Introduction, Differences between Task analysis and other techniques, Task decomposition, Knowledge based analysis, Entity-relationship-based technique, source of information and data collection, Uses of Task analysis.	

Text Books:

1. Human – Computer Interaction, Alan Dix, Janet Fincay, GreGoryd, Abowd, Russell Bealg, Pearson 3rd Edition, 2004.

Reference Books:

1. Designing the User Interface: Techniques for Effective Human-Computer Interaction, Ben Shneiderman and Catherine Plaisant, Pearson Publications, 6th Edition, 2016, *Machine Learning*, Tom Mitchell, McGraw Hill, 2013.
2. Interaction Design, Prece, Rogers, Sharps, Wiley, 3rd Edition,2011.
3. The essential guide to user interface, Wilbert O Galitz, Wiley, 3rd Edition,2007

Course Outcomes	
CO1	Comprehend the fundamental principles and theories that underpin human-computer interaction.
CO2	Design user interfaces based on principles derived from HCI models.
CO3	Analyze and evaluate user interactions with interfaces.

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1												1		
CO2			1										1		
CO3		1		1									1		

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Human Computer Interaction (HCI)	NPTEL	https://nptel.ac.in/courses/106103115
2.	Human-Centered Design: an Introduction	Coursera	Human-Centered Design: an Introduction | Coursera
3.	Input and Interaction	Coursera	https://www.coursera.org/learn/interaction-techniques

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice / Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks
Unit 2	Internal Choice	Two questions to be asked for 20 marks each
Unit 3	Internal Choice	Two questions to be asked for 20 marks each
Unit 4	Mandatory	One question to be asked for 20 marks
Unit 5	Mandatory	One question to be asked for 20 marks

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	25%
Apply / Analyze	50%
Create / Evaluate	25%

Assessment Pattern:

Category			Score Split up	Total
Continuous Internal Evaluation (CIE)	**Theory**	CIE - 1	40M (Best of Two)	**50M**
		CIE – 2		
		CIE - 3		
		AAT	05M	
		Quiz	05M	
Semester End Examination (SEE)	100M (50% weightage)			**50M**
Total				**100M**

Course Title	INTERNET OF THINGS				
Course Code	24AM7PEIOT	Credits	3	L-T-P	3-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	3	Total Lecture Hours			36

UNIT – 1	7 Hrs
Introduction to IoT: Definition, Genesis of IoT, IoT and Digitization, IoT Impact, Convergence of IT and IoT, IoT Challenges, IoT Network Architecture and Design, Drivers Behind New Network Architectures, Comparing IoT Architectures, A Simplified IoT Architecture, The Core IoT Functional Stack, IoT Data Management and Compute Stack.	
UNIT – 2	**7 Hrs**
Smart Objects: The "Things" in IoT, Sensors, Actuators, and Smart Objects, Sensor Networks, Connecting Smart Objects, Communications Criteria, IoT Access Technologies.	
UNIT – 3	**7 Hrs**
IP as the IoT Network Layer: The Business Case for IP, The need for Optimization, Optimizing IP for IoT, Profiles and Compliances, Application Protocols for IoT, The Transport Layer, IoT Application Transport Methods.	
UNIT – 4	**8 Hrs**
Data and Analytics for IoT: An Introduction to Data Analytics for IoT, Machine Learning, Big Data Analytics Tools and Technology, Edge Streaming Analytics, Network Analytics, Securing IoT, A Brief History of OT Security, Common Challenges in OT Security, How IT and OT Security Practices and Systems Vary, Formal Risk Analysis Structures: OCTAVE and FAIR, The Phased Application of Security in an Operational Environment	
UNIT – 5	**7 Hrs**
IoT Physical Devices and Endpoints - Arduino UNO: Introduction to Arduino, Arduino UNO, Installing the Software, Fundamentals of Arduino Programming. IoT Physical Devices and Endpoints - RaspberryPi: Introduction to RaspberryPi, About the RaspberryPi Board: Hardware Layout, Operating Systems on RaspberryPi, Configuring RaspberryPi, Programming RaspberryPi with Python, Wireless Temperature Monitoring System Using Pi	

Text Books:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry,"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", 1st Edition, Pearson Education (Cisco Press Indian Reprint). (ISBN: 978-9386873743)
2. Srinivasa K G, "Internet of Things",CENGAGE Leaning India, 2017

Reference Books:

1. Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", 1 stEdition, VPT, 2014. (ISBN: 978-8173719547)
2. Raj Kamal, "Internet of Things: Architecture and Design Principles", 1st Edition, McGraw Hill Education, 2017. (ISBN: 978-9352605224).

Course Outcomes	
CO1	Interpret the impact and challenges posed by IoT networks leading to new architectural models.
CO2	Compare and contrast the deployment of smart objects and the technologies to connect them to network.
CO3	Illustrate different sensor technologies for sensing real world entities and identify the applications of IoT in Industry.

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3													2	
CO2		2												2	
CO3			1		2				2	2				2	

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Introduction To Internet Of Things	NPTEL	https://onlinecourses.nptel.ac.in/noc22_cs53/preview
2.	Introduction To Internet Of Things	Coursera	Introduction to Internet of Things | Coursera
3.	Introduction to Internet of Things	McGraw Hill	IT_Prelims.pdf (its.edu.in)

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice / Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks
Unit 2	Mandatory	One question to be asked for 20 marks
Unit 3	Mandatory	One question to be asked for 20 marks
Unit 4	Internal Choice	Two questions to be asked for 20 marks each
Unit 5	Internal Choice	Two questions to be asked for 20 marks each

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	25%
Apply / Analyze	50%
Create / Evaluate	25%

Assessment Pattern:

