MAHATMA GANDHI UNIVERSITY

SCHOOL OF ARTIFICIAL INTELLIGENCE AND ROBOTICS

M.Sc. Artificial Intelligence and Machine Learning

Scheme and Syllabi in OBE Framework

from 2021 Admission onwards

(Based on CSS 2020 Regulations)

Submitted on

May 2022

SCHOOL OF ARTIFICIAL INTELLIGENCE AND ROBOTICS

School of Artificial Intelligence and Robotics was established by the Mahatma Gandhi University with a vision to meet the growing demands of trained professionals and scientists in the field of Artificial Intelligence and Robotics. The M Sc programme in Artificial Intelligence and Machine Learning currently offered by the school aims to impart theoretical and practical knowledge in the specialized area of Artificial Intelligence and expose students to new, much sought- after skills and up-to-date areas of research. Recent technological advances are incorporated into the programme by developing novel interdisciplinary approaches and subject areas. The school also envisions to promote academic research in specialized areas like vision intelligence, speech and language processing, big data analytics and robotics by establishing specialized labs and workstations equipped with, high-end computing and supporting facilities.

Vision

School of Artificial Intelligence and Robotics envisions to emerge as a premier academic institution of excellence that innovates for a better future of the nation, through teaching, learning and research.

Mission

- *To nurture holistic graduates equipped with leadership and technology skills to address global technological challenges by means of innovative solutions.*
- *To develop global capabilities in Artificial Intelligence and Robotics for industrial and scientific solutions.*
- *To focus on training, research and consultancy that will gear up for Artificial Intelligence, Machine Learning, Robotics and Advanced Data Analytics.*

MAHATMA GANDHI UNIVERSITY

Program Outcomes (POs)

PO 1: Critical Thinking and Analytical Reasoning
Capability to analyse, evaluate and interpret evidence, arguments, claims, beliefs on the basis of empirical evidence; reflect relevant implications to the reality; formulate logical arguments; critically evaluate practices, policies and theories to develop knowledge and understanding; able to envisage the reflective thought to the implication on the society.

PO 2 : Scientific Reasoning and Problem Solving
Ability to analyse, discuss, interpret and draw conclusions from quantitative/qualitative data and experimental evidences; and critically evaluate ideas, evidence and experiences from an unprejudiced and reasoned perspective; capacity to extrapolate from what one has learned and apply their competencies to solve problems and contextualise into research and apply one's learning to real life situations.

PO 3: Multidisciplinary/Interdisciplinary/Transdisciplinary Approach
Acquire interdisciplinary /multidisciplinary/transdisciplinary knowledge base as a consequence of the learning they engage with their programme of study; develop a collaborative-multidisciplinary/interdisciplinary/transdisciplinary-approach for formulate constructive arguments and rational analysis for achieving common goals and objectives.

PO 4: Communication Skills
Ability to reflect and express thoughts and ideas effectively in verbal and nonverbal way; Communicate with others using appropriate channel; confidently share one's views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner and articulate in a specific context of communication.

PO 5: Leadership Skills
Ability to work effectively and lead respectfully with diverse teams; setting direction, formulating a goal, building a team who can help achieve the goal, motivating and inspiring team members to engage with that goal, and using management skills to guide people to the right destination, in a smooth and efficient way.

PO 6: Social Consciousness and Responsibility
Ability to contemplate of the impact of research findings on conventional practices, and a clear understanding of responsibility towards societal needs and reaching the targets for attaining inclusive and sustainable development.

PO 7: Equity, Inclusiveness and Sustainability
Appreciate equity, inclusiveness and sustainability and diversity; acquire ethical and moral reasoning and values of unity, secularism and national integration to enable to act as dignified

citizens; able to understand and appreciate diversity, managing diversity and use of an inclusive approach to the extent possible.

PO 8: Moral and Ethical Reasoning

Ability to embrace moral/ethical values in conducting one's life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work. Capable of demonstrating the ability to identify ethical issues related to one's work and living as a dignified person in the society.

PO 9: Networking and Collaboration

Acquire skills to be able to collaborate and network with scholars in an educational institution, professional organizations, research organizations and individuals in India and abroad.

PO 10: Lifelong Learning

Ability to acquire knowledge and skills, including "learning how to learn", that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development/reskilling.

SCHOOL OF ARTIFICIAL INTELLIGENCE AND ROBOTICS

Programme Specific Outcomes (PSOs)

PSO1	**Critical Thinking and Evaluation** Capability to critically evaluate ideas, evidence and experiences from an unprejudiced and reasoned perspective;
PSO2	**Scientific Analysis and Reasoning** Ability to analyse, discuss, interpret and draw conclusions from quantitative/ qualitative data and experimental evidences;
PSO3	**Problem Solving** Capacity to extrapolate and apply their knowledge and competencies to solve problems and contextualise into research and develop relevant software solutions to real life problems.
PSO4	**Multidisciplinary/Interdisciplinary/Transdisciplinary Approach** Ability to acquire knowledge and formulate solutions in interdisciplinary/ multidisciplinary/transdisciplinary levels of problem solving in a collaborative environment.
PSO5	**Communication Skills** Ability to document, present and demonstrate ideas and complex problem solutions in a very clear and effective way with the aid of appropriate tools.
PSO6	**Leadership Skills** Ability to work effectively and lead respectfully with diverse teams, formulating a goal in a smooth and efficient way.
PSO7	**Social Consciousness and Responsibility** Ability to evolve as a socially committed and responsible scientist/software professional meeting global demands and able to appreciate equity, inclusiveness and sustainability.
PSO8	**Moral and Ethical Reasoning** Capable of demonstrating the ability to identify ethical issues related to software development and use ethical practices in all phases of software development/deployment and research and embrace moral/ethical values in conducting one's life.
PSO9	**Networking and Collaboration** Acquire skills to be able to collaborate and network with scholars in an educational/, professional/research/industry organizations and individuals in India and abroad.
PSO10	**Lifelong Learning** Ability to acquire knowledge and skills through self-paced and self-directed learning and adapt to changing trends and demands of work place through knowledge/skill updation/reskilling.

SCHOOL OF ARTIFICIAL INTELLIGENCE AND ROBOTICS

Mahatma Gandhi University

PSO – PO Mapping

PSO Number	PSO	MGU PO No.
PSO1	**Critical Thinking and Evaluation** Capability to critically evaluate ideas, evidence and experiences from an unprejudiced and reasoned perspective;	**PO 1, PO 2**
PSO2	**Scientific Analysis and Reasoning** Ability to analyse, discuss, interpret and draw conclusions from quantitative/ qualitative data and experimental evidences;	**PO 1, PO 2**
PSO3	**Problem Solving** Capacity to extrapolate and apply their knowledge and competencies to solve problems and contextualise into research and develop relevant software solutions to real life problems.	**PO 2**
PSO4	**Multidisciplinary/Interdisciplinary/Transdisciplinary Approach** Ability to acquire knowledge and formulate solutions in interdisciplinary/ multidisciplinary/transdisciplinary levels of problem solving in a collaborative environment.	**PO 3**
PSO5	**Communication Skills** Ability to document, present and demonstrate ideas and complex problem solutions in a very clear and effective way with the aid of appropriate tools.	**PO 4**
PSO6	**Leadership Skills** Ability to work effectively and lead respectfully with diverse teams, formulating a goal in a smooth and efficient way.	**PO 5**
PSO7	**Social Consciousness and Responsibility** Ability to evolve as a socially committed and responsible scientist/software professional meeting global demands and able to appreciate equity, inclusiveness and sustainability.	**PO 6, PO 7**
PSO8	**Moral and Ethical Reasoning** Capable of demonstrating the ability to identify ethical issues related to software development and use ethical practices in all phases of software development/deployment and research and embrace moral/ethical values in conducting one's life.	**PO 8**
PSO9	**Networking and Collaboration** Acquire skills to be able to collaborate and network with scholars in an educational/, professional/research/industry organizations and individuals in India and abroad.	**PO 9**

PSO10	**Lifelong Learning** Ability to acquire knowledge and skills through self-paced and self-directed learning and adapt to changing trends and demands of work place through knowledge/skill updation/reskilling.	**PO 10**

MAHATMA GANDHI UNIVERSITY

SCHOOL OF ARTIFICIAL INTELLIGENCE AND ROBOTICS

SCHEME 2021

Programme : **M.Sc. Artificial Intelligence and Machine Learning**
Faculty : **Technology and Applied Sciences**
Duration : **4 Semesters** Minimum Total Credits Required: **84**

Semester wise List of Courses

Semester I

Course Code	Course Title	Hours/Week			Credits
		L	T	P	
AI M 21 C11	Artificial Intelligence: Principles and Techniques	3	2	2	4
AI M 21 C12	Mathematical Foundations for AI	3	2	1	4
AI M 21 C13	Machine Learning	3	2	2	4
AI M 21 C14	Algorithms and Complexity	3	2	1	4
AI M 21 E1*	Elective- I	3	1	2	3
AI M 21 C16	Machine Learning Lab	-	2	6	2
Total Credits (Semester I)					21

Semester II

AI M 21 C21	Digital Image Processing	3	2	3	4
AI M 21 C22	Applied Statistics	3	2	1	4
AI M 21 C23	Deep Learning	3	2	-	4
AI M 21 C24	Fuzzy Logic and Nature Inspired Computing	3	2	2	4
AI M 21 E2*	Elective - II	3	1	2	3
AI M 21 C26	Deep Learning Lab	-	2	6	2
Total Credits (Semester II)					21

Semester III

AI M 21 C31	Computer Vision	3	2	-	4
AI M 21 C32	Data Science and Analytics	3	2	-	4
AI M 21 E3*	Elective - III	3	1	2	3
AI M 21 E3*	Elective - IV	3	1	2	3
AI M 21 C35	Computer Vision and Data Analytics Lab	-	2	6	2
AI M 21 C36	Major Project Phase I	-	2	2	2
AI M21 O31	Open Course	3	1	2	4
Total Credits (Semester III)					22

Semester IV

AI M 21 C41	Major Project Phase II and Comprehensive Viva-voce	One Semester	20
Total Credits (Semester IV)			20

Total Credits for the M.Sc. Programme: 84

ELECTIVE COURSES

Course Code	Course Title	Hours/Week			Credits
		L	T	P	
AI M 21 E11	Operating Systems and Virtualization	3	1	2	3
AI M 21 E12	Cyber Physical Systems	3	1	2	3
AI M 21 E13	Distributed Computing	3	1	2	3
AI M 21 E21	Advanced Computer Architecture and Parallel Programming	3	1	2	3
AI M 21 E22	Cyber Security and Cyber Laws	3	1	2	3
AI M 21 E23	Internet of Things and Block Chain Technologies	3	1	2	3
AI M 21 E31	Reinforcement Learning	3	1	2	3
AI M 21 E32	Natural Language Processing	3	1	2	3
AI M 21 E33	AI in Bioinformatics	3	1	2	3
AI M 21 E34	Introduction to Robotics	3	1	2	3
AI M 21 E35	Big Data Analytics	3	1	2	3
AI M 21 E36	Cloud Computing	3	1	2	3

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School of Artificial Intelligence and Robotics
M Sc Artificial Intelligence and Machine Learning

AIM 21 C11 ARTIFICIAL INTELLIGENCE: PRINCIPLES AND TECHNIQUES

School Name	School of Artificial Intelligence and Robotics					
Programme	M.Sc. Artificial Intelligence and Machine Learning					
Course Name	Artificial Intelligence: Principles and Techniques					
Type of Course	Core					
Course Code	AI M21 C11					
Names of Academic Staff & Qualifications	Dr. Ivy Prathap, Ph.D.					
Course Summary & Justification	Today, the amount of data that is generated by both humans and machines far outpaces human ability to absorb, interpret, and make complex decisions based on that data. Artificial intelligence forms the basis for all computer learning and is the future of all complex decision making. This course aims to introduce the basic concepts, theories, state-of-the-art techniques and applications of artificial intelligence.					
Semester	I					
Total Student Learning Time(SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Explicit Teaching Seminar, Assignments etc.	42	28	28	 22	120
Pre-requisite	Basics of Data Structures and Algorithms					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Understand fundamentals of Artificial Intelligence and	U, An	1, 2, 10

	expert systems		
2	Elucidate state space and searching strategies	E, An, A	1, 2
3	Analyze various types of standard search algorithms	A, An	1,2
4	Illustrate advanced search techniques and algorithms like mini-max for game playing.	U, A, An, E	1,2,3
5	Examine Knowledge representation and predicate logic	U, A	1,2
6	Investigate the role of agents and how it is related to environment and the way of evaluating it and how agents can act by establishing goals.	E, A, S	1,2
7	Apply artificial intelligence concepts in real life problems	U, A, C, E	1,2,10
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S)			

COURSE CONTENT

Content for Classroom Transaction

Unit	Course description	Hrs	CO No.
1	Unit 1	10	1,2
2	Unit II	24	3,4
3	Unit III	20	4,5
4	Unit IV	16	6
5	Unit V	14	7

COURSE CONTENT

Content for Classroom Transaction

Unit I (10 hours)

Introduction to Artificial Intelligence: Definition of AI; Future of AI; Brief Discussion of Major Topics (Expert System, Natural Language Processing, Speech and Pattern Recognitionetc.) of AI. Problem definition as a State Space Search, Production System, Control Strategies, Problem Characteristics.

UNIT II (24 hours)

Types of search algorithms: Formal vs. Informal search: Breadth First Search, Depth First Search, iterative deepening, uniform cost search, Hill climbing and its Variations, simulated annealing, genetic algorithm search; Heuristics Search Techniques; Best First Search, A* algorithm, AO* algorithm, Alpha – Beta pruning, Constraint Satisfaction Problem, Means- End Analysis. Game playing; Game trees, Mini-max algorithm.

UNIT III (20 hours)

Game playing - Knowledge representation, Knowledge representation using Predicate logic, Introduction to predicate calculus, Resolution, Use of predicate calculus, Knowledge representation using other logic-Structured representation of knowledge.

UNIT IV (16 hours)

Architecture for Intelligent Agents – Agent communication – Negotiation and Bargaining – Argumentation among Agents – Trust and Reputation in Multi-agent systems.

UNIT V (14 hours)

AI applications – Language Models – Information Retrieval- Information Extraction – Natural Language Processing – Machine Translation – Speech Recognition – Robot – Hardware – Perception – Planning – Moving**.**

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, Interactive Instruction: Active co-operative learning, Seminar, Group Assignments Authentic learning: Library work and Group discussion, Presentation by individual student/Group representative.
Assessment Types	**Mode of Assessment** **A. Continuous Internal Assessment (CIA)** • Internal Tests – Minimum two (Extended answers) • Seminar – ▪ Research Literature review ▪ Report writing ▪ Presentation • Assignments – Written, Oral presentation and viva • Case study

	B. Semester End Examination

REFERENCES

1. S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 3rd edition, Pearson Education, 2015.
2. Elaine Rich and Kelvin Knight, Artificial Intelligence, 3rd edition, Tata McGraw Hill, 2017.
3. Richard E. Neapolitan, Xia Jiang, Artificial Intelligence - With an Introduction to Machine Learning, Chapman & Hall CRC, 2018.
4. M. Tim Jones, ―Artificial Intelligence: A Systems Approach (Computer Science)‖, Jones and Bartlett Publishers, Inc., First Edition, 2008.
5. Nils J. Nilsson, ―The Quest for Artificial Intelligence, Cambridge University Press, 2009.

