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 AND SYLLABUS: III to VIII SEMESTER

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 carrier 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

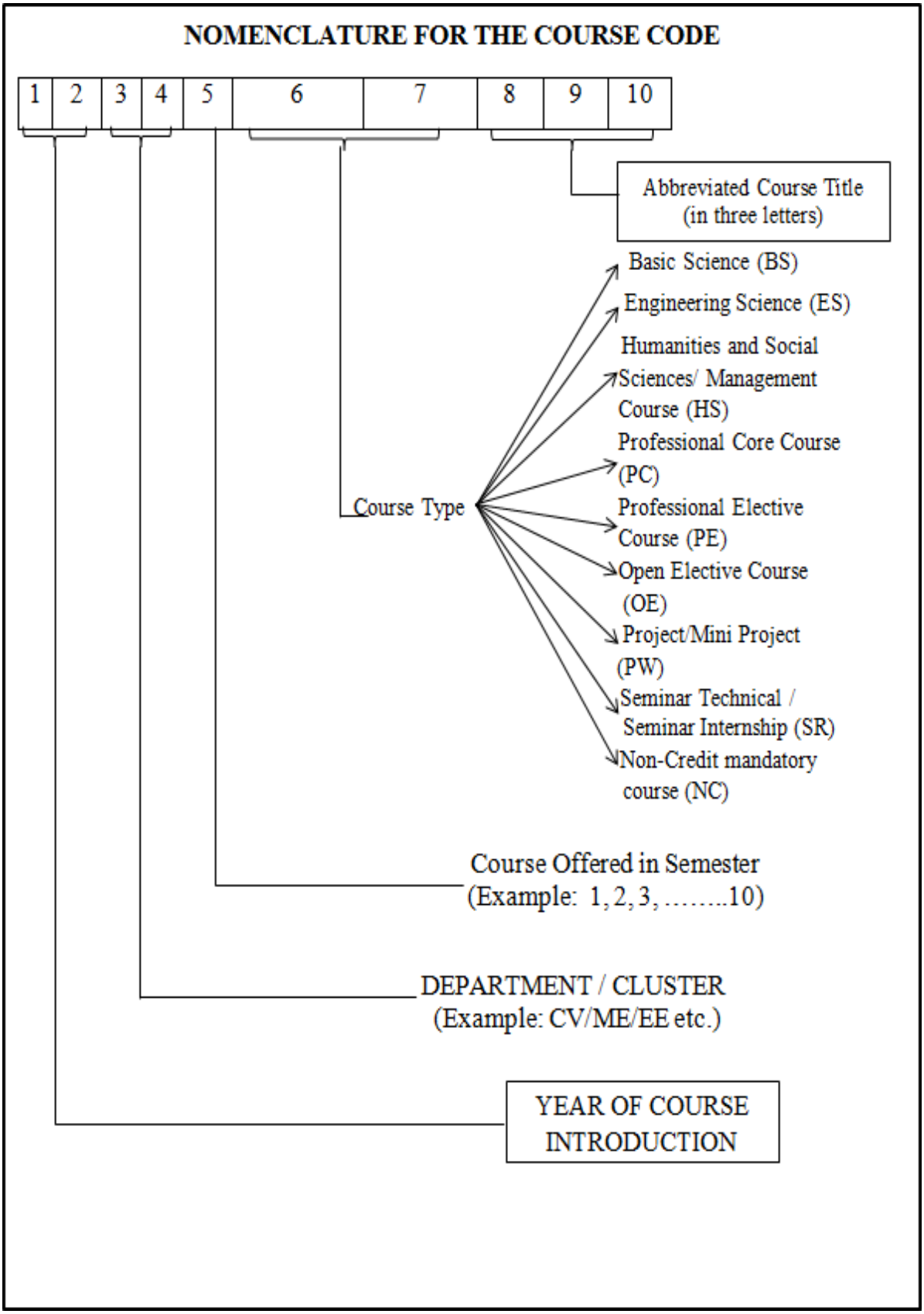
PROGRAMME SPECIFIC OUTCOMES (PSOs)