Category			Score Split up	Total
Continuous Internal Evaluation (CIE)	Theory	CIE - 1	40M (Best of Two)	50M
		CIE – 2		
		CIE - 3		
		AAT	05M	
		Quiz	05M	
Semester End Examination (SEE)	100M (50% weightage)			50M
Total				100M

Course Title	CYBER PHYSICAL SYSTEMS				
Course Code	24AM7PECPS	Credits	3	L-T-P	3-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	3	Total Lecture Hours			36

UNIT – 1	7 Hrs
Fundamentals of Cyber Physical Systems (CPS): Introduction, Key Features of Cyber-Physical Systems, Foundations, Design Principles, Challenges, and Applications. **Synchronous Model:** Reactive Components, Properties of Components, Composing Components, Synchronous Designs.	
UNIT – 2	**7 Hrs**
Safety requirements: Safety Specifications, Verifying Invariants, Enumerative Search, Symbolic Search	
UNIT – 3	**8 Hrs**
Asynchronous Model: Asynchronous Processes, Asynchronous Design Primitives, Asynchronous Coordination Protocols. **Timed Models:** Timed Processes, Timing-Based Protocols, Timed Automata, Timed Models of Computation.	
UNIT – 4	**8 Hrs**
Principles of Dynamical Systems: Continuous-Time Models, Linear Systems, Designing Controllers, Analysis Techniques. **Hybrid Systems:** Modal Models, Classes of Hybrid systems, Hybrid Dynamical Models, Designing Hybrid Systems, Linear Hybrid Automata.	
UNIT – 5	**6 Hrs**
CPS Security: Software Security, Information Flow, Sensor and Actuator Security, Side-channel Attacks	

Text Books:

1. E. A. Lee and S. A. Seshia, Introduction to Embedded Systems - A Cyber-Physical Systems Approach, Second Edition, MIT Press, 2017.
2. R. Alur, "Principles of Cyber-Physical Systems," MIT Press, 2015.
3. Suh, Sang C., U. John Tanik, John N. Carbone, and Abdullah Eroglu, eds. Applied cyber-physical systems. Springer New York, 2014.

Reference Books:

1. T. D. Lewis "Network Science: Theory and Applications", Wiley, 2009.
2. P. Tabuada, "Verification and control of hybrid systems: a symbolic approach", Springer-Verlag 2009.
3. C. Cassandras, S. Lafortune, "Introduction to Discrete Event Systems", Springer 2007.
4. Constance Heitmeyer and Dino Mandrioli, "Formal methods for real-time computing", Wiley publisher, 1996.

Course Outcomes	
CO1	Apply the architectural design principles of Cyber physical System (CPS).
CO2	Design CPS using synchronous, asynchronous and timed models.
CO3	Analyze various modeling , safety and security techniques of CPS

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3		
CO2			3										3		
CO3		3											3		

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Foundations of Cyber Physical Systems	NPTEL	https://onlinecourses.nptel.ac.in/noc23_cs62/preview
2.	Cyber-Physical Systems: Modeling and Simulation	Coursera	https://www.coursera.org/learn/cyber-physical-systems-1

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice / Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks
Unit 2	Mandatory	One question to be asked for 20 marks
Unit 3	Internal Choice	Two questions to be asked for 20 marks each
Unit 4	Internal Choice	Two questions to be asked for 20 marks each
Unit 5	Mandatory	One question to be asked for 20 marks

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	35%
Apply / Analyze	40%
Create / Evaluate	25%

Assessment Pattern:

Category			Score Split up	Total
Continuous Internal Evaluation (CIE)	**Theory**	CIE - 1	40M (Best of Two)	**50M**
		CIE – 2		
		CIE - 3		
		AAT/Quiz	10M	
Semester End Examination (SEE)	100M (50% weightage)			**50M**
			Total	**100M**

Course Title	PATTERN RECOGNITION				
Course Code	24AM7PEPRN	Credits	3	L-T-P	3-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours /Week	3	Total Lecture Hours			36

UNIT – 1	7 Hrs
Pattern Classifier: Overview of pattern recognition, Discriminant functions, Supervised learning, Parametric estimation, Maximum likelihood estimation, Bayesian parameter estimation, Perceptron algorithm, LMSE algorithm, Problems with Bayes approach, Pattern classification by distance functions, Minimum distance pattern classifier.	
UNIT – 2	**7 Hrs**
Unsupervised Classification: Clustering for unsupervised learning and classification, Clustering concept, C-means algorithm, Hierarchical clustering procedures, Graph theoretic approach to pattern clustering, Validity of clustering solutions.	
UNIT – 3	**7 Hrs**
Structural Pattern Recognition: Elements of formal grammars, String generation as pattern description, Recognition of syntactic description, Parsing – Stochastic grammars and applications, Graph based structural representation.	
UNIT – 4	**7 Hrs**
Feature Extraction and Selection: Entropy minimization, Karhunen– Loeve transformation, Feature selection through functions approximation, Binary feature selection.	
UNIT – 5	**8 Hrs**
Advances in Pattern Recognition: Neural network structures for Pattern Recognition, Neural network-based Pattern associators, Unsupervised learning in neural Pattern Recognition, Self-organizing networks, Fuzzy logic Fuzzy pattern classifiers, Pattern classification using Genetic Algorithms.	

Text Books:

1. *Pattern Recognition: Statistical, Structural and Neural Approaches*, Robert J, Schalkoff, , John Wiley & Sons Inc., New York, 1992.
2. *Pattern Classification and Scene Analysis*, Duda R.O. and Hart P.E., John Wiley, New York, 2001.

Reference Books:

1. *Pattern Recognition Engineering*, Morton Nadler and Eric Smith P.John Wiley and Sons,New York, 1993.
2. *Pattern Recognition Principles* ,Touand , Gonzalez R. ,Addision Wesley, 1974.
3. *Pattern Recognition and Image Analysis* ,Earl Gose, Richard Johnsonbaugh, Steve Jost, ,Prentice Hall of India Private Ltd., New Delhi – 110 001, 1999.
4. *Pattern Classification*, Duda R.O, Hart .P.E., D.G. Stal, John Wiley, 2001.

