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 - VI SEMESTERS

From 2022-23 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

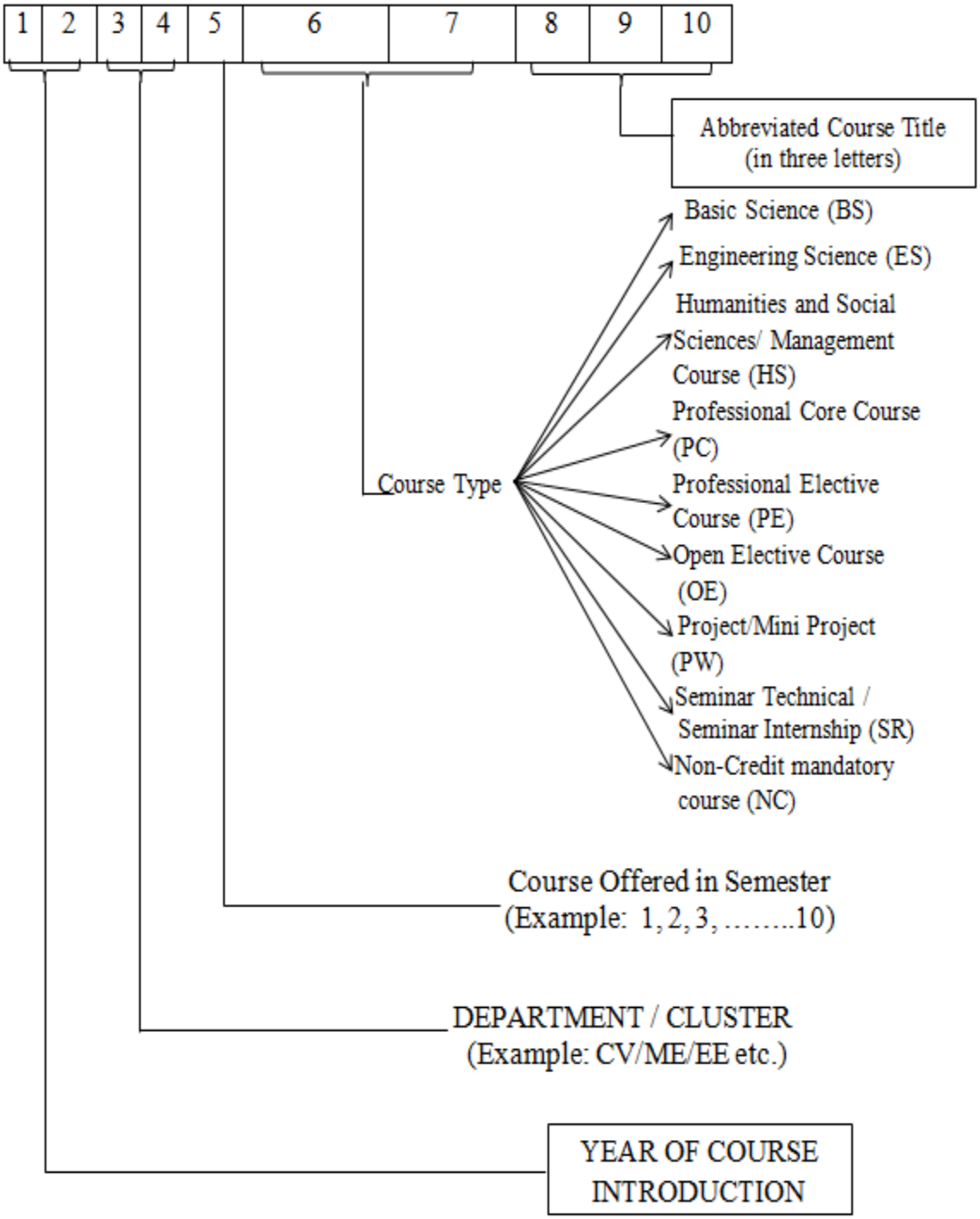
PROGRAMME SPECIFIC OUTCOMES (PSOs)

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



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Scheme of Instructions Semester – III (With effect from the Academic Year 2022-23: 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-3	23MA3BSMML	Mathematical Foundations for Machine Learning	2	0	1	3	4	50	50	100
2.	ES-3	23AM3ESCOA	Computer Organization and Architecture	3	0	0	3	3	50	50	100
3.	PC-1	23AM3PCDST	Data Structures	3	0	1	4	5	50	50	100
4.	PC-2	23AM3PCPSM	Probability and Statistics for Machine Learning	2	0	1	3	4	50	50	100
5.	PC-3	23AM3PCOOP	Object Oriented Programming	2	0	1	3	4	50	50	100
6.	PC-4	23AM3PCDBM	Database Management Systems	2	0	1	3	4	50	50	100
7.	AE-3	23AM3AETFC	Theoretical Foundations of Computations	3	0	0	3	3	50	50	100
8.	NCMC-1	23NCMC3PE1	Physical Education-1	Non-credit mandatory Course (1Hr)							
			Total	16	1	5	22	28	350	350	700

Note: BS: Basic Science Course, **ES**: Engineering Science Course, **PC**: Professional Core Courses, **AE**: Ability Enhancement Courses, **NC**: Non-credit mandatory courses

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Scheme of Instructions Semester – IV (With effect from the Academic Year 2022-23: 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-4	23MA4BSMML	Mathematical Foundation for Machine Learning-2	2	0	1	3	4	50	50	100
2.	ES-4	24AM4ESOPS	Operating Systems	3	0	0	3	3	50	50	100
3.	PC-5	24AM4PCDAA	Design and Analysis of Algorithms	3	0	0	3	3	50	50	100
4.	PC-6	24AM4PCIAI	Introduction to Artificial Intelligence	3	0	0	3	3	50	50	100
5.	PC-7	24AM4PCIML	Introduction to Machine Learning	3	0	1	4	5	50	50	100
6.	PC-8	24AM4PCIST	Inferential Statistics	2	1	0	3	4	50	50	100
7.	PC-9	24AM4PCAAL	Algorithm Analysis Laboratory	0	0	1	1	2	50	50	100
8.	UHV-1	22MA4AEUHV	Universal Human Values	0	1	0	1	2	50	50	100
9.	AE-4	24AM4AEJAP	Java Programming	0	0	1	1	2	50	50	100
10.	NCMC-2	23NCMC4PE2	Physical Education	Non-credit mandatory Course (1Hr)							
Total				16	2	4	22	28	450	450	900

Note: BS: Basic Science Course, **ES**: Engineering Science Course, **PC**: Professional Core Courses, **AE**: Ability Enhancement Courses, **NC**: Non-credit mandatory courses

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Scheme of Instructions Semester – V (With effect from the Academic Year 2022-23: 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-10	24AM5PCDEL	Deep Learning	3	0	1	4	5	50	50	100
2	PC-11	24AM5PCCNS	Computer Networks	2	0	0	2	2	50	50	100
3	PC-12	24AM5PCSML	Statistical Modeling	3	0	1	4	5	50	50	100
4	PC-13	24AM5PCDAV	Data Analysis and Visualization	1	0	1	2	3	50	50	100
5	PC-14	24AM5PCNIC	Nature Inspired Computing	2	0	0	2	2	50	50	100
6	HS-3	23CV5HSEVS	Environmental Studies (CV/CH)	1	0	0	1	1	50	50	100
7	PE-1	24AM5PEDIP	Digital Image Processing	3	0	0	3	3	50	50	100
		24AM5PEKDD	Knowledge Discovery								
		24AM5PEIOT	Internet of Things								
8	PW-1	24AM5PWMPW	Mini Project Work	0	0	2	2	4	50	50	100
9	AE-5	24AM5AERMD	Research Methodology	2	0	0	2	2	50	50	100
10	NCMC-3	24NCMC5PE3	Physical Education	Non-credit mandatory Course (1Hr)							
			Details of 40 AICTE Activity Points								
				17	0	5	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 – VI (With effect from the Academic Year 2022-23: 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-15	24AM6PCSEP	Software Engineering and Project Management	3	0	0	3	3	50	50	100
2	PC-16	24AM6PCPAG	Parallel Architectures and Programming	2	0	0	2	2	50	50	100
3	PC-17	24AM6PCAGA	Autoencoders and Generative AI	3	0	1	4	5	50	50	100
4	PC-18	24AM6PCREL	Reinforcement Learning	3	0	0	3	3	50	50	100
5	PC-19	24AM6PCSCL	Soft Computing Lab	0	0	1	1	2	50	50	100
6	PE-2	24AM6PECVV	Computer Vision	3	0	0	3	3	50	50	100
		24AM6PEBDA	Big Data Analytics								
		24AM6PERPA	Robotic Process Automation								
7	OE-1	24AM6OEAIG	Introduction to Artificial Intelligence	3	0	0	3	3	50	50	100
		24AM6OEMLG	Introduction to Machine Learning								
		24AM6OEINN	Introduction to Neural Networks								
8	PW-2	24AM6PWPW1	Project work -1	0	0	2	2	4	50	50	100
9	AE-6	24AM6AEMLO	MLOPS	0	0	1	1	2	50	50	100
10	NCMC-4	24NCMC6PE4	Physical Education	Non-credit mandatory Course (1Hr)							
			Details of 60 AICTE Activity Points Earned								
			Total	17	0	5	22	27	450	450	900

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Scheme of Instructions Semester – VII (With effect from the Academic Year 2022-23: 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-20	24AM7PCTSA	Time Series Analysis	2	0	1	3	4	50	50	100
2	PC-21	24AM7PCLLM	Natural Language Processing for LLM	2	0	0	2	2	50	50	100
3	PE-3	24AM7PEVCV	Video Analytics using OpenCV	3	0	0	3	3	50	50	100
		24AM7PESNA	Social Network Analysis								
		24AM7PECYS	Cyber Physical Systems								
4	OE-2	24AM7OEAIG	Introduction to AI	3	0	0	3	3	50	50	100
		24AM7OEMLG	Introduction to Machine Learning								
		24AM7OEINN	Introduction to Neural Networks								
5	PW-3	24AM7PWPW2	Project work-2	0	0	5	5	10	50	50	100
			Details of 80 AICTE Activity Points Earned								
			Total	10	0	6	16	22	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 – VIII (With effect from the Academic Year 2022-23: 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	PE-4	24AM8PEFMS	Financial Mathematics	3	0	0	3	3	50	50	100
		24AM8PEFMT	Financial Management								
		24AM8PEEPM	Entrepreneurship and Management								
2	OE-3	24AM8OEIAI	Introduction to AI	3	0	0	3	3	50	50	100
		24AM8OEIML	Introduction to Machine Learning								
		24AM8OEINN	Introduction to Neural Networks								
3	INT-1	24AM8SRINT	Internship (16-20 weeks)	0	0	10	10	20	50	50	100
			Details of 100 AICTE Activity Points Earned								
			Total	6	0	10	16	26	150	150	300