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



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DEPARTMENT OF MACHINE LEARNING

Credits Distribution among Curricular Components (160 Credits)

Curricular Component/ Semester	I	II	III	IV	V	VI	VII	VIII	Total
Basic Science Course (BS)	8	8	3	3			1		23
Engineering Science Course (ES)	10	10	3						23
Professional Core Course (PC)			13	15	15	11	5		59
Professional Elective Course (PE)					3	3	3	3	12
Open Elective Course (OE)						3	3	3	9
Project/ Mini-Project (PW)					2	2	2	6	12+4 = 16
Seminar on Internship (SR)				1		1		2	
Humanities and Social Sciences, Management Course (HS)	1	1	2	1	2	2	2	2	13
Ability Enhancement Course / Mandatory Course(AEC)	1	1	1	2					5
Non-Credit Mandatory Course (NCMC)	-	-	NC	NC	NC	NC	NC	NC	6 Units
Total Credits	20	20	22	22	22	22	16	16	160

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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	22AM5PCTFM	Time Series and Financial Mathematics	3	0	0	3	03	50	50	100
2	PC - 10	22AM5PCINN	Introduction to Neural Networks	3	1	0	4	05	50	50	100
3	PC - 11	22AM5PCOPG	Object Programming	3	0	1	4	05	50	50	100
4	PC - 12	22AM5PCIML	Introduction to Machine Learning	3	0	1	4	05	50	50	100
5	PE - 1	22AM5PEABI	AI in Business Intelligence	3	0	0	3	03	50	50	100
		22AM5PEKDI	Knowledge Discovery								
		22AM5PECGV	Computer Graphics & Visualization (Practice using Tableau / Power BI)								
6	PW - 1	22AM5PWMEL	Project work on Machine Learning	0	0	2	2	04	50	50	100
7	HS - 6	22AM5HSPMA	Project Management in AI	2	0	0	2	02	50	50	100
8	NCMC - 3	22AM5NCCSE	Communication Skills Enhancement	Non-Credit Mandatory Course				01	-	-	-
Details of 40 AICTE Activity Points											
			Total	17	1	4	22	28	350	350	700

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 – 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	22AM6PCAAI	Advanced Artificial Intelligence	3	0	0	3	03	50	50	100
2	PC - 14	22AM6PCDEL	Deep Learning	3	0	1	4	05	50	50	100
3	PC - 15	22AM6PCAML	Advanced Machine Learning	3	0	1	4	05	50	50	100
4	PE - 2	22AM6PESMA	Social Media Analytics	3	0	0	3	03	50	50	100
		22AM6PEBCT	Block Chain Technology								
		22AM6PEVCV	Video Analytics using Open CV								
5	OE - 1	22AM6OEIDM	Introduction to Data Mining	3	0	0	3	03	50	50	100
		22AM6OEIAI	Introduction to Artificial Intelligence								
		22AM6OEIML	Introduction to Machine Learning								
6	PW - 2	22AM6PWDLN	Project work on Deep Learning	0	0	2	2	04	50	50	100
7	INT - 2	22AM6SRIN2	Internship Based Seminar	0	0	1	1	02	50	50	100
8	HS - 7	22AM6HSRLF	Reinforcement Learning in Finance	2	0	0	2	02	50	50	100
9	NCMC - 4	22AM6NCPDT	Personality Development Training	Non-Credit Mandatory Course				01	-	-	-
Details of 60 AICTE Activity Points											
			Total	17	0	5	22	28	400	400	800