Course Outcomes

CO1	Apply the knowledge of state-of-the-art algorithms used in pattern recognition.
CO2	Analyze and interpret various techniques of pattern recognition.
CO3	Demonstrate the pattern recognition techniques in practical applications.

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1													2
CO2		3													2
CO3			2	2	1										2

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Pattern Recognition and Application	IIT Kharagpur	https://nptel.ac.in/courses/117105101
2.	Pattern Recognition and Analysis	MIT	https://ocw.mit.edu/courses/mas-622j-pattern-recognition-and-analysis-fall-2006/

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice / Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks
Unit 2	Mandatory	One questions to be asked for 20 marks
Unit 3	Internal Choice	Two questions to be asked for 20 marks each
Unit 4	Mandatory	One questions to be asked for 20 marks
Unit 5	Internal Choice	Two questions to be asked for 20 marks each

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	25%
Apply / Analyze	50%
Create / Evaluate	25%

Assessment Pattern:

<table>
<tr><th colspan="3">Category</th><th>Score Split up</th><th>Total</th></tr>
<tr><td rowspan="5">Continuous Internal Evaluation (CIE)</td><td rowspan="5">Theory</td><td>CIE - 1</td><td rowspan="3">40M
(Best of Two)</td><td rowspan="5">50M</td></tr>
<tr><td>CIE – 2</td></tr>
<tr><td>CIE - 3</td></tr>
<tr><td>AAT</td><td>05M</td></tr>
<tr><td>Quiz</td><td>05M</td></tr>
<tr><td>Semester End Examination (SEE)</td><td colspan="3">100M (50% weightage)</td><td>50M</td></tr>
<tr><td colspan="4">Total</td><td>100M</td></tr>
</table>

Course Title	INTRODUCTION TO ARTIFICIAL INTELLIGENCE				
Course Code	24AM7OEIAI	Credits	3	L-T-P	3-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hrs/Week	3	Total Lecture Hrs.			36

UNIT – 1	8 Hrs.
INTRODUCTION TO AI: AI in real world, Intelligent Agents: Agent Mechanisms, Structure of Intelligent Agents. Environments Problem solving: Problem formulation, Problem Definition, Production systems. **UNIFORMED-SEARCH STRATEGIES:** Depth First Search, Breadth First Search, Uniform Cost Search, Dept Limited Search.	
UNIT – 2	**8 Hrs.**
INFORMED (Heuristic) SEARCH STRATEGIES: Generate-and-Test, Hill Climbing, Best-first-Search, Problem Reduction and Constrain Satisfaction, Means-ends Analysis.	
UNIT – 3	**7 Hrs.**
KNOWLEDGE REPRESENTATION: Propositional Logic – Syntax and Semantics, Using Propositional Logic, First-Order Logic – Syntax and Semantics. Forward and Backward Chaining.	
UNIT – 4	**7 Hrs.**
REPRESENTING KNOWLEDGE USING RULES: Procedural Versus Declarative Knowledge, Forward Versus Backward Reasoning. **UNCERTAINTY REPRESENTATION:** Acting under uncertainty, Case Study: Wumpus world.	
UNIT – 5	**6 Hrs.**
EXPERT SYSTEMS: Architecture of expert systems, Roles of expert systems, Knowledge Acquisition, Meta knowledge, Heuristics. Typical expert systems – MYCIN, DART, XOON.	

Text Books:

1. *Artificial Intelligence - A Modern Approach,* Stuart Russell and Peter Norvig, 4th Edition, Pearson, 2022.
2. *Artificial Intelligence*, Elaine Rich, Kevin Knight, Shivashankar B Nair, 3rd Edition, Mc Graw Hill Education, 2015.

Reference Books:

1. *Introduction to Artificial Intelligence and Expert Systems,* Dan W Patterson, 1st Edition, Pearson, 2015.
2. *Introduction to Expert Systems,* Peter Jackson, 3rd Edition, Pearson Education, 2007.

Course Outcomes	
CO1	Apply principles of Artificial Intelligence (AI) to solve real-world problems.
CO2	Analyze the performance and limitations of different search algorithms in solving AI problems
CO3	Assess and provide solutions for AI based applications.

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2												1		
CO2		3											1		
CO3			2	1	1								1		

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Introduction to Artificial Intelligence	NPTEL	https://nptel.ac.in/courses/106105077
2.	Introduction to Artificial Intelligence	Coursera	https://in.coursera.org/learn/introduction-to-ai
3.	Artificial Intelligence : Knowledge Representation and Reasoning	NPTEL	https://nptel.ac.in/courses/106106140

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice / Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks
Unit 2	Internal Choice	Two questions to be asked for 20 marks each
Unit 3	Internal Choice	Two questions to be asked for 20 marks each
Unit 4	Mandatory	One question to be asked for 20 marks
Unit 5	Mandatory	One question to be asked for 20 marks

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	25%
Apply / Analyze	50%
Create / Evaluate	25%

Assessment Pattern:

Category			Score Split up	Total
Continuous Internal Evaluation (CIE)	**Theory**	CIE - 1	40M (Best of Two)	**50M**
		CIE – 2		
		CIE - 3		
		AAT/Quiz	01M	
Semester End Examination (SEE)	100M (50% weightage)			**50M**
Total				**100M**

Course Title	INTRODUCTION TO MACHINE LEARNING				
Course Code	24AM7OEIML	Credits	3	L-T-P	3-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact ours/Week	3	Total Lecture Hours			36

UNIT - 1	7 Hours
Introduction: Types, Applications and Challenges of Machine Learning, Testing and Validating, Learning problems, Designing a Learning system, Perspectives and Issues.	
UNIT - 2	**6 Hours**
Concept Learning Task: Concept learning task as search, Find-S algorithm, Version space, Candidate Elimination algorithm.	
UNIT - 3	**8 Hours**
Supervised Learning: Instance Based Learning, Support Vector Machines: Linear and Non-Linear, k-Nearest Neighbor Learning. **Linear Models**-linear and logistic regression	
UNIT - 4	**7 Hours**
Decision Tree Learning: Decision tree representation, Problems, ID3 algorithm, Pruning, Rule extraction from Decision trees.	
UNIT - 5	**8 Hours**
Unsupervised Learning: Types and Challenges, Clustering – K means, DBSCAN, Hierarchical, Association Rule Mining, Anomaly detection. **Reinforcement Learning:** Introduction, The learning task.	