MAHATMA GANDHIUNIVERSITY
School of Artificial Intelligence and Robotics
M Sc Artificial Intelligence and Machine Learning

AI M 21 C12 MATHEMATICAL FOUNDATIONS FOR AI

School Name	School of Artificial Intelligence and Robotics					
Programme	M.Sc. Artificial Intelligence and Machine Learning					
Course Name	Mathematical Foundations for AI					
Type of Course	Core					
Course Code	AI M 21 C12					
Names of Academic Staff & Qualifications	Dr. Sharon Susan Jacob, M.Tech., Ph.D.					
Course Summary & Justification	Various tools of machine learning are having a rich mathematical theory. Therefore, in order to develop new algorithms of machine/deep learning, it is necessary to have knowledge of all such mathematical concepts. This course introduces these basic mathematical concepts related to the machine/deep learning. In particular, the course focus on the three main branches of mathematics such as Linear algebra, calculus, and Probability those are having strong linkage with machine learning. So, thestudents will learn the basic mathematical concepts required to understand and develop machine learning algorithms.					
Semester	I					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hrs
	Explicit Teaching Seminar, Assignments, etc.	42	28	14	36	120
Pre-requisite	Good knowledge in Mathematics					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Understand and apply mathematical concepts required to develop efficient machine learning	U, A	1,2,3

	algorithms.		
2	Outline the concepts of linear algebra	U, R	1,2
3	Find the relationship between the vectors by the help of vector algebra	An	2,3
4	Prioritize the components of a matrix with the help of Eigen values & eigen vectors	A, U, An	1,2
5	Describe the role of local-global maxima & minima Gradient algorithms optimization	U, An	1,3
6	Articulate the concept and derivation of gradients	U, A	1,2
7	Apply Baye's theorem	A, U, An	1,3
8	Build some of the basic machine learning applications	S, C	2,3,10
Remember(R), Understand(U), Apply(A), Analyse(An), Evaluate(E),Create(C),Skill (S)			

COURSE CONTENT

Content for Classroom Transaction

Unit	Course description	Hrs	CO No.
1	Unit 1	16	1,3
2	Unit II	14	2
3	Unit III	20	4
4	Unit IV	17	5,6
5	Unit V	17	7,8

COURSE CONTENT

Content for Classroom Transaction

Unit I (16hrs)

Vectors and its operations, cosine similarity, orthogonal vectors. Review of vector norms, Vector space and basis, Spanning sets, Linear independence, Bases and Dimension.

Unit II (14hrs)

Matrices, Hadamard product, linear transformation, identity matrix, invertible matrix and inverse, rank, Type of matrices- symmetric, diagonal, orthogonal, orthonormal, positive definite matrix.

Unit III (20hrs)

Calculus – Review of Functions, Rules of differentiation, Partial derivatives, Gradient concept, intuition properties, directional derivative.

Unit IV (17hrs)

Vector and matrix calculus, Eigen values & eigenvectors, Jacobian Gradient algorithms, local-global maxima and minima, saddle point, convex functions, gradient descent algorithms- batch, mini-batch, stochastic.

Unit V (17hrs)

Probability - Basic rules and axioms, events, sample space, frequentist approach, dependent and independent events, conditional probability, Random variables- continuous and discrete, expectation, variance.

Distributions- joint and conditional, Bayes' Theorem, Distributions- binomial, bernoulli, gaussian. Basics of Information theory- entropy, cross-entropy, mutual information

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brainstorming lecture, Explicit Teaching, E-learning, Interactive Instruction: Active co-operative learning, Seminar,Group Assignments Authentic learning: Library work and Group discussion, Presentation by individual student/Group representative.

Assessment Types	**Mode of Assessment** **A. Continuous Internal Assessment (CIA)** • Internal Tests–Minimum two (Extended answers/Practical) • Seminar – ▪ Research Literature review ▪ Report writing ▪ Presentation • Assignments–Written, Practical, Oral presentation and viva • Case study/Mini project **B. Semester End Examination**

REFERENCES

1. Axler, Sheldon. Linear Algebra Done Right. Springer, 2014.
2. Deisenroth, Marc Peter, et al. Mathematics for Machine Learning. Cambridge University Press, 2020.
3. Härdle, Wolfgang Karl, and Léopold Simar. Applied Multivariate Statistical Analysis. Springer, 2015.
4. Morin, David. Probability. Createspace Independent Publishing Platform, 2016.

MAHATMA GANDHI UNIVERSITY

School of Artificial Intelligence & Robotics
M Sc Artificial Intelligence and Machine Learning

AI M 21 C13 MACHINE LEARNING

School Name	School of Artificial Intelligence & Robotics					
Programme	M.Sc. Artificial Intelligence and Machine Learning					
Course Name	Machine Learning					
Type of Course	Core					
Course Code	AI M 21 C13					
Names of Academic Staff & Qualifications	Ms. Jissy Liz Jose, M.Tech.					
Course Summary & Justification	This course provides an introduction to the fundamentals of machine learning. It covers theoretical foundations as well as essential algorithms for supervised and unsupervised learning. The students will be acquainted with the design and implementation of efficient machine learning algorithms to solve various real-life problems.					
Semester	I					
Total Student LearningTime (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Explicit Teaching Seminar, Assignments etc.	42	28	28	 22	120
Pre-requisite	Mathematical Foundations, Programming, and Algorithms					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Understand the concept of machine learning and its applications.	U, A	1,2
2	Differentiate various learning approaches and familiarize with challenges and applications of machine	U, A, An	1,2,3

	learning.		
3	Understand and apply the Bayesian method.	U, A, An	1,2
4	Understand and analyse the concepts and techniques for prediction and classification.	U, An	1,2,3,7
5	Understand and apply the concept of linear regression, gradient descent and logistic regression.	U, An, A, C	1,2,3
6	Apply the concept of regularization in linear and logistic regression.	U, An, A	1,2
7	Understand and compare various dimensionality reduction techniques.	U, An, A, E	1,2,3
8	Understand the theoretical foundations and illustrate the working of classifier models like SVM, Neural Networks, Decision trees etc.	U, A, An, E	1,2,3
9	Illustrate and apply clustering algorithms and identify its applicability in real life problems.	U, A, An	1,2,3
10	Design and implement efficient algorithms to solve various real-life problems by applying various machine learning approaches and presenting the approach effectively with appropriate tools.	U, A, An, S,C, E	1,2,3,4,6, 7,10
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S)			

COURSE CONTENT
Content for Classroom Transaction

Unit	Course description	Hrs	CO No.
1	Unit 1	16	1,2,3
2	Unit II	20	4,5,10
3	Unit III	20	6,7
4	Unit IV	22	4,8,10

5	Unit V	20	9,10

COURSE CONTENT
Content for Classroom Transaction

Unit I (16 hours)
Introduction: Concept of Machine Learning, Types of Machine Learning, Challenges of Machine Learning, Applications of Machine Learning, Statistical Learning: Bayesian Method, The Naive Bayes Classifier.

Unit II (20 hours)
Linear Regression: Prediction using Linear Regression, Gradient Descent, Linear Regression with one Variable, Linear Regression with Multiple Variables, Polynomial Regression, Feature Scaling/Selection.
Logistic Regression: Classification using Logistic Regression, Logistic Regression vs. Linear Regression, Logistic Regression with one Variable and with Multiple Variables.

Unit III (20 hours)
Regularization: Regularization and its Utility: The problem of Overfitting, Application of Regularization in Linear and Logistic Regression, Regularization and Bias/Variance.

Data Pre-Processing Techniques, Feature Generation, Selection and Dimensionality Reduction - Subset selection, Principal Component Analysis, Cross validation and re- sampling methods.

Unit IV (22 hours)
Classification by Decision Trees, K-Nearest Neighbour Classifier, Support Vector Machines, Classification by back propagation, Ensemble Learning, Measuring Classifier Performance

Unit V (20 hours)
Unsupervised Learning - Clustering Methods - K-means, Expectation-Maximization Algorithm, Hierarchical Clustering Methods, Density based clustering.

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AI M 21 C13 MACHINE LEARNING

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Explicit Teaching, E-learning Interactive Instruction: Active co-operative learning, Seminar, Group Assignments Authentic learning: Library work and Group discussion, Presentation by individual student/Group representative.
Assessment Types	**Mode of Assessment** **A. Continuous Internal Assessment (CIA)** • Internal Tests – Minimum two (Extended answers) • Seminar – ▪ Research Literature review ▪ Report writing ▪ Presentation • Assignments – Written, Oral presentation and viva. • Case study **B. Semester End Examination**

REFERENCES

1. Ethem Alpaydin, "Introduction to Machine Learning", 4th Edition, The MIT Press.
2. Tom M. Mitchell, "Machine Learning", 1st Edition, Tata McGraw-Hill Education.
3. Sergios Theodoridis, Aggelos Pikrakis, Konstantinos Koutroumbas, Dionisis Cavouras, Introduction to Pattern Recognition: A MATLAB Approach, Academic Press, First Edition.
4. Sergios Theodoridis, Konstantinos Koutroumbas, Pattern Recognition, Academic Press.
5. Richard O. Duda, Peter E. Hart, David G. Stork, Pattern Classification, Wiley India, Second Edition.
6. V. Susheela Devi, M. Narasimha Murty, Pattern Recognition: An Introduction, University Press, Hyderabad.
7. Bishop C.M., Pattern Recognition and Machine Learning, Springer.
8. Mevin P. Murphy, "Machine Learning: A Probabilistic Perspective",The MIT Press.
9. Yegnanarayana B, Artificial Neural Networks, Prentice-HallIndia Pvt.Ltd.

MAHATMA GANDHI UNIVERSITY

School of Artificial Intelligence & Robotics
M Sc Artificial Intelligence and Machine Learning

AI M 21 C14 ALGORITHMS AND COMPLEXITY

School Name	School of Artificial Intelligence & Robotics					
Programme	M.Sc. Artificial Intelligence and Machine Learning					
Course Name	Algorithms and Complexity					
Type of Course	Core					
Course Code	AI M 21 C14					
Names of Academic Staff & Qualifications	Dr. Anuj Mohamed, MCA, Ph. D.					
Course Summary & Justification	This course provides knowledge of techniques to design efficient algorithms to solve various types of problems and to make evaluative judgments about the algorithms. It also covers techniques to establish the efficiency of the designed algorithms. It also provides concepts of NP-completeness and to evaluate algorithms accordingly.					
Semester	I					
Total Student LearningTime (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Explicit Teaching Seminar, Assignments etc.	42	28	14	 36	120
Pre-requisite	Design and Analysis of Algorithms, Data Structures, Programming Skills					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Analyse a given algorithm and express its time and space complexities in asymptotic notations.	U, An	1,2

2	Solve recurrence equations using different methods.	A	2
3	Describe various techniques for deriving good lower bounds	U, A, E	2,4
4	Compute the lower bound on the time of an algorithm	A, E	2
5	Understand and apply the concepts of randomized algorithms and string-matching algorithms.	U, A, An	1,2
6	Describe computational models for parallel algorithms	U	1,4
7	Implement parallel algorithms for suitable applications	An, C	2
8	Understand concepts of NP-completeness and evaluate algorithms accordingly	U, An, E	1,2,8
9	Distinguish between problems that can be solved by a polynomial time algorithm and problems for which no polynomial time algorithm is known	U, An, E	1,2
10	Apply approximation algorithms to generate feasible solutions for NP-hard problems.	U, A	1,2
11	Design algorithms to solve real-life problems, analyze its complexity and present the approach in an effective way with the aid of appropriate tools.	U, An, C,E,S	1,2,3,4,7, 8,10
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S)			

COURSE CONTENT

Content for Classroom Transaction

Unit	Course description	Hrs	CO No.
1	Unit 1	17	1,2,11
2	Unit II	15	3,4,11
3	Unit III	19	5,11
4	Unit IV	15	6,7,11
5	Unit V	18	8,9,10,11

AI M 21 C14 ALGORITHMS AND COMPLEXITY

COURSE CONTENT
Content for Classroom Transaction

Unit I (17 hrs.)
Introduction: The Role of Algorithms in Computing, Performance Analysis- Time and Space Complexity, Asymptotic Notations, Best, worst and average case complexities, Running time comparisons, Mathematical Background for Algorithm Analysis, Recurrences: Substitution Method, Recursion-Tree Method, Master Method.

Unit II (15 hrs.)
Lower Bound Theory: Importance of Lower Bound Theory, Comparison Trees, Adversary Arguments, Lower Bounds through Reductions.

Unit III (19 hrs.)
Randomized Algorithms: Motivation, Applications and Advantages, Monte Carlo and Las Vegas Algorithms, De-Randomization.
String Matching Algorithms: The Naive String-Matching Algorithm, The Rabin-Karp Algorithm, String Matching with Finite Automata, The Knuthmorris-Pratt Algorithm, Longest Common Subsequence.

Unit IV (15 hrs.)
Parallel Algorithms: Sequential vs. Parallel Algorithms; Models: Data Parallel Model, Task Graph Model, Work Pool Model, Master Slave Model, Producer Consumer or Pipeline Model; Hybrid Model; Speedup and Efficiency; Examples of Parallel Algorithms: Parallel Sorting, Parallel Matrix Chain Multiplication.

Unit V (18 hrs.)
Introduction to NP-Completeness: The class P and NP, NP-Complete, NP-Hard, NP-Completeness and Reducibility; Cook's Theorem. Approximation Algorithms: Absolute Approximations, Є-Approximations, Polynomial Time and Fully Polynomial Time Approximation Schemes. Vertex Cover Problem, Traveling-Salesman Problem.

AI M 21 C14 ALGORITHMS AND COMPLEXITY

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Explicit Teaching, E-learning Interactive Instruction: Active co-operative learning, Seminar, Group Assignments Authentic learning: Library work and Group discussion, Presentation by individual student/Group representative.
Assessment Types	**Mode of Assessment** **A. Continuous Internal Assessment (CIA)** • Internal Tests – Minimum two (Extended answers) • Seminar – ▪ Research Literature review ▪ Report writing ▪ Presentation • Assignments – Written, Oral presentation and viva. • Case study **B. Semester End Examination**

REFERENCES

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, Introduction to Algorithms, Prentice Hall India, Third Edition.
2. G. Brassard, P. Bratley, Fundamentals of Algorithms, PHI.
3. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajeshekharan, Computer Algorithms/C++, Second Edition, Universities Press.
4. A. Levitin, Introduction to Design and Analysis of Algorithms, Pearson.
5. Basu S.K., Design Methods and Analysis of Algorithms, Prentice Hall, Second Edition.
6. A. Bhargava, Grokking Algorithms: An illustrated guide for programmers and other curious people, Manning Publications.
7. A. Basheer, M. Zaghlool, FPGA-Based High Performance Parallel Computing, Scholars' Press.
8. Richard Neapolitan, Kumars Naimipour, Foundations of Algorithms, Jones and Barlett Publishers, Canada, Fourth Edition.
9. Sara Base Allen Van Gelder, Computer Algorithms: Introduction to Design and Analysis, Pearson Education Asia.
10. Prabhakar Gupta, Vineet Agarwal, Manish Varshney, Design and Analysis of Algorithms, Prentice Hall India, Second Edition.

MAHATMA GANDHI UNIVERSITY

School of Artificial Intelligence and Robotics
M Sc Artificial Intelligence and Machine Learning

AI M 21 E11 OPERATING SYSTEMS AND VIRTUALIZATION

School Name	School of Artificial Intelligence & Robotics					
Programme	M.Sc. Artificial Intelligence and Machine Learning					
Course Name	Operating Systems and Virtualization					
Type of Course	Elective					
Course Code	AI M 21 E11					
Names of Academic Staff &Qualifications	Prof. Dr. Bindu V R, M.Sc., Ph.D.					
Course Summary &Justification	The course provides a thorough discussion on the fundamentals ofoperating system design, relating these to contemporary design issues and current directions in the development of operating systems.The students will get acquainted with the design principles and implementation on issues of contemporary operating systems. The students will also get adeep understanding of various types of virtualization techniques, theiradvantages and disadvantages, in order to be able to apply them in apractical setting. For illustrating the concepts, four operating systems have been chosen as case studies.					
Semester	I					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Explicit Teaching Seminar, Assignment, case Study etc.	42	14	28	36	120
Pre-requisite	Overview of Computer System and Operating System–Processes, Memory, Scheduling, Input/Output and Files					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Analyse the key design areas that have been instrumental in the development to modern operating systems	U, An	1
2	Elucidate OS design issues raised by the introduction of Multiprocessor and multicore organization.	An	1,2
3	Compare and analyse the structure, functional elements and features of Windows, Traditional and Modern UNIX, Linux and Android operating systems.	An	1,2,4
4	Critically examine the requirements for process control by the OS and analyse the issues involved in the Execution of OS code.	A, An	1,2
5	Develop programs implementing multithreading.	U,A	1,2,3,4
6	Compare and analyse the process and thread management, concurrency and synchronization methods and the virtual memory management mechanisms in UNIX, Linux, Solaris, Windows and Android operating systems.	R, U, An	1,2
7	Identify and analyse the key design issues in multiprocessor thread scheduling and some of the key approaches to scheduling and understand the Requirements imposed by real-time scheduling.	An	1,2,3
8	Analyse and compare the scheduling methods used in Linux, UNIX SVR4, and Windows10.	U,An	1,2
9	Critically examine some of the key issues in the design Of OS support for I/O and describe the I/O mechanisms in UNIX, Linux, and Windows.	U,An	1,2
10	Define and discuss virtual machines and virtualization and conceptualize and implement the various approaches To virtualization.	U,A,An	1,2,3

11	Conceptualize, formulate and design a sample operating system and document, present and demonstrate concepts in a very clear and effective way with the aid of appropriate tools.	U,A,An,C, E	1,2,3,5,6, 10

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S)

COURSE CONTENT

Content for Classroom Transaction

Unit	Course description	Hrs	CO No.
1	Unit I	12	1,2,3
2	Unit II	20	4,5,6,11
3	Unit III	16	7,8,11
4	Unit IV	16	9,11
5	Unit V	20	10,11

COURSE CONTENT

Content for Classroom Transaction

Unit I (12hrs)

Introduction - Characteristics of Modern Operating Systems, Symmetric Multiprocessingand Micro- kernels, Virtual Machines, OS Design Considerations for Multiprocessor and Multicore, Windows Overview, Modern UNIX Systems, Linux, Android.

Unit II (20hrs)

Processes and Threads- Process Description and Control, Security issues, UNIXSVR4 Process Management, Threads, Windows Process and Thread Management, Solaris Thread and SMP Management, Linux Process and Thread Management, Android Process and Thread

Management Unix Concurrency Mechanisms, Linux Kernel Concurrency Mechanisms, Solaris Thread Synchronization Primitives, Windows Concurrency Mechanisms, Android Interprocess Communication.

Unit III (16hrs)

Memory- UNIX and Solaris Memory Management, Linux Memory Management, Windows Memory Management, Android Memory Management.

Scheduling-Traditional UNIX Scheduling, Multiprocessor and Multicore Scheduling, Real-time Scheduling, Linux Scheduling, UNIXSVR4 Scheduling, Windows Scheduling.

Unit IV (16hrs)

Input / Output and Files - UNIX SVR4 I/O, Linux I/O, Windows I/O, Unix File Management, Linux Virtual File Systems, Windows File System, Android File Management.

Unit V (20hrs) Virtualization Concepts: Introduction to Virtual machines; Process Virtual Machines, System Virtual Machines, Multiprocessor Virtualization, Applications for VM Technology Approaches toVirtualization: Hypervisors, Containers, Processor Issue, Memory Management, I/OManagement, VMware ESXi, Microsoft Hyper-V and Xen Variants, Java VM, Linux V ServerVirtual Machine Architecture, Android Virtual Machine.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Authentic learning: Library work and Group discussion, Presentation by individual student/Group representative

Assessment Types	Mode of Assessment
	A. Continuous Internal Assessment (CIA) • Internal Tests–Minimum Two (Extendedanswers/Practical) • Seminar – ▪ Research Literature Review ▪ Report Writing ▪ Presentation • Assignment–Written, Practical, Oral Presentation and Viva • Case study/Mini project **B. Semester End Examination**

REFERENCES

1. William Stallings, Operating Systems: Internals and Design Principles, 9th Ed, Prentice-Hall.
2. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, Operating System Concepts, 8th Ed, John Wiley.
3. James E. Smith, Ravi Nair, Virtual Machines-Versatile Platforms for Systems and Processes, Morgan Kaufmann Publishers.
4. Matthew Portnoy, Virtualization- Essentials, John Wiley & Sons, Inc.

MAHATMAGANDHIUNIVERSITY

School of Artificial Intelligence and Robotics
M Sc Artificial Intelligence and Machine Learning

AI M 21 E12 CYBER PHYSICAL SYSTEMS

School Name	School of Artificial Intelligence & Robotics					
Programme	M.Sc. Artificial Intelligence and Machine Learning					
Course Name	Cyber Physical Systems					
Type of Course	Elective					
Course Code	AI M 21 E12					
Names of Academic Staff & Qualifications	Dr. Abdul Jabbar P, MPhil, PhD					
Course Summary & Justification	The course aims to familiarise with fundamental concepts of Cyber Physical Systems (CPS). The main topics covered in this course are data harvesting, various CPS controls and challenges. The students will get the concepts, principles, and applications of CPS so that they can do abstractions, modelling, design, and analysis of Cyber Physical Systems. It offers students an opportunity to appreciate those concepts, develop new insights and methods, and turn them into practical problem-solving and modelling.					
Semester	I					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Explicit Teaching Seminar, Assignments etc.	42	14	28	 36	120
Pre-requisite	Fundamental of Networking					

MAHATMAGANDHIUNIVERSITY

School of Artificial Intelligence and Robotics
M Sc Artificial Intelligence and Machine Learning

AI M 21 E12 CYBER PHYSICAL SYSTEMS

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Familiarise the fundamental concepts of Cyber Physical Systems (CPS)	R, U, A	1,2,6
2	Understand and analyse various CPS Control	U, A, An	1,2
3	Understand and analyse various data harvesting methods	U, An, S, E	1,2
4	Analyse and evaluate Industrial CPS	An,C,E	1,2,3
5	Manage security, reliability and programming challenges in CPS	A,C,An,E	1,2,3
6	Formulate and evaluate reliable Cyber system to manage data and communication	A, S, C, E	1,2,3,6,7
7	Apply, design and create Cyber Physical System and analyse its performance	U,A,An, C, S	1,2,3,4,6, 7,8,10
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S)			

COURSE CONTENT
Content for Classroom Transaction

Unit	Course description	Hrs	CO No.
1	Unit I	15	1,7
2	Unit II	20	2,7
3	Unit III	15	3,7
4	Unit IV	20	4,7
5	Unit V	14	5,6,7

COURSE CONTENT
Content for Classroom Transaction

AI M 21 E12 CYBER PHYSICAL SYSTEMS

UNIT I - (15 hrs)

Introduction to Cyber Physical Systems (CPS); Characteristics of CPS, CPS Domains, Cross-Domain Analysis, Adaptive control in CPS.

UNIT II (20 hrs)

Distributed Consensus control for wireless CPS, Communication channels of multi agent system, Consensus control, Interaction control theory, Distributed control, Adaptive Quantization, Transmission length.

UNIT III (15 hrs)

Online control and optimization of CPS, Framework, Intelligent Personal Assistant (IPA), Data harvesting problems, Direct RF energy harvesting, Relayed RF energy harvesting.

UNIT IV - (20 hrs)

Industrial CPS, Communication in 5G Mobile Tele-Systems (MTS), Challenges and research trends, Network architecture for Machine-Type-Communication (MTC), Random Access (RA) for MTC.

UNIT V - (14 hrs)

Data reliability challenges, Network wide programming challenges, CPS and human action, Security and privacy of CPS, Validation, Verification and formal methods of CPS.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Explicit Teaching, E-learning Interactive Instruction: Active co-operative learning, Seminar, Group Assignments Authentic learning: Library work and Group discussion, Presentation by individual student/Group representative.
Assessment Types	**Mode of Assessment** **A. Continuous Internal Assessment (CIA)** • Internal Tests – Minimum two (Extended answers) • Seminar –

	▪ Research Literature review ▪ Report writing ▪ Presentation • Assignments – Written, Oral presentation and viva. • Case study **B. Semester End Examination**

REFERENCES

1. Danda B. Rawat, Sabina Jeschke, Christian Brecher, Cyber-Physical Systems Foundations, Principles and Applications, Elsevier Science.
2. Glenn A. Fink, Sabina Jeschke, Security and Privacy in Cyber-Physical Systems Foundations, Principles, and Applications, Wiley.
3. Walid M. Taha, Abd-Elhamid M. Taha, Johan Thunberg, Cyber-Physical Systems: A Model-Based Approach, Springer International Publishing.

MAHATMA GANDHI UNIVERSITY
School of Artificial Intelligence and Robotics
M Sc Artificial Intelligence and Machine Learning

AI M 21 E13 DISTRIBUTED COMPUTING

School Name	School of Artificial Intelligence & Robotics					
Programme	M.Sc. Artificial Intelligence and Machine Learning					
Course Name	Distributed Computing					
Type of Course	Elective					
Course Code	AI M 21 E13					
Names of Academic Staff & Qualifications	Dr. Ivy Prathap, Ph.D.					
Course Summary & Justification	Distributed systems consist of a collection of independent computers that appears to its users as a single coherent system. This course aims to discuss some of the basic principles behind distributed systems, review main paradigms used to organize them and an introduction to distributed programming environment.					
Semester	I					
Total Student LearningTime (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Explicit Teaching Seminar, Assignments etc.	42	14	28	36	120
Pre-requisite	Basics of Computer Networks					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Understand fundamentals of Distributed Systems	U, A, An	1,2,10

2	Elucidate Communication between Distributed Objects	U, E, A, An	1,2,3,4
3	Analyze Co-ordination and Agreement	U, An, E	1,2,9,10
4	Illustrate Concurrency Control in Distributed Transactions	A, An, E	1,2,9,10
5	Elucidate distributed programming environments	U, E, An, R	1,2,7,9,10
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S)			

COURSE CONTENT
Content for Classroom Transaction

Unit	Course description	Hrs	CO No.
1	Unit 1	10	1
2	Unit II	24	2
3	Unit III	20	3
4	Unit IV	16	4
5	Unit V	14	5

COURSE CONTENT

Content for Classroom Transaction

Unit I (10 hours)

Characterization of distributed systems: Introduction, Examples of Distributed Systems, Resource sharing and the Web, Challenges, Architectural models, Fundamental models, Networking issues.

UNIT II (24 hours)

Distributed Objects and Remote Invocation: Communication between Distributed Objects, Remote Procedure Call, Remote Method Invocation, Request Reply Protocol.

UNIT III (20 hours)

Overview of Clocks, Events and Process States, Synchronizing Physical Clocks, Logical time and Logical clocks-Coordination and Agreement: Overview of Distributed Mutual Exclusion-Central Server Algorithm and Ring-Based Algorithm, Elections-Ring based Election Algorithm.

UNIT IV (16 hours)

Distributed Transactions: Flat and Nested Distributed Transactions, Atomic Commit protocols, Concurrency Control in Distributed Transactions, Distributed Deadlocks,Transaction Recovery.

UNIT V (14 hours)

Distributed Shared Memory- Check pointing and Rollback Recovery- Consensus and Agreement- Failure Detectors- Distributed file servers- Distributed programming environments-Communication primitives, selected case studies.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, Interactive Instruction: Active co-operative learning, Seminar, Group Assignments Authentic learning: Library work and Group discussion, Presentation by individual student/Group representative.
Assessment Types	**Mode of Assessment** **A. Continuous Internal Assessment (CIA)** • Internal Tests – Minimum two (Extended answers) • Seminar – ▪ Research Literature review ▪ Report writing ▪ Presentation • Assignments – Written, Oral presentation and viva • Case study **B. Semester End Examination**

REFERENCES

1. George Coulouris, Jean Dollimore, Tim Kindberg, Distributed Systems: Concepts and Design, Pearson Education Asia, 5th Edition.
2. Tanenbaum Andrew S. and Steen Maarten Van, Distributed Systems: Principles and Paradigms, 2nd Edition.
3. Sukumar.Ghosh, "Distributed Systems", Chapman & Hall/CRC, Taylor & Francis Group, 2010.
4. Hagit Attiya, Jennifer Welch, "Distributed Computing: Fundamentals, Simulations, and Advanced Topics ", Wiley Publications.

MAHATMA GANDHI UNIVERSITY
School of Artificial Intelligence and Robotics
M Sc Artificial Intelligence and Machine Learning

AI M 21 C16 MACHINE LEARNING LAB

School Name	School of Artificial Intelligence & Robotics					
Programme	M.Sc. Artificial Intelligence and Machine Learning					
Course Name	Machine Learning Lab					
Type of Course	Core					
Course Code	AI M 21 C16					
Names of Academic Staff & Qualifications	Ms. Jissy Liz Jose M.Tech.					
Course Summary & Justification	The course provides an insight into the fundamentals of Python programming for Machine Learning and Artificial Intelligence based applications. The students will be acquainted with the design and implementation of essential mathematical operations, efficient machine learning algorithms and AI based applications to solve various real-life problems.					
Semester	I					
Total Student LearningTime (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Explicit Teaching Seminar, Assignments etc.	--	28	84	8	120
Pre-requisite	Mathematical Foundations, Programming, and Algorithms					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Familiarise with concepts in Python programming and write, test and debug Python programs.	U, A	1,2
2	Familiarise with built in functions, modules and	U, A, An	1,2

	packages in Python and effectively use the various machine learning tools.		
3	Understand the mathematical and statistical perspectives of machine learning algorithms through python programming.	U, A, An	1,2,3
4	Implement dimensionality reduction techniques, linear and logistic regression, clustering and classification algorithms and analyze its performance	U, A, An, C, E	1,2,3,6,7
5	Design and develop solutions for formal and informal search problems and Game playing algorithms in AI.	U, A, An, C, E	1,2,3,6,7
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S)			

COURSE CONTENT
Content for Classroom Transaction

Practice Python programming and implement various algorithms in Artificial intelligence, Mathematics, and Machine learning. Programs from the following areas are to be at least covered in the lab: Familiarization of Python Programming, Python packages- numpy, scipy, pandas, mathplotlib etc., Implementation of Vector operations, Matrix operations, Calculus, Regression techniques, Dimensionality Reduction techniques, Classification and Clustering algorithms, Formal and Informal search techniques in AI and Game playing algorithms in AI.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Explicit Teaching, E-learning, Active co-operative learning, Inquiry- based instruction, Authentic learning, Library work and Group discussions.
Assessment Types	**Mode of Assessment** **Continuous Internal Assessment (CIA)** • Technical skills evaluation - Correctness of programs • Assignments -Lab Records, Practical and Viva • Internal Test • Case study

REFERENCES

1. Tony Gadis, Starting out with python,2nd edition Pearson Publications.
2. Peter Norton,Alex Samuel, David Aitel, Beginning Python, wrox publications
3. Andreas Muller and Sarah Guido, Introduction to Machine Learning with Python: A Guide for Data Scientists, O'Reilly,2016.
4. Deisenroth, Marc Peter, et al. Mathematics for Machine Learning. Cambridge University Press, 2020.
5. S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach,3rd edition, Pearson Education, 2015.
6. Ethem Alpaydin, "Introduction to Machine Learning", 4th Edition, The MIT Press.
7. Tom M. Mitchell, "Machine Learning", 1st Edition, Tata McGraw-Hill Education.
8. Bishop C.M., Pattern Recognition and Machine Learning, Springer.

MAHATMA GANDHI UNIVERSITY
School of Artificial Intelligence and Robotics
M Sc Artificial Intelligence and Machine Learning

AI M 21 C21 DIGITAL IMAGE PROCESSING

School Name	School of Artificial Intelligence and Robotics					
Programme	M.Sc. Artificial Intelligence and Machine Learning					
Course Name	Digital Image Processing					
Type of Course	Core					
Course Code	AIM 21 C21					
Names of Academic Staff & Qualifications	Prof. Dr. Bindu V R, M. Sc., Ph. D.					
Course Summary & Justification	The course provides a thorough discussion on the fundamentals ofdigital image processing, relating these to contemporary technologies and applications. The students will get a deep understanding of digital image processing operations and can implement these operations practically through programming. They will also be made capable of applying this knowledge for practical applications.					
Semester	II					
Total Student LearningTime (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Explicit Teaching Seminar, Assignment, case Study etc.	42	28	42	8	120
Pre-requisite	Overview of Computer System and basic mathematics.					

COURSE OUTCOMES

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Define the elements of image processing and differentiate color image models in image representation.	U, An	1,2,10

2	Compare and analyse various spatial domain and frequency domain image transformations and filtering techniques.	An	1,2,3
3	Analyse and compare various image enhancement Techniques.	An	1,2
4	Illustrate histogram processing on an image.	A, An	1,2
5	Analyse and compare various image restoration techniques.	An	1,2,3
6	Illustrate different morphological operations on an Image.	A, An	1,2,3
7	Analyse and compare various image segmentation techniques.	An	1,2,3
8	Illustrate segmentation of an image.	A, An	2,3
9	Develop programs implementing the different image processing operations on sample images and illustrate	U, A	1,2
10	Discuss image recognition techniques.	U, An	1,2
11	Analyse and compare the methods for image compression.	An	1,2,3
12	Discuss, analyse and compare the latest technologies and issues in Digital Image Processing.	U, An, A, C, E	1,2,10
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S)			

COURSE CONTENT

Content for Classroom transaction

Unit	Course description	Hrs	CO No.
1	Unit I	20	1

2	Unit II	22	2,12
3	Unit III	24	2,3,4,5,12
4	Unit IV	24	6,7,8,10,12
5	Unit V	22	9,11,12

COURSE CONTENT

Content for Classroom Transaction

Unit 1 (23 hrs)

Elements of digital image processing systems, Elements of visual perception, psycho visual model, brightness, contrast, hue, saturation, mach band effect, Color image fundamentals - RGB,HSI models, Image acquisition and sampling, Quantization, Image file formats, Two-dimensional convolution, correlation, and frequency responses.

Unit II (23 hrs)

Image Transforms- 1D DFT, 2D transforms – DFT, DCT, Discrete Sine, Walsh, Hadamard, Slant, Haar, KLT, SVD, Radon and Wavelet Transform.

Unit III (22 hrs)

Image Enhancement and Restoration- Histogram modification and specification techniques, Noise distributions, Spatial averaging, Directional Smoothing, Median, Geometric mean, Harmonic mean, Contra harmonic filters, Homomorphic filtering, Color image enhancement. Image Restoration – degradation model, Unconstrained and Constrained restoration, Inverse filtering, Wiener filtering, Geometric transformations – spatial transformations, Gray-Level interpolation.

Unit IV (21 hrs)

Image Segmentation and Recognition- Edge detection. Image segmentation by region growing, region splitting and merging, edge linking, Morphological operators: dilation, erosion, opening, and closing. Image Recognition – Patterns and pattern classes, matching by minimum distance classifier, Statistical Classifier. Matching by correlation, Neural network application for image recognition.

Unit V (23 hrs)

Image Compression- Need for image compression, Huffman, Run Length Encoding, Arithmetic coding, Vector Quantization, Block Truncation Coding. Transform Coding – DCT and Wavelet. Image compression standards.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Authentic learning: Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** **C. Continuous Internal Assessment(CIA)** • Internal Tests – Minimum Two (Extended answers / Practical) • Seminar– ▪ Research Literature Review ▪ Report Writing ▪ Presentation • Assignment – Written, Practical, Oral Presentation and Viva • Case study/ Mini project **D. Semester End Examination**

REFERENCES

1. Rafael C. Gonzalez, Richard E. Woods, 'Digital Image processing', Pearson Education,Inc.
2. Scott E Umbaugh, 'Digital Image Processing and Analysis', CRC Press.
3. Anil K.Jain, 'Fundamentals of Digital Image Processing', Prentice Hall of India.
4. David Salomon: Data Compression – The Complete Reference, SpringerVerlag New YorkInc.
5. Rafael C. Gonzalez, Richard E.Woods, Steven Eddins, 'DigitalImage Processing using MATLAB', Pearson Education.
6. William K. Pratt, 'Digital Image Processing', John Wiley, NewYork.
7. Milan Sonka, Vaclav Hlavac, Roger Boyle, 'Image Processing, Analysis, and Machine Vision', Brooks/Cole, Vikas Publishing House.

School Name	School of Artificial Intelligence and Robotics					
Programme	M.Sc. Artificial Intelligence and Machine Learning					
Course Name	Applied Statistics					
Type of Course	Core					
Course Code	AI M 21 C22					
Names of Academic Staff &Qualifications	Dr. Sharon Susan Jacob, M.Tech, Ph.D.					
Course Summary & Justification	This course aim to provide a solid foundation in all aspects of statistics and to enable the students to understand the fundamentals of statistics to apply descriptive measures and probability for data analysis. The course covers the essential topics such as concept correlation, regression, probability and various tests.					
Semester	II					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Explicit Teaching Seminar, Assignments, etc.	42	28	14	 36	 120
Pre-requisite	Proficiency in Linear Algebra and familiarity with Probability					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Understand and implement trending statistical methods to solve problems.	U, A, S	1,3

2	Use techniques of inferential statistics appropriately (confidence intervals, hypothesis tests for proportions, means, chi-squared tests and linear regression).	A, An, E	1,2,3
3	Carry out model selection in a multiple linear regression modelling context	A, E, S	1,3
4	To acquaint the students familiar with basic probability distributions and their basic properties	U, R, An	1,2
5	Able to apply and use the basic concepts related to sampling techniques	A, An	2,3
6	Perform statistical analysis such as correlation and regression	A, An, S	2,3
7	Able to prepare the data and select appropriate methods to represent data graphically and derive the basic descriptive statistics of the data.	A, S, An, E	1,2,3,10
Remember(R),Understand(U),Apply(A),Analyse(An),Evaluate(E),Create(C),Skill (S)			

COURSE CONTENT
Content for Classroom Transaction

Unit	Course description	Hrs	CO No.
1	Unit I	14	1
2	Unit II	15	7
3	Unit III	20	3,6
4	Unit IV	18	4
5	Unit V	17	5

COURSE CONTENT
Content for Classroom Transaction

Unit I (14 hrs)
Introduction to Statistics. Role of Statistics in Data Science. Concept of Population: Finite and Infinite population, Hypothetical and existent population, census method, sample method, types of sampling. Statistical Errors, Absolute Error and Relative error, Reducing Sample Error, Test of Reliability Error.

Unit II (15 hrs)
Classification and Tabulation: Overview of Classification, Statistical Series, Types of Series, Frequency Distribution, Continuous or Grouped Frequency Distribution. Magnitude of Class intervals, Cumulative Frequency Distribution, Two Way Frequency Distribution. Measures of Central Tendency, Measures of Dispersion.

Unit III (20 hrs)
Correlation: Concept of Correlation, Karl Pearson's Coefficient of Correlation, Spearman's rank correlation coefficient, Probable Error in correlation. Regression: Overview of Correlation, Graphical Method, Algebraic Method, Regression Line, Regression Equation, Standard Error of Estimate. Association of attributes: Introduction, Classification, Correlation and Association, Types of Association, Comparison of Observed and Expected Frequencies, Yule's Coefficient of Association, Yule's Coefficient of Colligation, Pearsons' Coefficient of Contingency Partial Association.

Unit IV (18)
Probability: Introduction, Mathematical Properties, Important terms and concepts: Permutation, Combination, Trail, Sample Events, Sample Space, Mutually Exclusive Cases, Exhaustive Events, Independent Events, Dependent Events, Simple and Compound Events, Classical, Relative Frequency. Theorems on probability. Theoretical Distribution: Binominal Distribution, Obtaining Coefficient, Poison Distribution, Normal Distribution.

UnitV (17 hrs)
Sampling Theory and test of significance: Introduction Estimation, Hypothesis, Standard Error, Test of Significance for Attributes, Test of Significance for Large Samples. Test of Significance for Small Samples. Chi-Square Test: Introduction, Assumption, Uses of Chi-Square Test of Goodness of fit, Chi-Square Test of Independence, Yate's Correction, Chi-Square test of Homogeneity, Additive Property.

Technique and Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, Interactive Instruction: Active co-operative learning, Seminar,Group Assignments Authentic learning: Library work and Group discussion, Presentation by individual student/Group representative.
Assessment Types	**Mode of Assessment** **C. Continuous Internal Assessment (CIA)** • Internal Tests–Minimum two (Extended answers/Practical) • Seminar – ▪ Research Literature review ▪ Report writing ▪ Presentation • Assignments–Written, Practical, Oral presentation and viva • Case study/Mini project **D. Semester End Examination**

REFERENCES

1.R.S.N. Pillai, Bagavathi, "Statistics Theory and Practice, S.Chand& Company.

2. Douglas C. Montgomery, George C. Runger., "Applied Statistics & Probability for Engineers", John Wiley & Sons. Inc.

MAHATMA GANDHI UNIVERSITY
School of Artificial Intelligence and Robotics
M Sc Artificial Intelligence and Machine Learning

AI M 21 C23 DEEP LEARNING

School Name	School of Artificial Intelligence and Robotics					
Programme	M.Sc. Artificial Intelligence and Machine Learning					
Course Name	Deep Learning					
Type of Course	Core					
Course Code	AI M 21 C23					
Names of Academic Staff & Qualifications	Ms. Jissy Liz Jose M.Tech					
Course Summary & Justification	Deep Learning is one of the most exciting and promising segments of Artificial Intelligence and machine learning technologies. This course aims to provide foundational concepts of deep neural networks. Advanced deep learning technologies focuses on various applications ranging across speech and natural language processing to machine vision and medical imaging.					
Semester	II					
Total Student LearningTime (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Explicit Teaching Seminar, Assignments etc.	42	28	--	 50	120
Pre-requisite	Machine Learning					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Understand the concepts of artificial neural networks, multilayer perceptrons and apply the back propagation algorithm for training the neural network	U,An,A,E	1,2,3

2	Understand and apply gradient-descent techniques to train deep neural networks.	U, An, A	1,2,3
3	Understand and apply optimization and regularization in deep neural networks	U, An, A	1,2,3
4	Construct and train convolutional and recurrent neural networks.	U, An , A, E	1,2,3,7,8
5	Understand and apply the concept of Auto encoders and Long Short-Term Memory	U, An, A	1,2,3
6	Investigate Advanced Deep Learning Models and Applications	U, A, An, C,E	1,2,3,4,7, 8,10
7	Design and implement efficient algorithms to solve various real-life problems by applying concepts of deep neural network and presenting the approach effectively with appropriate tools.	U, A, An, C, E	1,2,3,4,7, 8,9,10
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S)			

COURSE CONTENT
Content for Classroom Transaction

Unit	Course description	Hrs	CO No.
1	Unit I	12	1
2	Unit II	14	2,3
3	Unit III	16	4
4	Unit IV	12	4,5
5	Unit V	16	6,7

COURSE CONTENT
Content for Classroom Transaction

Unit I (12 hrs.)

Artificial Neural Networks: Introduction, Perceptron Training Rule, Gradient Descent Rule, Activation Functions: Sigmoid, ReLU, Hyperbolic Fns, Softmax, McCulloch Pitts Neuron,

Thresholding Logic, Perceptrons, Perceptron Learning Algorithm.

Unit II (14 hrs.)

Gradient Descent and Backpropagation: FeedForward Neural Networks, Backpropagation, Gradient Descent (GD), Stochastic Gradient Descent, Momentum Based GD, Nesterov Accelerated GD, Backpropagation, Some problems in ANN, vanishing gradient problem, Optimization and Regularization: Overfitting and Capacity, Cross Validation, Feature Selection, Regularization, Bias Variance Tradeoff, L2 regularization, Dataset augmentation, Parameter sharing and tying, Ensemble methods

Unit III (16 hrs.)

Convolutional Neural Networks: Convolution Operation, Pooling Operation, Convolution-Detector-Pooling Building Block, Convolution Variants, Intuition Behind Convolutional Neural Networks, Advanced CNNs and Transfer Learning, GANs.

Unit IV (12 hrs.)

Recurrent Neural Networks: RNN Basics, Training RNNs, Bidirectional RNNs, Encoder-Decoder Architecture, Gradient Explosion and Vanishing, Gradient Clipping, Autoencoders, Long Short-Term Memory

Unit V (16 hrs.)

Advanced Deep Learning Models and Applications: Image Processing, Natural Language Processing, Speech Recognition, Video Analytics.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Explicit Teaching, E-learning Interactive Instruction: Active co-operative learning, Seminar, Group Assignments Authentic learning: Library work and Group discussion, Presentation by individual student/Group representative.
Assessment Types	**Mode of Assessment** **A. Continuous Internal Assessment (CIA)** • Internal Tests – Minimum two (Extended answers) • Seminar – ▪ Research Literature review

	▪ Report writing ▪ Presentation • Assignments – Written, Oral presentation and viva. • Case study **B. Semester End Examination**

REFERENCES

1. Goodfellow, Y. Bengio and A. Courville, Deep Learning, MIT Press.
2. Sandro Skansi, Introduction to Deep Learning, From Logical Calculus to Artificial Intelligence, Springer.
3. Umberto Michelucci, Advanced Applied Deep Learning, Apress.
4. Yegnanarayana B, Artificial Neural Networks, Prentice-HallIndiaPvt.Ltd.
5. N. Buduma, N. Locascio, Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms, O'Reilly.
6. C. Aggarwal, Neural Networks and Deep Learning: A Textbook, Springer.

MAHATMA GANDHI UNIVERSITY
School of Artificial Intelligence and Robotics
M Sc Artificial Intelligence and Machine Learning

AI M 21 C24 FUZZY LOGIC AND NATURE INSPIRED COMPUTING

School Name	School of Artificial Intelligence and Robotics					
Programme	M.Sc. Artificial Intelligence and Machine Learning					
Course Name	Fuzzy Logic and Nature Inspired Computing					
Type of Course	Core					
Course Code	AI M 21 C24					
Names of Academic Staff & Qualifications	Prof. Dr. Bindu V R, M. Sc., Ph. D.					
Course Summary & Justification	The course provides an overview of concepts in fuzzy logic and nature inspired computing. Upon completion of this course, the students will comprehend the fuzzy logic and the concept of fuzziness involved in various systems and fuzzy set theory. The students will also get the concepts, principles, and applications of computing, which are inspired by processes and phenomena found in nature. It offers students an opportunity to appreciate those concepts, develop new insights and methods, and turn them into practical problem-solving and modelling. Particular examples of nature-inspired computing approaches included in this course are Genetic Algorithms, Ant Colony Algorithms, Particle Swam algorithms and Artificial Bee Colony algorithms.					
Semester	II					
Total Student LearningTime (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Explicit Teaching Seminar, Assignments etc.	42	28	28	 22	120
Pre-requisite	Basics of Algorithms, Programming, and Statistical analysis**.**					

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M Sc Artificial Intelligence and Machine Learning

AI M 21 C24 FUZZY LOGIC AND NATURE INSPIRED COMPUTING

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Comprehend the fuzzy logic and the concept of fuzziness involved in various systems.	U	1,2
2	Understand the concepts of fuzzy sets, fuzzification, defuzzification, fuzzy rules, fuzzy inference systems etc. and apply fuzzy logic control to real time system.	U, A	1,2,3,4
3	Understand the underlying nature inspired principles of Genetic Algorithms, Ant Colony Algorithms, Particle Swam algorithms and Artificial Bee Colony algorithms and the key ideas and steps involved in it.	U, A, An	1,2,3,4
4	Compare and analyse different nature inspired computing approaches and understand the strength, weakness, and suitability and applications of each.	U, An, A, E	1,2,3,4,10
5	Apply nature-inspired algorithms to optimization, design and learning problems.	S, A, An	1,2,3,4,7, 8,10
6	Evaluate performance of Nature inspired algorithm in context of problem solving in optimized manner	E, An	1,2,3,10
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S)			

COURSE CONTENT

Content for Classroom Transaction

Unit	Course description	Hrs	CO No.
1	Unit I	22	1,2
2	Unit II	22	3,4,5,6
3	Unit III	18	3,4,5,6
4	Unit IV	18	3,4,5,6
5	Unit V	18	3,4,5,6

AI M 21 C24 FUZZY LOGIC AND NATURE INSPIRED COMPUTING

COURSE CONTENT
Content for Classroom Transaction

Unit I (22 Hours)

Fuzzy Logic: Concepts of uncertainty and imprecision; Properties and operations on classical sets and fuzzy sets; Classical and fuzzy relations; Membership functions and its types; Fuzzification: Fuzzy rule-based systems; Defuzzification; Fuzzy propositions; Fuzzy extension principle; Fuzzy inference system, Fuzzy Logic Control Systems, Recent applications.

UNIT II (22 Hours)

Genetic Algorithms: Difference between traditional algorithms and Genetic Algorithm (GA); Basic concepts of GA; Working principle; Encoding methods; Fitness function; GAOperators: Reproduction, Crossover, Mutation; Convergence of GA; Detailed algorithmic steps; Adjustment of parameters; Multicriteria optimization; Solution of typical problemsusing genetic algorithm; Recent applications.

UNIT III (18 Hours)

Ant Colony Algorithms - Ant colony basics, hybrid ant system, ACO in combinatorial optimisation, variations of ACO.

UNIT IV (18 Hours)

Particle Swam algorithms - particles moves, particle swarm optimization, variable lengthPSO, applications of PSO.

UNIT V (18 Hours)

Artificial Bee Colony algorithms - ABC basics, ABC in optimization, multi-dimensionalbee colony algorithms, applications of bee algorithms, Case studies and Hybrid Systems.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Explicit Teaching, E-learning Interactive Instruction: Active co-operative learning, Seminar, Group Assignments. Authentic learning: Library work and Group discussion, Presentation by individual student/Group representative.

Assessment Types	Mode of Assessment A. Continuous Internal Assessment (CIA) • Internal Tests – Minimum two (Extended answers) • Seminar – ▪ Research Literature review ▪ Report writing
	▪ Presentation • Assignments – Written, Oral presentation and viva. • Case study B. Semester End Examination

REFERENCES

1. D. Goldberg, Genetic Algorithms in Search, Optimization and Machine Learning, Addison-Wesley.
2. S. Rajasekaran and G. A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications, PHI.
3. S. N. Sivanandam and S. N. Deepa, Principles of Soft Computing, 2nd ed., Wiley India.
4. J. Zurada, Introduction to Artificial Neural Systems, Jaico Publishing House.
5. G. Klir, B. Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Pearson.
6. John Yen, Reza Langari, Fuzzy Logic –Intelligence, Control and Information, PearsonEducation.
7. Albert Y.Zomaya, "Handbook of Nature-Inspired and Innovative Computing", Springer.
8. Floreano, D. and C. Mattiussi, "Bio-Inspired Artificial Intelligence: Theories, Methods,and Technologies", MIT Press.
9. Leandro Nunes de Castro, "Fundamentals of Natural Computing, Basic Concepts,Algorithms and Applications" Chapman & Hall/ CRC, Taylor and Francis Group.
10. Marco Dorrigo, Thomas Stutzle -" Ant Colony Optimization", Prentice Hall of India,New Delhi.

MAHATMA GANDHI UNIVERSITY
School of Artificial Intelligence and Robotics
M Sc Artificial Intelligence and Machine Learning

AI M 21 E21 ADVANCED COMPUTER ARCHITECTURE AND PARALLEL PROGRAMMING

School Name	School of Artificial Intelligence and Robotics					
Programme	M.Sc. Artificial Intelligence and Machine Learning					
Course Name	Advanced Computer Architecture and Parallel Programming					
Type of Course	Elective					
Course Code	AI M 21 E21					
Names of Academic Staff & Qualifications	Ms. Jissy Liz Jose, M.Tech					
Course Summary & Justification	The course covers the parallel computer architectures and various parallel programming models. The course further discusses parallel programming with OpenMP and MPI. It also gives training in parallel programming with OpenCL/ CUDA for massively parallel GPUs. The students will be equipped with various technical and programming skills to generate parallel executable software that reduce the delay in getting the output or that increase the speed and overall performanceof a computer system for solving problems that requires huge sized data.					
Semester	II					
Total Student LearningTime (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Explicit Teaching Seminar, Assignments etc.	42	14	28	36	120
Pre-requisite	Computer Organization and Architectures, Microprocessors and Basic Programming Skills					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Understand the difference in the features of single core	U	1,2

	microprocessors and multicore microprocessors.		
2	Conceptualise the specific features of a parallel computer through Flynn's Taxonomy.	U, An	1, 2
3	Evaluate the performance of processors based on memory hierarchy, cache performance and cache designing.	A, An, E	1, 2, 3
4	Develop and test programs that can do shared memory parallel programming using OpenMP	A, An, C	1,2, 3
5	Develop and test programs that can do process to process communication using MPI.	A, An, C	1,2, 3,
6	Demo the application of the features of OpenCL/ CUDA to solve problems that needs massively parallel data handling operations with GPU processors.	A, C, S	1,2,3, 7
7	Document, present and demonstrate concepts of parallel programming in a very clear and effective way with the aid of appropriate tools.	An, E, C	1,2, 3,7,8,9,10
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S)			

COURSE CONTENT
Content for Classroom Transaction

Unit	Course description	Hrs	CO No.
1	Unit I	14	1,3
2	Unit II	18	2
3	Unit III	15	4,7
4	Unit IV	15	5,7
5	Unit V	22	6,7

AI M 21 E21 ADVANCED COMPUTER ARCHITECTURE AND PARALLEL PROGRAMMING

COURSE CONTENT
Content for Classroom Transaction

Unit I (14 hours)
Introduction to Multicore Processors, Single Core Vs Multicore Processors, Architecture of Multicore Processors, Case Study: Architecture of the Intel Core i7, Caches and Memory Hierarchy

Unit II(18 hours)
Parallel Computer Architecture, Flynn's Taxonomy of Parallel Architectures, Memory organization of parallel computers, Parallel Programming Models, Levels of parallelism, Performance Analysis of Parallel Programs

Unit III(15 hours)
Shared Memory Parallel Programming using OpenMP, Shared Memory Programming Model, Multithreaded Programs, Parallelization of Loops, Parallel Tasks.

Unit IV (15 hours)
MPI Processes and Messaging, Distributed Memory Computers, Message Passing Interface, Basic MPI Operations, Process-to-Process Communication, Collective MPI Communication, Sources of Deadlocks.

Unit V(22 hours)
Graphics Processing Unit (GPU) - Anatomy of a GPU, Programmer's View, GPU Programming using OpenCL/ CUDA.

Teachingand LearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Explicit Teaching, E-learning Interactive Instruction: Active co-operative learning, Seminar, Group Assignments Authentic learning: Library work and Group discussion, Presentation by individual student/Group representative.

Assessment Types	Mode of Assessment **A. Continuous Internal Assessment (CIA)** • Internal Tests – Minimum two (Extended answers) • Seminar – ▪ Research Literature review ▪ Report writing ▪ Presentation • Assignments – Written, Oral presentation and viva.
	• Case study **B. Semester End Examination**

REFERENCES

1. A. K. Ray & K. M. Bhurchandi, Advanced Microprocessors and Peripherals- Architectures, 3e, McGrawHill Education (India)Pvt. Ltd.

2. Berry.B.Brey, The Intel Microprocessors 8086/8088 /80186/80188, 80286, 80386,80486 PENTIUM, PENTIUM Pro, PII, PIII & IV Architecture, Programming & Interfacing, Pearson Education..

3. Roman Trobec, Boštjan Slivnik Patricio Bulić, Borut Robič, Introduction to Parallel Computing From Algorithms to Programming on State-of-the-Art Platforms, Springer Nature Switzerland AG 2018, ISSN 1863-7310 ISSN 2197-1781 (electronic).

4. Yan Solihin, Fundamentals of Parallel Multicore Architecture, CRC Press

5. Thomas Rauber, Gudula Runger, Parallel Programming for Multicore and Cluster Systems, Second Edition, Springer-Verlag Berlin Heidelberg, ISBN 978-3-642-37800-3.

6. Aaftab Munshi, Benedict R. Gaster, Timothy G. Mattson, James Fung, Dan Ginsburg, OpenCL Programming Guide, Addison-Wesley, Pearson Education Inc.

7. David W. Walker, Parallel Computing, Encyclopedia of Physical Science and Technology (Third Edition).

AI M 21 E22 CYBER SECURITY AND CYBER LAWS

School Name	School of Artificial Intelligence and Robotics					
Programme	M.Sc. Artificial Intelligence and Machine Learning					
Course Name	Cyber Security and Cyber Laws					
Type of Course	Elective					
Course Code	AIM 21 E22					
Names of Academic Staff & Qualifications	Dr. Ivy Prathap M.Sc. Ph. D.					
Course Summary & Justification	This course focuses on cutting-edge issues in the field of cyber law and security. This furnishes students to understand and work in the fields of internet-enabled and online business and commerce, as well as to understand the implications of online social interactions and actions. The course covers Proxies, Tunnelling technique, Fraud technique, Brute force and dictionary attacks, Cross site scripting, social engineering and protection of information using cyber laws.					
Semester	II					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Explicit Teaching Seminar, Assignment, case Study etc.	42	14	28	36	120
Pre-requisite	Fundamentals of networking					

COURSE OUTCOMES

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Understand the significance of cyber security, cryptography and its importance	R, U	1, 2, 7, 8, 9
2	Analyze Attacker technique and motivations	A, An, S, E	2, 3, 7, 8, 9
3	Analyse and evaluate various cyber attacks	C, An, S, E	2, 3, 7, 8, 9, 10
4	Understand various cybercrimes and cyber laws to protect information	U, A, An	2, 4, 7,8, 9
5	Illustrate cyber laws to protect information in social media	A, C, An, E	2, 7, 8, 9,10
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S)			

COURSE CONTENT
Content for Classroom Transaction

Unit	Course description	Hrs	CO No.
1	Unit I	15	1
2	Unit II	20	2
3	Unit III	15	3
4	Unit IV	20	4
5	Unit V	14	5

COURSE CONTENT
Content for Classroom Transaction

Unit I (15 hrs)

Introduction to Cyber Security; Information security, Network and security concept; Information assurance fundamentals, Basic cryptography, Symmetric encryption, Public key encryption, firewalls and virtualization.

Unit II (20 hrs)

Attacker technique and motivations; Using Proxies, Tunneling technique, Fraud technique, Rogue antivirus, Click fraud, Threat infrastructure, Exploitation; Shell code, Integer overflow, Stack based buffer overflows, String vulnerabilities, SQL injection, Malicious PDFfile, Race condition, Web exploit tools, DoS condition.

Unit III (15 hrs)

Brute force and dictionary attacks, Cross site scripting, Social engineering, WarXing, Malicious code; self-replicating malicious code, Evading detection and elevating privileges, Stealing information and exploitation, Memory forensics, Honeypots, Malicious code naming, Intrusion detection system

Unit IV (20 hrs)

Famous cybercrimes, Cybercrime taxonomy, Civil vs criminal cybersecurity offenses, Basic element of criminal law, Branches of law, Tort law, Cyber law enforcement, Cybersecurity law jurisdiction, Cybercrime and cyber tort punishment.

Unit V (14 hrs)

Cyber privacy and data protection law; Common law of privacy, Privacy laws, Data breach laws, Data breach litigation, Privacy notice law, Personal liability, Data disposal law, Cryptography and digital forensics law, Social media privacy, Future development in cybersecurity law.

Classroom Procedure	**Mode of transaction** Direct Instruction: Brain storming lecture, Practical Session, Explicit Teaching, E-learning, Interactive Instruction:, Active co-operative learning, Seminar, Group Assignments Authentic learning, Library work and Group discussion, Presentation by individual student/ Group representative.
Assessment Types	**Mode of Assessment** **A. Continuous Internal Assessment (CIA)** • Internal Tests – Minimum two (Extended answers / Practical) • Seminar – 1. Research Literature review 2. Report writing 3. Presentation

	• Assignments – Written, Practical, Oral presentation and viva • Case study/Mini project **B. Semester End Examination**

REFERENCES

1. James Graham, Rick Howard, Ryan Olson, Cyber Security Essentials, CRC Press, 2016.
2. MayankBhushan, Rajkumar Singh Rathore, AatifJamshed, Fundamentals of Cyber Security, BPB Publications, 2017.
3. TariSchreider, Cybersecurity Law, Standards and Regulations, 2nd Edition, Rothstein Publishing, 2020.
4. Information Resources Management Association, Cyber Law, Privacy, and Security Concepts, Methodologies, Tools, and Applications, IGI Global, 2019.
5. Jeff Kosseff, Cybersecurity Law, Wiley, 2019.

MAHATMA GANDHI UNIVERSITY
School of Artificial Intelligence and Robotics
M Sc Artificial Intelligence and Machine Learning

AI M 21 E23 INTERNET OF THINGS AND BLOCK CHAIN TECHNOLOGIES

School Name	School of Artificial Intelligence and Robotics					
Programme	M.Sc. Artificial Intelligence and Machine Learning					
Course Name	Internet of Things and Block Chain Technologies					
Type of Course	Elective					
Course Code	AI M 21 E23					
Names of Academic Staff & Qualifications	Dr. Abdul Jabbar P, MPhil, PhD					
Course Summary & Justification	The course covers the theoretical concept of the design, configuration, and implementation of block chain connected devices. The course includes in-depth coverage of various aspects of connections, smart object, smart environment and privacy issues of IoT and block chain. This course enables students to build different IoT based solutions and use principles of Blockchain technology and its applications over different sectors.					
Semester	II					
Total Student LearningTime (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Explicit Teaching Seminar, Assignments etc.	42	14	28	 36	120
Pre-requisite	Programming, Computer Networks, Operating Systems, Cryptography and Network Security.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Understand the applications and basic concepts of IoT and Block chain.	U, A,R	1,2,10
2	Understand and formulate key Block chain concepts	U, An, S, E	3,4

3	Create IoT smart object in smart environment	C,A,S, E	1,2,3
4	Identify the security and privacy issue of IoT	A, An ,C	1,2,3,7
5	Manage and develop secure system using IoT and Block chain	A, C, An, E	1,2,3,8
6	Formulate and evaluate remote controllable systems	A,S,C, E	1,2,3
7	Analyze, apply and use various cryptographic methods to secure data and connected devices.	U,A	1,2,3, 7
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S)			

COURSE CONTENT
Content for Classroom Transaction

Unit	Course description	Hrs	CO No.
1	Unit I	15	1
2	Unit II	20	2
3	Unit III	15	3
4	Unit IV	20	4,6
5	Unit V	14	5,7

COURSE CONTENT
Content for Classroom Transaction

Unit I (15 hrs)
Introduction to Blockchain in Internet of Things, Overview, Blockchain application in internet of things, Security and privacy in Internet of things, Technical dimensions of blockchain, Consensus mechanism, Key issues in internet of things, Architectures of Internet of things, Evaluation metrics of internet of things.

Unit II (20 hrs)
Key Blockchain concepts, Nodes, Cryptocurrency, Tokens, Cryptography, Modern encryption, Public and Private keys, Hash, Ledgers, Proof of work, Proof of stake,

Hyperledger, Ripple, Unearthing Ethereum, Second generation application of blockchain techniques, Smart contracts, Decentralised application.

Unit III (15 hrs)

Internet of things concepts, Smart object and smart environment, Machines to machines communication, IoT framework, Network connectivity, Sensors, Actuator, Radio frequency identification, Middleware Technologies, Data Exchange.

Unit IV (20hrs)

Security and Privacy issues in internet of things; Confidentiality, Integrity, Authentication, Privacy concerns in IoT; Identity, Location, Trajectory, Blockchain in privacy preserving cloud data storage services; Technical dimension in cloud data preserving services, Basic techniques, Threat model, Data submission, Primitiveness identification, Blockchain enabled controllable data management, System initialization, Document modification, Documents Management, User registration, Voting and counting, Use case.

Unit V (14 hrs)

Quantitative analysis; Problem of interest, Programs as graph, Factors determining execution time, Execution time analysis, Security and Privacy; Cryptographic primitives, Protocol and networks security, Information flow, Identity, Blockchain Protected Identity, Blockstack, Microsoft, IBM's Trusted Identity, Blockchain and IoT, Toyota, IBM.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Explicit Teaching, E-learning Interactive Instruction: Active co-operative learning, Seminar, Group Assignments Authentic learning: Library work and Group discussion, Presentation by individual student/Group representative.
Assessment Types	**Mode of Assessment** **A. Continuous Internal Assessment (CIA)** • Internal Tests – Minimum two (Extended answers) • Seminar – ▪ Research Literature review ▪ Report writing ▪ Presentation • Assignments – Written, Oral presentation and viva. • Case study

	B. Semester End Examination

REFERENCES

1. Shiho Kim, Peng Zhang and Ganesh Chandra, Role of Blockchain Technologies in IoT Applications, Academic Press, Elsevier.
2. Liehuang Zhu,Keke Gai and Meng Li, Blockchain Technology in Internet of Things, Springer International Publishing.
3. Qusay F. Hassan, Internet of Things A to Z; Technologies and Applications, Wiley.
4. Chellammal Surianarayanan, Kavita Saini, Pethuru Raj, Blockchain Technology and Applications, CRC Press.
5. Ahmed Banafa, Secure and Smart Internet of Things (IoT) Using Blockchain and Artificial Intelligence (AI), River Publishers.

MAHATMA GANDHI UNIVERSITY
School of Artificial Intelligence and Robotics
M Sc Artificial Intelligence and Machine Learning

AI M 21 C26 DEEP LEARNING LAB

School Name	School of Artificial Intelligence and Robotics					
Programme	M.Sc. Artificial Intelligence and Machine Learning					
Course Name	Deep Learning Lab					
Type of Course	Core					
Course Code	AI M 21 C26					
Names of Academic Staff & Qualifications	Ms. Jissy Liz Jose M.Tech.					
Course Summary & Justification	Deep Learning is one of the most exciting and promising segments of Artificial Intelligence and Machine Learning technologies. This course aims to provide practical skills on deep neural networks. After completion of this course, the students will be acquainted with the knowledge of developing a successful deep learning model from scratch.					
Semester	II					
Total Student LearningTime (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Explicit Teaching Seminar, Assignments etc.	--	28	84	 8	120
Pre-requisite	Python Programming, Machine Learning					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Implement backpropagation algorithm for training the neural network	U,An,A,E	1,2,3,8
2	Implement gradient-descent techniques to train deep neural networks.	U, An, A	1,2,3

3	Construct and train convolutional and recurrent neural networks.	U, An, A, E	1,2,3,8
4	Design and develop Auto encoders and Long Short-Term Memory	U, An, A	1,2,3
5	Evaluate the performance of deep learning models	An, A, E	1,2,3
6	Design and implement an application of deep learning by applying concepts of deep neural network and present the approach effectively with appropriate tools.	U, A, An, S,C,E	1,2,3,5, 8,10
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S)			

COURSE CONTENT

Content for Classroom Transaction

Apply deep learning techniques to solve problems by implementing and testing relevant learning algorithms. The programs from following topics are to be at least covered in the lab. Familiarization of deep libraries - Tensorflow, Keras, Caffe etc., Implementation of backpropagation algorithm, gradient-descent techniques to train deep neural networks, convolutional and recurrent neural networks, Auto encoders and Long Short-Term Memory and Case Studies.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Explicit Teaching, E-learning, Active co-operative learning, Inquiry- based instruction, Authentic learning, Library work and Group discussions.
Assessment Types	**Mode of Assessment** **Continuous Internal Assessment (CIA)** • Technical skills evaluation - Correctness of programs • Assignments -Lab Records, Practical and Viva • Internal Test • Case study

REFERENCES

1. Ronald T. Kneusel, Practical Deep Learning: A Python-Based Introduction, No StarchPress, 2021.
2. Goodfellow, Y. Bengio and A. Courville, Deep Learning, MIT Press.
3. Umberto Michelucci, Advanced Applied Deep Learning, Apress.
4. Yegnanarayana B, Artificial Neural Networks, Prentice-HallIndia Pvt.Ltd.
5. N. Buduma, N. Locascio, Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms, O'Reilly.
6. C. Aggarwal, Neural Networks and Deep Learning: A Textbook, Springer.

MAHATMA GANDHI UNIVERSITY
School of Artificial Intelligence and Robotics
M Sc Artificial Intelligence and Machine Learning

AI M 21 C31 COMPUTER VISION

School Name	School of Artificial Intelligence and Robotics					
Programme	M.Sc. Artificial Intelligence and Machine Learning					
Course Name	Computer Vision					
Type of Course	Core					
Course Code	**AI M 21 C31**					
Names of Academic Staff & Qualifications	Prof. Dr. Bindu V R, M. Sc., Ph. D.					
Course Summary & Justification	Computer vision seeks to develop algorithms that replicate one of the most amazing capabilities of the human brain, inferring properties of the external world purely by means of the light reflected from various objects to the eyes. We can determine how far away these objects are, how they are oriented with respect to us, and in relationship to various other objects. This is a field of computer science that focuses on enabling computers to identify and understand objects and people in images and videos. This course provides an introduction to computer vision including shapes, regions and boundaries, 3D vision, recent researches and applications.					
Semester	III					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Explicit Teaching Seminar, Assignment, case Study etc.	42	28	--	50	120
Pre-requisite	Fundamentals of image processing					

COURSE OUTCOMES

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Understand image processing fundamentals	U, An	1,2,10

2	Discuss shapes, regions and boundary tracking procedures	An, A, E	1,2,3
3	Understand Hough Transform	U, An	1,2,3
4	Illustrate 3D vision	U, A, An, C	1,2,3,9
5	Understand motion and types	U, A, C	1,2,3
6	Discuss case Studies and recent researches in Computer Vision	U, An, A, C, E	1,2,3,4,9
7	Illustrate applications of Computer Vision	A, An	1,2,9,10
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S)			

COURSE CONTENT

Content for Classroom transaction

Unit	Course description	Hrs	CO No.
1	Unit I	12	1
2	Unit II	15	2
3	Unit III	13	3
4	Unit IV	15	4, 5
5	Unit V	15	7, 8

Content for Classroom Transaction

Unit I (12 hrs)

Image Processing Foundations: Review of image processing techniques; classical filtering operations; thresholding techniques; edge detection techniques; corner and interest point detection; mathematical morphology; texture.

Unit II (15 hrs)

Shapes And Regions: Binary shape analysis; connectedness; object labelling and counting; size filtering; distance functions; skeletons and thinning; deformable shape analysis; boundary tracking procedures; active contours; shape models and shape recognition; centroidal profiles; handling occlusion; boundary length measures; boundary descriptors; chain codes; Fourier descriptors; region descriptors; moments.

Unit III (13 hrs)

Hough Transform: Line detection; Hough Transform (HT) for line detection; foot-of-normal method; line localization; line fitting; RANSAC for straight line detection; HT based circular object detection; accurate centre location; speed problem; ellipse detection; Generalized Hough Transform (GHT); spatial matched filtering; GHT for ellipse detection; object location; GHT for feature collation.

Unit IV (15 hrs)

3D Vision: Methods for 3D vision; projection schemes; shape from shading; photometric stereo; shape from texture; shape from focus; active range finding; surface representations; point-based representation; volumetric representations; 3D object recognition;3D reconstruction.

Introduction To Motion: Triangulation; bundle adjustment; translational alignment; Parametric motion; spline-based motion; optical flow; layered motion

Unit V (15 hrs)

Case Studies and recent researches in Computer Vision: Applications like face detection, face recognition, eigen faces, surveillance, foreground-background separation, particle filters, Chamfer matching, tracking, and occlusion; combining views from multiple cameras; human gait analysis; locating roadway; road markings; identifying road signs; locating pedestrians.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Authentic learning: Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** **C. Continuous Internal Assessment (CIA)** • Internal Tests – Minimum Two (Extended answers / Practical) • Seminar– ▪ Research Literature Review ▪ Report Writing ▪ Presentation • Assignment – Written, Practical, Oral Presentation and Viva • Case study/ Mini project **D. Semester End Examination**

REFERENCES

1. D. Forsyth, J. Ponce, Computer Vision: A Modern Approach, Pearson Education.
2. J. Solem, Programming Computer Vision with Python: Tools and Algorithms for Analyzing Images.
3. M. Nixon and A. Aquado, Feature Extraction & Image Processing for Computer Vision, 3rd Edition, Academic Press.
4. R. Jain, R. Kasturi, B. Schunck, Machine Vision, Indo American Books.
5. R. Szeliski, Computer Vision: Algorithms and Applications, Springer.
6. S. Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press.

School Name	School of Artificial Intelligence and Robotics					
Programme	M.Sc. Artificial Intelligence and Machine Learning					
Course Name	Data Science and Analytics					
Type of Course	Core					
Course Code	AI M 21 C32					
Names of Academic Staff &Qualifications	Dr. Sharon Susan Jacob, M.Tech, Ph.D.					
Course Summary & Justification	The main motive of the program is to enable students to create innovative solutions to real-time problems, the students are transformed to professionals by preparing them to critically analyze, design, and implement solutions based on strong theoretical and practical knowledge. Also provides the basic introduction to bigdata analysis.					
Semester	III					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Explicit Teaching Seminar, Assignments, etc.	42	28	-	50	120
Pre-requisite	Should have good knowledge in machine learning and statistics					

COURSE OUTCOMES(CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Define data science, its scope and applications	U, An	1,3

2	Describe the Data Science process and how its components interact.	U, E	1,3
3	Differentiate data science and data analytics	U, R	1
4	Apply EDA and the Data Science process in a case study	A, An	1,10
5	Classify Data Science problems	R, C	1,3
6	Understand the concept of Bigdata	U, R	1,3,10
7	Understand NoSql databases, HDFS and MapReduce	U, R, E	1,3
Remember(R), Understand(U),Apply(A),Analyse(An),Evaluate(E),Create(C),Skill (S)			

COURSE CONTENT

Content for Classroom Transaction

Unit	Course description	Hrs	CO No.
1	Unit I	12	1
2	Unit II	14	2,3
3	Unit III	13	4
4	Unit IV	16	6
5	Unit V	15	7

COURSE CONTENT

Content for Classroom Transaction

Unit I (12 hrs)

Introduction to Data Analytics: Sources and nature of data, classification of data (structured, semi-structured, unstructured), characteristics of data, need of data analytics, evolution of analytic scalability, analytic process and tools, analysis vs reporting, modern data analytic tools, applications of data analytics.

Unit II (14 hrs)

Data Analytics Lifecycle: Need, key roles for successful analytic projects, various phases of data analytics lifecycle – discovery, data preparation, model planning, model building, communicating results, operationalization.

Data Pre-processing and Feature selection: Data cleaning - Data integration - Data Reduction - Data Transformation and Data Discretization, Feature Generation and Feature Selection, Feature Selection algorithms.

Unit III (13 hrs)

Application: Exploratory Data Analysis (EDA), statistical measures, Basic tools (plots, graphs and summary statistics) of EDA, Data Analytics Lifecycle, Discovery, EDA case study, Web scraping, Text data and Natural Language Processing. Data Visualization, Data Science and Ethical Issues, Discussions on privacy, security, ethics.

Unit IV (16 hrs)

Bigdata – Concepts, Types and sources of Bigdata, Characteristics, Challenges of bigdata, Bigdata applications, Hadoop Distributors. NoSQL databases – Types of NoSQL databases, SQL vs NoSQL. Introduction to Hadoop, Features of Hadoop, Hadoop core components – HDFS, MapReduce, YARN.

Unit V (15 hrs)

Hadoop Distributed File System (HDFS)- HDFS architecture, Applicability of HDFS, Processing data with Hadoop – MapReduce, MapReduce Examples. Hadoop ecosystem technologies – Data Ingestion: Sqoop, Flume, Data processing: Spark, MapReduce, Data Analysis: Pig, Hive, Impala, Coordination: Zookeeper, Database: HBase, Streaming: Flink, Storm.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, Interactive Instruction: Active co-operative learning, Seminar,Group Assignments Authentic learning: Library work and Group discussion, Presentation by individual student/Group representative.
Assessment Types	**Mode of Assessment** **E. Continuous Internal Assessment(CIA)** • Internal Tests–Minimum two (Extended answers/Practical) • Seminar – ▪ Research Literature review ▪ Report writing ▪ Presentation • Assignments–Written, Practical, Oral presentation and viva • Case study/Mini project **F. Semester End Examination**

REFERENCES

1. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer
2. Tom White “Hadoop: The Definitive Guide” Third Edition, O’reily Media, 2012.
3. Seema Acharya, Subhasini Chellappan, "Big Data Analytics" Wiley 2015.
4. Mining of Massive Datasets. v2.1, Jure Leskovek, Anand Rajaraman and Jefrey Ullman., Cambridge University Press. (2019).
5. Data Mining: Concepts and Techniques”, Third Edition, 2 Jiawei Han, Micheline Kamber and Jian Pei, ISBN 0123814790, (2011).

MAHATMA GANDHI UNIVERSITY
School of Artificial Intelligence and Robotics
M Sc Artificial Intelligence and Machine Learning

AIM 21 E31 REINFORCEMENT LEARNING

School Name	School of Artificial Intelligence and Robotics					
Programme	M.Sc. Artificial Intelligence and Machine Learning					
Course Name	Reinforcement Learning					
Type of Course	Elective					
AI M 21 E33	AI M 21 E31					
Names of Academic Staff & Qualifications	Dr. Ivy Prathap M.Sc. Ph. D.					
Course Summary & Justification	Reinforcement learning is an area of machine learning, where an agent or a system of agents learns to achieve a goal by interacting with their environment. This is a powerful model for learning and sequential decision making and significant to a vast range of tasks, including robotics, game playing, consumer modeling and healthcare. This course introduces the statistical learning techniques where an agent explicitly takes actions and interacts with the world.					
Semester	III					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Explicit Teaching Seminar, Assignment, case Study etc.	42	14	28	36	120
Pre-requisite	Basic statistics					

COURSE OUTCOMES

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Understand the basics of Reinforcement Learning	U, An	1,2

2	Analyse the RL problem	An, A, S	1,2
3	Solve the RL problem	A, E, S	1,2,3
4	Elucidate Long-life learning in agents	E, A, R	1, 2, 9
5	Examine Distributed Reinforcement Learning .	An, E	1,2

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S)

COURSE CONTENT

Content for Classroom Transaction

Unit	Course description	Hrs	CO No.
1	Unit I	10	1
2	Unit II	24	2,3
3	Unit III	20	3
4	Unit IV	16	4
5	Unit V	14	5

COURSE CONTENT

Content for Classroom Transaction (Sub-units)

Unit I (10 hrs)

Introduction to Reinforcement Learning (RL) – Elements – Limitations and scope- Types of Reinforcement Learning - Supervised vs. unsupervised vs. Reinforcement Learning -Defining RL framework.

Unit II (24 hrs)

Defining an RL problem – Markov Decision Processes - The Agent -E nvironment relationship, Markov Property, Markov Process and Markov chains, Markov Reward Process. Classic Exploration strategies - Epsilon-greedy**,** Upper confidence bounds, Boltzmann exploration, Thompson sampling.

Unit III (20 hrs)

Solving an RL problem – Model based vs. Model-free reinforcement learning methods- Dynamic Programming, role of value functions, policy evaluation, policy improvement – value improvement - Monte Carlo methods - On-policy and off policy methods- Temporal Difference learning – SARSA and Q-Learning.

Unit IV (16 hrs)

n-step Bootstrapping - n-step TD Prediction - n-step SARSA – n-step off policy learning - Towards Long-life learning in agents- Reinforcement Learning in the multi-agent framework.

Unit V (14 hrs)

Imitation learning, Inverse Reinforcement Learning, Distributed Reinforcement Learning -Frontiers of RL research: using LSTM, Attention models, Transformers with reinforcement learning- Open challenges and hot topics in reinforcement learning.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, Interactive Instruction: Active co-operative learning, Seminar,Group Assignments Authentic learning: Library work and Group discussion, Presentation by individual student/Group representative.

AIM 21 E31 REINFORCEMENT LEARNING

Assessment Types	**Mode of Assessment** **E. Continuous Internal Assessment(CIA)** • Internal Tests–Minimum two (Extended answers/Practical) • Seminar – ▪ Research Literature review ▪ Report writing ▪ Presentation • Assignments–Written, Practical, Oral presentation and viva • Case study/Mini project **F. Semester End Examination**

REFERENCES

1. Richard S. Sutton and Andrew G. Barto, "Reinforcement Learning - An Introduction",Second Edition, The MIT Press.
2. Alberto Leon-Garcia , "Probability, Statistics, and Random Processes for ElectricalEngineering", 3rd Edition, Pearson Prentice Hall.
3. Szepesvári, Csaba. "Algorithms for reinforcement learning", Synthesis lectures onartificial intelligence and machine learning 4.1 (2010): 1-103.

MAHATMA GANDHI UNIVERSITY
School of Artificial Intelligence and Robotics
M Sc Artificial Intelligence and Machine Learning

AI M 21 E32 NATURAL LANGUAGE PROCESSING

School Name	School of Artificial Intelligence and Robotics					
Programme	M. Sc. Artificial Intelligence and Machine Learning					
Course Name	Natural Language Processing					
Type of Course	Elective					
Course Code	AIM 21 E32					
Names of Academic Staff & Qualifications	Ms. Jissy Liz Jose, M.Tech					
Course Summary & Justification	The course provides an insight into the principles and methodological introduction to the most widely used and effective strategies of natural language processing. The course examines various NLP models and algorithms, text retrieval strategies, exploratory analysis, syntactic parsing, semantics and pragmatics. NLP has applications in many domains such as computer science, journalism, social science, psychology, political science etc. where language processing is crucial. After successfully completing this course, the students will be able to understand the significance of natural language processing in solving real-world problems. They will be able to map the appropriate processing technique to a problem and implement the technique.					
Semester	III					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Explicit Teaching Seminar, Assignment, case Study etc.	42	14	28	36	120
Pre-requisite	Basics of Algorithms and Statistical analysis.					

COURSE OUTCOMES

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Understand the fundamental concepts and steps of natural language processing.	R, U	1,2,3
2	Distinguish among the various NLP	U, An, E	1,2,3

	techniques, considering the assumptions, strengths, and weaknesses of each.		
3	Apply preliminary pre-processing on text data, extract features and tokenize it.	A, An, C	1,2,3
4	Apply Parsing with Context-Free Grammars and Features and Unification	U, A	1,2,3
5	Understand and analyse the semantics and pragmatics in terms of NLP	U, An	1,2,3
6	Design and Implement Information Extraction, Machine Translation and Encoder-Decoder Models	A, S, An, E	1,2,3,8,10
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S)			

COURSE CONTENT

Content for Classroom Transaction (Sub-units)

Unit	Course description	Hours	CO No.
1	Unit I	19	1,2
2	Unit II	18	3
3	Unit III	17	4
4	Unit IV	15	5
5	Unit V	15	6

COURSE CONTENT

Content for Classroom Transaction (Sub-units)

Unit I (19 hrs)

Introduction to Natural Language Processing (NLP), History of NLP, Origin and challenges of NLP, Text Analytics and NLP, Various Steps in NLP, Regular Expressions and Automata, Text Normalization, Edit Distance Words, Words and Transducers, N-gram Language Models, Part-of-Speech Tagging, Evaluating Language Models.

Unit II (18 hrs)

Vector Semantics and Embeddings, Lexical Semantics, Vector Semantics, Words and Vectors, Cosine for measuring similarity, TF-IDF, Word2vec, Visualizing Embeddings, Semantic properties of embeddings, Evaluating Vector Models.

Unit III (17 hrs)

Formal Grammars of English, Syntactic Parsing, Statistical Parsing, Features and Unification, Language and Complexity .

Unit IV (15 hrs)

Semantics and Pragmatics- The Representation of Meaning, Computational Semantics, Lexical Semantics, Computational Lexical Semantics, Computational Discourse.

Unit V (15 hrs)

Information Extraction, Question Answering and Summarization, Dialog and Conversational Agent, Machine Translation and Encoder-Decoder Models, Sequence Modelling and Deep Learning.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Authentic learning: Library work and Group discussion, Presentation by individual student/ Group representative
sessment Types	**Mode of Assessment** **C. Continuous Internal Assessment (CIA)** • Internal Tests – Minimum Two (Extended answers / Practical) • Seminar– ▪ Research, Literature Review ▪ Report Writing ▪ Presentation • Assignment – Written, Practical, Oral Presentation and Viva • Case study/ Mini project **D. Semester End Examination**

REFERENCES

1. Dan Jurafsky and James H. Martin, Speech and Language Processing, An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition, Prentice Hall series in artificial intelligence
2. Dwight Gunning: Sohom Ghosh, Natural Language Processing fundamentals, Packt Publishing.
3. Palash Goyal and Sumit Pandey, Deep Learning for Natural Language Processing: Creating Neural Networks with Python, Apress.
4. Steven Bird, Ewan Klein, Edward Loper, Natural Language Processing with Python – Analyzing Text with the Natural Language Toolkit, O'Reilly.

MAHATMA GANDHI UNIVERSITY
School of Artificial Intelligence and Robotics
M Sc Artificial Intelligence and Machine Learning

AIM 21 E33 AI IN BIOINFORMATICS

School Name	School of Artificial Intelligence and Robotics					
Programme	M.Sc. Artificial Intelligence and Machine Learning					
Course Name	AI in Bioinformatics					
Type of Course	Elective					
AI M 21 E33	AI M 21 E33					
Names of Academic Staff & Qualifications	Dr. Ivy Prathap M.Sc. Ph. D.					
Course Summary & Justification	AI is transforming the field of Bioinformatics. This course discusses the fundamentals of how Artificial intelligence (AI) is applied in the field of bioinformatics. This includes Bioinformatics and Data Mining, Biological Sequence Analysis and Ethics in Bioinformatics.					
Semester	III					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Explicit Teaching Seminar, Assignment, case Study etc.	42	14	28	36	120
Pre-requisite	Fundamentals of Data Mining					

COURSE OUTCOMES

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Understand the basics of Bioinformatics	U, An	1,10
2	Analyse Biological sequence	U, A, An, S	1, 3
3	Analyse text retrieval in biomedicine	A, An	1, 2

4	Illustrate data mining in medicine	U, A, An	1, 3,9
5	Analyse Case Studies and recent research in application of artificial intelligence in bioinformatics .	An, E, S	1, 2, 3,10
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S)			

Unit	Course description	Hrs	CO No.
1	Unit I	10	1
2	Unit II	24	2
3	Unit III	16	3
4	Unit IV	20	4
5	Unit V	14	5

COURSE CONTENT

Content for Classroom Transaction (Sub-units)Unit I

(10 hrs)

Introduction to Bioinformatics and Data Mining; Molecular Biology background: Analysing DNA; Bioinformatics perspective of how individuals of a species differ and how different species differ; Bioinformatics challenges and opportunities.

Unit II (24 hrs)

Biological Sequence Analysis: DNA sequence analysis; DNA databases; Protein structure and function; Protein sequence databases; Sequence alignment; Sequence comparison, Sequence

similarity search; Longest common subsequence problem; Scoring matrices for similarity search PAM, BLOSUM, etc.

Unit III (16 hrs)

Mining Biological Data: Protein structural classification; Protein structural prediction; Modelling text retrieval in biomedicine; Mining from microarray and gene expressions; Feature selection for proteomic and genomic data mining.

Unit IV (20 hrs)

Ethics in Bioinformatics: Ethical and social challenges of electronic health information; Public access to anatomic images; Evidence based medicine; Outcome measures and practice guidelines forusing data mining in medicine; Computer assisted medical and patient education.

Unit V (14 hrs)

AI in Medical Informatics: Infectious disease informatics and outbreak detection; Identification of biological Relationships from text documents; Medical expert systems; Telemedicine and tele surgery; Internet grateful med (IGM).Case Studies and recent research in application of artificial intelligence in bioinformatics.

References

1. S. Rastogi, N. Mendiratta and P. Rastogi, Bioinformatics: Methods and Applications: Genomics,Proteomics and Drug Discovery, PHI.
2. Z. Ghosh, B. Mallick, Bioinformatics: Principles and Applications, Oxford University Press.
3. J. Chen and S. Lonardi, Biological Data Mining, Chapman and Hall/CRC.
4. V. Buffalo, Bioinformatics Data Skills, O′Reilly Publishing.
5. H. Zengyou, Data Mining for Bioinformatics Applications, Woodhead Publishing.
6. L. Low, Bioinformatics: A Practical Handbook of Next Generation Sequencing and its
7. Applications, World Scientific Publishing.
8. M. Model, Bioinformatics Programming Using Python, O′Reilly Publishing.

AIM 21 E33 AI IN BIOINFORMATICS

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Authentic learning: Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** **E. Continuous Internal Assessment(CIA)** • Internal Tests – Minimum Two (Extended answers / Practical) • Seminar– ▪ Research Literature Review ▪ Report Writing ▪ Presentation • Assignment – Written, Practical, Oral Presentation and Viva • Case study/ Mini project **F. Semester End Examination**

MAHATMA GANDHI UNIVERSITY
School of Artificial Intelligence and Robotics
M Sc Artificial Intelligence and Machine Learning

AI M 21 E34 INTRODUCTION TO ROBOTICS

School Name	School of Artificial Intelligence and Robotics					
Programme	M.Sc. Artificial Intelligence and Machine Learning					
Course Name	Introduction to Robotics					
Type of Course	Elective					
Course Code	AI M 21 E34					
Names of Academic Staff &Qualifications	Dr. Sharon Susan Jacob, M.Tech, Ph.D.					
Course Summary &Justification	The purpose of this course is to introduce the basics of modelling, design, planning, and control of robot systems. This course provides an overview of robot mechanisms, dynamics, and intelligent controls. Topics include planar and spatial kinematics, trajectory generation, robot sensors and applications.					
Semester	III					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Explicit Teaching Seminar, Assignments, etc.	42	14	28	36	120
Pre-requisite	Need a very strong background in Linear Algebra and good knowledge in Physics as a background for learning Robotics. Also need to be expert in coding languages for Robotics such as Python, C++, etc.					

AI M 21 E34 INTRODUCTION TO ROBOTICS

COURSEOUTCOMES(CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	To understand the functions of the basic components of a Robot.	U, R	1
2	To impart knowledge in Robot Kinematics and Programming.	U, An	1,9
3	To familiarize students with robot classifications and configurations.	U, R	1,3
4	To acquaint the students with Trajectory planning, dynamic modelling, control and applications of robots	U, S	1,2
5	Formulate the mathematical relations for forward and inverse kinematic analysis and trajectory generation of robotic manipulator.	U, E, S, A	1,2,3
6	To study the use of various types of Sensors.	U, R, An	1,3
7	To learn Robot safety issues and economics.	R, U	1,3,10
Remember(R),Understand(U),Apply(A),Analyse(An),Evaluate(E),Create(C),Skill (S)			

COURSE CONTENT

Content for Classroom Transaction

Unit	Course description	Hrs	CO No.
1	Unit 1	14	1,3
2	Unit 2	18	2

3	Unit 3	17	4,5
4	Unit 4	19	6
5	Unit 5	16	7

COURSE CONTENT

Content for Classroom Transaction

Unit I (14 hrs)
Introduction to Robotics – Definitions, Robot anatomy, Robot Elements - links, joints, end effector, actuators, sensors, hydraulic, pneumatic, electric drive systems, Robot specifications, Work envelope of different robots, Classification of Robots, Robot coordination systems, Need for Robots, Different applications.

Unit II (18hrs)
Robot Kinematics: Kinematic parameters, Basics of direct and inverse kinematics, Robot trajectories, 2D and 3D Transformation-Scaling, Rotation, Translation Homogeneous transformation. Jacobians, Velocity and Forces-Manipulator Dynamics, Trajectory Generator, Manipulator Mechanism Design-Derivations and problems.

Unit III (17hrs)
Trajectory Generation: General consideration in path description and generation, joint space schemes, collision free path planning, Robot programming.

Unit IV (19 hrs)
Robot Sensors: Sensors in Robotics – Touch sensors, Tactile sensors, Proximity and range sensors, Force and Torque sensors. Robot vision - Image representation, Perspective and inverse perspective Transformations.

Unit V (16hrs)

Robot Applications: Industrial applications of robots, Medical, Household, Entertainment, Space, Underwater, Defense, Disaster management. Applications, Micro and Nanorobots, Future Applications, Introduction to robot arm dynamics, introduction to mobile robots

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brainstorming lecture, Explicit Teaching, E- learning, Interactive Instruction: Active co-operative learning, Seminar,Group Assignments Authentic learning: Library work and Group discussion, Presentation by individual student/Group representative.
Assessment Types	**Mode of Assessment** **G. Continuous Internal Assessment (CIA)** • Internal Tests–Minimum two (Extended answers/Practical) • Seminar – ▪ Research Literature review ▪ Report writing ▪ Presentation • Assignments–Written, Practical, Oral presentation and viva • Case study /Mini project **H. Semester End Examination**

REFERENCES

1. Richard D. Klafter, Thomas A Chmielewski and Michael Negin, Robotics Engineering: An integrated approach, Prentice Hall
2. Mikell P. Groover, Mitchell Weiss, Roger N Nagel, Nicholas G Odrey, "Industrial Robotics Technology, Programming and Applications", Tata –McGraw Hill Pub. Co., 2008.
3. Fu.K.S, Gonzalez.R.C&Lee.C.S.G, "Robotics control, sensing, vision and intelligence", Tata- McGraw Hill Pub. Co., 2008

4. Introduction to Robotics (Mechanics and control), John. J. Craig, Pearson Education Asia 2002.
5. R K Mittal and I J Nagrath, "Robotics and Control", Tata McGraw Hill, New Delhi,2003.

MAHATMA GANDHI UNIVERSITY
School of Artificial Intelligence and Robotics
M Sc Artificial Intelligence and Machine Learning

AI M 21 E35 BIG DATA ANALYTICS

School Name	School of Artificial Intelligence and Robotics					
Programme	M.Sc. Artificial Intelligence and Machine Learning					
Course Name	Big Data Analytics					
Type of Course	Elective					
Course Code	AI M 21 E35					
Names of Academic Staff &Qualifications	Dr. Sharon Susan Jacob, M.Tech, Ph.D.					
Course Summary &Justification	The course enables the students to understand Big Data processing used in different business intelligence applications and provide an in-depth coverage of MapReduce analytics using Hadoop Eco system tools. The student will gain programming knowledge in Pig, Hive, Spark to handle the Big Data applications and they will get exposure in blooming Big Data technologies.					
Semester	III					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Explicit Teaching Seminar, Assignments, etc.	42	14	28	36	120
Pre-requisite	Thorough knowledge in SQL. Also need presentation and critical thinking skills					

COURSEOUTCOMES(CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Learn the challenges and their solutions in Big Data.	U, R	1,10

2	Understand and work on Hadoop Framework and eco systems.	U, An, S	1,2
3	Explain and Analyse the Big Data using Map-reduce programming in Both Hadoop and Spark framework.	S, A	1,3
4	Demonstrate Hive and Pig.	A, S	1,2
5	Demonstrate Spark programming.	An, A, S	1,2
6	Installation of Hadoop Architecture and its ecosystems	A, S	1,2
7	Access and Process Data on Distributed File System	A, S, E	1,3
Remember(R),Understand(U),Apply(A),Analyse(An),Evaluate(E),Create(C),Skill (S)			

COURSE CONTENT

Content for Classroom Transaction

Unit	Course description	Hrs	CO No.
1	Unit I	12	1,2
2	Unit II	12	7
3	Unit III	16	3
4	Unit IV	20	4
5	Unit V	20	5

MAHATMA GANDHI UNIVERSITY
School of Artificial Intelligence and Robotics
M Sc Artificial Intelligence and Machine Learning

AI M 21 E35 BIG DATA ANALYTICS

COUIRSE CONTENT

Content for Classroom Transaction

Unit I (12 hrs)
Introduction to Big Data – Introduction to Data Analytics, Type of Data Analytics – Descriptive, Predicative, Prescriptive, definition & importance of Big Data - four dimensions of Big Data - volume, velocity, variety, veracity – industry examples – terminologies – structured data, unstructured data, semi structured data, streaming data, real-time data, meta data, data at rest – Big Data Analytics in Industry Verticals.

UNIT II (12 hrs)
Relational databases and SQL – Non-Relational databases NoSQL Data model: Aggregate Models-Document Data Model- Key-Value Data Model, Columnar Data Model, Graph Based Data Model, NoSQL system ways to handle big data problems

Unit III (16 hrs)
Hadoop Ecosystem - Core components-Hadoop Distributions-Developing enterprise applications. HDFS - HDFS Architecture-Applicability of HDFS-Using HDFS files-Hadoop specific file types - HDFS federation and high availability. HBase-High Level HBase Architecture-HBase schema design-New HBase Features-Managing metadata with HCATALOG.

Unit IV (20hrs)

Hive-Features - Hive architecture – Datatypes and file formats –primitive and collection datatypes – HiveQL–databases in Hive – Creating, Altering, Partitioning and managing tables**Pig-**Features and uses- Comparison with Map-Reduce-Execution modes-Pig Latin commands- Developing Pig script-Joining Data sets- Join,Cogroup concepts- User Defined Functions-Controlling Execution-Pig Latin Preprocessor.

Unit V (20hrs)
Oozie-Functional Components-Oozie Job Execution Model-Scheduling workflow using Oozie coordinator-Oozie coordinator components and variables-Oozie coordinator lifecycle operation.
Spark-Spark Architecture-Spark Streaming-Streaming Operator-Spark SQL-ResilientDistribution Dataset (RDD).

MAHATMA GANDHI UNIVERSITY
School of Artificial Intelligence and Robotics
M Sc Artificial Intelligence and Machine Learning

AI M 21 E35 BIG DATA ANALYTICS

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brainstorming lecture, Explicit Teaching, E- learning, Interactive Instruction: Active co-operative learning, Seminar,Group Assignments Authentic learning: Library work and Group discussion, Presentation by individual student/Group representative.
Assessment Types	**Mode of Assessment** **I. Continuous Internal Assessment(CIA)** • Internal Tests–Minimum two(Extended answers/Practical) • Seminar – ▪ Research, Literature review ▪ Report writing ▪ Presentation • Assignments–Written, Practical, Oral presentation and viva • Case study/Mini project **J. Semester End Examination**

REFERENCES

1. Michael Minelli, Michele Chambers and, Ambiga Dhiraj, Big Data, Big Analytics:Emerging Business Intelligence and Analytic Trends for Today's Businesses.
2. Noreen Burlingame, Little Book of Big Data, Ed. 2012
3. Tom White, Hadoop, The definitive guide, O'Reilly Media, 2010

MAHATMA GANDHI UNIVERSITY
School of Artificial Intelligence and Robotics

AI M 21 E36 CLOUD COMPUTING

School Name	School of Artificial Intelligence & Robotics					
Programme	M.Sc. Artificial Intelligence and Machine Learning					
Course Name	Cloud Computing					
Type of Course	Elective					
Course Code	AI M 21 E36					
Names of Academic Staff & Qualifications	Dr. Abdul Jabbar P, M.Phil., Ph.D.					
Course Summary & Justification	This course will introduce various aspects of cloud computing including fundamentals, management issues, security challenges and research trends. The course includes in-depth coverage of cloud service models, security, testing, infrastructure and configurations. This will help students to use and explore the cloud computing platforms.					
Semester	III					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Explicit Teaching Seminar, Assignments etc.	42	14	28	 36	120
Pre-requisite	Basics of Computer Architecture and Organization, Networking.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Familiarise the fundamentals of cloud computing environment.	R, U	1,2
2	Understand, analyse and evaluate various cloud computing models and services.	U, A,An,S, E	1,2.3

3	Analyse and evaluate various cloud security issues.	A,S, E	1,2,3
4	Test and evaluate cloud computing services to ensure quality.	A,C,An,E	1,2,3,6,7
5	Formulate and evaluate security threats and issues in cloud environment	A,S,C,E	1,3,4,6
6	Demonstrate, analyze, design, apply and use cloud infrastructure to manage data	U,An,R,A	1,2,3,6,7, 8,9,10
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S)			

COURSE CONTENT

Content for Classroom Transaction

Unit	Course description	Hrs	CO No.
1	Unit I	15	1,6
2	Unit II	20	2,6
3	Unit III	15	3,6
4	Unit IV	20	4,6
5	Unit V	14	5,6

COURSE CONTENT

Content for Classroom TransactionUnit

Unit I (15 hrs)

Cloud computing, History of Cloud Computing, Cloud service providers, Properties, Characteristics - Benefits of Cloud Computing- Cloud Storage- Cloud computing vs. Cluster computing vs. Grid Computing-Role of Open Standards- Companies in the Cloud Today.

Unit II (20 hrs)

Web-Based Application, Pros and Cons of Cloud Service Development, The NIST model, Cloud Delivery Models- SaaS, Paas, Iaas, Cloud deployment models- Private cloud, public cloud, community cloud, hybrid cloud, Alternative Deployment Models- The Linthicum Model, The Jericho Cloud Cube Model.

Unit III (15 hrs)

Security objectives, Services, Security design principles, secure development practice, Approaches to Cloud Software Requirements Engineering.

Unit IV (20 hrs)

Secure Cloud Software Testing, Testing for SQA, Conformance, functional, Performance & security testing.

Unit V (14 hrs)

Threats to Infrastructure, Data and Access Control, Cloud Service Provider Risks- Back- Door, Spoofing, Man-in-the-Middle, replay threats, TCP Hijacking, Social Engineering, Dumpster Diving, Password Guessing, Trojan Horses and Malware.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Explicit Teaching, E-learning Interactive Instruction: Active co-operative learning, Seminar, Group Assignments Authentic learning: Library work and Group discussion, Presentation by individual student/Group representative.
Assessment Types	**Mode of Assessment** **A. Continuous Internal Assessment (CIA)** • Internal Tests – Minimum two (Extended answers) • Seminar – ▪ Research Literature review ▪ Report writing ▪ Presentation • Assignments – Written, Oral presentation and viva. • Case study **B. Semester End Examination**

REFERENCES

1. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A PracticalApproach", TMH.
2. Ronald L. Krutz, Russell Dean Vines, "Cloud Security – A comprehensive Guide to Secure Cloud Computing", Wiley – India.
3. M.N Rao, Cloud Computing, First Edition, PHI, 2014
4. Das Gupta, Cloud Computing Based Projects using distributed Architecture, PHI,2014.
5. Kai Hwang, Geoffrey C Fox, Jack G Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.
6. Michael Miller, Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online, Que Publishing.

MAHATMA GANDHI UNIVERSITY
School of Artificial Intelligence and Robotics
M Sc Artificial Intelligence and Machine Learning

AIM 21 C35 COMPUTER VISION AND DATA ANALYTICS LAB

School Name	School of Artificial Intelligence and Robotics					
Programme	M.Sc. Artificial Intelligence and Machine Learning					
Course Name	Computer Vision and Data Analytics Lab					
Type of Course	Core					
Course Code	AIM 21 C35					
Names of Academic Staff & Qualifications	Prof. Dr. Bindu V R, M. Sc., Ph. D.					
Course Summary & Justification	Computer vision and Data analytics lab provides solid understanding of computer vision problems and its implementation and also provides guidance with all aspects of quantitative and qualitative data collection, analysis, and interpretation.					
Semester	III					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Explicit Teaching Seminar, Assignment, case Study etc.					120
Pre-requisite	Good knowledge in Image processing and Data analytics					

COURSE OUTCOMES

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Design and implement the computer vision problems and visualization solutions	An, A, E, C, S	1,2
2	Solid understanding of computer vision libraries. Design and implement the deep learning algorithms for computer vision	U, A, An, S, C, E	1,2

	problems		
3	Implement numerical and statistical analysis on various data sources.	A, An	1,2,3
4	Apply data pre-processing and dimensionality reduction methods on raw data.	A, S	1,2
5	Use machine learning techniques in high-performance computing environment to solve real-world problems.	An, A, S	1,2,3,10
6	Describe various concepts of Bigdata.	U, R, An	1,3
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S)			

COURSE CONTENT

Part I

Build an image processing algorithm from scratch. Apply deep learning techniques to solve computer vision problems by implementing and testing relevant learning algorithms. Familiarization of computer vision libraries - OpenCV, Tensorflow, Keras, Caffe, pytorch, PCL,Deepface etc., Implementation of YOLO algorithm, feature extraction and descriptors approaches, 3 D reconstruction, variants of convolutional and recurrent neural networks and Case Studies.

Part II

A comprehensive and interdisciplinary introduction to data analytics using modern computing systems, with equal attention to fundamentals and practical aspects. Data Science curriculum is designed in a way to help students gather knowledge in the field of business, besides applying the tools and statistics to meet organizational challenges in the near future. The DataScience course syllabus comprises three main components, i.e., Big Data, Machine Learning and Modelling in Data Science.

AIM 21 C36 COMPUTER VISION AND DATA ANALYTICS LAB

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Authentic learning: Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** **C. Continuous Internal Assessment(CIA)** • Internal Tests – Minimum Two (Extended answers / Practical) • Seminar– ▪ Research, Literature Review ▪ Report Writing ▪ Presentation • Assignment – Written, Practical, Oral Presentation and Viva • Case study/ Mini project **D. Semester End Examination**

REFERENCES

1. Forsyth, J. Ponce, Computer Vision: A Modern Approach, Pearson Education.
2. J. Solem, Programming Computer Vision with Python: Tools and Algorithms for AnalyzingImages.
3. M. Nixon and A. Aquado, Feature Extraction & Image Processing for Computer Vision, 3rd Edition, Academic Press.
4. R. Jain, R. Kasturi, B. Schunck, Machine Vision, Indo American Books.
5. R. Szeliski, Computer Vision: Algorithms and Applications, Springer.
6. S. Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press.
7. Gaurav Aroraa, Chitra Lele, Dr. Munish Jindal, Data Analytics:Principles, Tools, and Practices: A Complete Guide for Advanced Data Analytics Using the Latest Trends, Tools, and Technologies (English Edition)
8. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer

MAHATMA GANDHI UNIVERSITY
School of Artificial Intelligence and Robotics
M Sc Artificial Intelligence and Machine Learning

AIM 21 C36 MAJOR PROJECT PHASE I

School Name	School of Artificial Intelligence & Robotics					
Programme	M.Sc. Artificial Intelligence and Machine Learning					
Course Name	Major Project Phase I					
Type of Course	Core					
Course Code	AI M 21 C36					
Names of Academic Staff & Qualifications	Prof. Dr. Bindu V R, PhD					
Course Summary & Justification	The course aims to gain a deep understanding of AI/ML concepts, algorithms, and applications through a well-structured project plan and implementation. AI/ML projects often involve complex problem-solving, fostering critical thinking and analytical abilities. This project work leads to foster research initiatives in Artificial Intelligence, which acts as a beginning step for Major Project Phase II in the coming semester. Students acquire practical skills in programming, data analysis, and model development, making them more competitive in the job market. Students may be inspired to create their startups based on AI/ML innovations developed during the project.					
Semester	III					
Total Student LearningTime (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Self-practicing, Experimental lab sessions	--	--	72	48	120
Pre-requisite	Knowledge in Artificial Intelligence and Machine Learning					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Select and comprehend research papers, demonstrating the ability to identify pertinent research topics, dissect methodologies, and recognize the practical implications.	U, A, An, S	1,2,3, 4,7,8, 9,10
2	Devise an implementation plan by designing a project architecture and formulating strategies that reflect the research paper's concepts, demonstrating a clear understanding of the practical application	U, A, An, C, S	1,2,3, 4,7,8

3	Implement the chosen research paper's concepts and methodologies, showcasing technical prowess and problem-solving skills through hands-on development.	A, An, C, E, S	1,2,3, 4,7
4	Identify and address challenges encountered during project implementation, displaying effective problem-solving abilities and resilience in overcoming obstacles	An, C, E, S	1,2,3, 4,6,7
5	Showcase the ability to contribute meaningfully to the field of artificial intelligence by practically applying research concepts, displaying a deep understanding of its practical implications.	U, A, An, C, E, S	1,2,3, 4,6,7
6	Document, present and demonstrate the project work in a very clear and effective way with the aid of appropriate tools.	S, C	5,6,7, 8,9,10
Remember (R), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S)			

COURSE CONTENT
Content for Classroom Transaction

Students with the support of Internal Guide (Faculty member of the school) have to select an area related to Artificial Intelligence and should identify the research gap and should carry out independent research in the identified area. At the end of the course, he/she should submit a detailed project report including all studies, methodology and findings as a report and should present these in a clear and effective way during project evaluation.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** E-learning, Active co-operative learning, Inquiry- based instruction, Authentic learning, Experiential Learning, Library work and Group discussions.
Assessment Types	**Mode of Assessment** **Continuous Assessment (CIA)** • Three Internal Reviews

MAHATMA GANDHI UNIVERSITY
School of Artificial Intelligence and Robotics
M Sc Artificial Intelligence and Machine Learning

AIM 21 O31 PYTHON FOR MACHINE LEARNING

School Name	School of Artificial Intelligence &Robotics					
Programme	M.Sc. Artificial Intelligence and Machine Learning					
Course Name	Python for Machine Learning					
Type of Course	Open					
Course Code	AI M21 O31					
Names of Academic Staff & