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

(Autonomous Institute, Affiliated to VTU)

DEPARTMENT OF MACHINE LEARNING

BACHELOR OF ENGINEERING

IN

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

SCHEME & SYLLABUS

III - VIII SEMESTERS

From 2020-21 Admitted Batch Onwards

INSTITUTE VISION

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

INSTITUTE MISSION

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

DEPARTMENT VISION

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

DEPARTMENT MISSION

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

To motivate the students for post-graduation and research.

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

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

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

PEO2: Pursue higher studies with research potential.

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

PROGRAMME OUTCOMES (POs)

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

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

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

PO4: Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

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

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

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

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

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

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

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

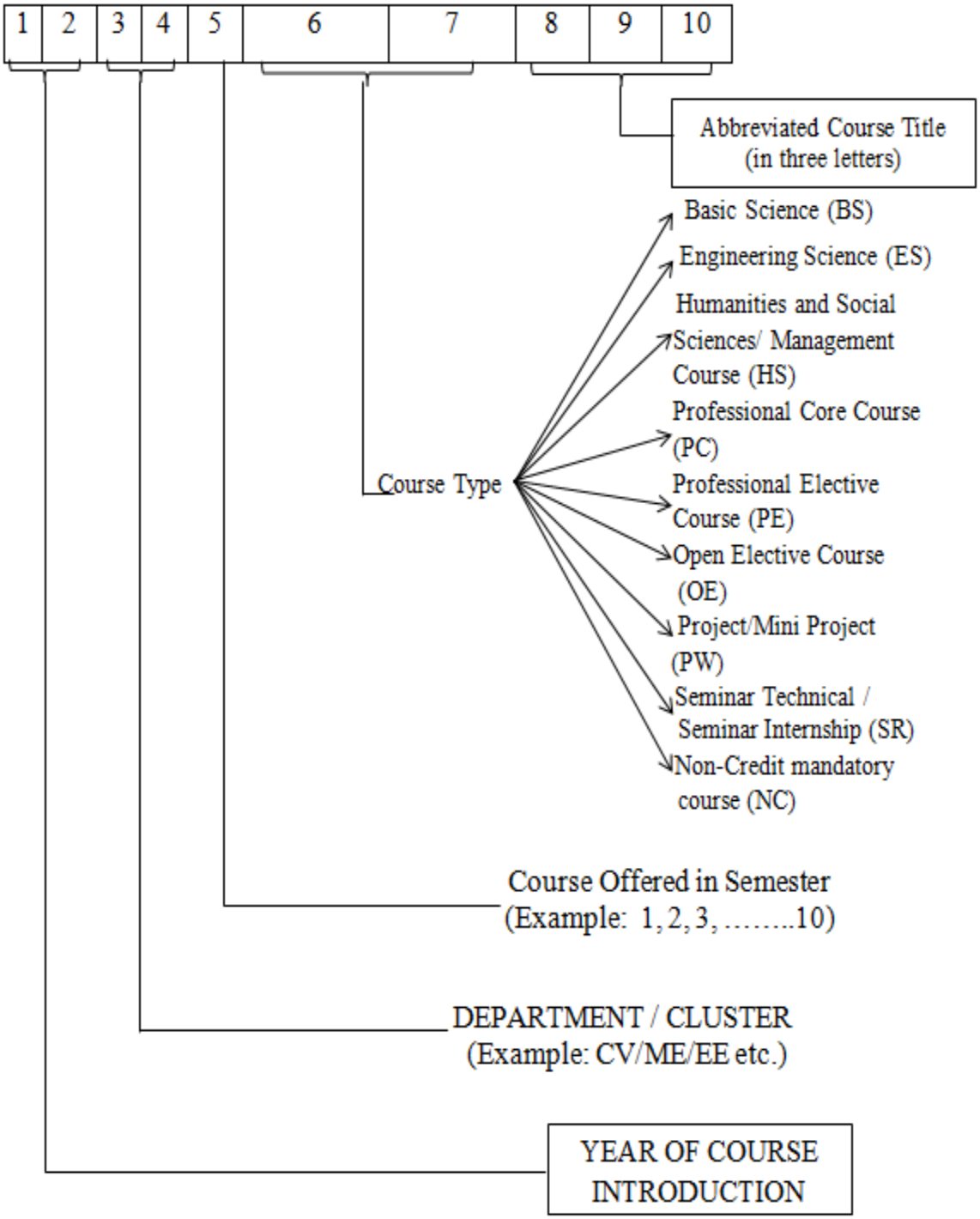
PROGRAMME SPECIFIC OUTCOMES (PSOs)

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

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

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

NOMENCLATURE FOR THE COURSE CODE



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

Scheme of Instructions Semester - III (With effect from the Academic Year 2020-21)

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 - 5	21MA3BSMAI	Mathematical Foundations For AI & ML	3	1	0	4	05	50	50	100
2	ES - 1	20AM3ESLDA	Logic Design and Computer Architecture	3	1	0	4	05	50	50	100
3	PC - 1	20AM3PCDST	Data Structures	3	0	1	4	05	50	50	100
4	PC - 2	20AM3PCCNS	Computer Networks	3	0	0	3	03	50	50	100
5	PC - 3	20AM3PCOPS	Operating Systems	3	0	0	3	03	50	50	100
6	PC - 4	20AM3PCTFC	Theoretical Foundations of Computations	3	1	0	4	05	50	50	100
7	PW - 1	20AM3PWWAD	Web Application Development	0	0	2	2	04	50	50	100
8	HS - 3	20HS4ICSAK / 20HS4ICBAK	SAMSKRUTHIKA KANNADA / BALAKE KANNADA	1	0	0	1	01	50	50	100
9	NC - 3	20AM3NCPAE	Participation in any Physical Activity/Event	Non-Credit Mandatory Course							
			Total	19	3	3	25	31	400	400	800

Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs: Additional Mathematics-I (19MA3IMMAT)

PW-1: Website based Application Development - Only Front End: Under this project work, student should develop front end for the websites of any chosen topic. Students can form a group with minimum of two and maximum of four. Teacher allotted for project work to students should teach students front end web technologies such as HTML, CSS, Java Script and basics of PHP (Sessions/Cookies Management) during Class/Lab hours as per the allotment. Teacher allotted for project work should guide the students in choosing the topic and towards carrying out project work and complete the evaluation of assigned students. The evaluation of project work will be based on the rubrics set by the department under the committee of HOD, UG NBA coordinator, One professor, One Associate professor and One Assistant Professor.

NC-3: Student can participate in any of the physical activities such as Sports, Marathon, Yoga conducted by college or any organization. Student should produce participation certificate for clearing this mandatory course. Note: If student is unable to participate in outside physical activities then department Head should take care of conducting Yoga and Meditation of one or two day event in the college. Physically challenged students can produce participation certificate of any technical/cultural events conducted by college/department clubs.

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

B.M.S. College of Engineering, Bengaluru - 19
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Scheme of Instructions Semester - IV (With effect from the Academic Year 2020-21)

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 - 6	19MA4BSLIA	Linear Algebra and Calculus	3	1	0	4	05	50	50	100
2	PC - 5	20AM4PCDAA	Design and Analysis of Algorithms	3	0	1	4	05	50	50	100
3	PC - 6	20AM4PCDBM	Database Management Systems	3	0	1	4	05	50	50	100
4	PC - 7	20AM4PCIAI	Introduction to Artificial Intelligence	3	0	0	3	03	50	50	100
5	PC - 8	20AM4PCPSM	Probability and Statistics for Machine Learning	3	1	0	4	05	50	50	100
6	SR -1	20AM4SRSLT	Seminar on Latest Trends	0	0	2	2	02	50	50	100
7	PW - 2	20AM4PWPML	Python for Machine Learning	0	0	2	2	04	50	50	100
8	HS - 4	19IC4HSCPH	Constitution of India, Professional Ethics and Human Rights	1	0	0	1	01	50	50	100
9	HS - 5	21HS4ICEVS	Environmental Studies	1	0	0	1	01	50	50	100
10	NC - 4	20AM4NCCAE	Participation in any Cultural Activity/Event	Non-Credit Mandatory Course							
			Total	17	2	6	25	31	450	450	900

Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs: Additional Mathematics-II (19MA4IMMAT)

PW-2: Python for Machine Learning - Under this project work, student should gain the skills of converting mathematical models to programming with the experience of developing real time applications. Students can form a group with minimum of two and maximum of four to explore the topics assigned as part of AAT. Teacher allotted for project work should help students to explore python basics in Lab hours as per the allotment. Teacher should guide the students in choosing the topic & towards implementation of the real time applications and complete the evaluation of assigned students. The evaluation of project work will be based on the rubrics set by the department under the committee of HOD, UG NBA coordinator, One professor, One Associate professor and One Assistant Professor.

NC-4: Student can participate in any of the cultural activities such as Music, dance conducted by college or any organization. Student should produce participation certificate for clearing this mandatory course. Note: If student is unable to participate in outside cultural activities then department Head should take care of conducting any small cultural event (like Essay, Debate etc.) of one or two day event in the college. Physically challenged students can produce participation certificate of any technical/cultural events conducted by college/department clubs.

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

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 2020-21: admitted batches and onwards)

Sl.#	Course Type	Course Code	Course Title	Teaching Hours in Credits/Week			Total Credits	Examination			
				Theory Lecture	Tutorial	Practical		Duration in hours	CIE Marks	SEE Marks	Total Marks
				L	T	P					
1	PC-9	22AM5PCOPJ	Object Oriented Programming using Java	3	0	1	4	05	50	50	100
2	PC-10	22AM5PCIML	Introduction to Machine Learning	3	0	0	3	03	50	50	100
3	PC-11	22AM5PCSED	Software Engineering and Design Patterns	3	0	0	3	03	50	50	100
4	PC-12	22AM5PCINN	Introduction to Neural Networks	3	0	0	3	03	50	50	100
5	HS-6	22AM5HSTFM	Time Series and Financial Mathematics	1	1	0	2	03	50	50	100
6	PE-1	22AM5PEABI	AI in Business Intelligence	3	0	0	3	03	50	50	100
		22AM5PEKDI	Knowledge Discovery								
		22AM5PECGV	Computer Graphics & Visualization								
7	PE-2	22AM5PEDIP	Digital Image Processing	3	0	0	3	03	50	50	100
		22AM5PENLP	Natural Language Processing								
		22AM5PEASC	Applied Soft Computing								
8	PW-3	22AM5PWPML	Project work on Machine Learning	0	0	2	2	04	50	50	100
9	PC-13	22AM5PCDVL	Data visualization Laboratory (Tableau / Power BI)	0	0	2	2	04	50	50	100
10	NC-5	22AM5NCMOC	MOOC	Non-credit mandatory Course							
			Total	19	1	5	25	31	450	450	900

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B.M.S. College of Engineering, Bengaluru – 19
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Scheme of Instructions Semester – VI (With effect from the Academic Year 2020-21: admitted batches and onwards)

Sl.#	Course Type	Course Code	Course Title	Teaching Hours in Credits/Week			Total Credits	Examination			
				Theory Lecture	Tutorial	Practical		Duration in hours	CIE Marks	SEE Marks	Total Marks
				L	T	P					
1	PC-14	22AM6PCAML	Advanced Machine Learning	3	0	1	4	05	50	50	100
2	PC-15	22AM6PCAAI	Advanced Artificial Intelligence	3	0	0	3	03	50	50	100
3	PC-16	22AM6PCDEL	Deep Learning	3	1	0	4	05	50	50	100
4	PE-3	22AM6PESMA	Social Media Analytics	2	0	1	3	04	50	50	100
		22AM6PEBCT	Block Chain Technology								
		22AM6PEVAC	Video Analytics using OpenCV								
5	PE-4	22AM6PEPRN	Pattern Recognition	3	0	0	3	03	50	50	100
		22AM6PESNA	Social Network Analysis								
		22AM6PEBDA	Big Data Analysis								
6	OE-1	22AM6OEIDM	Introduction to Data Mining	3	0	0	3	03	50	50	100
		22AM6OEIAI	Introduction to Artificial Intelligence								
		22AM6OEIML	Introduction to Machine Learning								
7	SR-2	22AM6SRITP	Internship	0	0	1	1	02	50	50	100
8	PW-4	22AM6PWMWP	MOOC with Project	2	0	0	2	02	50	50	100
9	HS-7	22AM6HSQAT	Quantitative Ability Training	2	0	0	2	02	50	50	100
10	NC-6	22AM6NCPAE	Participation in any Activity/Event	Non-credit mandatory Course							
			Total	21	1	3	25	29	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, SR: Seminar Technical / Seminar Internship, NC: Non-credit mandatory course

B.M.S. College of Engineering, Bengaluru – 19
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Scheme of Instructions Semester – VII (With effect from the Academic Year 2020-21: admitted batches and onwards)

Sl.#	Course Type	Course Code	Course Title	Teaching Hours in Credits/Week			Total Credits	Examination			
				Theory Lecture	Tutorial	Practical		Duration in hours	CIE Marks	SEE Marks	Total Marks
				L	T	P					
1	BS-7	22AM7BSIPR	Management, Entrepreneurship and IPR	2	0	0	2	02	50	50	100
2	HS-8	22AM7HSGAL	Generative AI With Large Language Models	3	0	0	3	03	50	50	100
3	PC-17	22AM7PCDLL	Deep Learning Laboratory	0	0	1	1	02	50	50	100
4	PE-5	22AM7PECSS	Cognitive Science and Systems	3	0	0	3	03	50	50	100
		22AM7PEEHP	Ethical Hacking Principles								
		22AM7PEAUR	Augmented Reality and Virtual Reality								
5	OE-2	22AM7OEBDA	Introduction to Big Data Analytics	3	0	0	3	03	50	50	100
		22AM7OEINN	Introduction to Neural Networks								
		22AM7OEISC	Introduction to Soft Computing								
		22AM7OEJIR	Jira Programming [L : T : P = 1 : 1 : 1]								
6	HS-9	22AM7HSRMD	Research Methodology	3	0	0	3	03	50	50	100
7	PW-5	22AM7PWCPR	Capstone Project – Phase I	0	0	3	3	06	50	50	100
8	SR-3	22AM7SRIMC	Industry Motivated Course (Seminar/Technical Writing)	0	0	1	1	02	50	50	100
9	NC-7	22AM7NCPDC	Personality Development and Communication Skills or Aptitude Skills	Non-credit mandatory Course							
			Total	14	0	5	19	24	400	400	800

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B.M.S. College of Engineering, Bengaluru – 19
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Scheme of Instructions Semester – VIII (With effect from the Academic Year 2020-21: admitted batches and onwards)

Sl.#	Course Type	Course Code	Course Title	Teaching Hours in Credits/Week			Total Credits	Examination			
				Theory Lecture	Tutorial	Practical		Duration in hours	CIE Marks	SEE Marks	Total Marks
				L	T	P					
1	HS-10	24AM8HSBFE	Biology for Engineers	2	0	0	2	02	50	50	100
2	OE-3	24AM8OEBDA	Big Data Analytics	3	0	0	3	03	50	50	100
		24AM8OEPYP	Python Programming								
3	PW-6	24AM8PWCPT	Capstone Project – Phase II	0	0	10	10	00	50	50	100
4	SR-4	24AM8SRITP	Internship	0	0	1	1	00	50	50	100
5	NC-8	24AM8NCPCE	Competitive Exam / MOOC Course	Non-credit mandatory Course							
			Total	5	0	11	16	05	200	200	400

B.M.S. College of Engineering, Bengaluru - 19
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Scheme of Instructions Semester - III (With effect from the Academic Year 2020-21)

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 - 5	21MA3BSMAI	Mathematical Foundations For AI & ML	3	1	0	4	05	50	50	100
2	ES - 1	20AM3ESLDA	Logic Design and Computer Architecture	3	1	0	4	05	50	50	100
3	PC - 1	20AM3PCDST	Data Structures	3	0	1	4	05	50	50	100
4	PC - 2	20AM3PCCNS	Computer Networks	3	0	0	3	03	50	50	100
5	PC - 3	20AM3PCOPS	Operating Systems	3	0	0	3	03	50	50	100
6	PC - 4	20AM3PCTFC	Theoretical Foundations of Computations	3	1	0	4	05	50	50	100
7	PW - 1	20AM3PWWAD	Web Application Development	0	0	2	2	04	50	50	100
8	HS - 3	20HS4ICSAK / 20HS4ICBAK	SAMSKRUTHIKA KANNADA / BALAKE KANNADA	1	0	0	1	01	50	50	100
9	NC - 3	20AM3NCPAE	Participation in any Physical Activity/Event	Non-Credit Mandatory Course							
			Total	19	3	3	25	31	400	400	800

Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs: Additional Mathematics-I (19MA3IMMAT)

PW-1: Website based Application Development - Only Front End: Under this project work, student should develop front end for the websites of any chosen topic. Students can form a group with minimum of two and maximum of four. Teacher allotted for project work to students should teach students front end web technologies such as HTML, CSS, Java Script and basics of PHP (Sessions/Cookies Management) during Class/Lab hours as per the allotment. Teacher allotted for project work should guide the students in choosing the topic and towards carrying out project work and complete the evaluation of assigned students. The evaluation of project work will be based on the rubrics set by the department under the committee of HOD, UG NBA coordinator, One professor, One Associate professor and One Assistant Professor.

NC-3: Student can participate in any of the physical activities such as Sports, Marathon, Yoga conducted by college or any organization. Student should produce participation certificate for clearing this mandatory course. Note: If student is unable to participate in outside physical activities then department Head should take care of conducting Yoga and Meditation of one or two day event in the college. Physically challenged students can produce participation certificate of any technical/cultural events conducted by college/department clubs.

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Course Title	MATHEMATICAL FOUNDATIONS FOR AI & ML				
Course Code	21MA3BSMAI	Credits	4	L-T-P	3-1-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours/Week	5	Total Lecture Hours			36

UNIT - 1	[8 L + 2T]
Graph-Theory-1: Basic concepts: Types of graphs, order and size of a graph, in-degree andout-degree, connected and disconnected graphs, Eulerian graph, Hamiltonian graphs, sub- graphs, isomorphic graphs. Matrix representation of graphs: adjacency matrix, incidence matrix. Planar Graphs and Coloring.	
UNIT - 2	**[6 L + 2T]**
GRAPH THEORY-2: Trees: spanning Trees: minimal spanning tree: Kruskal's algorithm, Prim's algorithm, Network flows, DFS, BFS, shortest path-Dijkstra's algorithm, Matchings.	
UNIT - 3	**[8 L + 2T]**
COMBINATORICS Principles of counting: The rules of sum and product, permutations. Combinations- Binomial and multinomial theorems. Pigeonhole principle, Catalan numbers, the principle of inclusion and exclusion, Derangements, Rook Polynomials, Generating functions	
UNIT - 4	**[7 L + 3T]**
INDUCTION AND RECURRENCE RELATIONS Mathematical Induction, Strong Induction and Well-Ordering, Recursive Definitions and Structural Induction, First order recurrence relations, second-order homogeneous recurrence relations, third and higher order linear homogeneous recurrence relations.	
UNIT - 5	**[7 L + 3T]**
CONGRUENCES AND ITS APPLICATIONS Introduction to Congruences, Linear Congruences, The Chinese Remainder Theorem, Solving Polynomials, System of Linear Congruences, , Applications of Congruences	

Text Books:

1. Kenneth H.Rosen, *Discrete Mathematics and its applications*, 7th Edition, McGraw Hill Publishers
2. Dr. D.S.C, *Graph Theory and Combinatorics*, 4th Edition, Prism engineering education series,

Reference Books:

1. Kenneth H.Rosen, *Elementary number theory and its applications*, 5th Edition, Pearson publications
2. *Discrete Mathematics, Kolman*, Busby Ross,5th Edition, 2004, Prentice Hall.
3. *Graph Theory with Applications to Engineering and Computer Science*, Narsingh Deo, Eastern Economy Edition, PHI Learning Pvt., Ltd.