Text Books:

1. *Machine Learning,* Tom Mitchell, McGraw Hill, 3rd Edition, 1997.
2. *Introduction to Machine Learning,* Ethem Alpaydın, 3rd Edition, MIT press, 2014.

Reference Books:

1. *MACHINE LEARNING - An Algorithmic Perspective,* Stephen Marsland, 2nd Edition, 2015.
2. *Introduction to Machine Learning with Python, A Guide for Data Scientists,* Andreas C.Miller and Sarah Guido, O'Reilly Media, 2017.
3. *Hands-on Machine Learning with Scikit-Learn and Tensor Flow: concepts, tools, and techniques to build intelligent systems,* Aurelien Geron, O'Reilly Media, 2019.

Course Outcomes	
CO1	Apply the concepts of Machine Learning techniques to solve the problems across various domains.
CO2	Analyze the given data for modeling and prediction using machine learning techniques.
CO3	Provide solutions for real time applications using Machine Learning techniques.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3													2	
CO2		2												2	
CO3			1		2				2	2				2	

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1	Machine Learning – Introduction to everyone	Coursera	https://www.coursera.org/learn/machine-learning-introduction-for-everyone
2	Introduction to Machine Learning	NPTEL	https://archive.nptel.ac.in/courses/106/106/106106139/

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice/ Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks each
Unit 2	Mandatory	One question to be asked for 20 marks each
Unit 3	Internal Choice	Two questions to be asked for 20 marks each
Unit 4	Mandatory	One question to be asked for 20 marks each
Unit 5	Internal Choice	Two questions to be asked for 20 marks each

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	20%
Apply / Analyze	70%
Create / Evaluate	10%

Assessment Pattern

<table>
<tr><th colspan="3">Category</th><th>Score Split up</th><th>Total</th></tr>
<tr><td rowspan="5">Continuous Internal Assessment (CIE)</td><td rowspan="5">Theory</td><td>CIE – 1</td><td rowspan="3">40M
(Best of Two)</td><td rowspan="5">50M</td></tr>
<tr><td>CIE – 2</td></tr>
<tr><td>CIE – 3</td></tr>
<tr><td>Quiz</td><td>05M</td></tr>
<tr><td>AAT</td><td>05M</td></tr>
<tr><td colspan="2">Semester End Examination (SEE)</td><td colspan="2">100M (50% weightage)</td><td>50M</td></tr>
<tr><td colspan="4">Total</td><td>100M</td></tr>
</table>

Course Title	CAPSTONE PROJECT – PHASE I				
Course Code	24AM7PWCP1	Credits	2	L-T-P	0-0-2
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	4	Total Lecture Hours			

Capstone Project is to be carried out in 2 Phases. Capstone Project - Phase 1 in 7th Semester and Capstone Project - Phase 2 in 8th Semester. This is continuation of Capstone Project - Phase 1.

In Capstone Project - Phase 1 students have to do a detailed literature survey and come up with a problem statement, high level and detailed design. Students also have to prepare a report. The students are encouraged to identify relevant and prevailing societal problems and provide solutions.

Rules and Regulations

- A team should comprise minimum of two and maximum of three members.
- Internship projects are not allowed.
- Simple database related projects are not allowed.
- There shall be two reviews during the semester for evaluating the CIE.

Review-1: Shall be reviewed by the panel consisting of three internal faculty. At the time of Project Work Review 1, the students should be able to satisfy the below outcomes:

Sl. No.	Parameters	Marks
1	Exhaustive Literature Survey for the project work.	10
2	Problem Definition and Scope	10

Review-2: Shall be reviewed by the panel consisting of three internal faculty members. At the time of Project Work Review 2, the students should be able to satisfy the below outcomes:

Sl. No.	Parameters	Marks
1	Completeness, Consistency of requirements and System Architecture	10
2	Component Design and Interaction/ Detailed Design	10
3	Presentation, Report, Timeline.	10

COURSE OUTCOMES (COs)

At the end of the course, the student will be able to:

CO 1: Synthesize existing knowledge thorough literature review to identify gaps in existing system.

CO 2: Develop a comprehensive project proposal, including objectives, scope, deliverables and justify their project's relevance.

CO 3: Prepare and present a progress report summarizing their project high level and detailed design.