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 2022-23: 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-3	23MA3BSMML	Mathematical Foundations for Machine Learning	2	0	1	3	4	50	50	100
2.	ES-3	23AM3ESCOA	Computer Organization and Architecture	3	0	0	3	3	50	50	100
3.	PC-1	23AM3PCDST	Data Structures	3	0	1	4	5	50	50	100
4.	PC-2	23AM3PCPSM	Probability and Statistics for Machine Learning	2	0	1	3	4	50	50	100
5.	PC-3	23AM3PCOOP	Object Oriented Programming	2	0	1	3	4	50	50	100
6.	PC-4	23AM3PCDBM	Database Management Systems	2	0	1	3	4	50	50	100
7.	AE-3	23AM3AETFC	Theoretical Foundations of Computations	3	0	0	3	3	50	50	100
8.	NCMC-1	23NCMC3PE1	Physical Education-1	Non-credit mandatory Course (1Hr)							
			Total	16	1	5	22	28	350	350	700

Note: BS: Basic Science Course, **ES**: Engineering Science Course, **PC**: Professional Core Courses, **AE**: Ability Enhancement Courses, **NC**: Non-credit mandatory courses

Course Title	MATHEMATICAL FOUNDATION FOR MACHINE LEARNING				
Course Code	23MA3BSMML	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	6 Hrs.
LINEAR TRANSFORMATIONS -1: Linear transformations, Matrix as a linear transformation, matrix representation of linear transformations, one-one and onto transformations, singular and non-singular transformations, Determinant of Large matrices and its complexity.	
UNIT – 2	**5 Hrs.**
LINEAR TRANSFORMATIONS -2: Algebra of linear transformations, Geometric linear transformations, Composition of linear transformations, Affine Subspaces, Affine transformations.	
UNIT – 3	**5 Hrs.**
VECTOR NORMS AND INNER PRODUCT SPACES: Norms, Vector norms, matrix norms, L_1 norm, L_∞ norm, the Frobenius norm, condition number, Inner products, lengths and distances, angles and orthogonality, inner product of functions, orthonormal basis.	
UNIT – 4	**5 Hrs.**
APPLICATIONS OF INNER PRODUCT: Orthogonal complements, Orthogonal projections, Gram-Schmidt process, Orthogonal matrices, least square approximations, rotations, metric spaces	
UNIT – 5	**5 Hrs.**
EIGENVALUES AND EIGENVECTORS: Eigenspaces, Spectral norm, characteristic and minimal polynomials, Eigen decompositions and diagonalizations, diagonalization of symmetric matrices.	

Text Books:

1. *Mathematics for Machine learning*, Marc Peter Deisennroth, A. Aldo Faisal, Cheng Soonong, Cambridge University Press, 2020.
2. *Linear Algebra and its applications*, David C. Lay, Steven R. Lay, Judi J Mc. Donald, 6th Edition, Pearson Education, 2021.
3. *Linear Algebra: An Introduction*, Richard Bronson & Gabriel B. Costa, 2nd Edition, Academic press, 2007.

Reference Books:

1. *Linear Algebra and Optimization for Machine Learning*, Charu C. Aggarwal, Springer, 2020.
2. *Linear Algebra, Stephen H. Friedberg*, Arnold J. Insel and Lawrence E. Spence, 5th Edition, Pearson, 2019.
3. *Schaum's outline series -Theory and problems of linear algebra*, Seymour Lipschutz, Marc Lipson, 6th Edition, McGraw-Hill Education, 2017.

Course Outcomes	
CO1	Apply the concepts of Calculus and Linear Algebra to problems in Machine learning.
CO2	Apply the concepts of Calculus and Linear Algebra to Machine learning through modern IT tools.

Course Title	COMPUTER ORGANIZATION AND ARCHITECTURE				
Course Code	23AM3ESCOA	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.
Basic functional blocks of a computer: CPU, memory, input-output subsystems, control unit. Instruction set architecture of a CPU - registers, instruction execution cycle, RTL interpretation of instructions, addressing modes, instruction set.	
UNIT – 2	**8 Hrs.**
Data representation: signed number representation, fixed and floating-point representations, character representation. Computer arithmetic - integer addition and subtraction, ripple carry adder, carry look-ahead adder, etc. multiplication - shift-and-add, Booth multiplier, carry save multiplier, etc. Division - non-restoring and restoring techniques, floating point arithmetic.	
UNIT – 3	**7 Hrs.**
CPU control unit design: hardwired and micro-programmed design approaches, Case study - design of a simple hypothetical CPU. Memory system design: semiconductor memory technologies.	
UNIT – 4	**7 Hrs.**
Peripheral devices and their characteristics: Input-output subsystems, I/O transfers - program controlled, interrupt driven and DMA, privileged and non-privileged instructions, software interrupts and exceptions. Programs and processes - role of interrupts in process state transitions.	
UNIT – 5	**8 Hrs.**
Pipelining: Basic concepts of pipelining, throughput and speedup, pipeline hazards. **Memory organization**: Memory interleaving, concept of hierarchical memory organization, cache memory, cache size vs block size, mapping functions, replacement algorithms, write policy.	

Text Books:

1. *Computer Organization and Design*: The Hardware/Software Interface, David A. Patterson and John L. Hennessy, 4th, Elsevier, 2011.
2. *Computer Architecture and Organization*, John P. Hayes, McGraw Hill, 2017.
3. *Computer Systems Design and Architecture,* Vincent P. Heuring and Harry F. Jordan, 2nd Edition, Pearson Education, 2003.

Reference Books:

1. *Computer Organization, Carl Hamacher, 5th Edition, McGraw Hill Publishers, 2019.*
2. *Computer System and Architecture, Morris Mano, 3rd Edition, Pearson Education, 2017.*
3. *Computer Organization & Architecture, William Stallings, 11th Edition, Pearson, 2016*.

Course Outcomes	
CO1	Comprehend the basic principles and components of computer architecture.
CO2	Apply principles of computer organization and architecture to improve the performance of computer systems.
CO3	Analyze the performance of different computer architectures and evaluate trade-offs in terms of speed, cost, and energy consumption.

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.	Computer architecture and organization	NPTEL	https://nptel.ac.in/courses/106105163
2.	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)	**50M**
		CIE – 2		
		CIE - 3		
		AAT/Quiz	10M	
Semester End Examination (SEE)	100M (50% weightage)			**50M**
Total				**100M**

Course Title	DATA STRUCTURES				
Course Code	23AM3PCDST	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.	
UNIT – 3	**6 Hrs.**
Recursion: Definition, Writing recursive programs, Efficiency 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 and algorithms in Python*, Michael T. Goodrich, Roberto Tamassia, Michel H Goldwasser, John Wiley & Sons, Incorporated, 2013.
2. *Python Data Structures and Algorithms*, Benjamin Baka, Packt Publishing Ltd, 2017.

Reference Books:

1. *Data Structures and Algorithmic Thinking with Python*, by Narasimha Krumanchi, 1st Edition, Career Monk Publications, 2015.
2. *Hands on Data Structures and Algorithms with Python*, Dr. Basant Agarwal, 3rd Edition, Packt Publishing, 2022.

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	PROBABILITY AND STATISTICS FOR MACHINE LEARNING				
Course Code	23AM3PCPSM	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 Hrs.
Probability: Introduction-What is Probability, Uncertainty in Machine Learning, Why Probability for Machine Learning, Joint, Marginal, and Conditional Probability, Intuition for Joint, Marginal, and Conditional Probability, Examples of Calculating Probability.	
UNIT– 2	**5 Hrs.**
Bayesian Probability: Introduction to Bayes Theorem, Modeling Hypotheses, Density Estimation, Maximum a Posteriori, Bayes Optimal Classifier, develop a Naive Bayes Classifier, Conditional Probability Model of Classification, Simplified or Naive Bayes, Prior and Conditional Probabilities Naive Bayes.	
UNIT– 3	**6 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.	
UNIT– 4	**5 Hrs.**
Continuous Random variables: Probability density, Union, Exponential, Normal distributions, Pareto Distribution and Central Limit Theorem.	
UNIT– 5	**5 Hrs.**
Introduction to statistics: Population and sample, parameters and statistics descriptive statistics, Mean, Median, Quantiles, Percentiles, Quartiles, Variance, Standard Deviation, Standard Errors of Estimates, Interquartile range.	

Text Books:

1. *Probability and Statistics for Computer Scientists*, Michael Baron, CRC press, 2019.
2. *Probability for machine learning Discover how to harness uncertainty with Python*, Jason Brownlee.

Reference Books:

1. *Probability, Statistics, Queuing theory and Computer Science Applications,* Kishore S Trivedi, 2nd Edition, Willey Publishers, 2008.

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.

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	OBJECT ORIENTED PROGRAMMING				
Course Code	23AM3PCOOP	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 Hrs.
Introduction: The Concepts of Abstract Machine and Interpreter, Influences on language design, Programming environments, Language categories and examples. **Class and Object Modeling:** classes, objects and instantiation, OOP principles. **Functions in classes**: Defining functions in classes, calling functions in classes, Attributes, Passing arguments to a Method, creating multiple instances, Initializing parameters.	
UNIT – 2	**5 Hrs.**
Encapsulation: Encapsulations with functions, Encapsulations with objects, Making Instance Variables More Private. **Abstraction:** Abstract base classes, Creation of abstract base class.	
UNIT – 3	**6 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 – 4	**5 Hrs.**
Concurrency: Processes and Threads, Thread life cycle, creating a Thread, Thread Libraries, Thread scheduling, Thread pools, Thread Priorities, Daemon Threads, Multithreading, Synchronizing Threads, Inter-Thread Communication, Thread Deadlock.	
UNIT – 5	**5 Hrs.**
Managing Memory used by objects: Object lifetime, Reference count, Garbage collection, Class variables and constants, Managing memory slots. **Timers in python**: Approaches for implementing timers, Displaying time.	