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

Course Code	CO#	COURSE OUTCOME(CO)	PO	Strength
21MA3BSMML	CO1	Apply Discrete mathematical tools and concepts in Machine learning algorithms	1	3
	CO2	Analyze the machine learning application using Discrete mathematical tools.	1	2
	CO3	Demonstrate the applications of machine learning concepts using the Discrete mathematical tools.	1, 5, 9, 10	2

Assessment Details (both CIE and SEE)

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

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

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

SEMESTER END EXAMINATION:

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

Text Books:

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

Reference Books:

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

E books and online course materials:

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

Online Courses and Video Lectures:

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

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Course Title	LOGIC DESIGN AND COMPUTER ARCHITECTURE				
Course Code	20AM3ESLDA	Credits	4	L-T-P	3-1-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours /Week	5	Total Lecture Hours			36

UNIT - 1	8 Hrs
Basics of Gates: Review of Basic Logic gates, Positive and Negative Logic Combinational Logic Circuits: Sum-of-Products Method, Truth Table to Karnaugh Map, Pairs, Quads,and Octets, Karnaugh Simplifications, Don't-care Conditions, Product-of-Sums Method, Product-of- Sums simplifications, Simplification by Quine-McClusky Method. **Data-Processing Circuits**: Multiplexers, Demultiplexers, 1-of-16 Decoder, Exclusive-or Gates, Encoders, Parity Generators.	
UNIT - 2	**7 Hrs**
Flip- Flops: RS Flip-Flops, Gated Flip-Flops, Edge-triggered Flip-Flops, Flip-Flop Timing, JK Master-Slave Flip-Flop, Various Representation of FLIP-FLOPs, Analysis of Sequential Circuits. Registers: Types of Registers, Applications of Shift Registers. **Counters:** Asynchronous Counters, Synchronous Counters, Changing the Counter Modulus, Counter Design as a Synthesis problem. **Design of Synchronous Sequential Circuits**: Model Selection, State Transition Diagram, State Synthesis Table, Design Equations and Circuit Diagram, State Reduction Techniques.	
UNIT - 3	**7 Hrs**
Basic Structures of Computers: Computer Types, Functional Units, Basic Operational Concepts, Bus Structures, Software, Performance. **Machine instructions and Programs:** Memory Locations and Addresses, Memory Operations, Instructions and Instruction Sequencing, Addressing Modes, Assembly Language, Basic Input Output Operations.	
UNIT - 4	**7 Hrs**
Input/output Organization: Accessing I/O Devices, Interrupts. **Arithmetic:** Additionand Subtraction of Signed Numbers, Design of Fast Adders, Multiplication of Positive Numbers, Signed-Operand Multiplication.	
UNIT - 5	**7 Hrs**
Basic Processing Unit: Concepts, Execution of a Complete Instruction, Multiple-Bus Organization, Hardwired and microprogrammed control unit. **Memory Organization**: Memory Hierarchy, Main Memory- RAM & ROM chips, Memory Address Map, Memory connection to CPU, Cache Memory-Associative Mapping.	

Text Books:

1. Donald P Leach, Albert Paul Malvino & Goutam Saha: *Digital Principles and Applications*, 8th Edition, Tata McGraw Hill, 2015
2. Carl Hamacher, *Computer Organization*, 5th Edition, McGraw Hill Publishers

Reference Books:

1. R D Sudhaker Samuel: *Illustrative Approach to Logic Design*, Sanguine-Pearson, 2010.
2. Morris Mano, *Computer System and Architecture*, 3rd Edition, Pearson Education.
3. William Stallings: *Computer Organization & Architecture*, 9th Edition, Pearson,2015.

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

CO – PO - PSO Mapping

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

Massive Open Online Course (MOOC)

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

Semester End Examination (SEE) Question Paper Pattern:

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

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

Assessment Pattern:

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

Course Title	DATA STRUCTURES				
Course Code	20AM3PCDST	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 using C and C++*, Yedidyah, Augenstein, Tannenbaum, 2nd Edition, Pearson Education, 2007.
2. *Data Structures using C*, Reema Thareja, 2nd Edition, Oxford University Press, 2011

Reference Books:

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

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

CO – PO - PSO Mapping

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

Massive Open Online Course (MOOC)

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

Semester End Examination (SEE) Question Paper Pattern:

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

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

Assessment Pattern:

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

Course Title	COMPUTER NETWORKS				
Course Code	20AM3PCCNS	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 Network: Problem: Building a Network: Application, Network Requirement Network Architecture, Implementation of Network software, performance measures	
UNIT - 2	**7 Hrs**
Connecting to Network: Perspective on connecting, Encoding, Framing, Error Detection, Reliable transmission, 802.XX protocols.	
UNIT - 3	**7 Hrs**
Internetworking: switching and bridging, Basic Internetworking, Routing, Global Internet, Routing in mobile device and Deployment of IPv6.	
UNIT - 4	**7 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	**7 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,2010

Reference Books:

1. *Computer Networking: A Top-Down Approach Featuring the Internet*, JamesKurose and Keith Ross, Pearson, 7th Edition, 2010

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

CO – PO - PSO Mapping

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

Massive Open Online Course (MOOC)

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

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice / Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks
Unit 2	Internal Choice	Two questions to be asked for 20 marks each
Unit 3	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	OPERATING SYSTEM				
Course Code	20AM3PCOPS	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	5 Hrs
Introductions: Operating System Services, User- Operating System operations and interface, System Calls, Operating System design and implementation, Case Studies.	
UNIT - 2	**12 Hrs**
Processes & Thread Management: Process Overview, Process Scheduling algorithms, Inter-process communication. PCB, Multithreading models, Threading issues. **Process Synchronization:** The critical section problem, Peterson's solution, Mutexlocks, Semaphores, problems using synchronization.	
UNIT - 3	**6 Hrs**
Deadlocks: System Model, Deadlock characterization, Methods for handling deadlocks, Deadlock prevention, Deadlock avoidance, Deadlock detection and recovery from deadlock.	
UNIT - 4	**8 Hrs**
Main Memory: Background, swapping, Contiguous memory allocation, Segmentation, Paging, Structure of page table. **Virtual Memory:** Background, Demand paging, Copy on write, Page replacement algorithms, Allocation of frames, Thrashing.	
UNIT - 5	**6 Hrs**
Disk performance optimization: Introduction, Disk scheduling strategies, rotational optimization. **File Access Controlling mechanisms.**	

Text Books:

1. *Operating System Concepts*, by Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, 9th Edition, Wiley India, 2012.
2. *Operating systems*, by H.M.Deitel, D.J.Deitel, D.R.Choffnes, 3rd Edition, Pearson Education.

Reference Books:

1. *Operating Systems, A Concept-Based Approach*, by DM Dhamdhere, 3rd Edition, Tata Mcgraw-Hill, 2012.
2. *Modern Operating Systems*, by Andrew S. Tanenbaum and Herbert Bos, 4th Edition, Pearson, 2014.

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

CO – PO - PSO Mapping

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

Massive Open Online Course (MOOC)

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

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice / Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks
Unit 2	Internal Choice	Two questions to be asked for 20 marks each
Unit 3	Mandatory	One question to be asked for 20 marks
Unit 4	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	THEORETICAL FOUNDATIONS OF COMPUTATIONS				
Course Code	20AM3PCTFC	Credits	4	L-T-P	3-1-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	5	Total Lecture Hours			36

UNIT - 1	8 Hrs
Introduction to Finite Automata: Introduction to Finite Automata, Central Concepts of Automata Theory, Deterministic Finite Automata (DFA), Nondeterministic Finite Automata (NFA), Finite Automata with Epsilon Transition, An Application Text Search	
UNIT - 2	**7 Hrs**
Regular Expressions and Languages: Regular Expressions, Finite Automata and Regular Expressions, Applications of Regular Expressions, Proving Languages Not to Be Regular, Closure Properties of Regular Languages, Equivalence and Minimization of Automata	
UNIT - 3	**7 Hrs**
Context Free Grammars and Languages Parse Trees: Applications of Context Free Grammars, Ambiguity in Grammars and Languages, Eliminating Useless Symbols, Computing the Generating and Reachable Symbols, Eliminating Epsilon Productions, Eliminating Unit Productions.	
UNIT - 4	**7 Hrs**
Context Free Grammars and Languages: Chomsky Normal Form, Greibach Normal Form, The Pumping Lemma for Context Free Languages, Closure Properties of Context Free Languages **Pushdown Automata:** Introduction to Pushdown Automaton, The Languages of a PDA, Deterministic Pushdown Automata	
UNIT - 5	**7 Hrs**
Pushdown Automata: Equivalence of PDA's and CFG's **Introduction to Turing Machines:** The Turing Machine, Multitape Turing Machine, Introduction to Post's Correspondence Problem, Undecidable Problems.	

Text Books:

1. *Introduction to Automata Theory, Languages and Computation*, John E. Hop croft, Rajeev Motwani, Jeffrey D.Ullman: education,3rd Edition, Pearson, 2007.

Reference Books:

1. *Introduction to Languages and Automata Theory*, John C Martin, 3rd Edition, Tata McGraw-Hill, 2007.
2. *Introduction to Computer Theory*, Daniel I.A. Cohen,John Willy & Son Inc, 2nd Edition, 2000.
3. *An Introduction to formal Languages and Automata*,Peter Linz , Narosa publishing house, 1997.

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	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		
		Quiz	05M	
		AAT	05M	
Semester End Examination (SEE)	100M (50% weightage)			**50M**

Course Title	WEB APPLICATION DEVELOPMENT				
Course Code	20AM3PWWAD	Credits	2	L-T-P	0-0-2
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	4	Total Lecture Hours			48

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

Text Books:

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

Reference Books:

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

	Course Outcomes
CO 1	Apply the knowledge of modern web languages and latest web frameworks to develop interactive web applications.
CO 2	Analyze front-end web coding languages to add dynamic content and discover the various ways of passing information from client to server.
CO 3	Design an interactive website(s) in team using modern integrated tools.

CO – PO - PSO Mapping

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

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Modern Application Development	NPTEL	https://onlinecourses.nptel.ac.in/noc20_cs52/preview

2.	Introduction to Web Development with HTML,CSS,Javascript	Coursera	https://in.coursera.org/learn/introduction-to-web-development-with-html-css-javacript
3.	Introduction to Web Development	Coursera	https://www.coursera.org/learn/web-development

Assessment Pattern:

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

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

Scheme of Instructions Semester - IV (With effect from the Academic Year 2020-21)

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 - 6	19MA4BSLIA	Linear Algebra and Calculus	3	1	0	4	05	50	50	100
2	PC - 5	20AM4PCDAA	Design and Analysis of Algorithms	3	0	1	4	05	50	50	100
3	PC - 6	20AM4PCDBM	Database Management Systems	3	0	1	4	05	50	50	100
4	PC - 7	20AM4PCIAI	Introduction to Artificial Intelligence	3	0	0	3	03	50	50	100
5	PC - 8	20AM4PCPSM	Probability and Statistics for Machine Learning	3	1	0	4	05	50	50	100
6	SR -1	20AM4SRSLT	Seminar on Latest Trends	0	0	2	2	02	50	50	100
7	PW - 2	20AM4PWPML	Python for Machine Learning	0	0	2	2	04	50	50	100
8	HS - 4	19IC4HSCPH	Constitution of India, Professional Ethics and Human Rights	1	0	0	1	01	50	50	100
9	HS - 5	21HS4ICEVS	Environmental Studies	1	0	0	1	01	50	50	100
10	NC - 4	20AM4NCCAE	Participation in any Cultural Activity/Event	Non-Credit Mandatory Course							
			Total	17	2	6	25	31	450	450	900

Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs: Additional Mathematics-II (19MA4IMMAT)

PW-2: Python for Machine Learning - Under this project work, student should gain the skills of converting mathematical models to programming with the experience of developing real time applications. Students can form a group with minimum of two and maximum of four to explore the topics assigned as part of AAT. Teacher allotted for project work should help students to explore python basics in Lab hours as per the allotment. Teacher should guide the students in choosing the topic & towards implementation of the real time applications and complete the evaluation of assigned students. The evaluation of project work will be based on the rubrics set by the department under the committee of HOD, UG NBA coordinator, One professor, One Associate professor and One Assistant Professor.

NC-4: Student can participate in any of the cultural activities such as Music, dance conducted by college or any organization. Student should produce participation certificate for clearing this mandatory course. Note: If student is unable to participate in outside cultural activities then department Head should take care of conducting any small cultural event (like Essay, Debate etc.) of one or two day event in the college. Physically challenged students can produce participation certificate of any technical/cultural events conducted by college/department clubs.

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

Course Title	LINEAR ALGEBRA AND CALCULUS				
Course Code	19MA4BSLIA	Credits	4	L-T-P	3-1-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	5	Total Lecture Hours			36

UNIT – 1	9 Hrs
SYSTEM OF LINEAR EQUATIONS AND VECTOR SPACES: Elementary row operations, echelon forms, rank of matrix. **System of Linear Equations:** solution of homogeneous equations, consistency of non- homogeneous system of linear equations. Gauss elimination method, LU decomposition method. **Vector spaces:** Subspaces, Linear Combinations, Linear Spans, row space and column space of a Matrix, Linear Dependence and Independence, Basis and Dimension, Coordinates.	
UNIT – 2	**7 Hrs**
LINEAR TRANSFORMATIONS: Introduction, Linear Mappings, Geometric linear transformation of, Kernel and Image of a linear transformations, Matrix representation of linear transformations, Rank-Nullity Theorem(No proof), Singular and Nonsingular linear transformations, Invertible linear transformations.	
UNIT – 3	**7 Hrs**
EIGENVALUES AND EIGENVECTORS: Introduction, Polynomials of Matrices, Characteristic polynomial, Cayley-Hamilton Theorem, eigenvalues and eigenvectors, eigen spaces of a linear transformation, Diagonalization, Minimal Polynomial, Characteristic and Minimal Polynomials of Block Matrices, Jordan Canonical form, Solving differential equations in Fundamental form.	
UNIT – 4	**7 Hrs**
INNER PRODUCT SPACES: Inner product, inner product spaces, length and orthogonality, orthogonal sets and Bases, projections, Gram-Schmidt process, QR-factorization, least squares problem and least square error.	
UNIT – 5	**6 Hrs**
SYMMETRIC MATRICES AND QUADRATIC FORMS: Diagonalization of real symmetric matrices, Orthogonal diagonalization of real symmetric matrices, quadratic forms and its classifications, Singular value decomposition.	

Text Books:

1. *Linear Algebra and its applications*, David C. lay, Steven R. lay, Judi J Mc. Donald, 5th Edition, 2015, Pearson Education.
2. *Linear Algebra and its applications*, Gilbert Strang, 4th Edition, 2005, Brooks Cole.

Reference Books:

1. Schaum's outline series-Theory and problems of linear algebra, Seymour Lipschutz, 5th edition, 2012, McGraw-Hill Education.
2. Linear Algebra an Introduction, Richard Bronson & Gabriel B. Costa, 2nd edition.

Course Outcomes

CO1	Apply the concepts of linear algebra in Computer and allied Engineering Sciences.
CO2	Analyze the computer science and allied engineering Sciences applications using Linear algebra.
CO3	Demonstrate the applications of computerscience and allied engineering Science applications using Linear algebra tools.

Assessment Details (both CIE and SEE)

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

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

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

SEMESTER END EXAMINATION:

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

SUGGESTED LEARNING RESOURCES:

Text Books:

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

Reference Books:

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

E books and online course materials:

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

Online Courses and Video Lectures:

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

Course Title	DESIGN AND ANALYSIS OF ALGORITHMS				
Course Code	20AM4PCDAA	Credits	4	L-T-P	3-0-1
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	5	Total Lecture Hours			36

UNIT – 1	7 Hrs
Fundamentals of Algorithm Analysis: Definition of algorithm, Algorithmic Problem Solving, Framework for Analysis of algorithm efficiency, Asymptotic Notations, Mathematical Analysis of Non recursive algorithms and Recursive algorithms.	
UNIT – 2	**7 Hrs**
Brute Force: Sorting techniques, String Matching, Exhaustive search. **Divide and Conquer:** Master Theorem, Merge sort, Quicksort. **Greedy Technique:** Minimum Spanning tree and its 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:** Travelling Salesman problem, Assignment problem	

Text Books:

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

Reference Books:

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

Course Outcomes

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

CO – PO - PSO Mapping

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

Massive Open Online Course (MOOC)

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

Semester End Examination (SEE) Question Paper Pattern:

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

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

Assessment Pattern:

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

Course Title	DATABASE MANAGEMENT SYSTEMS				
Course Code	20AM4PCDBM	Credits	4	L-T-P	3-0-1
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	5	Total Lecture Hours			36

UNIT – 1	7 Hrs

Introduction to Databases: Characteristics of Database approach, Advantages. **Database Architecture:** Data models, Schemas and instances, Three schema architecture and data independence Database languages and interfaces, The database system environment, **SQL:** SQL Data Definition and Data Types specifying basic constraints in SQL, Basic retrieval queries in SQL, Insert, Delete and Update statements in SQL, Additional features of SQL,More complex SQL Queries, Specifying Constraints as Assertions and Triggers, Views (Virtual Tables) in SQL, Schema Change Statement in SQL.

UNIT – 2	7 Hrs

Entity-Relationship(ER) model: Using High-Level conceptual Data Models for Database Design, A sample Database Application, Entity types, Entity Sets, Attributes and Keys, Relationship Types, Relationship Sets, Roles and Structural Constraints, Weak Entity types, Refining the ER Design, ER Diagrams, Naming Conventions and Design Issues, Relationship Types of Degree Higher than two, Relational Database Design using ER-toRelational Mapping.

UNIT – 3	7 Hrs

Relational Data Model and Relational Database Constraints: Relational Model Concepts, Relational Model Constraints and Relational Database Schemas, Update Operations, Transactions and Dealing with Constraint Violations. **Relational Algebra:** Unary Relational Operations, SELECT and PROJECT, Relational Algebra Operations from Set Theory Binary Relational Operations: JOIN and DIVISION, Additional Relational Operations

UNIT – 4	7 Hrs

Database Design Theory and Normalization: Informal Design Guidelines for Relation Schemas, Functional Dependencies, Normal Forms Based on Primary Keys, General Definitions of Second and Third Normal Forms, Boyce-Codd Normal Form, Multi-valued Dependencies and a Fourth Normal Form, Join Dependencies, Fifth Normal Form.

UNIT – 5	8 Hrs

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

Text Books:

1. *Database Systems: The Complete Book*, Hector Garcia-Molina Jeffrey D. Ullman Jennifer Widom,2nd Edition.
2. *Getting Started with NoSQL* by Gaurav Vaish, 2nd Edition, Packt Publishing, 2014.

Reference Books:

1. *Fundamental of Database Systems* by Elmasri and Navathe, 6th Edition, Addison-Wesley, 2011.

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

CO – PO - PSO Mapping

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

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	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	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	INTRODUCTION TO ARTIFICIAL INTELLIGENCE				
Course Code	20AM4PCIAI	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: What is AI? **Intelligent Agents:** How agent should act, Structure of Intelligent Agents, Environments Problem Solving: Formulating problems, Example problems **Uniformed-search strategies:** Breadth-First Search, Uniform Cost Search, Depth-First Search, Depth Limited Search, Iterative Deepening Search	
UNIT – 2	**8 Hrs**
Heuristic Search Strategies: Generate-and-Test, Hill Climbing, Best-first Search, Problem Reduction, Constraint Satisfaction, Means-ends Analysis	
UNIT – 3	**8 Hrs**
Knowledge Representation: Propositional Logic – Syntax and Semantics, Using Propositional Logic, First-Order Logic – Syntax and Semantics, Using First-Order Logic Representing Knowledge using Rules: Procedural Versus Declarative Knowledge, Forward Versus Backward Reasoning, Semantic Knowledge, Ontology Based representation.	
UNIT – 4	**8 Hrs**
Uncertain Knowledge & Reasoning: Acting under Uncertainty, Basic Probability notation, The Axioms of Probability, Bayes' Rule and its Use, Where do Probabilities come from?, Representing Knowledge in an Uncertain Domain, The Semantics of Belief Networks..	
UNIT – 5	**6 Hrs**
Introduction to Expert Systems: Definition, Features of an Expert System, Organization, Characteristics, Prospector, Knowledge Representation in Expert Systems, Expert System tools – MYCIN, EMYCIN.	

Text Books:

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

Reference Books:

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

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

CO – PO - PSO Mapping

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

Massive Open Online Course (MOOC)

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

Semester End Examination (SEE) Question Paper Pattern:

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

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

Assessment Pattern:

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

Course Title	PROBABILITY AND STATISTICS FOR MACHINE LEARNING				
Course Code	20AM4PCPSM	Credits	4	L-T-P	3-1-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	5	Total Lecture Hours			36

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

Text Books:

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

Reference Books:

1. Kishore S Trivedi, *Probability, Statistics, Queuing theory and Computer Science Applications*, 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	**1**													**2**	
CO2		**2**												**2**	
CO3				**1**							**1**	**1**		**2**	

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	Mandatory	One question to be asked for 20 marks
Unit 3	Mandatory	One question to be asked for 20 marks
Unit 4	Internal Choice	Two questions to be asked for 20 marks each
Unit 5	Internal Choice	Two questions to be asked for 20 marks each

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

Assessment Pattern:

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

Course Title	SEMINAR ON LATEST TRENDS				
Course Code	20AM4SRSLT	Credits	2	L-T-P	0-0-2
CIE	50	SEE	50 Marks (50% Weightage)		
Contact Hours / Week	04	Total Lecture Hours			NA

Seminar on Latest Trends: Seminar on the latest trends typically aims to provide students with insights and updates on current developments, innovations, and emerging patterns in the domain of artificial intelligence and machine learning. The content and focus of the seminar can vary widely based on the subject matter, but the primary goal is to keep attendees informed about the most recent advancements and trends.

Rules and regulations:

1. A student can do either of the three mentioned below, as part of course Seminar on latest trends:
    a. Paper presentation.
    b. MOOC
    c. Internship.
2. It should be done individually.
3. For paper presentation students should refer research papers published in the past two years.
4. For MOOC students should do courses hosted on renowned platforms such as NPTEL, Coursera, etc.
5. MOOC, Paper presentation or internship students should take prior permission of the allotted guide.

Course Outcomes	
CO1	Critically analyze emerging technologies, methodologies, and practices. in the field of artificial intelligence & Machine Learning.
CO2	Comprehend engineer's responsibility to contribute positively to society through the application of the latest trends in a manner that prioritizes safety, inclusivity, and sustainability.
CO3	Effectively communicate and articulate ideas and insights among the stake holders to stay informed about future trends.