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1				1	1								1
CO2				1				1							1
CO3										2	1				1

Assessment Pattern:

Category		Score Split up	Total
Continuous Internal Evaluation (CIE)	Review 1	20M	50M
	Review 2	30M	
Semester End Examination (SEE)	100M (50% weightage)		50M
		Total	100M

B.M.S. College of Engineering, Bengaluru – 19
(Autonomous Institute, Affiliated to VTU | Approved by AICTE)

Scheme of Instructions Semester – VIII (With effect from the Academic Year 2021-22: admitted batches and onwards)

Sl.#	Course Type	Course Code	Course Title	Teaching Hours in Credits/Week			Total Credits	Examination			
				Theory Lecture	Tutorial	Practical		Duration in hours	CIE Marks	SEE Marks	Total Marks
				L	T	P					
1	HS-8	24AM8HSNIC	Nature Inspired Computing	1	0	0	1	01	50	50	100
2	HS-9	24AM8HSMEI	Management, Entrepreneurship and IPR	2	0	0	2	02	50	50	100
3	PC-20	24AM8PCEAI	Ethical AI	2	0	0	2	02	50	50	100
4	OE-3	24AM8OEBDS	Big Data Analytics	3	0	0	3	03	50	50	100
		24AM8OEPPG	Python Programming								
5	PW-6	24AM8PWCP2	Capstone Project – Phase II	0	0	7	7	14	50	50	100
6	SR-4	24AM8SRINP	Internship	0	0	1	1	02	50	50	100
7	NC-8	24AM8NCPCM	Competitive Exam / MOOC Course	Non-credit mandatory Course							
			Total	8	0	8	16	24	200	200	600

Course Title	NATURE INSPIRED COMPUTING				
Course Code	24AM8HSNIC	Credits	1	L-T-P	1-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	1	Total Lecture Hours			13

UNIT – 1	3 Hrs
INTRODUCTION: From Nature-to-Nature Computing, Philosophy, Three Branches: A Brief Overview, Individuals, Entities and agents - Parallelism and Distributivity Interactivity, Adaptation Feedback-Self-Organization-Complexity.	
UNIT – 2	**3 Hrs**
SWARM INTELLIGENCE: Introduction - Ant Colonies, Ant Foraging Behavior, Ant Colony Optimization, Ant Colony Algorithm (ACA), Swarm Robotics.	
UNIT – 3	**2 Hrs**
NATURE-INSPIRED OPTIMIZATION ALGORITHMS: Grey Wolf Optimization, Dragon Fly Optimization.	
UNIT – 4	**3 Hrs**
SELECTED NATURE-INSPIRED TECHNIQUES - Social spider algorithm, Harmony search algorithm, Intelligent water drops algorithm.	
UNIT – 5	**2 Hrs**
COMPUTING WITH NEW NATURAL MATERIALS: DNA Computing: Motivation, DNA Molecule, Adleman's experiment, Scope of DNA Computing, From Classical to DNA Computing	

Text Books:

1. Leandro Nunes de Castro, " Fundamentals of Natural Computing, Basic Concepts, Algorithms and Applications", Chapman & Hall/ CRC, Taylor and Francis Group, 2007

Reference Books:

1. Floreano D. and Mattiussi C., "Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies", MIT Press, Cambridge, MA, 2008.
2. Albert Y.Zomaya - "Handbook of Nature-Inspired and Innovative Computing", Springer, 2006

Course Outcomes	
CO1	Comprehend the needs for present and future computing paradigm changes with examples found in the real world.
CO2	Apply the Nature Inspired Computing approaches in the context of problem-solving.
CO3	Analyze the emulation of natural phenomena in computers.

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1												1		
CO2			1										1		
CO3		1											1		

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Evolutionary Computation for Single and Multi-Objective Optimization	IIT Guwahati	https://nptel.ac.in/courses/112103301

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice / Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks
Unit 2	Internal Choice	Two questions to be asked for 20 marks each
Unit 3	Mandatory	One question to be asked for 20 marks
Unit 4	Mandatory	One question to be asked for 20 marks
Unit 5	Internal Choice	Two questions to be asked for 20 marks each

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	25%
Apply / Analyze	50%
Create / Evaluate	25%

Assessment Pattern:

Category			Score Split up	Total
Continuous Internal Evaluation (CIE)	**Theory**	CIE - 1	40M (Best of Two)	**40M**
		CIE – 2		
		CIE - 3		
		AAT/Quiz	05M	
		AAT	05M	
Semester End Examination (SEE)	100M (50% weightage)			**50M**
Total				**100M**

Course Title	MANAGEMENT, ENTREPRENEURSHIP AND IPR				
Course Code	24AM8HSMEI	Credits	2	L-T-P	2-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	2	Total Lecture Hours			26

UNIT – 1	5 Hrs
MANAGEMENT: Meaning, nature and characteristics of management, scope and functional areas of management, goals of management, levels of management. Planning- Nature, importance, types of plans, steps in planning. Organizing- nature and purpose, types of Organization, Staffing- meaning, process of recruitment and selection.	
UNIT – 2	**5 Hrs**
ENTREPRENEUR: Meaning of entrepreneur, types of entrepreneurships, stages of entrepreneurial process, role of entrepreneurs in economic development, entrepreneurship in India, barriers to entrepreneurship. Identification of business opportunities- market feasibility study, technical feasibility study, financial feasibility study and social feasibility study.	
UNIT – 3	**5 Hrs**
MICRO AND SMALL ENTERPRISES: Definition of micro and small enterprises, characteristics and advantages of micro and small enterprises, steps in establishing micro and small enterprises, Government of India industrial policy 2007 on micro and small enterprises. Institutional support: MSME-DI, NSIC, SIDBI, KIADB, KSSIDC, TECSOK, KSFC, DIC and District level single window agency.	
UNIT – 4	**5 Hrs**
INTELLECTUAL PROPERTY SYSTEM: What is Intellectual Property? Historical Background of IP, Economic Value of IP, Motivation to IP Development, IP System Strategy, Institutions for administering the IP system. IP rights and Marketing Regulations – IPR Protection, Protecting Consumers, Protecting Competition**,** Clinical Research Regulations, IPR Vs Regulations.	
UNIT – 5	**6 Hrs**
INTELLECTUAL PROPERTY RIGHTS: What is IPR? Types of IPR, Indian IPR Scenario, Legal use of IP, Global vs. Indian IPR Landscape, TRIPS – its implication. Intersection of Intellectual Property Rights and AI-Generated Works – Copyright, Patent, Trademark Law in India.	

Text Books:

1. *Managing Intellectual Property.* Scople Vinod, Prentice Hall of India Pvt Ltd, 2012.
2. *Principles of Management*, P. C. Tripathi, P. N. Reddy, Tata McGraw Hill, 4th/ 6th Edition, 2010.

Reference Books:

1. *Intellectual Property Rights and Copy Rights,* S. V. Satakar, Ess Ess Publications, New Delhi, 2002.
2. *Management Fundamentals – Concepts, Application, Skill Development,* Robert Lusier – Thomson, Thomson/South-Western, 3rd Edition, 2006.

Course Outcomes	
CO1	Ability to apply Engineering knowledge to effectively exhibit managerial skills at different levels of management in a global context.
CO2	Identify the critical awareness of the principles and importance of entrepreneurship.
CO3	Apply the practices and scope for protecting his/her novel creations and analyze an ethical issue and respective laws and acts in relevant fields.

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												1		
CO2						2									
CO3								3							

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Entrepreneurship and IP Strategy	IIT Kharagpur	https://onlinecourses.nptel.ac.in/noc21_hs102/preview
2.	Intellectual Property for Entrepreneurs	Coursera	https://www.coursera.org/learn/intellectual-property-for-entrepreneurs
3.	Intellectual Property: Inventors, Entrepreneurs, Creators	Udemy	https://www.udemy.com/course/intellectual-property-inventors-entrepreneurs-creators/

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice / Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks
Unit 2	Internal Choice	Two questions to be asked for 20 marks each
Unit 3	Mandatory	One question to be asked for 20 marks
Unit 4	Mandatory	One question to be asked for 20 marks
Unit 5	Internal Choice	Two questions to be asked for 20 marks each

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	70%
Apply / Analyze	20%
Create / Evaluate	10%

Assessment Pattern:

Category			Score Split up	Total
Continuous Internal Evaluation (CIE)	Theory	CIE - 1	40M (Best of Two)	40M
		CIE – 2		
		CIE - 3		
		AAT/Quiz	05M	
		AAT	05M	
Semester End Examination (SEE)	100M (50% weightage)			50M
Total				100M

Course Title	CONSTITUTIONAL AI				
Course Code	24AM8PCCAI	Credits	2	L-T-P	2-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	2	Total Lecture Hours			26

UNIT – 1	5 Hrs
Ethical Impact of AI: Mapping the main ethical dilemmas and moral questions associated with the deployment of AI: Impact on society, Impact on human psychology, Impact on the financial system, Impact on the legal system, Impact on the environment and the planet, Impact on trust.	
UNIT – 2	**5 Hrs**
Ethical initiatives in the field of artificial intelligence: International ethical initiatives, Ethical harms, and concerns tackled by these initiatives, Harms in detail, **Case studies:** healthcare robots, Autonomous Vehicles, Warfare and weaponization	
UNIT – 3	**5 Hrs**
AI for Ethics: What is AI?, Its Ethical Relevance, Main Debates, Machine Ethics: Bottom-up Approaches, Top-down Approaches, Mixed Approaches, Autonomous Systems, Machine Bias, The Problem of Opacity, Machine Consciousness, The Moral Status of Artificial Intelligent Machines. Risks and benefits of AI.	
UNIT – 4	**6 Hrs**
National and International Strategies on AI: Europe, North America, Asia, Africa, South America, and Australasia, International AI Initiatives, in addition to the EU, Government Readiness for AI, **Emerging Themes:** Addressing ethical issues through national and international strategies, Addressing the governance challenges posed by AI.	
UNIT – 5	**5 Hrs**
Philosophy, Ethics and Safety of AI: The Limits of AI, Can Machines Really Think?, Unfair and Illegal Discrimination, Privacy, Cases of AI Adversely Affecting the Right to Life, Liberty and Security of Persons	

Text Books:

1. *The ethics of artificial intelligence: Issues and initiatives,* EPRS|European Parliamentary Research Service, Scientific Foresight Unit (STOA) PE 634.452 – March 2020
2. *Ethics of Artificial Intelligence: Case Studies and Options for Addressing Ethical Challenges*, Bernd Carsten Stahl, Doris Schroeder, Springer, 2023
3. *Arificial Intelligence-A modern approach,Pearson*, 4th edition, Staurt Russel,Peter Norvig,2010

Reference Books:

1. *Artificial Intelligence: A Guide for Thinking Humans, Melanie Mitchell, Pelicon books, First edition 2019.*
2. *Ethics of Artificial Intelligence and Robotics, Müller, Vincent C, Edward N. Zalta & Uri Nodelman ,The Stanford Encyclopedia of Philosophy (Fall 2023 Edition).*

Course Outcomes	
CO1	Apply ethical concepts on the problems solved using Artificial Intelligence approach.
CO2	Analyze various safety, privacy and ethical aspects on AI
CO3	Design the AI models on real time applications with constitutional ethics

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3							2					2		
CO2		2						2						2	
CO3			2		2			2	2	2					1

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Ethics of Artificial Intelligence	IEP	https://iep.utm.edu/ethics-of-artificial-intelligence/
2.	AI Law, Ethics, Privacy & Legalities	Udemy	https://www.udemy.com/course/ai-law-ethics-privacy-by-dr-pavan-duggal/?couponCode=ST16MT70224

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice / Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks
Unit 2	Mandatory	One question to be asked for 20 marks
Unit 3	Internal Choice	Two questions to be asked for 20 marks each
Unit 4	Internal Choice	Two questions to be asked for 20 marks each
Unit 5	Mandatory	One question to be asked for 20 marks

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	35%
Apply / Analyze	40%
Create / Evaluate	25%

Assessment Pattern:

Category			Score Split up	Total
Continuous Internal Evaluation (CIE)	**Theory**	CIE - 1	40M (Best of Two)	**50M**
		CIE – 2		
		CIE - 3		
		AAT	10M	
Semester End Examination (SEE)	100M (50% weightage)			**50M**
			Total	**100M**

Course Title	BIG DATA ANALYTICS				
Course Code	24AM8OEBDS	Credits	3	L-T-P	3-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours /Week	3	Total Lecture Hours			36

UNIT – 1	7 Hrs
Introduction to Big Data Analytics: what is Big Data? Sources of Big Data, Big Data Characteristics, Types of Big Data, Tools and Technologies Available for Big Data, Infrastructure for Big Data, Types of Big Data Analytics, Uses of Big Data Analytics, Big Data Challenges, Big Data Case Studies.	
UNIT – 2	**6 Hrs**
Big Data File Formats and Compression Techniques: Various file formats supported by Big Data, Difference between Row oriented and Column oriented file formats and use cases, Understanding RC, ORC, Avro, Parquet, Sequence, Text File Formats and associated Compression techniques of zip, gzip, bzip, bzip2, lz4, snappy to optimize processing.	
UNIT – 3	**8 Hrs**
Introduction to Hadoop and Hadoop Architecture: Hadoop and its Modules , HDFS, Features of HDFS, Yarn, Hadoop Architecture, Hadoop Installation, Hadoop MapReduce- what is MapReduce?, Dataflow in MapReduce, MapReduce API, MapReduce Examples,, Moving Data in and out of Hadoop – Understanding inputs and outputs of MapReduce, Data Serialization and Deserialization.	
UNIT – 4	**7 Hrs**
HDFS and HIVE: HDFS Overview, Java API, Hive Architecture and Installation, Comparison with Traditional Database, HiveQL Querying Data, Sorting and Aggregating, Map Reduce Scripts, Joins & Sub queries.	
UNIT – 5	**8 Hrs**
HBase and client -server Architecture: Advanced Usage, Schema Design, Advance Indexing, PIG, Zookeeper, how it helps in monitoring a cluster, HBase uses Zookeeper and how to Build Applications with Zookeeper. **Spark:** Introduction to Apache Spark, Spark Architecture, Spark SQL, Spark RDD and case studies.	

Text Books:

1. Bart Baesens , Analytics in a Big Data World: The Essential Guide to DataScience and its Applications, ,Wiley, 2014.

2. Xyz Dirk Deroos et al., Hadoop for Dummies, Dreamtech Press, 2014.

Reference Books:

1. Tom White, Hadoop: The Definitive Guide:by , June 2009, Publisher(s): O'Reilly Media, Inc.

2. Chuck Lam, Hadoop in Action, December, 2010.

3. Leskovec, Rajaraman, Ullman, Mining of Massive Datasets, Cambridge University Press.

4. I.H. Witten and E. Frank, Data Mining: Practical Machine learning tools and techniques.

Course Outcomes	
CO1	Comprehend the key techniques, tools, and fundamental concepts of big data analytics.
CO2	Analyze various data storage, retrieval technologies and choose the most suitable one based on specific use cases.
CO3	Attain proficiency in the use of a variety of tools for comprehensive data analysis.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PS01	PS02	PS03
CO1	1												2	
CO2		2											2	
CO3					2						2		2	

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1	Introduction to Big Data	Coursera	https://www.coursera.org/learn/big-data-introduction
2	Introduction to Big Data with Spark and Hadoop	Coursera	https://www.coursera.org/learn/introduction-to-big-data-with-spark-hadoop

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice/ Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks each
Unit 2	Mandatory	One question to be asked for 20 marks each
Unit 3	Internal Choice	Two questions to be asked for 20 marks each
Unit 4	Mandatory	One question to be asked for 20 marks each
Unit 5	Internal Choice	Two questions to be asked for 20 marks each

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	30%
Apply / Analyse	40%
Create / Evaluate	30%

Assessment Pattern

Category			Score Split up	Total
Continuous Internal Assessment (CIE)	Theory	CIE – 1	40 M (Best of Two)	50M
		CIE – 2		
		CIE – 3		
		AAT	10M	
Semester End Examination (SEE)	100M (50% weightage)			50M
Total				100M

Course Title	PYTHON PROGRAMMING				
Course Code	24AM8OEPPG	Credits	3	L-T-P	3-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	3	Total Lecture Hours			36

UNIT – 1	7 Hrs
Introduction: The Concepts of Abstract Machine and Interpreter, Influences on language design, Implementation methods, Programming environments, Language categories and examples. Overview of Python Programming: Conditionals and Loops, Lists, Tuples, Sets Dictionaries	
UNIT – 2	**6 Hrs**
Functions: Defining a Function, Parameters and arguments in a function, Calling a Function, Built-in Functions, Recursive functions, The lambda function.	
UNIT – 3	**7 Hrs**
Object Oriented Programming: OOP principles, classes, objects and instantiation, Encapsulation: Encapsulations with functions, Encapsulations with objects Abstraction: Abstract base classes, Creation of abstract base class.	
UNIT – 4	**8 Hrs**
Inheritance: Extending built-ins, overriding and super keyword, Multiple Inheritance, Diamond problem, Real-World Examples of Inheritance. Polymorphism: Sending messages to objects, Pygame shapes, Polymorphism in pywidgets, Polymorphism for operators, Magic methods.	
UNIT – 5	**8 Hrs**
Error handling with Exceptions in python: Try and except, Raise statement and custom exceptions. Managing Memory used by objects: Object lifetime, Reference count, Garbage collection, Class variables and constants, Managing memory slots. Concurrency: Threads, Multithreading, Multiprocessing.	

Text Books:

1. *Programming Languages: Principles and Paradigms, springer, Maurizio Gabbrielli, Simone Martini, 2023.*
2. *Wesley J. Chun, "Core Python Applications Programming", 3rd Edition , Pearson Education, 2016.*

Reference Books:

1. *Downey, A. et al., "How to think like a Computer Scientist: Learning with Python", John Wiley, 2015.*
2. *Mark Lutz, "Learning Python", 5th edition, Orelly Publication, 2013, ISBN 978- 1449355739.*
3. *John Zelle, "Python Programming: An Introduction to Computer Science", Second edition,* Course Technology Cengage Learning Publications, 2013, ISBN 978- 1590282410.

Course Outcomes

CO1	Apply the Python's core syntax and semantics, and effectively utilize control flow statements.
CO2	Design and model efficient class and object interaction mechanisms using object-oriented problem- solving techniques.
CO3	Implement real-world scenarios that showcase the usage of object oriented programming principles.

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3													2	
CO2		2												2	
CO3			2		2				2					2	

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Programming in Python	NPTEL	https://onlinecourses.swayam2.ac.in/cec22_cs20/preview
2.	Programming in Python	Coursera	https://www.coursera.org/learn/programming-in-python
3.	Programming for Everybody (Getting Started with Python)	Coursera	https://www.coursera.org/learn/python

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice / Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks
Unit 2	Mandatory	One question to be asked for 20 marks
Unit 3	Internal Choice	Two questions to be asked for 20 marks each
Unit 4	Internal Choice	Two questions to be asked for 20 marks each
Unit 5	Internal Choice	Two questions to be asked for 20 marks each

Bloom's Level	Percentage of Questions to be included in SEE Question Paper
Remember / Understand	25%
Apply / Analyze	50%
Create / Evaluate	25%

Assessment Pattern:

Category			Score Split up	Total
Continuous Internal Evaluation (CIE)	**Theory**	CIE - 1	40M (Best of Two)	**50M**
		CIE – 2		
		CIE - 3		
		AAT	05M	
		Quiz	05M	
Semester End Examination (SEE)	100M (50% weightage)			**50M**
			Total	**100M**

Course Title	INTERNSHIP				
Course Code	24AM8SRINP	Credits	1	L-T-P	0-0-1
CIE	50 Marks	SEE	50 Marks (100% Weightage)		
Contact Hours / Week	0	Total Lecture Hours			0

Internship is carried out for 12 weeks.

The students must make two presentations on the scheduled dates, and this will be evaluated by internal reviewers based on the rubrics for 50 marks each. Finally, internship report must be submitted to the guide allotted.

Total internal assessment : Average of two reviews evaluated for 50 marks each. SEE will be conducted for 50 marks. The final marks would be CIE+SEE (50+50)=100 marks.

Course Outcomes:

CO1	Apply technical knowledge in the given domain of the work and contribute towards finding optimal solutions to the identified problem.
CO2	Analyze the job assigned extensively and learn the tools and technologies required to execute the job.
CO3	Develop and refine oral and written communication skills.
CO4	Demonstrate ethical conduct and professional accountability while working in a team or individually for the benefit of society.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PS01	PS02	PS03
CO1	3	2												
CO2		2												
CO3										3				
CO4								3						

Semester End Examination (SEE) Review:

SEE will be carried out for 50 marks based on the evaluation rubrics. The report to be carried during the evaluation process.

Assessment Pattern

Category			Score Split up	Total
Continuous Internal Assessment (CIE)	**Theory**	Review – 1	20M +30 M	**50M**
		Review – 2		
Semester End Examination (SEE)	**50M (100% weightage)**			**50M**
			Total	**100M**

Course Title	CAPSTONE PROJECT – PHASE II				
Course Code	24AM8PWCP2	Credits	7	L-T-P	0-0-7
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	14	Total Lecture Hours			

Capstone Project-II: The student will continue the identified engineering problem and design solutions carried out during Capstone Project-1. A detailed implementation, Modules Integration and Testing has to be carried out. Students also have to prepare a detailed project report.

The outcome of the capstone project should be either published in a reputed conference/journal of Scopus/Web of science indexed, based on the strength of the work carried out. If the outcome of the project is a combination of software and hardware it is recommended to apply for patent. The students should be encouraged to submit their work in project competitions/Ideathon either national or international forums, government agencies like KSCST, VGST, etc.

Rules and Regulations

- The student shall submit the progress report every week showing the progress made, to their respective guides.
- The project report shall be submitted as per the approved guidelines and formats.
- Marks are awarded to each student of the project group based on the individual performance in the viva-voce external examination.
- If a candidate fails to submit the project report on or before the specified deadline, he/she is deemed to have failed in the Project Work and shall re-register for the same in a subsequent semester.

Review-1: Shall be reviewed by the panel consisting of three internal faculty. At the time of Project Work Review 1, the students should be able to satisfy the below outcomes:

Sl. No.	Parameters	Marks
1	Methodology and Implementation	10
2	Individual contribution, team work and communication.	10

Review-2: Shall be reviewed by the panel consisting of three internal faculty members. At the time of Project Work Review 2, the students should be able to satisfy the below outcomes:

Sl. No.	Parameters	Marks
1	Testing and Results	10
2	Ethical Considerations, Societal impact, innovation and creativity	10
3	Project Report	10

COURSE OUTCOMES (COs)
At the end of the course, the student will be able to:

CO 1: Demonstrate proficiency in the technical skills and tools applied in their project.
CO 2: Apply project management principles to organize and manage their project effectively.
CO 3: Function effectively within the team and contribute to its success while adhering to standards, legal requirements, and ethical practices.

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1					3										1
CO2											2				1
CO3						1		1	1	1					1

Assessment Pattern:

Category		Score Split up	Total
Continuous Internal Evaluation (CIE)	Review 1	20M	50M
	Review 2	30M	
Semester End Examination (SEE)	100M (50% weightage)		50M
		Total	100M