Text Books:

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

Reference Books:

1. *Object oriented python,* Irv Kalb, 2022.
2. *Concepts of programming languages,* 10th Edition, Robert W. Sebesta, 2012.

Course Outcomes	
CO1	Exhibit object-oriented programming paradigm to enhance code reusability.
CO2	Design and Model efficient class and object interaction mechanisms using Object-oriented problem-solving techniques.
CO3	Demonstrate object-oriented principles and practices through modern 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.	Object Oriented Programming	NPTEL	https://onlinecourses.nptel.ac.in/noc25_cs34/preview
2.	Object-Oriented Programming in Python	Coursera	https://www.coursera.org/projects/object-oriented-programming-in-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	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	DATABASE MANAGEMENT SYSTEMS				
Course Code	23AM3PCDBM	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 Hrs.
Introduction to data: Information, databases, database management system; Characteristics of database approach, Data models, Schema and instances, Three schema architecture and Data Independence. **Database Languages and Interfaces:** Database System Environment, Centralized and Client/ Server Architectures of DBMS	
UNIT – 2	**5 Hrs.**
Conceptual Relational Data Modeling: A Sample Database Application, Entity Types, Entity Sets, Attributes, Relationship Types, Relationship Sets, Roles, and Structural Constraints, Weak Entity Types, Refining the ER Design for the Company Database, Naming Conventions, and Design Issues. **Relational Model Concepts:** Relational Model Constraints and Relational Database Schemas and Keys	
UNIT – 3	**6 Hrs.**
Database Design: Informal Design Guidelines for Relation Schemas, Functional Dependencies, Normal Forms Based on Primary Keys, General Definitions of Second and Third Normal Forms, Boyce-Cod Normal Form **Transaction Processing:** Transaction and System Concepts, Desirable Properties of Transactions, Characterizing Schedules Based on Recoverability, Characterizing Schedules Based on Serializability.	
UNIT – 4	**5 Hrs.**
Storage and Indexing: Magnetic Disks – RAID – Tertiary storage – File Organization – organization of Records in Files – Indexing and Hashing –Ordered Indices – B+ tree Index Files – B Tree Index Files – Static Hashing – Dynamic Hashing.	
UNIT – 5	**5 Hrs.**
NoSQL: SQL versus NoSQL, Types of NoSQL Databases, CAP theorem Getting Started with MongoDB – Documents, Collections, Databases, Data Types.	

Text Books:

1. *Fundamentals of Database Systems*, Ramez Elmasri and Shamkant B. Navathe, 5th Edition, Pearson Education, 2008.

Reference Books:

1. *Database System Concepts,* Abraham Silberschatz, Henry F. Korth and S. Sudarshan, 6th Edition, Tata Mc Graw Hill, 2011.
2. *An Introduction to Database Systems*, C.J.Date, A.Kannan and S.Swamynathan, 8th Edition, Pearson Education, 2006.

Course Outcomes	
CO1	Apply and Analyze the concepts of database management system for various real-world applications.
CO2	Develop and exhibit a conceptual framework for business applications through the process of design and demonstration.
CO3	Conduct experiments to showcase the practical application of query processing techniques.

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	THEORETICAL FOUNDATIONS OF COMPUTATIONS				
Course Code	23AM3AETFC	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.
Finite Automata (FA): Central Concepts of Automata Theory, Deterministic Finite Automata (DFA), Nondeterministic FiniteAutomata (NFA), Epsilon – NFA, Equivalence of NFA and DFA, FA state reductions, Applications.	
UNIT – 2	**6 Hrs.**
Regular Languages and Expressions: Finite Automata and Regular Expressions, Proving Languages Not to be Regular, Closure Properties, Equivalence and Minimization ofAutomata, Applications.	
UNIT – 3	**8 Hrs.**
Context Free Grammars (CFG) and Languages (CFL): Introduction, Ambiguity in Grammars, Eliminating Useless Symbols, Computing the Generating and Reachable Symbols, Eliminating Epsilon Productions and Unit Productions, Chomsky Normal Form (CNF), Greibach Normal Form (GNF), CFL Properties, Pumping Lemma, Applications.	
UNIT – 4	**7 Hrs.**
Pushdown Automata: Deterministic and Non-Deterministic Pushdown Automaton, PDA for CFL, Equivalence of PDA's and CFG's, Applications.	
UNIT – 5	**7 Hrs.**
Turing Machines (TM): Deterministic & Non-Deterministic TM, TM as language Accepters and Transducers, Combining TM for complicated Task, Turing's Thesis, Problems that cannot be solved by TMs, Post's Correspondence Problem, Undecidable Problems, Applications.	

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

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 2022-23: 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-4	23MA4BSMML	Mathematical Foundation for Machine Learning-2	2	0	1	3	4	50	50	100
2.	ES-4	24AM4ESOPS	Operating Systems	3	0	0	3	3	50	50	100
3.	PC-5	24AM4PCDAA	Design and Analysis of Algorithms	3	0	0	3	3	50	50	100
4.	PC-6	24AM4PCIAI	Introduction to Artificial Intelligence	3	0	0	3	3	50	50	100
5.	PC-7	24AM4PCIML	Introduction to Machine Learning	3	0	1	4	5	50	50	100
6.	PC-8	24AM4PCIST	Inferential Statistics	2	1	0	3	4	50	50	100
7.	PC-9	24AM4PCAAL	Algorithm Analysis Laboratory	0	0	1	1	2	50	50	100
8.	UHV-1	22MA4AEUHV	Universal Human Values	0	1	0	1	2	50	50	100
9.	AE-4	24AM4AEJAP	Java Programming	0	0	1	1	2	50	50	100
10.	NCMC-2	23NCMC4PE2	Physical Education	Non-credit mandatory Course (1Hr)							
			Total	16	2	4	22	28	450	450	900

Note: BS: Basic Science Course, **ES**: Engineering Science Course, **PC**: Professional Core Courses, **AE**: Ability Enhancement Courses, **NC**: Non-credit mandatory courses

SYLLABUS (2023-2024)

FOURTH SEMESTER B.E. COURSE

(Artificial Intelligence and Machine Learning)

Course Title	**Mathematical Foundation for Machine Learning – 2**	**Course Code**	**23MA4BSMML**
Credits	**03**	**L – T – P**	**2- 0 - 1**
Contact hours	**26 + 0 + 13**		

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; that 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.
- Encourage collaborative (Group Learning) Learning in the class.
- Ask HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
- Adopt Problem-Based Learning (PBL), which fosters students' Analytical skills, develops thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
- 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

MATRIX OPERATION IN MACHINE LEARNING[6 hours]

Matrix decompositions – LU and Cholesky decomposition, singular value decomposition, Data compression with SVD, Dimensionality reduction - Principal Component Analysis, the Moore-Penrose pseudoinverse.

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

UNIT-2

VECTOR CALCULUS [5 hours]

Functions of several variables, Differentiation and partial differentials, gradients of vector-valued functions, gradients of matrices, useful identities for computing gradients, linearization and multivariate Taylor series.

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

UNIT-3

APPLICATIONS OF VECTOR CALCULUS [5 hours]

Backpropagation and automatic differentiation, gradients in a deep network, The Gradient of Quadratic Cost, Descending the Gradient of Cost, The Gradient of Mean Squared Error.

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

UNIT-4

UNIVARIATE OPTIMIZATION[5 hours]

Local and global optima, convex sets and functions separating hyperplanes, application of Hessian matrix in optimization, Optimization using gradient descent and NR method, Legendre-Fenchel Transform and convex conjugates.

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

UNIT-5

MULTIVARIABLE OPTIMIZATION[5 hours]

Sequential search 3-point search and Fibonacci search, constrained optimization using Lagrange multipliers, KKT optimality conditions.

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

MATHEMATICS LAB:
2 hours/week per batch of 15 students
1 Introduction + 10 lab sessions + 1 repetition class + 1 Lab Assessment

List of Laboratory experiments:

Lab-0: Introduction**.**
Lab-1: Finding LU and Cholesky decomposition.
Lab-2: Finding Singular value decomposition and PCA.
Lab-3: Automatic Differentiation and Backpropagation.
Lab-4: Computing gradients of vector-valued function and matrices.
Lab-5: Computing Hessian Matrices and their eigenvalues.
Lab-6: Computing minimum of quadratic functions using the Gradient descent method.
Lab-7: Finding minimum using NR method.
Lab-8: Lagrange's multiplier method for finding extremum values.
Lab-9: Sequential search 3-point search method.
Lab-10: Fibonacci search method.

****

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
23MA4BSMML	**CO 1**	Apply the concepts of Calculus and Linear Algebra to problems in Machine learning.	1	3
	CO 2	Apply the concepts of Calculus and Linear Algebra to Machine learning through modern IT tools.	1 & 5	3

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	
SEE	End Exam	100		50	

CIE methods/question paper is designed to attain the different levels of Bloom's taxonomy as 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 each from Units 2, 3 and 5 and two questions each from Units 1 and 4.

SUGGESTED LEARNING RESOURCES:

Text Books:

1. Mathematics for Machine learning, Marc Peter Deisennroth, A. Aldo Faisal, Cheng Soon Ong, 2020, Cambridge University Press.
2. Linear Algebra and its applications, David C. Lay, Steven R. Lay, Judi J Mc. Donald, 6th Edition, 2021, Pearson Education.
3. Linear Algebra: An Introduction, Richard Bronson & Gabriel B. Costa, 2nd edition, Academic press.

Reference Books:

1. Linear Algebra and Optimization for Machine Learning, Charu C. Aggarwal, Springer, 2020.
2. Linear Algebra, Stephen H. Friedberg, Arnold J. Insel and Lawrence E. Spence, Pearson, 2019, Fifth Edition.
3. Schaum's outline series -Theory and problems of linear algebra, Seymour Lipschutz, Marc Lipson, 6th edition, 2017, McGraw-Hill Education.
4. Linear Algebra and its Applications, Gilbert Strang, 4th edition, 2005, Brooks Cole.
5. Linear Algebra, Kenneth Hoffman, Ray Kunze, 2nd edition, Pearson.