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	BS – 9	22AM7BSBAM	Biology for AI-ML Engineers	1	0	0	1	01	50	50	100
2	PC - 16	22AM7PCSCT	Soft Computing	3	1	0	4	05	50	50	100
3	PC - 17	22AM7PCPMJ	Project Management using Jira	0	1	0	1	02	50	50	100
4	PE - 3	22AM7PECSS	Cognitive Systems	3	0	0	3	05	50	50	100
		22AM7PEEHP	Ethical Hacking Principles								
		22AM7PEBDA	Big Data Analytics								
5	PW - 3	22AM7PWCP1	Capstone Project – Phase I	0	0	2	2	04	50	50	100
6	OE - 2	22AM7OEIBI	Introduction to Business Intelligence	3	0	0	3	03	50	50	100
		22AM7OEINN	Introduction to Neural Networks								
		22AM7OETSA	Time Series Analysis								
7	HS - 8	22AM7HSPAI	IPR in Artificial Intelligence	2	0	0	2	02	50	50	100
8	NCMC - 5	22AM7NCMC1	MOOC – 1	Non-Credit Mandatory Course				01	-	-	-
Details of 80 AICTE Activity Points											
			Total	12	2	2	16	23	350	350	700

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 – 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	PE - 4	22AM8PEDIP	Digital Image Processing	3	0	0	3	3	50	50	100
		22AM8PEPRN	Pattern Recognition								
		22AM8PEAVR	Augmented Reality and Virtual Reality								
2	PW - 4	22AM8PWCP2	Capstone Project – Phase II	0	0	6	6	12	50	50	100
3	OE - 3	22AM8OEDAS	Data Analytics	3	0	0	3	03	50	50	100
		22AM8OEFAP	Financial Analytics using Python								
		22AM8OEDRL	Deep and Reinforcement Learning								
4	HS - 9	22AM8HSEMN	Entrepreneurship and Management	2	0	0	2	02	50	50	100
5	INT - 3	22AM8SRIN3	Internship	0	0	2	2	04	50	50	100
6	NCMC - 6	22AM8NCMC2	MOOC – 2	Non-Credit Mandatory Course				01	-	-	-
Details of 100 AICTE Activity Points											
			Total	8	0	8	16	25	250	250	500

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 - 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 learning applications.
- Gain the knowledge of Discrete Mathematical 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 of teaching 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 critical 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 than simply 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 up with 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 to 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, Cheng Soon 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	Ability to analyze and design efficient synchronous systems from the functional description of computing systems.
CO2	Ability to design tradeoff in the development of modern computing systems.
CO3	Ability to use design tools in a team to simulate and verify logic circuits and computer architecture.

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 of Automata.	
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.

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.

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 and Analyze the concepts of database management system for various applications to its correctness.
CO2	Design and demonstrate conceptual models, query and optimization
CO3	Conduct experiments to demonstrate the various SQL query processing

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, **Global Internet:** 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.

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 using HTML, 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 in team using modern integrated tools.

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 of teaching 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 to improve 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	Analyze the real time challenges based on distribution of data, predict future estimations using the concept of probability and acquire skills to better handle the present situation.
CO2	Apply statistical knowledge to understand the uncertainty in daily applications and formulate automated solutions.
CO3	Analyze the relationship between the features extracted from the samples and apply the learnt algorithms to handle data efficiently.

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	Understand the structure and functionality of operating system and apply CPU scheduling
CO2	Explore design tradeoffs in designing various components of the Operating system such as process management, memory management, device management.
CO3	Analyze and apply various tradeoffs of system software of modern multiprocessing computers.

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	Design efficient algorithms and perform time complexity analysis of Recursive & Non-recursive algorithms using asymptotic notations.
CO2	Apply the knowledge of complexity classes P, NP, and NP-Complete and prove certain problems are NP-Complete.
CO3	Solve problems using an appropriate designing method and find time efficacy by practical programming experiments.

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	Understand the concept of Intelligent agents to solve problems using uninformed and informed search strategies.
CO2	Represent procedural and declarative knowledge by applying agent-based rules and to provide logic-based analysis for question and answering techniques.
CO3	Formulate probabilities for handling uncertain knowledge and understand the concept of expert systems.

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	Learn and apply core Python scripting elements such as variables, flow control structures, file operations and functions.
CO2	Implement control structures and various data structures for simple to complex operations.
CO3	Demonstrate the usage of python libraries for performing data operations and data visualizations.
CO4	Expertise in using and configuring modern integrated development tools related to python programming.