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									2	3		1			1

Assessment Pattern:

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

Course Title	PYTHON FOR MACHINE LEARNING				
Course Code	20AM4PWPML	Credits	2	L-T-P	0-0-2
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	4	Total Lecture Hours			36

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

Text Books:

1. *Python Crash Course: A Hands-On, Project-Based Introduction to Programming*, Eric Matthes, 2nd Edition.
2. *Learn Python the Hardway* by Zeo A Shaw, 3rd Edition.

Reference Books:

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

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

UNIT – 1

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

UNIT – 2

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

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

UNIT – 3

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

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

UNIT – 4

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

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

UNIT – 5

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

CASE STUDY

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

List of Text Books:

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

Course Outcomes:

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

CO – PO - PSO Mapping

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

Massive Open Online Course (MOOC)

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

Assessment Pattern:

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

Course Title	CONSTITUTION OF INDIA, PROFESSIONAL ETHICS AND HUMAN RIGHTS				
Course Code	19IC4HSCPH	Credits	1	L-T-P	1-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	1	Total Lecture Hours			12

UNIT – 1	3 Hrs

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

UNIT – 2	2 Hrs

Union Executive and State Executive:
The Union Executive – The President and The Vice President, The Prime Minister and The Council of Ministers. The Union Parliament –LokSabha & RajyaSabha.
The Supreme Court of India.
State Executive – The Governors, The Chief Ministers and The Council of Ministers. The State Legislature – Legislative Assembly and Legislative Council. State High Courts.

UNIT – 3	2 Hrs

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

UNIT – 4	2 Hrs

Special Constitutional Provisions/ Human Rights:
Special Constitutional Provisions for Schedule Castes, Schedule Tribes & Other Backward Classes, Women & Children. Case Studies.
Human Rights/values – Meaning and Definitions, Legislative Specific Themes in Human Rights and Functions / Roles of National Human Rights Commission of India. Human Rights (Amendment Act) 2006

UNIT – 5	3 Hrs

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

Text Books:

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

Reference Books:

1. "*V.N. Shukla's Constitution of India*" by Prof (Dr.) M ahendra Pal Singh (Revised), Eas tern Book Company,Edition: 13th Edition, 2017, Reprint 2019.
2. "Ethics in Engineering" by M artin, W. M ike.,Schinzinger, Roland., M cGraw-Hill Education; 4th Edition(February 6, 2004).

Course Outcomes:

CO1	Understand and explain the significance of Indian Constitution as the Fundamental Law of the Land.
CO2	Analyze the concepts and ideas of Human Rights.
CO3	Apply the practice of ethical responsibilities and duties to protect the welfare and safety of the public.

CO – PO - PSO Mapping

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

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	ENVIRONMENTAL STUDIES				
Course Code	21HS4ICEVS	Credits	1	L-T-P	1-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	1	Total Lecture Hours			12

UNIT – 1	4 Hrs

Introduction to Environment:
Definition, About Earth i.e Atmosphere, Hydrosphere, Lithosphere and Biosphere, Structure of Atmosphere, Internal structural of Earth.
Ecology & Ecosystem, balanced ecosystem, types of ecosystem.
Effect of Human activities on Environment – i) Agriculture ii) Housing iii) Industries iv) Mining and v) Transportation activities.

UNIT – 2	3 Hrs

Natural Resources: Definition,
i) Water resources – its availability, quality, water borne
& water induced disease.
ii) Mineral resources
iii) Forest resources
iv) Energy resources – conventional & non - conventional energy resources, Hydroelectric, wind
power, solar, Biogas. Fossil fuel based energy resources- Coal, Oil & Gas, Nuclear power.

Hydrogen as an alternate future source of energy.

UNIT – 3	3 Hrs

Environmental pollution: Introduction, types, effects of pollutions
i) Water pollution – definition, types, sources, effects, control methods
ii) Land pollution - definition, types, sources, effects, Solid waste management
iii) Noise pollution - definition, sources, effects, control methods

UNIT – 4	3 Hrs

Current environmental issues & importance: Population growth, effects & control, climatic changes, Global warming. Acid rain, ozone layer depletion & effects.
Environmental protection, Role of government, legal aspects

Text Books:
1. *Environmental studies* by - Dr. Geetha Balakrishnan (Revised Edition)
2. *Ecology* by - Subramanyam (Tata McGraw Hill Publication)
3. *Environmental studies* by - Dr. J. P. Sharma (Third edition)
4. *Environmental studies* by - Smriti Srivastav

REFERENCES:
1. *Environmental studies* by – Benny Joseph
2. *Environmental studies* by – Dr. D. L. Manjunath

Course Outcomes:

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

CO – PO - PSO Mapping

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

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**

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 2020-21: admitted batches and onwards)

Sl.#	Course Type	Course Code	Course Title	Teaching Hours in Credits/Week			Total Credits	Examination			
				Theory Lecture	Tutorial	Practical		Duration in hours	CIE Marks	SEE Marks	Total Marks
				L	T	P					
1	PC-9	22AM5PCOPJ	Object Oriented Programming using Java	3	0	1	4	05	50	50	100
2	PC-10	22AM5PCIML	Introduction to Machine Learning	3	0	0	3	03	50	50	100
3	PC-11	22AM5PCSED	Software Engineering and Design Patterns	3	0	0	3	03	50	50	100
4	PC-12	22AM5PCINN	Introduction to Neural Networks	3	0	0	3	03	50	50	100
5	HS-6	22AM5HSTFM	Time Series and Financial Mathematics	1	1	0	2	03	50	50	100
6	PE-1	22AM5PEABI	AI in Business Intelligence	3	0	0	3	03	50	50	100
		22AM5PEKDI	Knowledge Discovery								
		22AM5PECGV	Computer Graphics & Visualization								
7	PE-2	22AM5PEDIP	Digital Image Processing	3	0	0	3	03	50	50	100
		22AM5PENLP	Natural Language Processing								
		22AM5PEASC	Applied Soft Computing								
8	PW-3	22AM5PWPML	Project work on Machine Learning	0	0	2	2	04	50	50	100
9	PC-13	22AM5PCDVL	Data visualization Laboratory (Tableau / Power BI)	0	0	2	2	04	50	50	100
10	NC-5	22AM5NCMOC	MOOC	Non-credit mandatory Course							
			Total	19	1	5	25	31	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, SR: Seminar Technical / Seminar Internship, NC: Non-credit mandatory course

Course Title	OBJECT ORIENTED PROGRAMMING USING JAVA				
Course Code	22AM5PCOPJ	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 and Overview of Java: How Java changed the Internet Java is interpreted, Java's Magic: Byte code, Java Buzz Words, First Simple Program. **Data types, Variables and Arrays**: Java is strongly typed language, Integers, Floating Point Types, Characters, Booleans, Variables, Arrays-One Dimensional, Multidimensional Arrays, Alternative Array Declaration syntax. **Control Statements:** Selection statements, iteration statements, Jump statements. **Introducing Classes**-class Fundamentals, Declaring Objects, Introducing Methods, Constructors, this keyword, Garbage Collection, finalize() method. **Closer Look at Methods and Classes**: Overloading Methods, Using Objects as parameters, A closer look at Argument passing, Returning Objects, Introducing Access Control, Understanding static, Introducing Final, Arrays Revisited, Inner classes.	
UNIT - 2	**8 Hrs**
Inheritance: Inheritance Basics, Using super, Multilevel hierarchy, Dynamic method dispatch, Using abstract class, Using final with inheritance. **Packages:** Defining a package, Finding packages and class path, Example, Access protection, importing packages. **Interfaces:** Defining Interface, Implementing Interface, Nested Interfaces, Applying interfaces, Variables in interfaces. Interfaces can be Extended.	
UNIT - 3	**6 Hrs**
Enumeration: Enumeration Fundamentals, value() and valueOf() Methods, Java Enum's are class types. I/O Basics: Streams: Byte Streams and Character Streams, Predefined Streams, Reading Console Input .Reading Characters, Reading Strings, Writing Console Output, Reading and Writing Files. **String handling:** String Constructors, Special string operations, character extraction, string comparison, searching strings, modifying a string, String Buffer, additional string buffer methods.	
UNIT - 4	**6 Hrs**
Exception handling: Fundamentals, Exception types, uncaught exceptions, using try and catch, multiple catch clauses, nested try statements, throw, throws, finally, Java's built-in exceptions. Creating your own exception subclasses. **Multithreaded Programming:** Introduction to Process, Difference between Process and Threads, Java thread model, main thread, creating thread, creating multiple threads, using isalive() and Join(), thread priorities, synchronization, Interthread communication, suspending, resuming and stopping threads.	
UNIT - 5	**8 Hrs**
Event Handling: Two Event Handling Mechanisms, The Delegation Event Model, Events-Event Sources, Event Listeners, Key Event Class-The Mouse Event Class, Text Event class Event Listener Interfaces-The Mouse Listener Interface. **Abstract window toolkit:** Window Fundamentals, Working with Frame windows, Creating a Frame Window in an AWTBased Applet-Handling Events in a Frame Window, Creating windowed Program. Introducing Graphics-Drawing Lines, Rectangles, Ellipses and Circles, Arcs.	

Text Books:

1. *The Complete Reference -Java,* Herbert Schildt, Tata McGraw-Hill Education, 10th Edition, 2017.

Reference Books:

1. *Java SE8 for Programmers,* Paul J. Deitel, Harvey Deitel, 3rd Edition, Deitel Developer Series, 2014.
2. *Introduction to Java programming,* Y. Daniel Liang, comprehensive version, 10th Edition, Pearson, 2015.

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

CO – PO - PSO Mapping

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

Massive Open Online Course (MOOC)

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

Semester End Examination (SEE) Question Paper Pattern:

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

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

Assessment Pattern:

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

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

Course Title	INTRODUCTION TO MACHINE LEARNING				
Course Code	22AM5PCIML	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
The Machine Learning Landscape: What Is Machine Learning (ML)? Uses and Applications with examples, Types of Machine Learning, Main Challenges of Machine Learning, Testing and Validating. **End to End Machine Learning**: Working with Real Data, Frame the Problem, Select the Performance Measure, Prepare the Data for ML Algorithms, Training and Evaluating the Data Set. **Bayesian Decision Theory**: Introduction, Classification, Losses and Risks, Discriminant Functions, Association Rules.	
UNIT – 2	**7 Hrs**
Classification: MNIST, Training Binary Classifier, Performance Measures, Multiclass classification, Error Analysis, Multilabel & Multioutput Classifications. **Training Models**: Linear Regression, Gradient Descent, Regularized Linear Models – Ridge & Lasso Regression, Logistic Regression.	
UNIT – 3	**7 Hrs**
Dimensionality Reduction: The Curse of Dimensionality, Main Approaches for Dimensionality, PCA, Kernel PCA, LLE, Linear Discriminant Analysis (LDA). **Support Vector Machines**: Linear SVM Classification, Nonlinear SVM, SVM Regression, Kernelized SVMs.	
UNIT – 4	**7 Hrs**
Decision Trees: Univariate Trees: classification & Regression Trees, Training and Visualizing a Decision Tree, Pruning, Rule Extraction from Trees, Learning Rules from Data, Making Predictions, Estimating Class Probabilities, CART Training Algorithm, Computational Complexity, Gini Impurity or Entropy? Regularization Hyperparameters, Multivariate Trees.	
UNIT – 5	**7 Hrs**
Ensemble Learning and Random Forests: Voting Classifiers, Bagging and Pasting, Random Patches and Random Subspaces, Random Forests, Boosting **Unsupervised Learning Techniques**: Clustering – K means, Spectral, Hierarchical;	

Text Books:

1. *Introduction to Machine Learning*, Ethem Alpaydin, PHI Learning Pvt. Ltd, 3rd Edition, 2018.
2. *Hands-on machine learning with Scikit-Learn and TensorFlow: concepts, tools, and techniques to build intelligent systems*, Aurelien Geron, O'Reilly Media, 2019.

Reference Books:

1. *Machine Learning*, Tom Mitchell, McGraw Hill, 2013.
2. *The Elements of Statistical Learning*, T. Hastie, R. Tibshirani, J. H. Friedman, Springer, 1st Edition, 2001.
3. *Pattern Recognition and Machine Learning*, Christopher M Bishop, Springer, 2006.

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

CO – PO - PSO Mapping

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

Massive Open Online Course (MOOC)

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

Semester End Examination (SEE) Question Paper Pattern:

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

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

Assessment Pattern:

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

Course Title	SOFTWARE ENGINEERING AND DESIGN PATTERNS				
Course Code	22AM5PCSED	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. **Introduction to Software Project Management:** Scope, Work Breakdown Structures, Milestones, **Software Metrics**: Size-Oriented Metrics, Halsted Metrics, Cyclomatic Complexity Metrics.	
UNIT – 2	**8 Hrs**
Modeling Requirements: Requirements Engineering, Requirement Elicitation, SRS Document, Functional and Non-Functional Requirements, Modelling, **Case Study:** Unified Modeling Language, Use Cases, Class, Sequence, Activity, State Diagrams. **Software Design:** Software Quality Guidelines and Design Principles, Design concepts and principles – Abstraction – Modularity, Types of Cohesion and Coupling, Functional Independence.	
UNIT – 3	**8 Hrs**
Software Testing: Verification and Validation, Strategic Approach to Software Testing: Unit Testing, Integration Testing, Testing Strategies for Web Apps, Alpha Testing, Beta Testing, Stress Testing, Test Cases Generation. 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. **Software Quality Assurance**: Quality Standards Models ISO, Six-Sigma.	
UNIT – 4	**8 Hrs**
Patterns: What is a Pattern? What Makes a Pattern? Pattern Categories, Relationships between Patterns. **Architectural Patterns**: Introduction, From Mud to Structure, Layers, Pipes and Filters. **Distributed Systems:** Broker. **Interactive Systems**: Model-View-Controller, Presentation-Abstraction-Control. **Adaptable Systems:** Microkernel.	
UNIT – 5	**6 Hrs**
Design Patterns: Introduction, **Structural Decomposition**: Whole-Part, **Organization of Work:** Master-Slave, **Access Control**: Proxy, Publisher-Subscriber. **Idioms:** What can Idioms Provide, Idioms & Styles.	

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 designing, implementing and testing software systems
CO2	Analyze software requirements, models and metrics for developing quality software.
CO3	Design, demonstrate and document the solutions for given software requirements using software pattern

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	INTRODUCTION TO NEURAL NETWORKS				
Course Code	22AM5PCINN	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: A Neural Network, Human Brain, Models of a Neuron, Representing Neural Network as Graphs, Network Architectures, Knowledge Representation, Artificial Intelligence and Neural Networks.

Learning Process: Error Correction Learning, Memory Based Learning, Hebbian Learning, Competitive, Boltzmann Learning, Credit Assignment Problem, Memory, Adaption, Statistical Nature of the Learning Process.

UNIT – 2	7 Hrs

Single Layer Perceptron: Adaptive Filtering Problem, Unconstrained Optimization Techniques, Linear Least Square Filters, Least Mean Square Algorithm, Learning Curves, Learning Rate Annealing Techniques, Perceptron –Convergence Theorem.
Multilayer Perceptron: Introduction and preliminaries, XOR Problem, Output Representation and Decision Rule.

UNIT – 3	8 Hrs

Back Propagation: Back Propagation Algorithm, Heuristics, Back Propagation and Differentiation, Hessian Matrix, Generalization, Cross Validation, Network Pruning Techniques, Virtues and Limitations of Back Propagation Learning, Accelerated Convergence, Supervised Learning.

UNIT – 4	7 Hrs

Radial-Basis Function Networks: Cover's Theorem, Interpolation Problem, Posed Hypersurface Reconstruction problem, Regularization Theory, Generalized Radial-Basis Function Networks, Approximation properties of Radial-Basis Function Networks, Comparison of RBF Networks and Multi-layer Perceptron's, Learning Strategies.

UNIT – 5	7 Hrs

Self-Organization Maps (SOM): Two Basic Feature-Mapping Models, Self-Organization Map, SOM Algorithm, Properties of Feature Map, Computer Simulations, Learning Vector Quantization, Adaptive Patter Classification, Hierarchical Vector Quantization, Contextual Maps.

Text Books:

1. *Neural Networks a Comprehensive Foundations*, Simon Haykin, PHI, 2nd Edition.

Reference Books:

1. *Neural Networks and Learning Machines*, Simon Haykin, PHI, 3rd 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 the 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	TIME SERIES AND FINANCIAL MATHEMATICS				
Course Code	22AM5HSTFM	Credits	2	L-T-P	1-1-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	3	Total Lecture Hours			13

UNIT – 1	7 Hrs (L+T)
Components of Time Series: Additive and Multiplicative models - Resolving components of a Time Series. **Measuring Trend**: Graphic, Semi-Averages, Moving Average and Least Squares Methods.	
UNIT – 2	**8 Hrs (L+T)**
Seasonal variation: Measuring Seasonal Variation: Method of Simple Averages, Ratio-to-Trend Method, Ratio-to-Moving Average Method and Link Relative Method, Cyclical and Random Fluctuations, Variate Difference Method.	
UNIT – 3	**7 Hrs (L+T)**
Index Numbers and their Definitions: Construction and Uses of Fixed and Chain based Index Numbers, Simple and Weighted Index Numbers, Laspeyre's, Paasche's, Fisher's, and Marshall - Edgeworth Index Numbers, Optimum Tests for Index Numbers, Cost of Living Index Numbers.	
UNIT – 4	**7 Hrs (L+T)**
Characteristics of Time Series: Introduction, Examples, Objectives and its nature, Statistical Models, Measures of dependence, Stationary Time Series, Estimation of Correlation, Vector-Valued and Multidimensional Series. **Time series Regression and Exploratory Data Analysis**: Classical Regression, Exploratory Data Analysis, Smoothing in the Time Series Context.	
UNIT – 5	**7 Hrs (L+T)**
ARIMA Models: Autoregressive Moving Average Models, Differential Equations, Autocorrelation and Partial Correlation, Forecasting, Estimation, Integrated Models for Nonstationary Data, Building ARIMA Models, Regression with Autocorrelated Errors, Multiplicative Seasonal ARIMA Models.	

Text Books:

1. *Fundamentals of Statistics*, A M Gun, M K Gupta, B Dasgupta, Volume 1, World Press, 2019.
2. *Time Series Analysis and its Applications with R Examples*, Robert H Shumway, David S Stoffer, 4th Edition, Springer, 2017.

Reference Books:

1. *Fundamentals of Applied Statistics*, S C Gupta, V K Kapoor, 4th Edition, Sultan Chand & Sons, 2014.
2. *Fundamentals of Statistics,* S C Srivastava, Sangya Srivastava, Ammol Publisher, 2006.
3. *Introduction to Time Series and Forecasting*, Peter J Brokewell, Richard A Davis, 3rd Edition, Springer, 2016.
4. *The Analysis of Time Series – An Introduction*, Chris Chatfield, 5th Edition, Chapman & Hall / CRC, 1996.
5. *Time Series Analysis: Forecasting and Control*, Box, Jenkins and Reinsel, 3rd Edition, Wiley, 1994.

Course Outcomes	
CO1	Analyse the basic principles of time series analysis, including stationarity, autocorrelation, and lagged regression models.
CO2	Use financial mathematics to evaluate investment opportunities, including the calculation of ne present value, internal rate of return and other financial metrics.
CO3	Apply time series and financial mathematics to real world financial data, including stock prices, interest rates, and foreign exchange rates.

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.	Time Series Analysis (ARIMA) with R	Coursera	https://in.coursera.org/projects/time-series-analysis-arima-with-r

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	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	05M	
		Quiz	05M	
Semester End Examination (SEE)	100M (50% weightage)			**50M**
Total				**100M**

Course Title	AI IN BUSINESS INTELLIGENCE				
Course Code	22AM5PEABI	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
Business Intelligence, Data Analytics and Decision Support: Opening Vignette, Changing Business Environments and Computerized Decision Support, Managerial Decision Making, Information systems Support for Decision Making, An Early Framework for Computerized Decision Support, The Concept of Decision Support Systems (DSS), A framework for Business Intelligence (BI), A Work System View of Decision Support, Overview of Business Analytics, Introduction to Big Data Analytics.	
UNIT – 2	**8 Hrs**
Decision Making Technologies: Decision Making, Models, Phases of the Decision-Making Process, The Intelligence Phase, The Design Phase, The Choice Phase, The Implementation Phase, How Decisions Are Supported, DSS - Capabilities, Classifications and Components. **Modeling and Analysis**: Structure of Mathematical Models for Decision Support, Certainty, Uncertainty, and Risk, Management Support Systems, Multiple Goals, Sensitivity Analysis, What-If Analysis, and Goal Seeking.	
UNIT – 3	**7 Hrs**
Data Warehousing: Data Warehousing Definitions and Concepts, Data Warehousing Process Overview, Data Warehousing Architectures, Data Integration and the Extraction, Transformation, and Load (ETL) Processes, Data Warehouse - Development, Implementation Issues, Administration, Security Issues and Future Trends.	
UNIT – 4	**7 Hrs**
Knowledge Management and Collaborative Systems: Introduction to Knowledge Management, Organizational Learning and Transformation, Knowledge Management Activities, Approaches to Knowledge Management, Information Technology (IT) In Knowledge Management, Knowledge Management Systems Implementation, Making Decisions in Groups, Supporting Group work with Computerized Systems, Tools for indirect support of Decision Making, Direct Computerized Support for Decision Making.	
UNIT – 5	**7 Hrs**
Business Analytics for Emerging Trends and Future Impacts: Location based Analytics for Organizations, Analytics Applications for Consumers, Recommendation Engines, Web 2.0 and Online Social Networking, Cloud computing and BI, Impact of Analytics in Organizations, Issues of - Legacy, Privacy and Ethics; An Overview of Analytics Ecosystem.	

Text Books:

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

Reference Books:

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

Course Outcomes	
CO1	Apply tools and techniques to understand real-world datasets and generate insights that are relevant to business decision making
CO2	Ability to analyse the tools and processes of business to gain knowledge on data and support business systems

CO3	Analyse ethical considerations related to the use of AI in Business intelligence

CO – PO - PSO Mapping

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

Massive Open Online Course (MOOC)

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

Semester End Examination (SEE) Question Paper Pattern:

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

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

Assessment Pattern:

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

Course Title	KNOWLEDGE DISCOVERY				
Course Code	22AM5PEKDI	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 and Data Preprocessing: Why data mining, what is data mining, What kinds of data can be mined, What kinds of patterns can be mined, Which Technologies Are used, Which kinds of Applications are targeted, Major issues in data mining, Data Preprocessing: An overview, Data cleaning, Data integration, Data reduction, Data transformation and data discretization.

Data warehousing and online analytical processing: Data warehousing: Basic concepts-What Is a Data Warehouse, Differences between Operational Database Systems and Data Warehouses, Why Have a Separate Data Warehouse? Data Warehousing: A Multitiered Architecture.

UNIT – 2	8 Hrs

Data Warehouse Models: Enterprise Warehouse, Data Mart, and Virtual Warehouse Extraction, Transformation, and Loading.
Data warehouse modeling: Data Cube: A Multidimensional Data Model Stars, Snowflakes, and Fact Constellations: Schemas for Multidimensional Data Models, Dimensions: The Role of Concept Hierarchies, Measures: Their Categorization and Computation, Typical OLAP Operations. A Business Analysis Framework for Data Warehouse Design, Data Warehouse Design Process.

UNIT – 3	7 Hrs

Mining Frequent Patterns, Associations, and Correlations: Market Basket Analysis: A Motivating Example, Frequent Itemsets, Closed Itemsets, and Association Rules, Apriori Algorithm: Finding Frequent Itemsets by Confined Candidate Generation, Generating Association Rules from Frequent Itemsets, Improving the Efficiency of Apriori, A Pattern-Growth Approach for Mining Frequent Itemsets, Mining Frequent Itemsets Using Vertical Data Format, Mining Closed and Max Patterns, Which Patterns Are Interesting?—Pattern Evaluation Methods.

UNIT – 4	7 Hrs

Cluster Analysis: What Is Cluster Analysis? Requirements for Cluster Analysis, Partitioning methods: k-Means: A Centroid-Based Technique, k-Medoids, Hierarchical Methods: Agglomerative versus Divisive Hierarchical Clustering, BIRCH, Chameleon, Probabilistic Hierarchical Clustering, Density-based methods: DBSCAN, OPTICS, DENCLUE Evaluation of clustering.

UNIT – 5	7 Hrs

Grid-Based Methods: STING: STatistical INformation Grid, CLIQUE: An Apriori-like Subspace Clustering Method
Evaluation of Clustering: Assessing Clustering Tendency, Determining the Number of Clusters, Measuring Clustering Quality.
Data mining trends and research frontiers: Mining complex data types, other methodologies of data mining, Data mining applications, Data Mining and society.

Text Books:

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

Reference Books:

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

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

CO – PO - PSO Mapping

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

Massive Open Online Course (MOOC)

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

Semester End Examination (SEE) Question Paper Pattern:

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

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

Assessment Pattern:

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

		AAT	05M	
Semester End Examination (SEE)	100M (50% weightage)			**50M**
			Total	**100M**

Course Title	COMPUTER GRAPHICS & VISUALIZATION				
Course Code	22AM5PECGV	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: Basics and applications of Computer Graphics - Graphics software and standards - Interaction (sample and event-driven) and Graphics user Interface (GUI) features.
Display Systems: Raster and Random displays - CRT basics - Flat panel displays - 3D display systems - Hardcopy devices–Printers and Plotters - Various File formats and Colour models.

UNIT - 2	6 Hrs

Output Primitives: Point - Line - Circle – Ellipse - Scan conversion algorithms for primitives - Fill area primitives– scan - line - polygon filling - inside-outside test - boundary and flood fill - character generation - line attributes –area - fill attributes - character attributers.

UNIT - 3	6 Hrs

2D Transformations and Viewing: Rotation - Translation - Scale - Reflection and Shear Transform - Matrix representation - homogeneous co-ordinates - composite transformations - Clipping algorithms for point - line and polygon - Text.

UNIT - 4	8 Hrs

3D object representation: 3D display methods - polygon surfaces - tables - equations - meshes. Curves and Surfaces: curved lines and surfaces - quadric surfaces - spline representation - cubic spline interpolation methods - Bezier curves and surfaces - B-spline curves and surfaces.
3D transformation and viewing: 3D translation - rotation and scaling - composite transformation - viewing pipeline and coordinates - parallel and perspective transformation - view volume and general (parallel and perspective) projection transformations.

UNIT - 5	8 Hrs

OpenGL primitives: Functions - pipeline - sample programs for drawing 2-D and 3-D objects; event handling and view manipulation.
Implementation using OpenGL : Basic Implementation Strategies; Four major tasks; Clipping; Line-segment clipping; Polygon clipping; Clipping of other primitives; Clipping in three dimensions; Rasterization; Bresenham's algorithm; Polygon Rasterization; Hidden-surface removal; Antialiasing; Display considerations.

Text Books:

1. *Computer Graphics with OpenGL*, D. Hearn, M. P. Baker, 4th Edition, Pearson Education, 2013.
2. *Computer Graphics; Principles and Practice*, J. D. Foley, A. Van Dam, S. K. Feiner, J. F. Hughes, 2nd Edition, Addison Wesley, 1997.
3. *Interactive Computer Graphics A Top-Down Approach with OpenGL*, Edward Angel, 5th Edition, Pearson Education, 2008.

Reference Books:

1. *Mathematical Elements for Computer Graphics*, D. F. Rogers, J. A. Adams, 2nd Edition, McGraw Hill International. Edition, 1990.
2. *Computer Graphics using OpenGL*, F. S. Hill Jr., 2nd Edition, Pearson Education, 2003.
3. *OpenGL Programming Guide*, Shreiner, Woo, Neider, Davis, 6th Edition, Pearson Education, 2008.
4. *Fundamentals of Computer Graphics,* Peter Shirley et al., 3rd Edition, A K Peters/CRC Press, 2009.

Course Outcomes	
CO1	Apply the fundamental concepts of computer graphics and visualization to develop skills in 2D and 3D graphics programming.
CO2	Analyze various techniques for generating realistic 3D models, including texture mapping, bump mapping, and reflection mapping.
CO3	Develop the ability to analyze and evaluate existing visualizations, and to design new visualizations that effectively communicate complex data.

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.	Computer Graphics	NPTEL	https://onlinecourses.nptel.ac.in/noc20_cs90/preview
2.	Computer Graphics	NPTEL	https://nptel.ac.in/courses/106103224
3.	Interactive Computer Graphics	Coursera	https://in.coursera.org/learn/interactive-computer-graphics

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	DIGITAL IMAGE PROCESSING				
Course Code	22AM5PEDIP	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: The origins of Digital Image Processing, Examples of Fields that Use Digital Image Processing, Fundamentals Steps in Image Processing. **Elements of Digital Image Processing Systems** : Image Sampling and Quantization, Some basic relationships like Neighbours, Connectivity, Distance Measures between pixels, Translation, Scaling, Rotation and Perspective Projection of image, Linear and Non-Linear Operations.	
UNIT – 2	**7 Hrs**
Image Enhancement in the Spatial Domain: Some basic Gray Level Transformations, Histogram Processing, Enhancement Using Arithmetic and Logic operations, Combining Spatial Enhancement Methods, Basics of Spatial Filters, Smoothening and Sharpening Spatial Filters, Intensity Transformation Function, Histogram Processing and Function Plotting.	
UNIT – 3	**7 Hrs**
Image Enhancement in the Frequency Domain: Introduction to Fourier Transform and the frequency Domain, Computing and Visualizing the 2D DFT, Smoothing Frequency Domain Filters, Sharpening Frequency Domain Filters, Homomorphic Filtering.	
UNIT – 4	**8 Hrs**
Image Restoration: A model of The Image Degradation / Restoration Process, Noise Models, Restoration in the presence of Noise Only- Spatial Filtering, Periodic Noise Reduction by Frequency- Domain Filtering, Linear Position-Invariant Degradations, Estimation of Degradation Function, Inverse filtering, Wiener filtering, Geometric Mean Filter, Geometric Transformations. **Image Compression:** Coding, Interpixel and Psychovisual Redundancy, Image Compression models, Compression standards.	
UNIT – 5	**6 Hrs**
Image Segmentation: Detection of Discontinuities, Edge linking and boundary detection, Thresholding. **Object Recognition:** Patterns and Pattern Classes, Decision-Theoretic Methods, Structural Methods.	
Text Books: 1. *Digital Image Processing,* Rafael C. Gonzalez and Richard E. Woods, 3rd Edition, Prentice Hall, 2008.	
Reference Books: 1. *Fundamentals of Digital Image Processing,* Anil K Jain, Pearson Education, 2015.	

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

CO – PO - PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3

CO1		**1**											**2**	
CO2			**2**										**2**	
CO3					**1**	**1**							**2**	

Massive Open Online Course (MOOC)

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

Semester End Examination (SEE) Question Paper Pattern:

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

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

Assessment Pattern:

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

Course Title	NATURAL LANGUAGE PROCESSING				
Course Code	22AM5PENLP	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: Introduction: What is Natural Language Processing (NLP), Origins of NLP, Language and Knowledge, Phases of NLP, The Challenges of NLP- Why NLP is hard? Language and Grammar. **Language Modeling:** Introduction, Statistical Language Model: N-grams, evaluating language model, Smoothing.	
UNIT – 2	**8 Hrs**
Word Level Analysis: Regular Expressions, Words, Corpora, Text Normalization, Minimum Edit Distance, Part-of-Speech Tagging: English Word Classes, The Penn Treebank Part-of-Speech Tag set, HMM Part-of-Speech Tagging. **Syntactic Analysis:** Constituency, Context-Free Grammars, Some Grammar Rules for English, Treebanks, Grammar Equivalence and Normal Form, Lexicalized Grammars.	
UNIT – 3	**8 Hrs**
Parsing: Constituency Parsing: Ambiguity, CKY Parsing, Dependency parsing. **Semantic Analysis:** Lexical Semantics, Vector Semantics, Words and Vectors, Cosine for measuring similarity, TF-IDF: Weighing terms in the vector, Applications of the TF-IDF vector model, Word2vec, Visualizing Embeddings, Semantic properties of embeddings, Bias and Embeddings, Evaluating Vector Models.	
UNIT – 4	**8 Hrs**
Word Senses and WordNet: Word Senses, Relations Between Senses, WordNet: A Database of Lexical Relations, Word Sense Disambiguation, Alternate WSD algorithms and Tasks, Using Thesauruses to Improve Embeddings, Word Sense Induction. **Coreference Resolution:** Coreference Phenomena: Linguistic Background, Coreference Tasks and Datasets, Mention Detection, Architectures for Coreference Algorithms, Classifiers using hand-built features.	
UNIT – 5	**6 Hrs**
Applications of Natural Language Processing: Question Answering Systems, Information Retrieval, Information Extraction, Automatic Text Summarization, Automatic Text Categorization, Machine Translation, Speech Technologies, Human and Machine Intelligence.	

Text Books:

1. *Speech and Language Processing: An introduction to Natural Language Processing, Computational Linguistics and Speech Recognition*, Daniel Jurafsky, James H Martin, 3rd Edition, Prentice Hall, 2019.
2. *Natural Language Processing: An information Access Perspective,* Kavi Narayana Murthy, Ess Ess Publications, 2006.

Reference Books:

1. *Natural Language Processing and Information Retrieval*, Tanveer Siddiqui, U.S. Tiwary, 1st Edition Oxford University press, 2008.
2. *Applied Text Analysis with Python*, Benjamin Bengfort, Tony Ojeda, Rebecca Bilbro, O'Reilly Media, 2018.

Course Outcomes	
CO1	Apply the concepts of Natural Language Processing pipeline to solve real-world problems across different domains.
CO2	Analyse existing mathematical models and machine learning algorithms to build NLP applications.

CO3	Conduct experiments on basic natural language processing tasks using modern tools.

CO – PO - PSO Mapping

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

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Natural Language Processing	NPTEL	https://onlinecourses.nptel.ac.in/noc19_cs56/preview
2.	Natural Language Processing Specialization	Coursera	https://in.coursera.org/specializations/natural-language-processing

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	APPLIED SOFT COMPUTING				
Course Code	22AM5PEASC	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 Soft Computing: Concept of computing systems, Soft and Hard computing, Characteristics of Soft computing, Applications of soft computing techniques, Optimization and Traditional Methods, Introduction to Genetic Algorithms (GA), Basic Terminologies, Simple GA, Binary Coded GA, GA Parameter Setting, Constraints, Advantages and Disadvantages.	
UNIT – 2	**8 Hrs**
Fuzzy System and Relations: Introduction to Fuzzy Logic, Classical Sets and Fuzzy Sets, Classical Relations, Cartesian Product of Relation, Classical Relation, Fuzzy Relation, Tolerance & Equivalence Relation, Membership Functions: Features, Fuzzification: Rules, Propositions, Implications and inferences, Applications. **Defuzzification techniques**: Introduction, Fuzzy logic controller design, Lambda – Cuts for fuzzy sets & relations, Defuzzification methods, Applications.	
UNIT – 3	**8 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, Independent Sampling, Real Coded; Genetic Programming, Advantages, Limitations & Applications of GA.	
UNIT – 4	**7 Hrs**
Meta Heuristic, SWARM Intelligence and Rough Set Theory: Ant Colony Optimization, Bee Colony Optimization, Particle SWARM Optimization, Cuckoo Search Algorithm, Rough Sets Knowledge Representations, Rough Decision Making and Data Mining Techniques.	
UNIT – 5	**7 Hrs**
Hybrid Systems: Sequential Hybrid Systems, Auxiliary Hybrid Systems, Embedded Hybrid Systems, Neuro-Fuzzy Hybrid Systems, Neuro-Genetic Hybrid Systems, Fuzzy-Genetic Hybrid Systems, Fuzzy – Rough set Systems.	

Text Books:

1. *Principles of Soft Computing*, S N Sivanandam, S N Deepa, 3rd Edition, Wiley India, 2018.
2. *Soft Computing*, D. K. Pratihar, Narosa Publishing House Pvt. Ltd., (Revised Edition), 2015.

Reference Books:

1. *Genetic Algorithms in Search, Optimization & Machine Learning*, David E Goldberg, Pearson Education, 2013.
2. *Foundations of Neural Networks, Fuzzy Systems, and Knowledge Engineering*, Nikola K. Kasabov, MIT Press, 1998.
3. *Soft computing*, N. P Padhy and S P Simon, Oxford University Press, 2015.

Course Outcomes	
CO1	Apply the fundamental concepts and techniques of soft computing such as fuzzy logic, neural networks, genetic algorithms, and swarm intelligence.
CO2	Apply soft computing techniques to solve real-world problems in different domains such as finance, healthcare, manufacturing, and transportation.
CO3	Develop critical thinking and problem-solving skills necessary to apply soft computing techniques to solve complex problems.

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**										**2**	

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Introduction to Soft Computing	NPTEL	https://nptel.ac.in/courses/106105173
2.	Fuzzy Sets, Logic and Systems & Applications	NPTEL	https://onlinecourses.nptel.ac.in/noc22_ee21/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	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 ON MACHINE LEARNING				
Course Code	22AM5PWPML	Credits	2	L-T-P	0-0-2
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	4	Total Lecture Hours			48

About the Course: The students should develop a machine learning projects by adopting various technologies. The course will be executed in two cycles. 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 complete project based on the requirements and design considerations.

Text Books:

1. *Introduction to Machine Learning with Python, A Guide for Data Scientists,* Andreas C. Miller and Sarah Guido, O'Reilly Media, 2017.
2. Ethem Alpaydın*, Introduction to machine learning,* third edition, MIT press.

Reference Books:

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

	Course Outcomes
CO 1	Apply the knowledge of various machine learning algorithms, including regression, classification, clustering, and dimensionality reduction.
CO 2	Utilize programming languages, such as Python, for implementing machine learning models.
CO 3	Demonstrate problem-solving skills in addressing challenges encountered during the machine learning project in team.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO 3
CO1		1												2	
CO2			2					1						2	
CO3					2				1	1		1		2	

Course Title	DATA VISUALIZATION LABORATORY				
Course Code	22AM5PCDVL	Credits	2	L-T-P	0-0-2
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	4	Total Lecture Hours			14

About the Course: Data visualization is a technique for presenting data in a graphical or pictorial format to make it easier to understand and analyze. It can be used to display patterns, relationships, and trends in data that might not be easily identified in raw data form. This can be done through a variety of methods such as graphs, charts, maps, and heat maps. Effective data visualization can help decision makers to identify key insights and make data-driven decisions.

The goal of this laboratory is to communicate information clearly and effectively through graphical representations, such as bar charts, line graphs, scatter plots, pie charts, histograms, and heat maps. It helps to present complex data in a simplified form, making it easier to understand and identify patterns, trends, and relationships. By visualizing data, it becomes easier to spot outliers, trends, and anomalies in the data, making it easier to make informed decisions.

Modern Tool Used: Tableau

TEXTBOOK:

Visualization Analysis & Design by Tamara Munzner (2014) (ISBN 9781466508910)

REFERENCES BOOKS:

1. Interactive Data Visualization for the Web by Scott Murray 2nd Edition (2017)
2. D3.js in Action by Elijah Meeks 2nd Edition (2017)
3. Semiology of Graphics by Jacques Bertin (2010)
4. The Grammar of Graphics by Leland Wilkinson
5. ggplot2 Elegant Graphics for Data Analysis by Hadley Wickham

Course Outcomes:

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

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

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 2020-21: admitted batches and onwards)

Sl.#	Course Type	Course Code	Course Title	Teaching Hours in Credits/Week			Total Credits	Examination			
				Theory Lecture	Tutorial	Practical		Duration in hours	CIE Marks	SEE Marks	Total Marks
				L	T	P					
1	PC-14	22AM6PCAML	Advanced Machine Learning	3	0	1	4	05	50	50	100
2	PC-15	22AM6PCAAI	Advanced Artificial Intelligence	3	0	0	3	03	50	50	100
3	PC-16	22AM6PCDEL	Deep Learning	3	1	0	4	05	50	50	100
4	PE-3	22AM6PESMA	Social Media Analytics	2	0	1	3	04	50	50	100
		22AM6PEBCT	Block Chain Technology								
		22AM6PEVAC	Video Analytics using OpenCV								
5	PE-4	22AM6PEPRN	Pattern Recognition	3	0	0	3	03	50	50	100
		22AM6PESNA	Social Network Analysis								
		22AM6PEBDA	Big Data Analysis								
6	OE-1	22AM6OEIDM	Introduction to Data Mining	3	0	0	3	03	50	50	100
		22AM6OEIAI	Introduction to Artificial Intelligence								
		22AM6OEIML	Introduction to Machine Learning								
7	SR-2	22AM6SRITP	Internship	0	0	1	1	02	50	50	100
8	PW-4	22AM6PWMWP	MOOC with Project	2	0	0	2	02	50	50	100
9	HS-7	22AM6HSQAT	Quantitative Ability Training	2	0	0	2	02	50	50	100
10	NC-6	22AM6NCPAE	Participation in any Activity/Event	Non-credit mandatory Course							
			Total	21	1	3	25	29	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, SR: Seminar Technical / Seminar Internship, NC: Non-credit mandatory course

Course Title	ADVANCED MACHINE LEARNING				
Course Code	22AM6PCAML	Credits	4	L-T-P	3-0-1
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	5	Total Lecture Hours			36

UNIT – 1	7 Hrs
Generative models for discrete data: Introduction, The beta-binomial model – Likelihood, Prior, Posterior, Posterior Predictive Distribution; The Beta-Binomial Model, The Dirichlet-multinomial model – Likelihood, Prior, Posterior, Posterior Predictive; Naive Bayes classifiers – Model fitting, Using Model for Prediction, The long-sum-exp trick, Feature selection using Mutual Information, Classifying Documents using Bag of Words.	
UNIT – 2	**7 Hrs**
Gaussian models: Introduction, Gaussian discriminant Analysis, Inference in jointly Gaussian distributions, Linear Gaussian Models, Digression, Inferring the parameters of an MVN.	
UNIT – 3	**8 Hrs**
Bayesian statistics: Introduction, Summarizing posterior distributions, Bayesian model selection, Priors and Hierarchical Bayes, Empirical Bayes and Bayesian decision theory. **Frequentist statistics:** Introduction, Sampling distribution of an estimator, Frequentist decision theory, Desirable properties of estimators, Empirical risk minimization, Pathologies.	
UNIT – 4	**7 Hrs**
Approximate Inference: Variational Inference, Illustration, Variational Linear & Logistic Regression, Exponential Family Distributions, Local Methods and Expectation Propagation. **Sampling Methods:** Basic Sampling Algorithms, Markov Chain Monte Carlo, Gibbs and Slice Sampling, The Hybrid Monte Carlo Algorithm, Estimating the partition function.	
UNIT – 5	**7 Hrs**
Kernels: Introduction, Functions, Using Kernels inside GLMs, The kernel trick, Support Vector Machines, Comparison, Kernels for Generative Models **Markov and hidden Markov models:** Introduction, Markov and Hidden Markov Models, Inferences, Learning and Generalization of Hidden Markov models.	

Text Books:

1. *Machine Learning: A Probabilistic Perspective,* Kevin P. Murphy, MIT Press, 2012

Reference Books:

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

Course Outcomes	
CO1	Demonstrate a critical understanding of advanced machine learning algorithms, to assess and compare their performance on diverse datasets.
CO2	Apply the acquired knowledge to real-world scenarios by implementing advanced machine learning techniques on practical projects.
CO3	Develop hands-on proficiency in applying advanced machine learning techniques to real-world datasets and projects.

CO – PO - PSO Mapping

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

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Introduction to Machine Learning	NPTEL	https://onlinecourses.nptel.ac.in/noc23_cs18/preview
2.	Introduction to Machine Learning	NPTEL	https://nptel.ac.in/courses/106105152
3.	Introduction to Machine Learning	Coursera	https://in.coursera.org/learn/machine-learning-duke
4.	Machine Learning Specialization	Coursera	https://in.coursera.org/specializations/machine-learning-introduction
5.	Advanced Machine Learning and Signal Processing	Coursera	https://in.coursera.org/learn/advanced-machine-learning-signal-processing
6.	Machine Learning for Engineering and Science Applications	NPTEL	https://onlinecourses.nptel.ac.in/noc19_cs82/preview

Semester End Examination (SEE) Question Paper Pattern:

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

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

Assessment Pattern:

Category			Score Split up	Total
Continuous Internal Evaluation (CIE)	**Theory**	CIE - 1	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	ADVANCED ARTIFICIAL INTELLIGENCE				
Course Code	22AM6PCAAI	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
Adversarial Search: Games, Optimal Decisions in Games, Alpha–Beta Pruning, Imperfect Real-Time Decisions, Stochastic Games, Partially Observable Games, State-of-the-Art Game Programs.	
UNIT – 2	**8 Hrs**
Constraint Satisfaction Problems: Defining Constraint Satisfaction Problems, Constraint Propagation: Inference in CSPs, Backtracking Search for CSPs, Local Search for CSPs, The Structure of Problems. **Learning:** Introduction, Explanation-Based Learning, Inductive Logic Programming.	
UNIT – 3	**7 Hrs**
Classical Planning: Definition of Classical planning, Algorithms for planning as state-space search, Planning graphs, Other Classical Planning Approaches, Analysis of Planning Approaches. **Planning and Acting in the Real World:** Time, Schedules, and Resources, Hierarchical Planning , Planning and Acting in Nondeterministic Domains, Multiagent Planning.	
UNIT – 4	**7 Hrs**
Making Simple Decisions: Combining Beliefs and Desires under Uncertainty, The Basis of Utility Theory, Utility Functions, Multiattribute Utility Functions, Decision Networks, The Value of Information, Decision-Theoretic Expert systems. **Making Complex Decisions:** Sequential Decision Problems, Value Iteration, Policy Iteration, Decisions with Multiple Agents: Game Theory.	
UNIT – 5	**7 Hrs**
Perception: Image Formation, Early Image-Processing Operations, Object Recognition by Appearance, Reconstructing the 3DWorld, Object Recognition from Structural Information. **Robotic**s: Introduction, Robot Hardware, Robotic Perception, Planning to Move, Planning Uncertain Movements, Moving, Robotic Software Architectures, Application Domains.	

Text Books:

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

Reference Books:

1. *Artificial Intelligence,* Elaine Rich, Kevin Knight and Shivashankar B Nair, 3rd Edition, McGraw-Hill Education, 2015.

Course Outcomes	
CO1	Solve AI based problems using games, learning and planning under competitive and multi-agent environments.
CO2	Apply planning and decision theory principles under uncertainty.
CO3	Analyze the necessary architecture and perception techniques for building robotic applications.

CO – PO - PSO Mapping

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

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Applied Accelerated Artificial Intelligence	NPTEL	https://onlinecourses.nptel.ac.in/noc22_cs83/preview
2.	An Introduction to Artificial Intelligence	NPTEL	https://nptel.ac.in/courses/106102220
3.	AI for Everyone	Coursera	https://in.coursera.org/learn/ai-for-everyone

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	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	DEEP LEARNING				
Course Code	22AM6PCDEL	Credits	4	L-T-P	3-1-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	5	Total Lecture Hours			36

UNIT – 1	8 Hrs
Deep Networks: Deep Feed forwarded Networks - Gradient-Based Learning, Hidden Units, Architecture, Back-Propagation and Other Differentiation Algorithms. **Regularization:** 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, Bagging and Other Ensemble Methods, Dropout, Adversarial Training, Tangent Distance, Tangent Prop and Manifold Tangent Classifier.	
UNIT – 2	**6 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.	
UNIT – 3	**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; Case Studies on Architectures – AlexNet, ZFNet, VGG, GoogLeNet, ResNet, Effects of Depth, Pretrained Models, Visualization & Unsupervised Learning, Applications	
UNIT – 4	**7 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. **Representation Learning:** Greedy Layer-wise Unsupervised Learning, Transfer Learning & Domain Adaption, Semi-Supervised Disentangling of Casual Factors.	
UNIT – 5	**8 Hrs**
Deep Generative Models: Boltzmann Machines, Restricted Boltzmann Machines, Deep Belief Networks, Deep Boltzmann Machines, Boltzmann Machines for Real-Valued Data, Convolutional Boltzmann Machines, Boltzmann Machines for Structured or Sequential Outputs, Other Boltzmann Machines, Back-Propagation through Random Operations, Directed Generative Nets, Drawing Samples from Autoencoders, Generative Stochastic Networks, Other Generation Schemes, Evaluating Generative Models	

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.

Reference Books:

1. *Pattern Recognition and Machine Learning*, Christopher M. Bishop, Springer, 2006
2. Neural Networks: A Systematic Introduction, Raul Rojas, Springer, 1996.
3. *Machine Learning: A Probabilistic Perspective,* Kevin P. Murphy, MIT Press, 2012

Course Outcomes	
CO1	Evaluate the existing network models and regularize for better performance using optimization techniques.
CO2	Create automated models for classification and future trends prediction ensuring public safety.

CO3	Design AI enabled assistants by automating the process of learning using large unlabeled datasets for the benefit of society.

CO – PO - PSO Mapping

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

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Deep Learning Part-1	NPTEL	https://onlinecourses.nptel.ac.in/noc23_cs18/preview
2.	Deep Learning Part-2	NPTEL	https://nptel.ac.in/courses/106106201
3.	Deep Learning Specialization	Coursera	https://in.coursera.org/specializations/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
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	SOCIAL MEDIA ANALYTICS				
Course Code	22AM6PESMA	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

Social Media Analytics: An Overview Purpose of Social Media Analytics, social media vs. Traditional Business Analytics Seven Layers of Social Media Analytics, Types of Social Media Analytics, Social Media Analytics Cycle, Challenges to Social Media Analytics, Social Media Analytics Tools.
Introduction to Social Media: Core Characteristics of Social Media, Types of Social Media.

UNIT – 2	5 Hrs

Social Media Text Analytics: Types of Social Media Text, Purpose of Text Analytics, Steps in Text Analytics, Social Media Text Analysis Tools, Case Study: Tapping into Online Customer Opinions.
Social Media Network Analytics: Common Network Terms, Common Social Media Network Types, Types of Networks, Common Network Terminologies, strong ties, weak ties, Network Analytics Tools, Case Study.

UNIT – 3	5 Hrs

Social Media Actions Analytics: What are Actions Analytics? Common Social Media Actions. Actions Analytics Tools, Case Study: Cover-More Group. **Mobile analytics:** what is mobile analytics? Types of apps, characteristics of mobile apps.
Social Media Hyperlink Analytics: Types of Hyperlinks, Hyperlink Analytics, Random surfer page rank algorithm, Hyperlink Analytics Tools, Case Study: Hyperlinks and Viral YouTube Videos.

UNIT – 4	5 Hrs

Location Analytics: Sources of Location Data, Categories of Location Analytics, Location Analytics and Privacy Concerns, Location Analytics Tools, Case study OWL bus.
Search Engines Analytics: Types of Search Engines, Search Engine Analytics, Search Engine Analytics Tools, Tutorial: Search Engine Analytics with Google Trends.

UNIT – 5	6 Hrs

An Introduction to Recommender Systems: Introduction, Goals of Recommender Systems, Basic Models of Recommender Systems, Domain-Specific Challenges in Recommender Systems, Advanced Topics and Applications.
Evaluating Recommender Systems: Evaluation Paradigms, General Goals of Evaluation Design, Design Issues in Offline Recommender Evaluation.

Text Books:

1. "*Seven Layers of Social Media Analytics: Mining Business Insights from Social Media Text, Actions, Networks, Hyperlinks, Apps, Search Engine, and Location Data",* Gohar F. Khan, Amazon Digital Services, 2015.
2. *"Recommender Systems", Charu C. Aggarwal,* Springer International Publishing Switzerland,2016.

Reference Books:

1. "*Networks, Crowds, and Markets: Reasoning about a Highly Connected World", David Easley and Jon Kleinberg, Cambridge University Press, 3rd Edition, 2017*
2. *"Analysing Social Media Networks with Node XL", Derek Hansen Ben Shneiderman Marc Smith ItaiHimelboim, Morgan Kaufmann, 2nd Edition, 2019*
3. *"Social Media Mining: An Introduction", Huan Liu, Mohammad Ali Abbasi, and Reza* Zafarani, Cambridge University Press, 1st Edition, 2014.

Course Outcomes	
CO1	Apply concepts of social media analytics to derive meaningful insights and patterns of user behavior on digital platforms.
CO2	Analyse real-world scenarios through case studies to propose appropriate solutions by incorporating social media analytics.
CO3	Evaluate the strengths and limitations of various analytical tools in the context of social media data and recommender systems.

CO – PO - PSO Mapping

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

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
3.	Introduction to Social Media analytics	Coursera	https://in.coursera.org/learn/social-media-analytics-introduction
4.	Social Media Data analytics	Coursera	https://in.coursera.org/learn/social-media-data-analytics

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice / Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	One question to be asked for 20 marks
Unit 2	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	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	BLOCK CHAIN TECHNOLOGY				
Course Code	22AM6PEBCT	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: Blockchain 101: Distributed systems, History of blockchain, Introduction to blockchain, Types of blockchain, CAP theorem and blockchain, Benefits and limitations of blockchain.	
UNIT – 2	**6 Hrs**
Decentralization and Cryptography: Decentralization using blockchain, Methods of decentralization, Routes to decentralization, Decentralized organizations. Cryptography and Technical Foundations: Cryptographic primitives, Asymmetric cryptography, Public and private keys.	
UNIT – 3	**5 Hrs**
Bitcoin and Alternative Coins A: Bitcoin, Transactions, Blockchain, Bitcoin payments B: Alternative Coins, Theoretical foundations, Bitcoin limitations, Namecoin, Litecoin, Primecoin, Zcash.	
UNIT – 4	**5 Hrs**
Smart Contracts and Ethereum 101: Smart Contracts: Definition, Ricardian contracts. **Ethereum 101**: Introduction, Ethereum blockchain, Elements of the Ethereum blockchain, Precompiled contracts.	
UNIT – 5	**5 Hrs**
Alternative Blockchains: Blockchains Blockchain-Outside of Currencies: Internet of Things, Government, Health, Finance, Media.	

Text Books:

1. *Mastering Blockchain - Distributed ledgers, decentralization and smart contracts explained,* Imran Bashir, Packt Publishing Ltd., 2nd Edition, ISBN 978-1- 78712-544-5, 2017.

Reference Books:

1. *Bitcoin and Cryptocurrency Technologies,* Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, Steven Goldfeder, Princeton University, 2016
2. *Blockchain Basics: A Non-Technical Introduction in 25 Steps,* Daniel Drescher, Apress, 1st Edition, 2017.
3. *Mastering Bitcoin: Unlocking Digital Cryptocurrencies,* Andreas M. Antonopoulos, O'Reilly Media, 1st Edition, 2014.

Course Outcomes	
CO1	Apply the key components and the role of cryptography in securing blockchain networks.
CO2	Analyze the concept of smart contracts and their applications for creating and verifying transactions on a blockchain.
CO3	Develop real-world use cases of blockchain technology, such as supply chain management, identity verification and the ethical considerations surrounding the use of blockchain technology.

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										2

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Blockchain and its Applications	NPTEL	https://onlinecourses.nptel.ac.in/noc22_cs44/preview
2.	Blockchain Specialization	NPTEL	https://in.coursera.org/specializations/blockchain

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

Course Title	VIDEO ANALYTICS USING OPENCV				
Course Code	22AM6PEVAC	Credits		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
Getting Started with OpenCV : Introduction to computer vision, Introduction to images, Basic image operations, Mathematical operations on images, Sunglass filter : A simple application, Bitwise operations, Image Annotation. **Video IO and GUI:** Video IO using HighGUI, Callback functions, Keyboard as input device.	
UNIT – 2	**5 Hrs**
Binary Image Processing: Thresholding, Erosion / Dilation, Opening and Closing, Connected Component Analysis, Contour Analysis, Blob Detection. **Image Enhancement and Filtering**: Color Spaces, Color Transforms, Image Filtering, Image Smoothing, Image Gradients.	
UNIT – 3	**5 Hrs**
Advanced Image Processing and Computational Photography: Hough Transforms, High Dynamic Range Imaging, Seamless Cloning, Image Inpainting. **Geometric Transforms and Image Features**: Geometric Transforms, Image Features, Feature Matching, **Application**: Image Alignment, Application: Creating Panorama, Application: Finding Known Objects using OpenCV.	
UNIT – 4	**5 Hrs**
Image Segmentation and Recognition: Image segmentation using GrabCut, Image Classification, Object Detection. **Video Analysis:** Motion Estimation using Optical Flow, Application: Video Stabilization, Object Tracking, Object Trackers in OpenCV, Multiple Object Tracking using OpenCV, Kalman Filter, MeanShift and CamShift.	
UNIT – 5	**6 Hrs**
Deep Learning with OpenCV: Image Classification- Image Classification using Caffe and Tensorflow ,Object Detection - Single Shot Multibox Detector(SSD) , You Only Look Once Detector(YOLO), Face Detection- SSD based Face Detector , Human Pose Estimation- OpenPose.	

Reference Materials:

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

Course Link:

https://opencv.org/coursess/

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

CO – PO - PSO Mapping

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

Massive Open Online Course (MOOC)

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

Semester End Examination (SEE) Question Paper Pattern:

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

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

Assessment Pattern:

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

Course Title	PATTERN RECOGNITION				
Course Code	22AM6PEPRN	Credits		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
Pattern Classifier: Overview of pattern recognition, Discriminant functions, Supervised learning, Parametric estimation, Maximum likelihood estimation, Bayesian parameter estimation, Perceptron algorithm, LMSE algorithm, Problems with Bayes approach, Pattern classification by distance functions, Minimum distance pattern classifier.	
UNIT – 2	**6Hrs**
Unsupervised Classification: Clustering for unsupervised learning and classification, Clustering concept, C-means algorithm, Hierarchical clustering procedures, Graph theoretic approach to pattern clustering, Validity of clustering solutions.	
UNIT – 3	**8 Hrs**
Structural Pattern Recognition: Elements of formal grammars, String generation as pattern description, Recognition of syntactic description, Parsing – Stochastic grammars and applications, Graph based structural representation.	
UNIT – 4	**8 Hrs**
Feature Extraction and Selection: Entropy minimization, Karhunen– Loeve transformation, Feature selection through functions approximation, Binary feature selection.	
UNIT – 5	**6 Hrs**
Advances in Pattern Recognition: Neural network structures for Pattern Recognition, Neural network based Pattern associators, Unsupervised learning in neural Pattern Recognition, Self-organizing networks, Fuzzy logic Fuzzy pattern classifiers, Pattern classification using Genetic Algorithms.	

Text Books:

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

Reference Books:

1. *Pattern Recognition Engineering,* Morton Nadier and Eric Smith P, John Wiley & Sons, New York.
2. *Pattern Recognition Statistical, Structural and Neural Approaches,* Robert J.Schalkoff, John Wiley & Sons Inc., New York.
3. *Pattern Recognition Principles,* Tou and Gonzales, Wesley Publication Company, London.
4. *Pattern Recognition Engineering,* Morton Nadier and Eric Smith P., John Wiley & Sons, New York.

Course Outcomes	
CO1	Apply the basic principles and techniques of pattern recognition, including supervised and unsupervised learning, clustering, classification, and feature extraction.
CO2	Apply statistical and machine learning algorithms to solve pattern recognition problems, such as image and speech recognition, natural language processing, and bioinformatics.
CO3	Develop the ability to analyze and evaluate the performance of different pattern recognition models, and to select the appropriate models for different types of data and applications.

CO – PO - PSO Mapping

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

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Pattern Recognition and Application	NPTEL	https://onlinecourses.nptel.ac.in/noc19_ee56/preview
2.	Introduction to statistical Pattern Recognition	NPTEL	https://nptel.ac.in/courses/117108048

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	SOCIAL NETWORK ANALYSIS				
Course Code	22AM6PESNA	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: The Social Networks Perspective, Historical and Theoretical Foundations, Fundamental Concepts in Network Analysis, Distinctive Features. **Social Network Data:** What are Network Data? Boundary Specification and Sampling, Types of Networks, Network Data, Measurement and Collection. **Graph Theory and Social Networks:** Graphs: Basic Definitions, Paths and Connectivity, Distance and Breadth-First Search.	
UNIT – 2	**8 Hrs**
Strong and Weak Ties: Triadic Closure, The Strength of Weak Ties, Tie Strength and Network Structure in Large-Scale Data, Tie Strength, Social Media, and Passive Engagement, Closure, Structural Holes, and Social Capital. **Networks in Their Surrounding Contexts:** Homophily, Mechanisms Underlying Homophily: Selection and Social Influence, Affiliation. **Positive and Negative Relationships:** Structural Balance, Characterizing the Structure of Balanced Networks.	
UNIT – 3	**6 Hrs**
Information Networks and the World Wide Web: The Structure of the web: The World Wide Web, Information Networks, Hypertext, and Associative Memory, The Web as a Directed Graph, The Bow-Tie Structure of the Web. **Link Analysis and Web Search:** Searching the Web: The Problem of Ranking, Link Analysis using Hubs and Authorities, PageRank.	
UNIT – 4	**8 Hrs**
Network Dynamics: Information Cascades, Following the Crowd, A Simple Herding Experiment, Bayes' Rule: A Model of Decision-Making Under Uncertainty, Bayes' Rule in the Herding Experiment, A Simple, General Cascade Model, Sequential Decision-Making and Cascades. **Structural Models:** Cascading Behavior in Networks: Diffusion in Networks, Modeling Diffusion through a Network, Cascades and Clusters, Diffusion, Thresholds, and the Role of Weak Ties.	
UNIT – 5	**6 Hrs**
The Small-World Phenomenon: Six Degrees of Separation, Structure and Randomness, Decentralized Search, Modeling the Process of Decentralized Search, Core-Periphery Structures and Difficulties in Decentralized Search.	

Text Books:

1. *Social Network Analysis: Methods and Applications,* Stanley Wasserman, Katherine Faust, Cambridge University Press, 2012.
2. *Networks, Crowds, and Markets: Reasoning about a Highly Connected World,* David Easley, Jon Kleinberg.

Reference Books:

1. *Social Network Analysis,* John Scott, 3rd Edition, SAGE publications Ltd., 2012.
2. *Understanding-Social-Networks-Theories-Concepts-and findings,* Charles Kadushin, Oxford university press, 2012.

Course Outcomes	
CO1	Apply the fundamentals of social network theory and analysis including nodes, edges, centrality, clustering, and network dynamics.

CO2	Analyze social networks using appropriate tools and methods such as Gephi, NodeXL, or R to visualize and analyze social network data.
CO3	Apply social network analysis to real-world problems such as organizational behavior, health care, social movements, or international relations.

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**									**2**	

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Social Network Analysis	NPTEL	https://onlinecourses.nptel.ac.in/noc22_cs117/preview
3.	Introduction to Social Network Analysis	Coursera	https://in.coursera.org/learn/social-media-analytics-introduction

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 ANALYSIS				
Course Code	22AM6PEBDA	Credits		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

What is Big Data and Why Is It Important?:
A Flood of Mythic "Start-Up" Proportions, Big Data Is More Than Merely Big , Why Now? , A Convergence of Key Trends, Relatively Speaking , A Wider Variety of Data ,The Expanding Universe of Unstructured Data.
Industry Examples of Big Data: Digital Marketing and the Non-line World, Database Marketers, Pioneers of Big Data, Big Data and the New School of Marketing, Fraud and Big Data, Risk and Big Data, Credit Risk Management, Big Data and Algorithmic Trading, Big Data and Advances in Health Care, Pioneering New Frontiers in Medicine, Advertising and Big Data: From Papyrus to Seeing Somebody, Using Consumer Products as a Doorway.

UNIT – 2	8 Hrs

Big Data Technology:
The Elephant in the Room: Hadoop's Parallel World, Old vs. New Approaches, Data Discovery: Work the Way People's Minds Work, Open-Source Technology for Big Data Analytics, The Cloud and Big Data, Predictive Analytics Moves into the Limelight, Software as a Service BI, Mobile Business Intelligence is Going Mainstream, Crowdsourcing Analytics, Inter- and Trans-Firewall Analytics, R&D Approach Helps Adopt New Technology, Big Data Technology Terms, Data Size.

UNIT – 3	8 Hrs

Business Analytics: The Last Mile in Data Analysis, Geospatial Intelligence Will Make Your Life Better, Listening: Is It Signal or Noise?, Consumption of Analytics, From Creation to Consumption, Visualizing: How to Make It Consumable?, Organizations Are Using Data Visualization as a Way to Take Immediate Action , Moving from Sampling to Using All the Data, Thinking Outside the Box, 360° Modeling, Need for Speed, Let's Get Scrappy , What Technology Is Available?, Moving from Beyond the Tools to Analytic Applications.

UNIT – 4	8 Hrs

The People Part of the Equation: Rise of the Data Scientist, Using Deep Math, Science, and Computer Science, The 90/10 Rule and Critical Thinking, Analytic Talent and Executive Buy-in, Developing Decision Sciences Talent, Holistic View of Analytics, Creating Talent for Decision Sciences, Creating a Culture That Nurtures Decision Sciences Talent, Setting Up the Right Organizational Structure for Institutionalizing Analytics.
Data Privacy and Ethics: The Privacy Landscape, The Great Data Grab Isn't New, Preferences, Personalization, and Relationships, Rights and Responsibility, Playing in a Global Sandbox, Conscientious and Conscious Responsibility, Privacy May Be the Wrong Focus, Can Data Be Anonymized?, Balancing for Counterintelligence.

UNIT – 5	6 Hrs

Information Management: The Big Data Foundation, Big Data Computing Platforms (or Computing Platforms That Handle the Big Data Analytics Tsunami), Big Data Computation, More on Big Data Storage, Big Data Computational Limitations, Big Data Emerging Technologies.
Big Data Analytics Tool- Hadoop, MongoDB, Cassandra, MapReduce, Hive, Pig, Jasper Report.

Text Books:

1. *Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses*, Michael Minelli ,Michele Chambers , Ambiga Dhiraj.

Reference Books:

1. *Fundamentals of Business Analytics,* R.N. Prasad, Seema Acharya, Wiley.
2. *An Introduction to Data Science,* Jeffery Stanton.
3. *Big Data and Analytics,* Seema Acharya, Subhashini Chellapan

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

CO – PO - PSO Mapping

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

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Big Data Computing	NPTEL	https://onlinecourses.nptel.ac.in/noc20_cs92/preview
2.	Big Data Specialization	Coursera	https://in.coursera.org/specializations/big-data

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 DATA MINING				
Course Code	22AM6OEIDM	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 Data Preprocessing: Why data mining, what is data mining, What kinds of data can be mined, What kinds of patterns can be mined, Which Technologies Are used, Which kinds of Applications are targeted, Major issues in data mining, Data Preprocessing: An overview, Data cleaning, Data integration, Data reduction, Data transformation and data discretization. **Data warehousing and online analytical processing:** Data warehousing: Basic concepts-What Is a Data Warehouse, Differences between Operational Database Systems and Data Warehouses, Why Have a Separate Data Warehouse? Data Warehousing: A Multitiered Architecture.	
UNIT – 2	**6 Hrs**
Data Warehouse Models: Enterprise Warehouse, Data Mart, and Virtual Warehouse Extraction, Transformation, and Loading. **Data warehouse modeling:** Data Cube: A Multidimensional Data Model Stars, Snowflakes, and Fact Constellations: Schemas for Multidimensional Data Models.	
UNIT – 3	**8 Hrs**
Mining Frequent Patterns, Associations, and Correlations: Market Basket Analysis: A Motivating Example, Frequent Itemsets, Closed Itemsets, and Association Rules, Apriori Algorithm: Finding Frequent Itemsets by Confined Candidate Generation, Generating Association Rules from Frequent Itemsets, Improving the Efficiency of Apriori, A Pattern-Growth Approach for Mining Frequent Itemsets, Mining Frequent Itemsets Using Vertical Data Format, Mining Closed and Max Patterns, Which Patterns Are Interesting?—Pattern Evaluation Methods**.**	
UNIT – 4	**7 Hrs**
Cluster Analysis: What Is Cluster Analysis? Requirements for Cluster Analysis, Partitioning methods: k-Means: A Centroid-Based Technique, k-Medoids, Hierarchical Methods: Agglomerative versus Divisive Hierarchical Clustering, BIRCH, Chameleon, Probabilistic Hierarchical Clustering, Density-based methods: DBSCAN, OPTICS, DENCLUE Evaluation of clustering.	
UNIT – 5	**7 Hrs**
Evaluation of Clustering: Assessing Clustering Tendency, Determining the Number of Clusters, Measuring Clustering Quality. **Data mining trends and research frontiers**: Mining complex data types, other methodologies of data mining, Data mining applications, Data Mining and society.	

Text Books:

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

Reference Books:

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

Course Outcomes	
CO1	Apply the fundamental concepts and principles of data mining techniques, such as classification, clustering, association rule mining, and anomaly detection.
CO2	Analyze how to preprocess data , evaluate and interpret the results of data mining models.

CO3	Develop critical thinking skills and problem-solving abilities related to data mining.

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**

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Data Mining	NPTEL	https://onlinecourses.nptel.ac.in/noc21_cs06/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	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/Quiz	10M	
Semester End Examination (SEE)	100M (50% weightage)			**50M**
			Total	**100M**

Course Title	INTRODUCTION TO ARTIFICIAL INTELLIGENCE				
Course Code	22AM6OEIAI	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: What is AI? **Intelligent Agents**: How agent should act, Structure of Intelligent Agents, Environments Problem Solving: Formulating problems, Example problems **Uniformed-search strategies:** Breadth-First Search, Uniform Cost Search, Depth-First Search, Depth Limited Search, Iterative Deepening Search.	
UNIT - 2	**8 Hrs**
Heuristic Search Strategies: Generate-and-Test, Hill Climbing, Best-first Search, Problem Reduction, Constraint Satisfaction, Means-ends Analysis.	
UNIT - 3	**8 Hrs**
Knowledge Representation: Propositional Logic – Syntax and Semantics, Using Propositional Logic, First-Order Logic – Syntax and Semantics, Using First-Order Logic **Representing Knowledge using Rules**: Procedural Versus Declarative Knowledge, Forward Versus Backward Reasoning, Semantic Knowledge, Ontology Based representation.	
UNIT - 4	**8 Hrs**
Uncertain Knowledge & Reasoning: Acting under Uncertainty, The Wumpus World Revisited, Representing Knowledge in an Uncertain Domain, The Semantics of Belief Networks, Efficient Representation of Conditional Distributions, Exact Inference in Bayesian Networks , Approximate Inference in Bayesian Networks ,Relational and First-Order Probability Models , Other Approaches to Uncertain Reasoning.	
UNIT - 5	**6 Hrs**
Introduction to Expert Systems: Definition, Features of an Expert System, Organization, Characteristics, Prospector, Knowledge Representation in Expert Systems, Expert System tools – MYCIN, EMYCIN.	

Text Books:

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

Reference Books:

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

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

CO – PO - PSO Mapping

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

Massive Open Online Course (MOOC)

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

Semester End Examination (SEE) Question Paper Pattern:

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

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

Assessment Pattern:

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

Course Title	INTRODUCTION TO MACHINE LEARNING				
Course Code	22AM6OEIML	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
The Machine Learning Landscape: What Is Machine Learning (ML)? Uses and Applications with examples, Types of Machine Learning, Main Challenges of Machine Learning, Testing and Validating. **End to End Machine Learning**: Working with Real Data, Frame the Problem, Select the Performance Measure, Prepare the Data for ML Algorithms, Training and Evaluating the Data Set. **Bayesian Decision Theory**: Introduction, Classification.	
UNIT – 2	**7 Hrs**
Classification: MNIST, Training Binary Classifier, Performance Measures, Multiclass classification. **Training Models**: Linear Regression, Gradient Descent, Regularized Linear Models – Ridge & Lasso Regression.	
UNIT – 3	**7 Hrs**
Dimensionality Reduction: The Curse of Dimensionality, Main Approaches for Dimensionality, PCA, Linear Discriminant Analysis (LDA). **Support Vector Machines**: Linear SVM Classification, Nonlinear SVM, SVM Regression, Kernelized SVMs.	
UNIT – 4`	**7 Hrs**
Decision Trees: Univariate Trees: classification & Regression Trees, Training and Visualizing a Decision Tree, Pruning, Rule Extraction from Trees, Learning Rules from Data, Making Predictions, Estimating Class Probabilities, CART Training Algorithm, Computational Complexity, Gini Impurity or Entropy? Regularization Hyperparameters, Multivariate Trees.	
UNIT – 5	**7 Hrs**
Ensemble Learning and Random Forests: Voting Classifiers, Bagging and Pasting, Random Patches and Random Subspaces, Random Forests, Boosting **Unsupervised Learning Techniques**: Clustering – K means, Spectral, Hierarchical;	

Text Books:

1. *Introduction to Machine Learning*, Ethem Alpaydin, PHI Learning Pvt. Ltd, 3rd Edition, 2018.
2. *Hands-on machine learning with Scikit-Learn and TensorFlow: concepts, tools, and techniques to build intelligent systems*, Aurelien Geron, O'Reilly Media, 2019.

Reference Books:

1. *Machine Learning*, Tom Mitchell, McGraw Hill, 2013.
2. *The Elements of Statistical Learning*, T. Hastie, R. Tibshirani, J. H. Friedman, Springer, 1st Edition, 2001.
3. *Pattern Recognition and Machine Learning*, Christopher M Bishop, Springer, 2006.

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

CO – PO - PSO Mapping

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

Massive Open Online Course (MOOC)

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

Semester End Examination (SEE) Question Paper Pattern:

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

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

Assessment Pattern:

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

Course Title	QUANTITATIVE ABILITY TRANING				
Course Code	22AM6HSQAT	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
Number System: Classification of Numbers, Test of Divisibility, HCF and LCM, Fractions and Ordering Fractions.	
UNIT – 2	**5 Hrs**
Averages, Ratio – Proportion, Time-Work and Wages, Pipes and Cisterns.	
UNIT – 3	**5 Hrs**
Time Speed and Distance: Boats and Streams, Problems on Trains. Ages.	
UNIT – 4	**5 Hrs**
Areas: Mensuration 2D, Permutation and Combination, Probability.	
UNIT – 5	**6 Hrs**
Clocks, Calendars, Data Interpretation: Tabular Data Interpretation, Bar Graphs, Venn Diagrams.	

Text Books:

1. *"Quantitative Aptitude for Competitive Examinations",* R.S Agarwal.

Reference Books:

1. *"Quantitative Aptitude for Competitive Examinations",* Dinesh Khattar, Pearson, 4th Edition.

Course Outcomes	
CO1	Apply a range of mathematical concepts and analytical methods to support decision-making processes.
CO2	Analyze complex data sets, employing statistical techniques and quantitative tools to extract meaningful insights and draw valid conclusions.
CO3	Provide solutions to complex real-world problems, fostering critical thinking and practical problem-solving expertise.

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											

Semester End Examination (SEE) Question Paper Pattern:

UNIT #	Internal Choice / Mandatory	Unit Wise Marks Distribution
Unit 1	Mandatory	10 Multiple choice questions to be asked for 20 Marks.
Unit 2	Mandatory	10 Multiple choice questions to be asked for 20 Marks.
Unit 3	Internal Choice	Two sets of 10 Multiple choice questions to be asked for 20 Marks each.
Unit 4	Mandatory	10 Multiple choice questions to be asked for 20 Marks.
Unit 5	Internal Choice	Two sets of 10 Multiple choice questions 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	60%
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	INTERNSHIP				
Course Code	22AM6SRITP	Credits	1	L-T-P	0-0-1
CIE	50 Marks	SEE	50 Marks		
Contact Hours / Week	2	Total Lecture Hours			24

Internship based on:

Internship work done for 12 weeks.

The students must make a presentation on the scheduled dates and this will be evaluated by the internal committee based on the rubrics for 50 Marks. Finally, the students should submit an internship report and it will be evaluated by the internal committee based on the internship rubrics.

Total internal assessment for the internship would be 50 Marks. SEE will be conducted for 50 Marks The final marks would be CIE+SEE (50+50) = 100 Marks.

Course Outcomes	
CO1	Apply technical knowledge to develop software solutions to open-ended engineering problems.
CO2	Design solutions for complex engineering problems.
CO3	Exhibit and demonstrate knowledge on industry grade tools, team spirit and professionalism in an Industry environment.

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

Course Title	MOOC WITH PROJECT				
Course Code	22AM6PWMWP	Credits	2	L-T-P	2-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	4	Total Lecture Hours			
About the Course: The students should develop project by applying the techniques and tools learnt in MOOC course. The course needs to be completed for minimum of 12 to 15 hours. During this project phase, the students would be able to design and develop a project. In the evaluation process the two assessment will be will conducted based on the rubrics. Along with project report mooc course completion certificate need to be attested.					

CO1	Analyse the methods, contemplate the constraints and relevance of the techniques.
CO2	Investigate the practical application of contemporary tools in a real-time project scenario.
CO3	Exhibit an enriched set of skills, fostering a collaborative and efficient team environment.

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

B.M.S. College of Engineering, Bengaluru – 19

(Autonomous Institute, Affiliated to VTU | Approved by AICTE)

Scheme of Instructions Semester – VII (With effect from the Academic Year 2020-21: admitted batches and onwards)

Sl.#	Course Type	Course Code	Course Title	Teaching Hours in Credits/Week			Total Credits	Examination			
				Theory Lecture	Tutorial	Practical		Duration in hours	CIE Marks	SEE Marks	Total Marks
				L	T	P					
1	BS-7	22AM7BSIPR	Management, Entrepreneurship and IPR	2	0	0	2	02	50	50	100
2	HS-8	22AM7HSGAL	Generative AI With Large Language Models	3	0	0	3	03	50	50	100
3	PC-17	22AM7PCDLL	Deep Learning Laboratory	0	0	1	1	02	50	50	100
4	PE-5	22AM7PECSS	Cognitive Science and Systems	3	0	0	3	03	50	50	100
		22AM7PEEHP	Ethical Hacking Principles								
		22AM7PEAUR	Augmented Reality and Virtual Reality								
5	OE-2	22AM7OEBDA	Introduction to Big Data Analytics	3	0	0	3	03	50	50	100
		22AM7OEINN	Introduction to Neural Networks								
		22AM7OEISC	Introduction to Soft Computing								
		22AM7OEJIR	Jira Programming [L : T : P = 1 : 1 : 1]								
6	HS-9	22AM7HSRMD	Research Methodology	3	0	0	3	03	50	50	100
7	PW-5	22AM7PWCPR	Capstone Project – Phase I	0	0	3	3	06	50	50	100
8	SR-3	22AM7SRIMC	Industry Motivated Course (Seminar/Technical Writing)	0	0	1	1	02	50	50	100
9	NC-7	22AM7NCPDC	Personality Development and Communication Skills or Aptitude Skills	Non-credit mandatory Course							
			Total	14	0	5	19	24	400	400	800

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

Course Title	MANAGEMENT, ENTREPRENEURSHIP AND IPR				
Course Code	22AM7BSIPR	Credits	2	L-T-P	2-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	2	Total Lecture Hours			24

UNIT – 1	4 Hrs
MANAGEMENT: Meaning, nature and characteristics of management, scope and functional areas of management, goals of management, levels of management. Planning- Nature, importance, types of plans, steps in planning.	
UNIT – 2	**5 Hrs**
ENTREPRENEUR: Meaning of entrepreneur, types of entrepreneurships, stages of entrepreneurial process, role of entrepreneurs in economic development, entrepreneurship in India, barriers to entrepreneurship. Identification of business opportunities- market feasibility study, technical feasibility study, financial feasibility study and social feasibility study.	
UNIT – 3	**5 Hrs**
MICRO AND SMALL ENTERPRISES: Definition of micro and small enterprises, characteristics and advantages of micro and small enterprises, steps in establishing micro and small enterprises, Government of India indusial policy 2007 on micro and small enterprises.	
UNIT – 4	**5 Hrs**
IPR: Introduction to IPRs, Basic concepts and need for Intellectual Property- Patents, Copyrights, Geographical Indications, IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO –TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR.	
UNIT – 5	**5 Hrs**
REGISTRATION OF IPRs: Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad.	

Text Books:

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

Reference Books:

1. *Intellectual Property Rights and Copy Rights,* S. V. Satakar, Ess Ess Publications, New Delhi, 2002.
2. *Management Fundamentals – Concepts, Application, Skill Development,* Robert Lusier – Thomson.

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

CO – PO - PSO Mapping

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

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Entrepreneurship and IP Strategy	NPTEL IIT Kharagpur	https://onlinecourses.nptel.ac.in/noc21_hs102/preview
2.	Innovation, Business Models and Entrepreneurship	NPTEL IIT Roorkee	https://nptel.ac.in/courses/110107094
3.	Entrepreneurship	NPTEL IIT Madras	https://nptel.ac.in/courses/110106141

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	75%
Apply / Analyze	20%
Create / Evaluate	5%

Assessment Pattern:

Category			Score Split up	Total
Continuous Internal Evaluation (CIE)	Theory	CIE - 1	20M (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	GENERATIVE AI WITH LARGE LANGUAGE MODELS				
Course Code	22AM7HSGAL	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 : Generative AI & LLMs, LLM use cases and tasks, Text generation before transformers, Transformers architecture, Generating text with transformers, Prompting and prompt engineering, Generative configuration, Generative AI project lifecycle. **Recommended reading:** 1. Attention Is All You Need (Transformers) 2. A Comprehensive Overview of Large Language Models	
UNIT – 2	**8 Hrs**
Large Language Models: Pre-training large language models, Computational challenges of training LLMs, Efficient multi-GPU compute strategies, Scaling laws and compute-optimal models, Pre-training for domain adaptation, Domain-specific training: BloombergGPT. **Recommended reading:** 1. ZeRO: Memory Optimizations Toward Training Trillion Parameter Models 2. BloombergGPT: A Large Language Model for Finance 3. Training Compute-Optimal Large Language Models (Refer Chinchilla Scaling Laws)	
UNIT – 3	**8 Hrs**
Fine-tuning and evaluating large language models: Introduction, Instruction fine-tuning, Fine-tuning on a single task, Multi-task instruction fine-tuning, Model evaluation, Benchmarks, Parameter efficient fine-tuning (PEFT),PEFT techniques 1: LoRA , PEFT techniques 2: Soft prompts. **Recommended reading:** 1. Prefix-Tuning: Optimizing Continuous Prompts for Generation 2. LoRA: Low-Rank Adaptation of Large Language Models	
UNIT – 4	**7 Hrs**
Reinforcement learning and LLM-powered applications: Introduction, Aligning models with human values, Reinforcement learning from human feedback (RLHF),RLHF: Obtaining feedback from humans, RLHF: Reward model, RLHF: Fine-tuning with reinforcement learning, Proximal policy optimization, RLHF: Reward hacking, Scaling human feedback. **Recommended reading:** 1. Learning to Generate Better Than Your LLM 2. QLORA: Efficient Finetuning of Quantized LLMs	
UNIT – 5	**7 Hrs**
Model optimizations for deployment: Generative AI Project Lifecycle: Revisited , Using the LLM in applications, Interacting with external applications, Helping LLMs reason and plan with chain-of-thought, Program-aided language models (PAL), ReAct : Combining reasoning and action, LLM application architectures, Responsible AI ,KL divergence, ReAct: Reasoning and action. **Recommended reading:** 1. Proximal Policy Optimization Algorithms 2. REAC T: SYNERGIZING REASONING AND ACTING IN LANGUAGE MODELS	
Reference Books & Links: 1. *Course Link* : https://www.coursera.org/learn/generative-ai-with-llms/home/ 2. *Generative Deep Learning,* David Foster, O'Reilly, Second Edition.	

Course Outcomes	
CO1	Explore the underlying architecture, training processes, and key components that enable the

	models to generate human-like text and creative content.
CO2	Develop practical skills in implementing and fine-tuning large language models for various applications.
CO3	Demonstrate the strategies for responsible AI development, including mitigating biases, addressing privacy concerns, and promoting transparency in AI-generated content.

CO – PO - PSO Mapping

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

Massive Open Online Course (MOOC)

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

Semester End Examination (SEE) Question Paper Pattern:

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

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

Assessment Pattern:

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

Course Title	DEEP LEARNING LABORATORY				
Course Code	22AM7PCDLL	Credits	1	L-T-P	0-0-1
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	2	Total Laboratory Sessions			13

About the Course: This course is dedicated to offering students a comprehensive grasp of Neural Networks (NN) within the domain of Artificial Intelligence. It delves into both the theoretical foundations and practical applications of Neural Networks, exploring topics such as Feedforward Networks, Convolutional Neural Networks (CNNs), and Recurrent Neural Networks (RNNs). Through engaging hands-on projects, students will develop practical skills in designing and implementing Neural Networks, fostering a profound understanding of their crucial role in contemporary AI applications. Designed to equip students with the knowledge and proficiency necessary to navigate the intricate landscape of NN, this course aims to empower them to make meaningful contributions to the field of Deep Learning.

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.

Reference Books:

1. *Pattern Recognition and Machine Learning*, Christopher M. Bishop, Springer, 2006
2. Neural Networks: A Systematic Introduction, Raul Rojas, Springer, 1996.
3. *Machine Learning: A Probabilistic Perspective,* Kevin P. Murphy, MIT Press, 2012

Course Outcomes:

CO1	Evaluate the existing network models and regularize for better performance using optimization techniques.
CO2	Develop automated models for classification and future trends prediction ensuring public safety.
CO3	Design AI enabled assistants by automating the process of learning using large unlabeled datasets for the benefit of society.

CO-PO-PSO Mapping

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

Massive Open Online Course (MOOC)

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

Assessment Pattern:

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

Course Title	COGNITIVE SCIENCE AND SYSTEMS				
Course Code	22AM7PECSS	Credits	3	L-T-P	3-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	3	Total Lecture Hours			36

UNIT – 1	7 Hrs
Introduction : The prehistory of cognitive science, The reaction against behaviorism in psychology, The theory of computation and the idea of an algorithm, Linguistics and the formal analysis of language, Information-processing models in psychology, The discipline matures: Three milestones: Language and micro-worlds, How do mental images represent? , An interdisciplinary model of vision.	
UNIT – 2	**8 Hrs**
The turn to the brain : Cognitive systems as functional systems , The anatomy of the brain and the primary visual pathway , Extending computational modeling to the brain , Mapping the stages of lexical processing , THE INTEGRATION CHALLENGE, Cognitive science and the integration challenge; Cognitive science: An interdisciplinary endeavor, Levels of explanation: The contrast between psychology and neuroscience, The integration challenge, Local integration I: Evolutionary psychology and the psychology of reasoning, Local integration II: Neural activity and the BOLD signal.	
UNIT – 3	**7 Hrs**
Information-Processing Models of the Mind : Physical symbol systems and the language of thought ; The physical symbol system hypothesis , From physical symbol systems to the language of thought , The Chinese room argument , Applying the symbolic paradigm ; Expert systems, machine learning, and the heuristic search hypothesis , ID3: An algorithm for machine learning , WHISPER: Predicting stability in a block world.	
UNIT – 4	**7 Hrs**
Neural networks and distributed information processing : Neural inspired models of information processing , Single-layer networks and Boolean functions , Multilayer networks, Information processing in neural networks: Key features, Neural network models of cognitive processes; Language and rules: The challenge for information-processing models, Language learning in neural networks, Object permanence and physical reasoning in infancy, Neural network models of children's physical reasoning.	
UNIT – 5	**7 Hrs**
The Organization of The Mind : How are cognitive systems organized?; Architectures for intelligent agents , Fodor on the modularity of mind , The massive modularity hypothesis , Strategies for brain mapping ; Structure and function in the brain , , Studying cognitive functioning: Techniques from neuroscience , Combining resources I: The locus of selection problem , Combining resources II: Networks for attention , From data to maps: Problems and pitfalls.	

Text Books:

1. *Cognitive Science :An Introduction to the Science of the Mind,* Jose Luis Bermudez ,Cambridge University Press, Second Edition 2020.

Reference Books:

1. *Cognition , Reisberg ,* W. W. Norton & Co. price, 2005.
2. *Why Everyone (Else) Is a Hypocrite , Kurzban ,* Princeton University Press; ISBN :978-0- 691-15439-8,2012.

Course Outcomes	
CO1	Apply the cognitive science principles for solving AI problems which are of interdisciplinary in nature.

CO2	Analyze and evaluate neuroscience and psychology for better reasoning.
CO3	Develop information processing models for decision making using machine learning/ neural network 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				**2**											**2**

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	ETHICAL HACKNIG PRINCIPLES				
Course Code	22AM7PECHP	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 Hacking : Important Terminologies, Penetration Test – Vulnerability Assessments versus Penetration Test – Pre-Engagement – Rules of Engagement - Penetration Testing Methodologies – OSSTMM – NIST – OWASP – Categories of Penetration Test – Types of Penetration Tests – Vulnerability Assessment Summary - Reports.	
UNIT – 2	**7 Hrs**
Information Gathering Techniques : Active and Passive mechanisms, sources, tools, interacting with DNS servers, Target enumeration and port scanning techniques.	
UNIT – 3	**8 Hrs**
Network Attacks: Vulnerability Data Resources – Exploit Databases – Network Sniffing – Types of Sniffing -Promiscuous versus Nonpromiscuous Mode – MITM Attacks – ARP Attacks – Denial of Service Attacks -Hijacking Session with MITM Attack – SSL Strip: Stripping HTTPS Traffic -DNS Spoofing – ARP Spoofing Attack Manipulating the DNS Records – DHCP Spoofing -Remote Exploitation – Attacking Network Remote Services – Overview of Brute Force Attacks – Traditional Brute Force – Attacking SMTP – Attacking SQL Servers – Testing for Weak Authentication.	
UNIT – 4	**7 Hrs**
Exploitation: Remote Exploitation: Network protocols, Server protocols functions and mechanism, real life examples. Client-Side Exploitation: Emails, Pdf attacks. Post Exploitation: Privileges, backdoors, maintain access.	
UNIT – 5	**8 Hrs**
Wireless and Web Hacking: Wireless Hacking – Introducing Aircrack- Cracking the WEP – Cracking a WPA/WPA2 Wireless Network Using Aircrack-ng – Evil Twin Attack – Causing Denial of Service on the Original AP – Web Hacking – Attacking the Authentication – Brute Force and Dictionary Attacks – Types of Authentication – Log-In Protection Mechanisms – Captcha Validation Flaw – Captcha RESET Flaw – Manipulating User-Agents to Bypass Captcha and Other Protection – Authentication Bypass Attacks – Testing for the Vulnerability – Automating It with Burp Suite – Session Attacks – SQL Injection Attacks – XSS (Cross-Site Scripting) -Types of Cross-Site Scripting – Cross-Site Request Forgery (CSRF) – SSRF Attacks.	

Text Books:

1. *Ethical Hacking and Penetration Testing Guide,* Rafay Baloch, , CRC Press, 2014.

Reference Books:

1. *Ethical Hacking for Dummies,* Kevin Beaver, Sixth Edition, Wiley, 2018.
2. *Hacking: The Art of Exploitation,* Jon Erickson , Second Edition, Rogunix , 2007.

Course Outcomes	
CO1	Gain knowledge and apply various ethical hacking principles and practices.
CO2	Analyze various types of attacks, security threats and vulnerabilities that harm computer systems/programs.
CO3	Conduct investigations on vulnerabilities using modern tools and techniques.

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**		**1**								**2**

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Ethical Hacking	Nptel	https://onlinecourses.nptel.ac.in/noc22_cs13/preview
2.	Ethical Hacking (v12) Specialization	Coursera	https://www.coursera.org/specializations/certified-ethical-hacking-v12-cehv12-exam-prep-course

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	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	AUGMENTED REALITY AND VIRTUAL REALITY				
Course Code	22AM7PEAUR	Credits	3	L-T-P	3-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	5	Total Lecture Hours			36

UNIT - 1	6 Hrs
Introduction to Augmented Reality (AR): Definition and Scope, A Brief History of Augmented Reality, Displays (Multimodal Displays, Spatial Display Model, and Visual Displays), Strong vs Weak AR, Applications of AR, Challenges in AR. **Introduction to Virtual Reality (VR):** Definition and Scope, Types of VR , Characteristics of VR , Basic VR environments, Limitations of VR environments, Immersion Vs Presence.	
UNIT - 2	**8 Hrs**
VR/AR Input Devices and Tracking: Input Devices: Three-dimensional position trackers, navigation and manipulation interfaces, gesture interfaces. **Tracking Techniques:** Types of tracking, Camera based tracking, Finger tracking, Eye tracking.	
UNIT - 3	**8 Hrs**
AR/VR Output Devices: Head Mounted Displays, Stationary VR systems, Audio output devices, Haptic output devices. **Interaction in Virtual Worlds:** Fundamentals of Human–Computer Interaction, System Control, Selection, Manipulation of Objects, Navigation, Processes for the Design and Implementation of Interaction.	
UNIT - 4	**8 Hrs**
Real-Time Aspects of VR Systems: Latency in VR Systems, Efficient Collision Detection in Virtual Worlds: Bounding Volumes, Real-Time Rendering of Virtual Worlds, Hardware-Related Strategies, Software Systems for Virtual Worlds. **Augmented Reality System components:** Introduction, Registration, Visual Output, Special AR Techniques, Special AR Interaction Techniques, Diminished and Mediated Reality.	
UNIT - 5	**6 Hrs**
Mathematical Foundations of VR/AR: Vector Spaces, Geometry and Vector Spaces, Points and Affine Spaces, Euclidean Space, Analytical Geometry in R3, Matrices, Affine Transformations. **Authoring of VR/AR Applications:** Supporting Authors, Foundations of Authoring Software, Examples of the Creation of VR/AR Applications.	

Text Books:

1. *Augmented reality: principles and practice,* Addison-Wesley Professional, Schmalstieg .D & Hollerer .T, (2016).
2. *Virtual and Augmented Reality (VR/AR), Foundations and Methods of Extended Realities (XR),* Ralf Doerner Wolfgang Broll, Paul Grimm Bernhard Jung Eds, Springer, 2021.

Reference Books:

1. *Virtual Reality Technology,* Grigore C. Burdea, Philippe Coiffet , Wiley Interscience, 2nd Edition, 2006. ISBN: 978-0-471-36089-6.
2. *Understanding virtual reality*. San Francisco, Sherman, W. R., & Craig, A. B. (2003), CA: Morgan Kauffman.
3. *Understanding Augmented Reality*, Alan B. Craig ,Concepts and Applications, Morgan Kaufmann,1st Edition, 2013 ISBN: 9780240824086.

Course Outcomes	
CO1	Demonstrate understanding and design of VR/AR technology relates to human perception and cognition
CO2	Apply techniques and methods of augmenting virtual objects in real space.
CO3	Formulate virtual environment for a given engineering problem and VR simulation for problem situation.

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**	**2**					**2**

Massive Open Online Course (MOOC)

Sl. No.	Course	Offered by	Course Link
1.	Virtual Reality Engineering	NPTEL	https://nptel.ac.in/courses/121106013
2.	Introduction to Augmented Reality and ARCore	Coursera	https://www.coursera.org/learn/ar
3.	Introduction to Virtual Reality	NPTEL	https://onlinecourses.swayam2.ac.in/nou23_ge34/preview
4.	Fundamentals of Augmented Reality & Virtual Reality	Udemy	https://www.udemy.com/course/fundamentals-of-augmented-reality-virtual-reality-101-ar-vr/?couponCode=HT815INMT81324

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
	Theory	CIE - 1	20M	**25M**

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

Course Title	INTRODUCTION TO BIG DATA ANALYTICS				
Course Code	22AM7OEBDA	Credits		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

What is Big Data and Why Is It Important ?:A Flood of Mythic "Start-Up" Proportions, Big Data Is More Than Merely Big , Why Now? , A Convergence of Key Trends, Relatively Speaking , A Wider Variety of Data ,The Expanding Universe of Unstructured Data.
Industry Examples of Big Data: Digital Marketing and the Non-line World, Database Marketers, Pioneers of Big Data, Big Data and the New School of Marketing, Fraud and Big Data, Risk and Big Data, Credit Risk Management, Big Data and Algorithmic Trading, Big Data and Advances in Health Care, Pioneering New Frontiers in Medicine, Advertising and Big Data: From Papyrus to Seeing Somebody, Using Consumer Products as a Doorway.

UNIT – 2	8 Hrs

Big Data Technology: The Elephant in the Room: Hadoop's Parallel World, Old vs. New Approaches, Data Discovery: Work the Way People's Minds Work, Open-Source Technology for Big Data Analytics, The Cloud and Big Data, Predictive Analytics Moves into the Limelight, Software as a Service BI, Mobile Business Intelligence is Going Mainstream, Crowdsourcing Analytics, Inter- and Trans-Firewall Analytics, R&D Approach Helps Adopt New Technology, Big Data Technology Terms, Data Size.

UNIT – 3	8 Hrs

Business Analytics: The Last Mile in Data Analysis, Geospatial Intelligence Will Make Your Life Better, Listening: Is It Signal or Noise?, Consumption of Analytics, From Creation to Consumption, Visualizing: How to Make It Consumable?, Organizations Are Using Data Visualization as a Way to Take Immediate Action , Moving from Sampling to Using All the Data, Thinking Outside the Box, 360° Modeling, Need for Speed, Let's Get Scrappy , What Technology Is Available?, Moving from Beyond the Tools to Analytic Applications.

UNIT – 4	8 Hrs

The People Part of the Equation: Rise of the Data Scientist, Using Deep Math, Science, and Computer Science, The 90/10 Rule and Critical Thinking, Analytic Talent and Executive Buy-in, Developing Decision Sciences Talent, Holistic View of Analytics, Creating Talent for Decision Sciences, Creating a Culture That Nurtures Decision Sciences Talent, Setting Up the Right Organizational Structure for Institutionalizing Analytics.
Data Privacy and Ethics: The Privacy Landscape, The Great Data Grab Isn't New, Preferences, Personalization, and Relationships, Rights and Responsibility, Playing in a Global Sandbox, Conscientious and Conscious Responsibility, Privacy May Be the Wrong Focus, Can Data Be Anonymized?, Balancing for Counterintelligence.

UNIT – 5	6 Hrs

Information Management: The Big Data Foundation, Big Data Computing Platforms (or Computing Platforms That Handle the Big Data Analytics Tsunami), Big Data Computation, More on Big Data Storage, Big Data Computational Limitations, Big Data Emerging Technologies. Big Data Analytics Tool- Hadoop, MongoDB, Cassandra, MapReduce, Hive, Pig, Jasper Report.

Text Books:

1. *Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses*, Michael Minelli ,Michele Chambers , Ambiga Dhiraj.

Reference Books:

1. *Fundamentals of Business Analytics,* R.N. Prasad, Seema Acharya, Wiley.
2. *An Introduction to Data Science,* Jeffery Stanton.
3. *Big Data and Analytics,* Seema Acharya, Subhashini Chellapan.

Course Outcomes	
CO1	Apply key data processing techniques, such as data cleaning, data integration, and data transformation.
CO2	Evaluate different data storage and retrieval technologies and select the appropriate technology based on specific use cases.
CO3	Develop and implement scalable algorithms and techniques for processing and analyzing big data in distributed environments.

CO-PO-PSO Mapping

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

Massive Open Online Course (MOOC)

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

Semester End Examination (SEE) Question Paper Pattern:

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

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

Create / Evaluate	30%

Assessment Pattern

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

Course Title	INTRODUCTION TO NEURAL NETWORKS				
Course Code	22AM7OEINN	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: A Neural Network, Human Brain, Models of a Neuron, Representing Neural Network as Graphs, Network Architectures, Knowledge Representation, Artificial Intelligence and Neural Networks. **Learning Process:** Error Correction Learning, Memory Based Learning, Hebbian Learning, Competitive, Boltzmann Learning, Credit Assignment Problem, Memory, Adaption, Statistical Nature of the Learning Process.	
UNIT – 2	**7 Hrs**
Single Layer Perceptron: Adaptive Filtering Problem, Unconstrained Optimization Techniques, Linear Least Square Filters, Least Mean Square Algorithm, Learning Curves, Learning Rate Annealing Techniques, Perceptron –Convergence Theorem. **Multilayer Perceptron**: Introduction and preliminaries, XOR Problem, Output Representation and Decision Rule.	
UNIT – 3	**8 Hrs**
Back Propagation: Back Propagation Algorithm, Heuristics, Back Propagation and Differentiation, Hessian Matrix, Generalization, Cross Validation, Network Pruning Techniques, Virtues and Limitations of Back Propagation Learning, Accelerated Convergence, Supervised Learning.	
UNIT – 4	**7 Hrs**
Radial-Basis Function Networks: Cover's Theorem, Interpolation Problem, Posed Hypersurface Reconstruction problem, Regularization Theory, Generalized Radial-Basis Function Networks, Approximation properties of Radial-Basis Function Networks, Comparison of RBF Networks and Multi-layer Perceptron's, Learning Strategies.	
UNIT – 5	**7 Hrs**
Self-Organization Maps (SOM): Two Basic Feature-Mapping Models, Self-Organization Map, SOM Algorithm, Properties of Feature Map, Computer Simulations, Learning Vector Quantization, Adaptive Patter Classification, Hierarchical Vector Quantization, Contextual Maps.	

Text Books:

1. *Neural Networks a Comprehensive Foundations,* Simon Haykin, PHI, 2nd Edition.

Reference Books:

1. *Neural Networks and Learning Machines,* Simon Haykin, PHI, 3rd 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	INTRODUCTION TO SOFT COMPUTING				
Course Code	22AM7OEISC	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 Soft Computing: Concept of computing systems, Soft and Hard computing, Characteristics of Soft computing, Applications of soft computing techniques, Optimization and Traditional Methods, Introduction to Genetic Algorithms (GA), Basic Terminologies, Simple GA, Binary Coded GA, GA Parameter Setting, Constraints, Advantages and Disadvantages.	
UNIT – 2	**8 Hrs**
Fuzzy System and Relations: Introduction to Fuzzy Logic, Classical Sets and Fuzzy Sets, Classical Relations, Cartesian Product of Relation, Classical Relation, Fuzzy Relation, Tolerance & Equivalence Relation, Membership Functions: Features, Fuzzification: Rules, Propositions, Implications and inferences, Applications. Defuzzification techniques: Introduction, Fuzzy logic controller design, Lambda – Cuts for fuzzy sets & relations, Defuzzification methods, Applications.	
UNIT – 3	**8 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, Independent Sampling, Real Coded; Genetic Programming, Advantages, Limitations & Applications of GA.	
UNIT – 4	**7 Hrs**
Meta Heuristic, SWARM Intelligence and Rough Set Theory: Ant Colony Optimization, Bee Colony Optimization, Particle SWARM Optimization, Cuckoo Search Algorithm, Rough Sets Knowledge Representations, Rough Decision Making and Data Mining Techniques.	
UNIT – 5	**7 Hrs**
Hybrid Systems: Sequential Hybrid Systems, Auxiliary Hybrid Systems, Embedded Hybrid Systems, Neuro-Fuzzy Hybrid Systems, Neuro-Genetic Hybrid Systems, Fuzzy-Genetic Hybrid Systems, Fuzzy – Rough set Systems.	

Text Books:

1. *Principles of Soft Computing,* S N Sivanandam, S N Deepa, 3rd Edition, Wiley India, 2018.
2. *Soft Computing,* D. K. Pratihar, Narosa Publishing House Pvt. Ltd., (Revised Edition), 2015.

Reference Books:

1. *Genetic Algorithms in Search, Optimization & Machine Learning,* David E Goldberg, Pearson Education, 2013.
2. *Foundations of Neural Networks, Fuzzy Systems, and Knowledge Engineering,* Nikola K. Kasabov, MIT Press, 1998.
3. *Soft computing,* N. P Padhy and S P Simon, Oxford University Press, 2015.

Course Outcomes	
CO1	Apply the fundamental concepts and techniques of soft computing such as fuzzy logic, neural networks, genetic algorithms, and swarm intelligence.
CO2	Analyse the soft computing techniques to solve real-world problems in different domains such as finance, healthcare, manufacturing, and transportation.

CO3	Develop critical thinking and problem-solving skills necessary to apply soft computing techniques to solve complex problems.

CO-PO-PSO Mapping

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

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

Semester End Examination (SEE) Question Paper Pattern:

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

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

Assessment Pattern:

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	JIRA PROGRAMMING				
Course Code	22AM7OEJIR	Credits	3	L-T-P	1-1-1
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours /Week	5	Total Lecture Hours			12

UNIT - 1	2 Hrs
Jira Fundamentals: Jira Overview- Project Boards, Enrich Issues, Kanban Boards, Scrum Projects, Quick Search and Basic Search, JQL , Filters, Epics ,Dashboards. **Jira Essentials with Agile Mindset**: Agile and Jira Overview, Project Boards, Enrich Issues, Kanban Method, Lean and Agile Principles, Scrum, Searching, JQL, Filters, Epics, Dashboards.	
UNIT - 2	**2 Hrs**
Managing Agile Boards and Reports: Overview, Board Configuration, Agile Reports, Board Caveats. **Jira and Confluence together**: Course Overview , Why Integrate Jira and Confluence? , Linking Issues and Pages, Creating Issues Using Confluence, Product Requirements Blueprint, Reporting Jira Information in Confluence ,Simulation Challenge. **Managing Jira Projects**: Course overview, Managing Projects ,Managing Roles and Permissions.	
UNIT – 3	**3 Hrs**
Managing Jira Projects: Managing Boards, Boards and Projects, Managing Issues, Automation, Reports and Dashboards, Other Jira Features, Creating and Configuring team-managed Projects. **JQL For Admins**: Overview ,JQL Syntax, Working with Dates & Times.	
UNIT – 4	**3 Hrs**
Gain Project Insights through JQL: Introduction, , Using Basic Search, , Exploring the elements of a Query, Building up your Query , Searching with Dates, Searching with Text, Searching with Functions, Searching with Keywords and Operators, Displaying your search results, , Other use cases of JQL. **Managing permissions in Jira Cloud**:Permissions overview, Accessing Jira, Global permissions, Company-managed projects, Team-managed projects, Issue permissions, Wrap up. **Jira Automation**: Course Overview, Automation Overview, Creating More Rules, Administration.	
UNIT – 5	**2 Hrs**
Jira Automation: Smart Values, Advanced Rules, Jira Service Management Rules, End Matter. Jira Automation for Admins: Overview ,Configuration, Use cases, Tips, tricks and techniques, Global admin settings. **Customizing Jira Workflows** : Skillbuilder-Configuration techniques, best practices and common pitfalls for all type of transition, advanced examples, troubleshooting and testing advices. Jira Service Desk approvals and automation. **Jira Reporting Basics**: How to use reporting in Jira ,Jira reports for Kanban projects ,Jira reports for scrum projects, Work management reports and insights in Jira.	

Text Books:

1. *Atlassian Jira Service Desk A Complete Guide* ,Gerardus Blokdyk , 2020.

Reference Books:

1. *Hands-On Agile Software Development with JIRA: Design and manage software projects using the Agile methodology* ,David Harned,2018.
2. *Jira 8 Essentials: Effective issue management and project tracking with the latest Jira features,* Patrick Li , , 5th Edition, 2019.

Course Outcomes	
CO1	Track multiple projects and teams.
CO2	Manage agile principles and practices like scrum and kabana workflows.
CO3	Analyze reports to avoid common pitfalls and tracking during software implementation in teams.

CO – PO - PSO Mapping

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

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	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	RESEARCH METHODOLOGY				
Course Code	22AM7HSRMD	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
Research Methodology: Introduction, Meaning of Research, Objectives of Research, Types of Research, Research Approaches, 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	9 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, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs.	

UNIT – 3	8 Hrs
Design of Sample Surveys: Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs. **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	6 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	6 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.

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 methods appropriate to identified research aims and objectives.

CO2	Develop skills in qualitative and quantitative data analysis and presentation.
CO3	Demonstrate enhanced research writing skills using modern tools like LaTeX, EndNote and alike.

CO – PO - PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO 1	3														
CO 2		3													
CO 3					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	20M (Best of Two)	**50M**
		CIE – 2		
		CIE - 3		
		AAT	10M	
Semester End Examination (SEE)	100M (50% weightage)			**50M**
Total				**100M**

Course Title	CAPSTONE PROJECT - 1				
Course Code	22AM7PWCPR	CREDITS	3	L-T-P	0-0-3
CIE	50 Marks	SEE	50 Marks		
Contact Hours/Week	6 Hrs./week	Total Lecture Hours	---		

Capstone Project: The capstone project is executed in two phases. **Capstone project-1** is executed during VII Semester and **Capstone Project-II** is executed during VIII Semester which is an extension of Capstone project-1.

Capstone Project-1: During phase I, the project student team will initially identify a potential engineering problem either from industry/research/societal perspective in the niche technology.A detailed literature survey, requirements identification, requirements elicitation, high leveland low-level designs has to be carried out for the identified problem. The students also have toprepare a project report.

Rules and regulation

A team should comprise minimum of two and maximum of three members.

Internship projects are not allowed.

Simple database related projects are not allowed.

Scheme of Evaluation

The **Capstone Project-1** CIE is evaluated in two phases based on the rubrics.

Review-1: will be evaluated for **20 marks** based on the following parameters: Preliminary study, Literature survey, problem formulation, Motivation and Objectives.

Review-2: will be evaluated for **30 marks** based on the following parameters: RequirementsIdentification and Elicitation, High level and Low level designs, documentation and presentation. Change of title is permitted during review-2 only upon panel recommendations.

Marks spilt up are as follows:

		Panel
Review1	20	Guide
Review2	30	Guide + UG Project Coordinator + Industry Person
Final CIE = SUM(Review1+Review2) = 50M		

The rubrics for Review 1 and Review 2 will be framed by the internal committee comprising of HOD, UG NBA Coordinator, UG Project Coordinator, One Professor, One Associate Professor and One Assistant Professor.SEE will be conducted for 50 marks.

COURSE OUTCOMES (COs)

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

CO 1	Identify an engineering problem and conduct extensive background investigation.	PO2
CO 2	Analyze the required design constraints towards feasible solution/s.	PO3
CO 3	Plan and monitor effectively the project schedules to meet the deadlines.	PO11
CO 4	Effectively work in the team and contribute to the team.	PO9
CO 5	Communicate effectively through presentation and documentation.	PO10

Course Title	INDUSTRY MOTIVATED COURSE (SEMINAR/TECHNICAL WRITING)				
Course Code	22AM7SRIMC	Credits	1	L-T-P	0-0-1
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	2	Total Lecture Hours			

DevOps and Kubernetes: Introduction to DevOps, Infrastructure Setup, Fundamentals of programming language, Version Control with Git, AWS fundamentals, automation control tools, virtualization tools, Projects, configuration management, Containerization Using Docker, Configuration Management using Ansible, Continuous Integration with Jenkins, Continuous Orchestration Using Kubernetes, Terraform Modules & Workspaces.

Text Books:

1. Introduction to DevOps | Coursera
2. DevOps Course Syllabus: What Does The DevOps Course Include? (pwskills.com)

Reference Books:

1. devops-course-content.pdf (technicalguftgu.in)
2. Devops course syllabus - Samyak Computer Classes (samyakinfotech.com)

Course Outcomes	
CO1	Apply Core DevOps Principles for Real-World Projects.
CO2	Analyze CI/CD Pipelines Using Advanced Automation Tools.
CO3	Demonstrate DevOps Solutions using Modern Tools.

CO – PO - PSO Mapping:

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

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

Scheme of Instructions Semester – VIII (With effect from the Academic Year 2020-21: admitted batches and onwards)

Sl.#	Course Type	Course Code	Course Title	Teaching Hours in Credits/Week			Total Credits	Examination			
				Theory Lecture	Tutorial	Practical		Duration in hours	CIE Marks	SEE Marks	Total Marks
				L	T	P					
1	HS-10	24AM8HSBFE	Biology for Engineers	2	0	0	2	02	50	50	100
2	OE-3	24AM8OEBDA	Big Data Analytics	3	0	0	3	03	50	50	100
		24AM8OEPYP	Python Programming								
3	PW-6	24AM8PWCPT	Capstone Project – Phase II	0	0	10	10	20	50	50	100
4	SR-4	24AM8SRITP	Internship	0	0	1	1	02	50	50	100
5	NC-8	24AM8NCPCE	Competitive Exam / MOOC Course	Non-credit mandatory Course							
			Total	5	0	11	16	27	200	200	400

Course Title	BIOLOGY FOR ENGINEERS				
Course Code	24AM8HSBFE	Credits		L-T-P	2-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours /Week	2	Total Lecture Hours			26

UNIT – 1	4 Hrs
Introduction: Why Engineers Should Study Biology?, What Is life?, The Hierarchy of Life, Evolution, Taxonomy, Interaction of Living Things with the Environment, Brief History of Life, Basic Organic Chemical Structure.	
UNIT – 2	**5 Hrs**
Composition of Living Things: Carbohydrates, Lipids, Proteins, Nucleic Acids, Hybrid and Other Compounds.	
UNIT – 3	**5 Hrs**
Introduction to Radiation: Where does Radiation Come from, Types of Radiation, Types of Ionizing Radiation ,X-rays for Medical Use and Generators, Types of Electromagnetic Waves, Ionization of Radiation – Property of Ionizing Radiation, Types of Radiation and Biological Effects ,Penetrating Power of Radiation, Penetrating Power of Radiation within the Body, Penetrating Power and Range of Effects on the Human Body. **The Cell:** The Common Denominator of Living Things, Prokaryotes and Eukaryotes, The Biological Membrane, Eukaryotic Cell Structure and Function, Cell Reproduction.	
UNIT – 4	**5 Hrs**
Radiation Effects on Human Body: Types of Effects, Exposure Modes and Effects, Classification of Radiation Effects, Deterministic Effects and Stochastic Effects. **Mechanism of Causing Effects on Human Body:** Ionization due to Radiation, Damage and Repair of DNA, DNA→Cells→Human Body, Radiation Damage to DNA, Lapse of Time after Exposure and Effects, Deterministic Effects, Radiosensitivity of Organs and Tissues, Stochastic Effects **Cell phone Radiation Hazards**: Introduction, Mutation.	
UNIT – 5	**5 Hrs**
Organic Farming: History and Background, Requirements of Plants for Soil-Derived Nutrients: Effects of Nitrogen, Phosphorous and Potassium on Plant Growth and Quality, Symptoms of Nitrogen, Phosphorous and Potassium Deficiency in Crops.	

Text Books:

1. Arthur T. Johnson, Biology for Engineers, Second Edition, CRC Press 2019.
2. Hand Book on " Basic Knowledge and Health Effects of Radiation" by Radiation Health Management Division, Ministry of the Environment, Government of Japan and National Institutes for Quantum and Radiological Science and Technology.
3. David A. Vaccari, Peter F. Strom and James E. Alleman, Environmental Biology for Engineers and Scientists Wiley Interscience, 2006.
4. Allen V. Barker, Science and Technology of Organic Farming, CRC Press, 2010

Reference Books:

1. Suraishkumar, Madhulika Dixit, Biology for Engineers and Non – Biologists, IIT Madras, Oxford University Press.
2. Naren, Anubhav E, Vinay C, Mohsen G, 'Electromagnetic Radiation Due to Cellular, Wi-Fi and Bluetooth Technologies: How Safe are we?', IEEE Access Special section on Antenna Propagation for 5G and beyond, pp42980 – 43000, January 2020.
3. Sapna E.T., India's Organic Farming Revolution, University of Iowa Press, Iowa City, 2014.

E Resourse: https://letstalkscience.ca/educational-esources/backgrounders/radiation-effects-on-body

MOOCs : https://nptel.ac.in/courses/121/106/121106008/

Course Outcomes	
CO1	Ability to understand and explain basic concepts of Biology
CO2	Ability to apply the knowledge of Biology to convey the role of basic building blocks of life PO1(3)
CO3	Ability to understand and analyse basics of Radiation and its effects on Human Body PO6 (3)
CO4	Understand role of Biology in organic farming PO7(3)

Course Title	BIG DATA ANALYTICS				
Course Code	24AM8OEBDA	Credits		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

What is Big Data and Why Is It Important?:
A Flood of Mythic "Start-Up" Proportions, Big Data Is More Than Merely Big , Why Now? , A Convergence of Key Trends, Relatively Speaking , A Wider Variety of Data ,The Expanding Universe of Unstructured Data.
Industry Examples of Big Data: Digital Marketing and the Non-line World, Database Marketers, Pioneers of Big Data, Big Data and the New School of Marketing, Fraud and Big Data, Risk and Big Data, Credit Risk Management, Big Data and Algorithmic Trading, Big Data and Advances in Health Care, Pioneering New Frontiers in Medicine, Advertising and Big Data: From Papyrus to Seeing Somebody, Using Consumer Products as a Doorway.

UNIT – 2	8 Hrs

Big Data Technology: The Elephant in the Room: Hadoop's Parallel World, Old vs. New Approaches, Data Discovery: Work the Way People's Minds Work, Open-Source Technology for Big Data Analytics, The Cloud and Big Data, Predictive Analytics Moves into the Limelight, Software as a Service BI, Mobile Business Intelligence is Going Mainstream, Crowdsourcing Analytics, Inter- and Trans-Firewall Analytics, R&D Approach Helps Adopt New Technology, Big Data Technology Terms, Data Size.

UNIT – 3	8 Hrs

Business Analytics: The Last Mile in Data Analysis, Geospatial Intelligence Will Make Your Life Better, Listening: Is It Signal or Noise?, Consumption of Analytics, From Creation to Consumption, Visualizing: How to Make It Consumable?, Organizations Are Using Data Visualization as a Way to Take Immediate Action , Moving from Sampling to Using All the Data, Thinking Outside the Box, 360° Modeling, Need for Speed, Let's Get Scrappy , What Technology Is Available?, Moving from Beyond the Tools to Analytic Applications.

UNIT – 4	8 Hrs

The People Part of the Equation: Rise of the Data Scientist, Using Deep Math, Science, and Computer Science, The 90/10 Rule and Critical Thinking, Analytic Talent and Executive Buy-in, Developing Decision Sciences Talent, Holistic View of Analytics, Creating Talent for Decision Sciences, Creating a Culture That Nurtures Decision Sciences Talent, Setting Up the Right Organizational Structure for Institutionalizing Analytics.
Data Privacy and Ethics: The Privacy Landscape, The Great Data Grab Isn't New, Preferences, Personalization, and Relationships, Rights and Responsibility, Playing in a Global Sandbox, Conscientious and Conscious Responsibility, Privacy May Be the Wrong Focus, Can Data Be Anonymized?, Balancing for Counterintelligence.

UNIT – 5	6 Hrs

Information Management: The Big Data Foundation, Big Data Computing Platforms (or Computing Platforms That Handle the Big Data Analytics Tsunami), Big Data Computation, More on Big Data Storage, Big Data Computational Limitations, Big Data Emerging Technologies.
Big Data Analytics Tool- Hadoop, MongoDB, Cassandra, MapReduce, Hive, Pig, Jasper Report.

Text Books:

1. *Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses*, Michael Minelli ,Michele Chambers , Ambiga Dhiraj.

Reference Books:

1. *Fundamentals of Business Analytics,* R.N. Prasad, Seema Acharya, Wiley.
2. *An Introduction to Data Science,* Jeffery Stanton.
3. *Big Data and Analytics,* Seema Acharya, Subhashini Chellapan

Course Outcomes	
CO1	Apply key data processing techniques, such as data cleaning, data integration, and data transformation.
CO2	Analyse different data storage and retrieval technologies and select the appropriate technology based on specific use cases.
CO3	Design and develop scalable algorithms and techniques for processing and analysing big data in distributed environments.

CO – PO - PSO Mapping

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

CO-PO-PSO Mapping

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

Massive Open Online Course (MOOC)

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

Semester End Examination (SEE) Question Paper Pattern:

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

Unit 4	Mandatory	One question to be asked for 20 marks each
Unit 5	Internal Choice	Two questions to be asked for 20 marks each

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

Assessment Pattern

<table>
<tr><th colspan="3">Category</th><th>Score Split up</th><th>Total</th></tr>
<tr><td rowspan="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="3">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	PYTHON PROGRAMMING				
Course Code	24AM8OEPYP	Credits		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
Why should you learn to write programs, Variables, expressions and statements, Conditional execution, Functions, Iteration, Strings, Lists, Dictionaries, Tuples, Regular Expressions.	
UNIT – 2	**8 Hrs**
Files: File Operations, Files and Streams, Creating a File, Reading From a File, Iterating Through Files, Seeking, Serialization. **Databases:** How to Use a Database, Working With a Database, Using SQL to Query a Database, Python and SQLite, Creating an SQLite DB, Pulling Data from a DB, SQLite Database Files.	
UNIT – 3	**8 Hrs**
NumPy: The Basics of NumPy Arrays, Computation on NumPy Arrays: Universal Functions, **Aggregations:** Min, Max, and Everything In Between, Computation on Arrays: Broadcasting, Comparisons, Masks, and Boolean Logic, Fancy Indexing, Sorting Arrays. Data visualization: Scatter plot, Line plot, Bar plot, Histogram, Box plot, Pair plot	
UNIT – 4	**8 Hrs**
Introduction to Pandas: Loading your first data set, Looking at columns, rows, and cells, Creating your own data, The Series, The DataFrame. **Data Manipulation with Pandas:** Operating on Data in Pandas, Handling Missing Data, Combining Datasets: Concat and Append, Merge and Join, Aggregation and Grouping.	
UNIT – 5	**6 Hrs**
GUI development – examining GUI, understanding event driven programming, root window, labels, buttons, creating a GUI using a class, binding widgets and event handlers, text and entry widgets and Grid layout manager, check buttons, radio buttons, mad lib program.	

Text Books:

1. *Learning to Program using Python* by Cody Jackson, Second Edition, 2014.

Reference Books:

1. *Pandas for Everyone: Python Data Analysis* by Daniel Y. Chen, First Edition, Pearson, 2018.
2. *Python Data Science Handbook* by Jake VanderPlas, O'Reilly, 2017.

Course Outcomes:

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

CO – PO - PSO Mapping

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

Massive Open Online Course (MOOC)

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

Assessment Pattern:

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

Course Title	CAPSTONE PROJECT - 2				
Course Code	24AM8PWCPR	CREDITS	10	L-T-P	0-0-10
CIE	50 Marks	SEE	50 Marks		
Contact Hours/Week	20 Hrs./week	Total Lecture Hours	---		

Capstone Project-2: The project student team will be continuing the identified engineering problem and design solutions carried out during Capstone Project-1. A detailed implementation, Modules Integration and Testing has to be carried out. Students also have to prepare a detailed project report.

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

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.
- The Head of the Department shall form a review committee for project work.
- There shall be three reviews during the semester for evaluating the CIE.

Review-1: Shall be reviewed by the panel consisting of three internal faculty members (One Professor, One Associate or One Senior Assistant Professor and Respective Project Guide).

At the time of Project Work Review 2, the students should be able to satisfy the below outcomes:

Sl. No.	Parameters	Marks (Max)
PR1.1	Technology Stack	5
PR1.2	Implementation	15
	Total	**20**

Review-2: Shall be reviewed by the panel consisting of three internal faculty members (One Professor, One Associate or One Senior Assistant Professor and Respective Project Guide).

Sl. No.	Parameters	Marks (Max)
PR2.1	Module Integration and Testing	5
PR2.2	Analysis of Experimental results	5
PR2.3	Presentation and Report Writing	15
PR2.4	Project outcome (Research Paper/Patent/Competition)	5
	Total	**30**

Review-3: Panel Review+

The Panel review committee should include:

1. Senior faculty Member
2. Respective Guides of the students
3. Industry Person or Alumni who is working in Industry with minimum experience of 5 years.

Parameters for Evaluation of Panel Review towards Best-Project Identification:

Sl.No.	Parameters	Marks (Max)
3.1	Originality and Novelty of the project	5
3.2	Industry relevant Modern tools Identification and Usage	10
3.3	Team Work	5
3.4	Presentation and Report Writing	10
3.5	Contribution to Society/Institute/Industry	5
3.6	Research component in the project	5
3.7	Viva-voce	10
	Total	**50**

- The student shall make presentation on the progress made by him / her before the committee for every week and to be presented to their respectiveguides for Review-1 and Review-2.
- The student shall present the Complete Project to the Panel members for Panel Review.
- The total marks obtained in the three reviews shall be reduced for 50 marks
- The project report shall be submitted as per the approved guidelines.
- The viva- voce external examination shall carry 50 marks.
- Marks are awarded to each student of the project group based on theindividual performancein the viva-voce external examination.
- If a candidate fails to submit the project report on or before the specified deadline, he/she is deemed to have failed in the Project Work and shall re-enroll for the same in a subsequent semester.

<table>
<tr><th colspan="3">CIE Marks Distribution</th><th>SEE Marks Distribution</th></tr>
<tr><td>Review I</td><td>Review II</td><td>Review III (Panel Review)</td><td rowspan="3">Identification of Problem and Detailed Analysis:10 marks
Demonstration and Technical Skills:15 marks Project Report Writing & Presentation:15 marksTeam Work:5 marks
Plagiarism:5 marks</td></tr>
<tr><td>20 Marks</td><td>30 marks</td><td>50 marks</td></tr>
<tr><td colspan="2">Total: 50 marks</td><td>Total: 50marks</td></tr>
<tr><td colspan="3">Average of both: 50 marks</td><td>Total: 50 marks</td></tr>
</table>

COURSE OUTCOMES (COs)

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

CO 1	Identify Industry relevant Modern tools relevant to identified engineering domain.	PO5
CO 2	Synthesize and Implement feasible solution/s for the identified problem.	PO1, PO4
CO 3	Communicate effectively through presentation and documentation.	PO10
CO 4	Identify the community that shall benefit through the solution to the identified engineering problem and demonstrate concern for environment.	PO7
CO 5	Function effectively in the team and contribute to the team.	PO9
CO 6	Adhere to the standards, legal and ethical practices.	PO6, PO8

Course Title	INTERNSHIP				
Course Code	24AM8SRITP	Credits	1	L-T-P	0-0-1
CIE	50 Marks	SEE	50 Marks (100% Weightage)		
Contact Hours / Week	0	Total Lecture Hours			0

Internship is carried out for 12 weeks.
The students must make two presentations on the scheduled dates, and this will be evaluated by internal reviewers based on the rubrics for 50 marks each. Finally, internship report must be submitted to the guide allotted.
Total internal assessment: Average of two reviews evaluated for 50 marks each. SEE will be conducted for 50 marks. The final marks would be CIE+SEE (50+50) =100 marks.

Course Outcomes:

CO1	Apply technical knowledge in the given domain of the work and contribute towards finding optimal solution to the identified problem.
CO2	Analyze the job assigned extensively and learn the tools and technologies required to execute the job.
C03	Develop and refine oral and written communication skills
CO4	Demonstrate ethical conduct and professional accountability while working in a team or individually for the benefit of society.

CO-PO-PSO Mapping

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

Semester End Examination (SEE) Review: SEE will be carried out for 50 marks based on the evaluation rubrics. The report to be carried during the evaluation process.

Assessment Pattern:

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