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	OPERATING SYSTEMS				
Course Code	24AM4ESOPS	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.

Introduction: Types of Operating System, Operating System Concepts, System Calls, 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.

Inter-process Communication: Race Conditions, Critical Regions, Mutual Exclusion with Busy Waiting, Semaphores, Mutexes, Monitors, Message Passing, Avoiding Locks, Read-Copy-Update.

Pre-emptive, non-pre-emptive scheduling: First come first serve, Shortest Job First, Round-Robin, Priority.

Case study: The Dining Philosophers Problem, The Readers and Writers Problem.

UNIT – 3	8 Hrs.

Memory Management: Memory management strategies, Background, Swapping, Contiguous memory allocation, Paging, Structure of page table, Segmentation.

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

UNIT – 4	8 Hrs.

Deadlocks: Resources, Introduction to Deadlocks, The Ostrich Algorithm, Deadlock Detection and Recovery, Deadlock Avoidance, Deadlock Prevention, Other Issues.

Disk performance optimization: Disk Hardware, Disk Formatting, Disk Arm Scheduling Algorithms, Error Handling.

UNIT – 5	6 Hrs.

File System: File concept, Access methods, Directory structure, File system mounting, File sharing.

Implementing File system: File system structure, File system implementation, Directory implementation, Allocation methods, Free space management

Text Books:

1. *Modern operating systems,* Tanenbaum, Andrew, 4th Edition, Pearson Education, 2015.
2. *Operating System Concepts,* Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, *9th Edition, Wiley India, 2013.*

Reference Books:

1. *Operating Systems: Internals and Design Principles, William Stallings, 9th Edition, Pearson,2008.*
2. *Operating Systems: A Concept Based Approach, D.M Dhamdhere, 3rd Ed, McGraw- Hill, 2017.*

Course Outcomes

CO1	Apply the fundamental concepts of modern operating systems.
CO2	Analyze and solve operating system issues, to improve system performance and reliability.
CO3	Design solutions for scheduling real-time applications to meet real-world demands effectively.

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			**2**										**3**		

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	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		
		AAT/Quiz	10M	
Semester End Examination (SEE)	100M (50% weightage)			**50M**
Total				**100M**

Course Title	DESIGN AND ANALYSIS OF ALGORITHMS				
Course Code	24AM4PCDAA	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.
Fundamentals of Algorithm Analysis: Algorithmic Problem-Solving techniques, 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 application.	
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, 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**: Traveling Salesman problem, Assignment problem	

Text Books:

1. Introduction to the design and analysis of algorithms, by Anany Levitin, 3rd Edition, Pearson Education, 2023.
2. Computer Algorithms, by Horowitz E., Sahani S., Rajasekharan S., 3rd Edition, Universities Press, 2022.

Reference Books:

1. Introduction to Algorithms, Cormen T.H, Leiserson C. E, Rivest R.L, Stein C, 4th Edition, The MIT Press 2022.
2. The Art of Computer Programming,Volume 1 Fundamental Algorithms, Donald E.Knuth, 3rd Edition, Addison-Wesley Professional, 2023

Course Outcomes:

CO1	Apply knowledge of computing and mathematics to algorithm analysis and design.
CO2	Analyze a problem and identify the time complexity of algorithms for an appropriate solution.
CO3	Assess the performance of different algorithms and their limitations.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3												2		
CO2		3											2		
CO3				2	2								2		

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1	Design and analysis of algorithms	NPTEL	https://onlinecourses.nptel.ac.in/noc19_cs47/preview
2	Algorithms Specialization	Coursera	https://www.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 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 ARTIFICIAL INTELLIGENCE				
Course Code	24AM4PCIAI	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.
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:** Uniform Cost Search, Dept Limited Search, Iterative Deepening 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	**8 Hrs.**
KNOWLEDGE REPRESENTATION: Propositional Logic – Syntax and Semantics, Using Propositional Logic, First-Order Logic – Syntax and Semantics. Inference in First-Order Logic: Propositional vs First-Order Inference, Forward and Backward Chaining.	
UNIT – 4	**7 Hrs.**
REPRESENTING KNOWLEDGE USING RULES: Procedural Versus Declarative Knowledge, Forward Versus Backward Reasoning. **ADVERSARIAL SEARCH AND GAMES**: Game theory optimal decision in games, heuristic alpha beta tree search. **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	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	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	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	20%
Apply / Analyse	70%
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	INTRODUCTION TO MACHINE LEARNING				
Course Code	24AM4PCIML	Credits	4	L-T-P	3-0-1
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hrs./Week	5	Total Lecture Hrs.			36

UNIT - 1	7 Hrs.
Introduction: Types, Applications and Challenges of Machine Learning, Testing and Validating, Learning problems, Designing a Learning system, Perspectives and Issues. **Concept Learning Task:** Concept learning task as search, Find-S algorithm, Version space, Candidate Elimination algorithm, Inductive Bias.	
UNIT - 2	**8 Hrs.**
Supervised Machine Learning: **Decision Trees:** Decision Tree Representation, Problems, Hypothesis Space Search, Inductive Bias and issues. Pruning, Rule extraction from Decision trees. **Instance- Based Learning: Support Vector Machines:** Linear and Non-Linear, SVM regression, k- Nearest Neighbor Learning, Locally Weighted Regression.	
UNIT - 3	**7 Hrs.**
Bayesian Learning: Concept Learning, Maximum Likelihood, Minimum Description Length Principle, Bayes Optimal Classifier, Naïve Bayes Classifier, Bayesian Belief Network, EM Algorithm. **Ensemble and Probabilistic Learning Model**: Voting classifiers, Bagging and pasting, Random patches, Random forests, Boosting, stacking.	
UNIT - 4	**7 Hrs.**
Unsupervised Machine Learning: Clustering: K means, Spectral, Hierarchical; Association rule mining, Anomaly detection.	
UNIT - 5	**7 Hrs.**
Dimensionality Reduction: Subset selection, Main Approaches for Dimensionality Reduction, PCA, Kernel PCA, LLE, Linear Discriminant Analysis (LDA).	

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													3	
CO2		3												3	
CO3			2		2				2	2				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	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	20%
Apply / Analyze	70%
Create / Evaluate	10%

Assessment Pattern

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

Integrated Lab Component

Sl. No.	List of Topics
1	Concept learning: Find-S algorithm
2	Concept learning: Candidate Elimination algorithm
3	Decision tree: ID3 algorithm
4	Support Vector Machine: Linear and Non-Linear
5	Instance- Based Learning: k-Nearest Neighbor algorithm
6	Bayesian Learning: EM algorithm
7	Bayesian Learning: Naïve Bayes classifier
8	Clustering: k-Means algorithm
9	Association rule learning: Apriori Algorithm
10	Dimensionality Reduction: Principle Component Analysis

Course Title	INFERENTIAL STATISTICS				
Course Code	24AM4PCIST	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: Population and Sample, Statistic and Parameter, Estimate and Estimator, Unbiasedness, Consistency, Sufficiency and Efficiency, Point and Interval Estimate. Parametric and Non-Parametric Tests.	
UNIT - 2	**5 Hrs.**
Sampling Techniques: Probability Sampling Techniques: Simple Random Sampling, Systematic Sampling, Stratified Random Sampling, Clustered Sampling.	
UNIT - 3	**5Hrs.**
Fundamentals of Inference: Statistical Hypothesis, Null and Alternate Hypothesis, Type-I and Type-II Errors, Level of Significance, Critical Region, Construction of Confidence Intervals, P-Value	
UNIT - 4	**6 Hrs.**
Hypothesis Testing I - Test of Significance of Single Proportion, Test of Significance of Difference of Proportions, Test of Significance for Single Mean, Test of Significance for difference of two means.	
UNIT - 5	**5 Hrs.**
Hypothesis Testing II - t-distribution, t-test for Single Mean, t-test for Difference of Two means, Independent Sample t-test, Paired t-test, F- Distribution, F-test, Chi-square Test.	

Text Books:

1. *Probability and Statistics for Computer Scientists,* Michael Baron, 3rd Edition, Chapman and Hall, 2019
2. *Fundamental of Mathematical Statistics*, S.C Gupta and V.K Kapoor, 12th Edition, Sultan Chand and Sons,2020

Reference Books:

1. *Probability & Statistics for Engineers & Scientists*, Ronal E. Walpole, Raymond H. Myers, Sharon L. Myers, Keying Ye, 9th Edition, Pearson, 2016
2. *Statistical Inference*, George Casella and Roger L. Berger. 2nd Edition, Cengage India Private Limited, 2007

Course Outcomes	
CO1	Apply appropriate sampling methods for different types of data and research scenarios.
CO2	Analyzing the effectiveness of statistical estimators for reliable estimations.
CO3	Formulate a suitable hypothesis, make informed decisions based on data, and draw valid conclusions.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3														2
CO2		3													2
CO3				3					2	2					2

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1	Statistical Inference	NPTEL	https://archive.nptel.ac.in/courses/111/102/111102112/
2	Inferential Statistics	Coursera	https://www.coursera.org/learn/inferential-statistics-intro
3	Sampling Theory	NPTEL	https://archive.nptel.ac.in/courses/111/104/111104073/

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**

Tutorial Topics:

SI No.	Topics
1	Unbiasedness and Consistency
2	Sufficiency and Efficiency
3	Sampling Techniques – I
4	Sampling Techniques – II
5	Test for Significance of Single Proportion and Difference of Proportions
6	Test for Significance of Single Mean and Difference of Two Means
7	t-test for Single Mean and Difference of Two Means
8	Independent Sample t-test and Paired t-test
9	F-test
10	Chi-Square Tests

Course Title	ALGORITHM ANALYSIS LABORATORY				
Course Code	24AM4PCAAL	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.	Program Description
1	Time Complexity Analysis
2	Brute force method
3	Divide and conquer
4	Greedy technique
5	Decrease and conquer technique.
6	Space and time tradeoff techniques
7	Transform and conquer technique.
8	Dynamic programming
9	Backtracking
10	Branch and bound technique

Course Outcomes	
CO1	Implement programs to solve computational problems using suitable algorithm design strategy.
CO2	Evaluate the asymptotic performance of algorithms and write formal correctness proof for algorithms.
CO3	Conduct experiments to choose appropriate algorithms for the given real time problem.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	**PO12**	PS01	PS02	PS03
CO1	3		2										2		
CO2		3											2		
CO3				2	3				2	2	2		2		

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Design and analysis of algorithms	NPTEL	https://onlinecourses.nptel.ac.in/noc19_cs47/preview
2.	Algorithms Specialization	Coursera	https://www.coursera.org/specializations/algorithms

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	JAVA PROGRAMMING				
Course Code	24AM4AEJAP	Credits	1	L-T-P	0-0-1
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hrs/Week	2	Total Lab Hrs..			12

Sl. No	List of Programming concepts
1.	Fundamentals of JAVA, Datatypes.
2.	Wrapper Classes, Boxing and Unboxing mechanisms.
3.	Strings, StringBuilder and StringBuffer
4.	Enumerations, Arrays
5.	Vectors
6.	Generics
7.	Collections Framework
8.	Exception Handling
9.	Interface
10.	Java Packages

COURSE OUTCOMES	
CO1	Apply the core concepts of Java to build console-based applications.
CO2	Analyze the need of Java collection framework to handle group of objects.
CO3	Design and implement robust and modular Java applications using modern integrated tools.

CO-PO-PSO Mapping

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

Massive Open Online Course (MOOC)

Sl. No	Course	Offered by	Course Link
1.	Programming in Java	IIT, KHARAGPUR	https://nptel.ac.in/courses/106105191
2.	Computer Science: Programming with a Purpose	Princeton University	https://www.coursera.org/learn/cs-programming-java/

Assessment Pattern:

Category		Score Split Up	Total
Continuous Internal Evaluation (CIE) Lab	CIE -1	20 M	**50M**
	CIE-2	30 M	
Semester End Examination (SEE)	100 M (50 % Weightage)		**50 M**
Total			**100 M**

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 2022-23: 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-10	24AM5PCDEL	Deep Learning	3	0	1	4	5	50	50	100
2	PC-11	24AM5PCCNS	Computer Networks	2	0	0	2	2	50	50	100
3	PC-12	24AM5PCSML	Statistical Modeling	3	0	1	4	5	50	50	100
4	PC-13	24AM5PCDAV	Data Analysis and Visualization	1	0	1	2	3	50	50	100
5	PC-14	24AM5PCNIC	Nature Inspired Computing	2	0	0	2	2	50	50	100
6	HS-3	23CV5HSEVS	Environmental Studies (CV/CH)	1	0	0	1	1	50	50	100
7	PE-1	24AM5PEDIP	Digital Image Processing	3	0	0	3	3	50	50	100
		24AM5PEKDD	Knowledge Discovery								
		24AM5PEIOT	Internet of Things								
8	PW-1	24AM5PWMPW	Mini Project Work	0	0	2	2	4	50	50	100
9	AE-5	24AM5AERMD	Research Methodology	2	0	0	2	2	50	50	100
10	NCMC-3	23NCMC5PE3	Physical Education	Non-credit mandatory Course (1Hr)							
			Details of 40 AICTE Activity Points								
				17	0	5	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

Course Title	DEEP LEARNING				
Course Code	24AM5PCDEL	Credits	4	L-T-P	3-0-1
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hrs. / Week	5	Total Lecture Hrs.			36

UNIT – 1	8 Hrs
Introduction: A Neural Network, Human Brain, Models of a Neuron, Representing Neural Network as Graphs, Network Architectures. **Single Layer Perceptron**: Perceptron, Perceptron –Convergence Theorem, Learning Curves, Least Mean Square Algorithm. **Multilayer Perceptron:** Back Propagation Algorithm, XOR Problem, Heuristics, Online and Batch Learning, Optimal annealing and adaptive control of learning rate.	
UNIT – 2	**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.	
UNIT – 3	**7 Hrs**
Network training: Parameter Norm Penalties (NP), NP as Constrained Optimization, Regularization and Under-Constrained Problems, Dataset Augmentation, Noise Robustness, Semi-Supervised & Multi-Task Learning, Early Stopping, Parameter Tying and Sharing, Sparse Representations, Dropout, Adversarial Training, Tangent Distance, Tangent Prop and Manifold Tangent Classifier. Optimization techniques: Adaboost and RMSprop.	
UNIT – 4	**7 Hrs**
Convolutional Networks (CNN): Introduction, Structure of CNN, Training a CNN – Back propagations through Convolutions, Backpropagation as Convolution with inverted/Transposed Filter, Convolution/Backpropagation as Matrix Multiplications, Data Augmentation.	
UNIT – 5	**7 Hrs**
Recurrent Neural Networks (RNN): Introduction – Expressiveness; Architecture – Language Modeling, Back Propagation, Bidirectional RNN, Multilayer RNN; Challenges of Training RNNs - Layer Normalization; Echo State Networks, LSTM, GRUs, Applications of RNN.	

Text Books:

1. *Deep Learning*, Ian Goodfellow, Yoshua Bengio, Aaron Courville, MIT press, 2016.
2. *Neural Networks and Deep Learning*, Charu C Agarwal, 1st Edition, Springer, 2016.
3. *Neural Networks - A Comprehensive Foundation* - Simon Haykin, 2nd edition.

Reference Books:

1. *Pattern Recognition and Machine Learning*, Christopher M. Bishop, Springer, 2006.
2. *Machine Learning*, Tom Mitchell, McGraw Hill, 2013.

Course Outcomes	
CO1	Apply back propagation and supervised learning techniques to train neural networks.
CO2	Analyze and implement regularization techniques and convolutional networks to enhance model performance.
CO3	Evaluate the architecture and applications of recurrent neural networks.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1		2													2
CO2			2		2										2
CO3				2											2

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

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 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	15%
Apply / Analyze	65%
Create / Evaluate	20%

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	24AM5PCCNS	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	6 Hrs
Introduction to Computer Network: Problem: Building a Network: Application, Network Requirement Network Architecture, Implementation of Network software, performance measures.	
UNIT – 2	**5 Hrs**
Connecting to Network: Perspective on connecting, Encoding, Framing, Error Detection, Reliable transmission, 802.XX protocols.	
UNIT – 3	**5 Hrs**
Internetworking: switching and bridging, Basic Internetworking, Routing, Global Internet, Routing in mobile device and Deployment of IPv6.	
UNIT – 4	**5 Hrs**
End to End Protocols: Simple De-multiplexer(UDP) Reliable Byte stream (TCP), and Transport for real time Application (RTP). **Congestion control and Resource Allocation**: Issues in resource allocation, TCP congestion control and congestion avoidance.	
UNIT – 5	**5 Hrs**
Network Security: Building blocks of cryptography, key pre-distribution, Authentication protocols and Firewalls. **Network Applications**: Traditional Applications, Multimedia Applications and infrastructure application.	

Text Books:

1. *Computer Networks : A Systems Approach*, Larry L Peterson and Bruce S Davie, 5th Edition, Morgan Kufmann,2021.

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	Apply protocols and routing mechanism principles and practices for error free data transmission over a network.
CO2	Analyze IP mechanisms for designing and implementing appropriate network requirements.
CO3	Examine various security mechanisms to protect data from various network attacks.

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		2											3		

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	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	60%
Create / Evaluate	20%

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	STATISTICAL MODELING				
Course Code	24AM5PCSML	Credits	4	L-T-P	3-0-1
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hrs./Week	5	Total Lecture Hrs.			36

UNIT - 1	6 Hrs
Simple Linear Regression: Introduction, Least – square estimation, hypothesis testing and Interval estimation of the parameters, Prediction of new observation, Coefficient of Determination (R^2), Adjusted R^2 value, ANOVA.	
UNIT - 2	**8 Hrs**
Multiple Linear Regression: Assumptions, Estimation of Model parameters, Gauss-Markov Theorem, Residual Analysis, Violation of Assumptions - Multicollinearity: detection using Variance Inflation factor(VIF) and remedies, heteroscedasticity: detection using plotting graph of residuals, autocorrelation: Detection using Durbin-Watson test , Ridge and LASSO Regression.	
UNIT - 3	**7 Hrs**
Model Diagnostics and Validation: **Model Diagnostics:** Introduction, Added-Variable Plots, Identifying Outlying Y Observations- Studentized Deleted Residuals, Identifying Outlying X Observations-Hat Matrix Leverage Values, Identifying Influential Cases-DFFITS, Cook's Distance, DFBETAS. **Model Validation:** Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC),Mallow's Cp Criterion.	
UNIT - 4	**8 Hrs**
Categorical Data Analysis: Introduction, Contingency tables, Odds Ratio, logit, Chi-squared Tests for Independence. **Logistic Regression Models:** Introduction, Interpretation of parameters, Inference, Summarizing Predictive power: (Sensitivity and Specificity) and ROC Curves.	
UNIT - 5	**7 Hrs**
Hidden Markov Models: Introduction to Markov Models, Higher-order Markov Models, Hidden Markov Models-Introduction- Application, issues and Examples, Algorithms for HMMs - The Forward-Backward Algorithm, The Viterbi Algorithm, HMM Training: Choosing the Number of Hidden States, Gaussian Mixture Models with Hidden Markov Models, HMM for Classification: Generative v/s Discriminative classifiers, Smoothing and filtering techniques.	

Text Books:

1. *Introduction to Linear Regression Analysis,* Douglas Montgomery, Elizabeth A. Peck, G. Geoffrey vining, Wiley.
2. *An Introduction to Categorical data analysis, Alan Agresti, Wiley, 3rd Edition, 2019.*

Reference Books:

1. *Applied Linear Regression Models,* Michael H. Kutner, Christopher J. Nachtsheim, John Neter, 4th Edition, McGraw-Hill, 2004.
2. *Statistics for Machine Learning,* Pratap Dangeti, Packt Publishing Ltd, 2017.
3. *The Elements of Statistical Learning Data Mining, Inference, and Prediction,* Trevor Hastie Robert Tibshirani Jerome Friedman, 2nd Edition, Springer. 2012.
4. *Basic Econometrics,* Damodar N Gujarati et.all., Mc Graw Hill, 5th Edition.

Course Outcomes	
CO1	Apply the concepts of statistical modeling on quantitative and qualitative data
CO2	Analyze mathematical methods to solve problems involving stochasticity.
CO3	Design and conduct experiments for real time data using modern tools.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	**3**													**2**	
CO2		**2**												**2**	
CO3			**2**	**2**	**3**				**2**					**2**	

Massive Open Online Course (MOOC)

Sl. No	Course	Offered by	Course Link
1	Data Science: What is statistical Modeling?	Coursera	https://www.coursera.org/articles/statistical-modeling
2	Applied multivariate Statistical Modeling, IIT Kharagpur	NPTEL	https://nptel.ac.in/courses/111105091

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	20%
Apply / Analyse	55%
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	Test	20M	**25M**
		AAT	05M	
Semester End Examination (SEE)	100M (50% weightage)			**50M**
			Total	**100M**

Course Title	DATA ANALYSIS AND VISUALIZATION				
Course Code	24AM5PCDAV	Credits	2	L-T-P	1-0-1
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	3	Total Lecture Hours			12

UNIT – 1	2 Hrs
Introduction: Data Analysis and its Steps, Issues, Applications, Challenges, Data Collection Methods, Types of data analysis. **Types of Data:** structured versus unstructured data, quantitative versus qualitative data, univariate vs multivariate data.	
UNIT – 2	**3 Hrs**
Data Processing: Error types, handling Missing data, Data Transformation, String Manipulation, Data Wrangling. **Exploratory Data Analysis**: Elements of Structured Data, Rectangular data, Estimates of Location and variability, Exploring Data Distribution, Binary and Categorical Data, Correlation, Exploring Two or More Variables. Case Studies.	
UNIT – 3	**3 Hrs**
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. **Creating visual representations**: visualization reference model, visual mapping, visual analytics, Design of visualization applications	
UNIT – 4	**2 Hrs**
Visualization: Groups, trees, graphs, clusters, networks, software, Metaphorical visualization. **Case Study**: Interactive Data Visualization in News Media. **Classification of visualization systems**: Interaction and visualization techniques misleading, Visualization of one, two and multi-dimensional data, text and text documents.	
UNIT – 5	**2 Hrs**
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 Analysis: Using Statistics and Probability with R Language* Partha Sarathi Bishnu.
3. *Practical Statistics for Data Scientists,* Peter Bruce, Andrew Bruce & Peter Gedeck, 2nd Edition, 2020.

Reference Books:

1. *Data Visualization: A Practical Introduction* Kieran Healy, 1st Edition, 2018.
2. *Visualizing Graph Data* Corey Lanum, 1st Edition, 2016.
3. *Data Visualization: a successful design process* Andy Krik, 1st Edition, 2016.
4. *Python for Data Analysis_ Data Wrangling with pandas, NumPy, and Jupyter*- Wes McKinney OReilly Media (2022).

Course Outcomes	
CO1	To understand and interpret data plots core data visualization concepts such as correlation, linear relationships, and log scales.
CO2	To explore the relationship between two continuous variables using scatter plots and line plots.

CO3	Develop proficiency in crafting visually engaging representations of complex datasets, ensuring clarity and accessibility for diverse audiences.

Massive Open Online Course (MOOC)

Sl. No	Course	Offered by	Course Link
1	Data Analysis and Visualization	Coursera	https://www.coursera.org/learn/data-analyze-visualize
2	2024 Data Visualization in Python Masterclass for Beginners	Udemy	https://www.udemy.com/share/102WYs/

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	20%
Apply / Analyse	55%
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	NATURE INSPIRED COMPUTING				
Course Code	24AM5PCNIC	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: From Nature-to-Nature Computing, Philosophy, Three Branches: A Brief Overview, Individuals, Entities and agents - Parallelism and Distributivity Interactivity, Adaptation Feedback-Self-Organization-Complexity, Emergence.	
UNIT – 2	**5 Hrs**
SWARM INTELLIGENCE: Ant Colony Optimization, Bee Colony Optimization, Particle SWARM Optimization(PSO).	
UNIT – 3	**6 Hrs**
GENETIC ALGORITHMS (GA): Operators - Encoding, Selection, Cross Over, Mutation; Stopping Condition for GA Flow, Problem Solving using GA, Schema Theorem, Classification of GA – Messy, Adaptive, Hybrid, Parallel	
UNIT – 4	**5 Hrs**
NATURE INSPIRED ALGORITHMS – Cuckoo search, Firefly algorithm, Social spider algorithm, Harmony search algorithm, Intelligent water drops algorithm.	
UNIT – 5	**5 Hrs**
NATURE-INSPIRED OPTIMIZATION ALGORITHMS - Grey Wolf Optimization, Dragon Fly Optimization, Whale Optimization Algorithm, Beam Search Algorithm.	

Text Books:

1. Leandro Nunes de Castro, " Fundamentals of Natural Computing, Basic Concepts, Algorithms and Applications", Chapman & Hall/ CRC, Taylor and Francis Group, 2007.
2. Marco Dorrigo, Thomas Stutzle, “Ant Colony Optimization”, PHI, 2005.

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	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	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	DIGITAL IMAGE PROCESSING				
Course Code	24AM5PEDIP	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 and Digital Image Fundamentals: Definition and Scope of Digital Image Processing, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Image Representation and Formats, Basic Image Operations.	
UNIT – 2	**7 Hrs**
Image Enhancement Techniques: Histogram Processing and Equalization, Spatial Domain Filters (Smoothing and Sharpening), Frequency Domain Filters, Contrast Adjustment, Noise Reduction Techniques.	
UNIT – 3	**7 Hrs**
Image Restoration: Image Degradation and Restoration Model, Noise Models (Gaussian, Salt-and-Pepper, etc.), Inverse Filtering, Wiener Filtering, Blind Deconvolution.	
UNIT – 4	**8 Hrs**
Color Image Processing: Color Models (RGB, CMYK, HSV, YCbCr), Pseudo-color Image Processing Full-Color Image Processing, Color Transformations, Applications of Color Image Processing.	
UNIT – 5	**6 Hrs**
Morphological Image Processing: Basic Morphological Operations (Erosion, Dilation), Opening and Closing, Hit-or-Miss Transformation, Morphological Algorithms (Boundary Extraction, Region Filling), Applications of Morphology in Image Processing.	

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	KNOWLEDGE DISCOVERY				
Course Code	24AM5PEKDD	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: An essential step in knowledge discovery, Diversity of data types for data mining, Mining various kinds of knowledge, Data mining: confluence of multiple disciplines, Data mining and applications, Data mining and society. **Data, measurements, and data preprocessing:** Similarity and distance measures, Data quality, Data cleaning, Data integration, Data Reduction, Data transformation.	
UNIT – 2	**7 Hrs**
Data warehousing and online analytical processing: Data warehouse, Data Warehouse Models, OLAP operations, Data cube computation, Data cube computation methods.	
UNIT – 3	**8 Hrs**
FP Growth: Basic concepts, Frequent itemset mining methods, which patterns are interesting?. Advanced methods: Mining various kinds of patterns, Mining compressed or approximate patterns, Constraint-based pattern mining, Mining sequential patterns, Mining subgraph patterns, Pattern mining: application examples.	
UNIT – 4	**7 Hrs**
Cluster analysis: Cluster analysis, Hierarchical methods: BIRCH, Probabilistic hierarchical clustering, Density-based and grid-based methods: DBSCAN, Evaluation of clustering.	
UNIT – 5	**8 Hrs**
Cluster analysis: **advanced methods**: Probabilistic model-based clustering, Clustering high-dimensional data, Bi-clustering, Dimensionality reduction for clustering, Clustering graph and network data.	

Text Books:

1. Data Mining Concepts and Techniques, Jiawei Han, Micheline Kamber, Jian Pei, 3rd Edition, Elsevier, 2022.

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	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	24AM5PEIOT	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: Genesis and Digitization, Impact, Convergence of IT and Challenges, Network Architecture and Design, Drivers Behind New Network Architectures, Comparing Architectures, A Simplified Architecture, The Core Functional Stack, 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**
Security Requirements and Challenges in IoT for AIML Applications: Overview of security needs, common threats, and vulnerabilities specific to IoT systems used in AI and machine learning.	
UNIT – 5	**7 Hrs**
IoT Applications: Smart and Connected Cities, An IoT Strategy for Smarter Cities, Smart City IoT Architecture, Smart City Security Architecture, Smart City Use-Case Examples. Transportation: Transportation Challenges, IoT Use Cases for Transportation, An IoT Architecture for Transportation.	

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	RESEARCH METHODOLOGY				
Course Code	24AM5AERMD	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:

1. Research Methodology: Methods and Techniques, C.R. Kothari and Gaurav Garg, 4th Edition, New Age International, 2018.
2. Research Methodology and Statistical Analysis, Dr. Chokkamreddy Prakash, Mr. Kasireddy Sandeep Reddy, Dr. Mohammad Mustafa, Paperback edition, Blue Duck Publications, 2023.

Reference Books:

1. 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	MINI PROJECT WORK				
Course Code	24AM5PWMPW	Credits	2	L-T-P	0-0-2
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hrs. / Week	4	Total Lecture Hrs.			-

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	Assess research methods and algorithms in technical literature to tackle real-world engineering challenges through prior knowledge application and thorough investigation.
CO2	Apply domain knowledge and relevant technologies to create a practical solution addressing societal and engineering challenges through the development of a mini project.
CO3	Demonstrate effective collaboration within the team to document and collectively present the implemented solutions.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1				3		3				3			3	3	3
CO2	3												3	3	3
CO3		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 – VI (With effect from the Academic Year 2022-23: 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-15	24AM6PCSEP	Software Engineering and Project Management	3	0	0	3	3	50	50	100
2	PC-16	24AM6PCPAG	Parallel Architectures and Programming	2	0	0	2	2	50	50	100
3	PC-17	24AM6PCAGA	Autoencoders and Generative AI	3	0	1	4	5	50	50	100
4	PC-18	24AM6PCREL	Reinforcement Learning	3	0	0	3	3	50	50	100
5	PC-19	24AM6PCSCL	Soft Computing Lab	0	0	1	1	2	50	50	100
6	PE-2	24AM6PECVV	Computer Vision	3	0	0	3	3	50	50	100
		24AM6PEBDA	Big Data Analytics								
		24AM6PERPA	Robotic Process Automation								
7	OE-1	24AM6OEAIG	Introduction to Artificial Intelligence	3	0	0	3	3	50	50	100
		24AM6OEMLG	Introduction to Machine Learning								
		24AM6OEINN	Introduction to Neural Networks								
8	PW-2	24AM6PWPW1	Project work -1	0	0	2	2	4	50	50	100
9	AE-6	24AM6AEMLO	Machine Learning Operations	0	0	1	1	2	50	50	100
10	NCMC-4	23NCMC6PE4	Physical Education	Non-credit mandatory Course (1Hr)							
Total				17	0	5	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

Course Title	SOFTWARE ENGINEERING AND PROJECT MANAGMENT				
Course Code	24AM6PCSED	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
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 development tools including CASE tools.	
UNIT – 2	**8 Hrs**
Software Metrics: Size-Oriented Metrics, Halsted Metrics, Cyclomatic Complexity Metrics. **Software Modeling:** Unified Modeling Language, Use Cases, Class, Sequence, Activity, State Diagrams. **Software Design**: Types of Cohesion and Coupling, Functional Independence.	
UNIT – 3	**8 Hrs**
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	**6 Hrs**
Patterns: What is a Pattern? What Makes a Pattern? Relationships between Patterns. **Architectural Patterns**: Introduction, From Mud to Structure, Layers, Pipes and Filters. Model-View-Controller.	
UNIT – 5	**8 Hrs**
Project Management: Components of SPM – challenges and opportunities – tools and techniques – managing human resource and technical resources – costing and pricing of projects – training and development – project management techniques. Software project management using Primavera & Redmine, Teamwork, Clickup.	

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	Apply techniques, principles and practices for requirements to managing the software systems.

CO2	Analyze software requirements, models and metrics for developing quality software.
CO3	Design, demonstrate and document the solutions for given software including project management.

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**3**												**1**		
CO2		**3**											**1**		
CO3			**3**		**2**				**2**	**2**	**2**		**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	PARALLEL ARCHITECTURES AND PROGRAMMING				
Course Code	24AM6PCPAG	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**
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	Assess the performance and scalability of parallel programming solutions.
CO2	Demonstrate proficiency in CUDA programming language and its applications in various domains.
CO3	Apply optimization techniques to enhance the performance of GPU-accelerated applications.

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	AUTOENCODERS AND GENERATIVE AI				
Course Code	24AM6PCAGA	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
Autoencoders (AE): Undercomplete and Regularized AE, Representational Power, Layer Size and Depth, Stochastic Encoders and Decoders, Denoising Autoencoders, Learning Manifolds, Contractive Autoencoders, Predictive Sparse Decomposition and Applications. **Variational Autoencoders (VAEs):**Understanding VAEs: encoder, decoder, and latent space, Variational inference and the reparameterization trick Case Studies :Image generation, data compression.	
UNIT – 2	**8 Hrs**
Restricted Boltzmann Machines: Introduction, Hopfield Networks, The Boltzmann Machine, Restricted Boltzmann Machines, RBMs Beyond Binary Data Types, Stacking Restricted Boltzmann Machines. **Representation Learning:** Greedy Layer-wise Unsupervised Learning, Transfer Learning & Domain Adaption, Semi-Supervised Disentangling of Casual Factors.	
UNIT – 3	**7 Hrs**
Deep Generative Models: Deep Belief Networks, Deep Boltzmann Machines for Real-Valued Data, Structured or Sequential Output, Convolutional Machines, Other Boltzmann Machines, Back-Propagation through Random Operations, Directed Generative Nets, Drawing Samples from Autoencoders, Generative Stochastic Networks, Other Generation Schemes, Evaluating Generative Models.	
UNIT – 4	**7 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, Generative AI project lifecycle.	
UNIT – 5	**7 Hrs**
Generative Adversarial Networks: Basic Concepts: Generator, Discriminator, Adversarial Process, Training GANs: Loss Functions, Optimization Challenges, GAN Architectures: Vanilla GAN, Deep Convolutional GAN (DCGAN), Case studies: Conditional GANs, Pix2Pix , CycleGAN, StyleGAN.	

Text Books:

1. *Deep Learning, Ian Goodfellow*, Yoshua Bengio, and Aaron Courville, MIT Press, 2016.
2. *GANs in Action*, Jakub Langr and Vladimir Bok, Manning Publications, 2019.
3. *Generative Deep Learning*, David Foster, O'Reilly, Second Edition.

Reference Books:

1. *Deep Learning,* Ian Goodfellow, Yoshua Bengio, Aaron Courville, MIT press, 2016.
2. *Neural Networks and Deep Learning*, Charu C Agarwal, 1st Edition, Springer, 2016.
3. *Neural Networks and Learning Machines* , Simon Haykin, Pearson; 3rd edition (1 April 2016).

Course Outcomes	
CO1	Apply deep generative models for various data types and evaluate their performance.
CO2	Analyze the architecture and applications of generative AI, including large language models (LLMs).
CO3	Evaluate the principles and challenges of training Generative Adversarial Networks (GANs).

CO – PO - PSO Mapping

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

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	Internal Choice	Two questions 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
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:

<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	REINFORCEMENT LEARNING				
Course Code	24AM6PCREL	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: Elements of Reinforcement Learning, Limitations and Scope, An Extended Example: Tic-Tac-Toe. **Tabular Solution Methods:** An n-Armed Bandit Problem, Action-Value Methods, Incremental Implementation, Tracking a Nonstationary Problem, Optimistic Initial Values, Upper-Confidence-Bound Action Selection, Gradient Bandits.	
UNIT – 2	**8 Hrs**
Markov Decision Processes: Agent– Environment Interface, Goals, Rewards, Markov Property, Markov Decision Processes, Value Functions and the Bellman Equation, Optimal Value Functions. **Dynamic Programming**: Policy Evaluation, Improvement, Policy Iteration, Value Iteration, Generalized Policy Iteration, Asynchronous Dynamic Programming, Efficiency.	
UNIT – 3	**8 Hrs**
Monte Carlo Methods: Prediction, Estimation of Action Values, Control, policy improvement. **Temporal-Difference Learning**: TD Prediction, TD error, Advantages, Optimality of TD(0), **Sarsa.Q-Learning**: Exploration vs. Exploitation trade-off, The Q-function, The Q-Learning Update Rule.	
UNIT – 4	**7 Hrs**
Deep Reinforcement Learning: Introduction to Deep RL, Deep Q-Networks (DQN), Policy Gradient Methods:REINFORCE Algorithm,Actor-Critic methods(A3C, A2C), Proximal Policy optimization.	
UNIT – 5	**7 Hrs**
Eligibility Traces: n-Step prediction, Forward and Backward View of TD(λ), Equivalences, Sarsa(λ), Watkins's Q(λ), Eligibility Traces using Importance Sampling, Implementation Issues. **Transfer Learning in Reinforcement Learning**: Introduction to Transfer Learning, Transfer Learning Techniques: Direct Transfer, Indirect Transfer, Domain Adaptation.	

Text Books:

1. *Reinforcement learning :* An introduction, Richard S.Sutton and Andrew G. Barto, MIT Press, 2019.

Reference Books:

1. *Deep Reinforcement Learning Hands-On,* Maxim Lapan, Packt Publishing, 2018.
2. *Algorithms for Reinforcement Learning,* Csaba Szepesvári, Morgan & Claypool Publishers, 2010.

Course Outcomes	
CO1	Analyze Markov Decision Processes and implement dynamic programming and Monte Carlo methods for policy evaluation and improvement.
CO2	Apply temporal-difference learning techniques, including Sarsa and Q-learning, to optimize decision-making in reinforcement learning environments.
CO3	Evaluate the use of eligibility traces and planning techniques in reinforcement learning.

CO – PO - PSO Mapping

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

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Reinforcement Learning	NPTEL IIT Madras	https://onlinecourses.nptel.ac.in/noc19_cs55/preview
2.	Reinforcement Learning Specialization	Coursera	https://www.coursera.org/specializations/reinforcement-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
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	**30%**
Apply / Analyze	**45%**
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	SOFT COMPUTING LAB				
Course Code	24AM6PCSCL	Credits	1	L-T-P	0-0-1
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hrs/Week	2	Total Lab Hrs			12

Sl. No	List of Programming concepts
1.	Fuzzy Relations (Max-min Composition)/ Implications / Inferences
2.	a) Defuzzification techniques b) Fuzzy Controller
3.	Genetic Algorithm
4.	Parallel algorithms and distributed systems. (Eg. Merge sort)
5.	Ant Colony Optimization
6.	Particle Swarm Optimization (PSO) for Function Optimization
7.	Grey Wolf Optimization
8.	Crisp partitions for real-life iris dataset
9.	Perceptron- Hebb's rule or Delta rule
10.	Ensemble Network Programming
11	Fuzzy Relations (Max-min Composition)/ Implications / Inferences
12	a) Defuzzification techniques b) Fuzzy Controller

COURSE OUTCOMES	
CO1	Apply the concepts of soft computing techniques for real-world scenario.
CO2	Analyze nature-inspired optimization algorithms in the computer engineering field.
CO3	Design solutions for real time problems using modern tools.

CO-PO-PSO Mapping

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

Massive Open Online Course (MOOC)

Sl. No	Course	Offered by	Course Link
1.	Introduction To Soft Computing	NPTEL ,IIT Karagpur	https://cse.iitkgp.ac.in/~dsamanta/courses/sca/index.html

Assessment Pattern:

Category		Score Split Up	Total
Continuous Internal Evaluation (CIE) Lab	CIE -1	20 M	**50M**
	CIE-2	30 M	
Semester End Examination (SEE)	100 M (50 % Weightage)		**50 M**
Total			**100 M**

Course Title	COMPUTER VISION				
Course Code	24AM6PECVV	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 Computer Vision: Basics of Computer Vision, Differences between Computer Vision and Image Processing, Applications of Computer Vision, Introduction to OpenCV. Setting Up OpenCV Environment.	
UNIT – 2	**7 Hrs**
Feature Detection and Matching -Edge Detection-Sobel, Canny, Corner Detection-Harris Corner Detector, Blob Detection, Feature Descriptors-SIFT, SURF, ORB, Feature Matching-Brute-Force, FLANN.	
UNIT – 3	**7 Hrs**
Image Segmentation: Thresholding-Global, Adaptive, Region-Based Segmentation, Clustering-Based Segmentation-K-means, Contour Detection, GrabCut Algorithm.	
UNIT – 4	**7 Hrs**
Object Recognition and Detection - Introduction to Object Recognition, Template Matching, Bag of Words Model, Object Detection Algorithms-HOG, Viola-Jones, Introduction to Deep Learning for Object Detection-YOLO, SSD.	
UNIT – 5	**7 Hrs**
3D Vision- Stereo Vision and Depth Perception, 3D Reconstruction, Structure from Motion (SfM), Point Clouds, Applications of 3D Vision.	

Text Books:

1. *Computer Vision: Algorithms and Applications,* Richard Szeliski, 1st Edition, Springer, 2010.

Reference Books:

1. *Multiple View Geometry in Computer Vision,* Richard Hartley and Andrew Zisserman, 2nd Edition, Cambridge University Press, 2003.
2. *Fundamentals of Digital Image Processing,* Anil K Jain, Pearson Education, 2015.
3. *Digital Image Processing*, Rafael C. Gonzalez and Richard E. Woods, 3rd Edition, Prentice Hall, 2008.

Journals:

IEEE-T-PAMI (IEEE Transactions on Pattern Analysis and Machine Intelligence).
IJCV (International Journal of Computer Vision) - Springer.

Course Outcomes	
CO1	Interpret the fundamental concepts and techniques in computer vision and apply them to solve practical problems.
CO2	Illustrate various computer vision algorithms for image processing, feature extraction, and object recognition.
CO3	Use of modern computer vision tools and frameworks to design and deploy vision-based systems.

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					3								2		

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Computer Vision	Prof. Jayanta Mukhopadhyay IIT Kharagpur	https://onlinecourses.nptel.ac.in/noc19_cs58/preview
2.	Deep Learning for Computer Vision	Prof. Vineeth N Balasubramanian IIT Hyderabad	https://onlinecourses.nptel.ac.in/noc21_cs93/preview
3.	Computer Vision for Engineering and Science Specialization	Coursera	https://www.coursera.org/specializations/computer-vision

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/Quiz	10M	
Semester End Examination (SEE)	100M (50% weightage)			**50M**
			Total	100M

Course Title	BIG DATA ANALYTICS				
Course Code	24AM6PEBDA	Credits	3	L-T-P	3-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours /Week	3	Total Lecture Hours			26

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.

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 – 2	7 Hrs

The Hadoop: History of Hadoop-Hadoop use cases, The Design of HDFS, Blocks and replication management, Rack awareness, HDFS architecture, Yarn, HDFS Federation, Name node and data node, Anatomy of File write, Anatomy of File read.

Mapreduce: Hadoop Map Reduce paradigm, Map and reduce tasks, Job Tracker and task tracker, Map reduce execution pipeline, Key value pair, Shuffle and sort, Combiner and Partitioner, APIs used to Write/Read files into/from Hadoop, Data Serialization and Deserialization.

UNIT – 3	8 Hrs

Hive and Hbase Analytical tools:

Hive: Apache Hive with Hive Installation, Hive Data Types, Hive Table partitioning, Hive DDL commands, Hive DML commands, and Hive sort by vs. order by, Hive Joining tables, Hive bucketing.

Hbase : Introduction to HBase and its working architecture- Commands for creation and listing of tables- disabled and is disabled of table - enable and is enabled of table- describing and dropping of table-Put and Get command - delete and delete all command-commands for scan, count, truncate of tables.

UNIT – 4	6 Hrs

Relational Data in Hadoop:

Bi directional data transfer between Hadoop and external database. Import data- Transfer an entire table, import subset data, use different file format.

Apache Flume: Introduction, Architecture, build different data flow architectures, including multi-hop flows, fan-in, fan-out, and contextual routing.

UNIT – 5	8 Hrs

Data Analytics with Spark

Spark: Introduction to Apache Spark: A unified Spark, uses of Spark, a brief history of Spark, Storage layers for Spark. Programming with RDDs: RDD Basics, Creating RDDs, RDD Operations, Passing functions to Spark, Common Transformations and Actions, Persistence. Scala: The Basics, Control Structures and functions, Working with arrays, Maps and Tuples.

Text Books:

1. Bart Baesens , Analytics in a Big Data World: The Essential Guide to Data Science and its Applications, ,Wiley, 2014
2. Jean-Georges Perrin, Spark in Action: Covers Apache Spark 3 with Examples in Java, Python, and Scala, Manning, 2020.

3. Jason Rutherglen, Dean Wampler, Edward Caprialo, Programming Hive, O'Reilly Media Inc, 2012.
4. Steve Hoffman, Apache Flume: Distributed Log Collection for Hadoop, Packt Publishing, 2015.

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	Analyse the performance of Big Data systems with respect to different applications.
CO2	Attain proficiency in the use of a variety of tools for comprehensive data analysis.
CO3	Analyse different data storage and retrieval technologies and select the appropriate technology based on specific use cases.

CO-PO-PSO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PS01**	**PS02**	PS03
CO1	1												2	
CO2			1		1						2		2	
CO3		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="5">Continuous Internal Assessment (CIE)</td><td rowspan="4">Theory</td><td>CIE – 1</td><td rowspan="3">40 M (Best of Two)</td><td rowspan="4">50M</td></tr>
<tr><td>CIE – 2</td></tr>
<tr><td>CIE – 3</td></tr>
<tr><td rowspan="2">AAT</td><td rowspan="2">10M</td></tr>
<tr><td></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	ROBOTIC PROCESS AUTOMATION				
Course Code	24AM6PERPA	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	Analyse 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:

<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>Quiz</td><td>05M</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 Title	INTRODUCTION TO ARTIFICIAL INTELLIGENCE				
Course Code	24AM6OEAIG	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	10M	
Semester End Examination (SEE)	100M (50% weightage)			**50M**
Total				**100M**

Course Title	INTRODUCTION TO MACHINE LEARNING				
Course Code	24AM6OEMLG	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
I**ntroduction**: 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

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

Course Title	INTRODUCTION TO NEURAL NETWORKS				
Course Code	24AM6OEINN	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: 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	**7 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	**7 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	**7 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	**7 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	PROJECT WORK -1				
Course Code	24AM6PWPW1	Credits	2	L-T-P	0-0-2
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	4	Total Lecture Hours			

Project is to be carried out in 2 Phases. Project work - Phase 1 in 6th Semester and Project work - Phase 2 in 7th Semester. This is continuation of Project work - Phase 1.

In Project work - 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 Desig	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**

Course Title	MACHINE LEARNING OPERATIONS				
Course Code	24AM6AEMLO	Credits	1	L-T-P	0-0-1
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	2	Total Lecture Hours	12		

1. **Data Ingestion and Pre-processing:**

   Create a pipeline for data ingestion from multiple sources. Perform data cleaning, transformation, and feature engineering.

2. **Model Training and Hyperparameter Tuning:**

   Implement a script to train a machine learning model.Use grid search or random search for hyperparameter tuning.

3. **Model Evaluation and Validation:**

Evaluate model performance using various metrics.Validate the model using cross-validation

techniques.

4. **Model Versioning and Management:**

   Implement model versioning using tools like DVC or MLflow. Manage different versions of models and track changes.

5. **Model Deployment:**

Deploy a trained model using a REST API with Flask or FastAPI.Containerize the

deployment using Docker.

6. **Automated Testing and CI/CD Pipeline:**

   Set up automated testing for the model and data pipeline. Implement a CI/CD pipeline using tools like Jenkins or GitHub Actions.

7. **Monitoring and Logging:**

   Implement monitoring for model performance in production. Set up logging for tracking predictions and errors.

8. **Data Drift and Model Retraining:**

Detect data drift and its impact on model performance. Automate model retraining when significant drift is detected.

9. **Orchestration with Workflow Management Tools:**

   Use tools like Apache Airflow or Kubeflow to orchestrate machine learning workflows. Schedule and manage different stages of the ML pipeline.

10. **Collaboration and Version Control with Git and GitOps:**

    Implement version control for code and model using Git. Utilize GitOps principles to automate deployment and manage infrastructure as code.

Text Books:

1. *Machine* Practical MLOps, by Noah Gift, Alfredo Deza, Released September 2021 Publisher(s): O'Reilly Media, Inc., ISBN: 978109810301

Reference Books:

1. Introducing MLOps, by Mark Treveil, Nicolas Omont, Clément Stenac, Kenji Lefevre, Du Phan, Joachim Zentici, Adrien Lavoillotte, Makoto Miyazaki, Lynn Heidmann, Released November 2020, Publisher(s): O'Reilly Media, Inc. ISBN: 9781492083290
2. ML Ops: Operationalizing Data Science, by David Sweenor, Dev Kannabiran, Thomas Hill, Steven Hillion, Dan Rope and Michael O'Connell, O'Reilly Media, 2021
3. Building Machine Learning Pipelines, by Hannes Hapke, Catherine Nelson, O'Reilly Publications, 2021

CO1: Comprehend the complete process from data preparation, model training, evaluation, and deployment to monitoring and maintenance.

CO2: Leverage MLOps principles and tools to efficiently scale, manage, and automate the deployment of machine learning models in production environments.

CO3: Acquire the skills to select the ideal MLOps stack and leverage Git and GitOps for efficient version control and seamless collaboration in machine learning initiatives.

CO – PO - PSO Mapping

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

Massive Open Online Course (MOOC)

Sl. No	Course	Offered by	Course Link
1.	MLOps | Machine Learning Operations Specialization	Coursera	https://www.coursera.org/specializations/mlops-machine-learning-duke
2.	MLOps Fundamentals - Learn MLOps Concepts with Azure demo	Udemy	https://www.udemy.com/share/104whC/

Assessment Pattern:

Category		Score Split Up	Total
Continuous Internal Evaluation (CIE) Lab	CIE -1	20 M	**50M**
	CIE-2	30 M	
Semester End Examination (SEE)	100 M (50 % Weightage)		**50 M**
Total			**100 M**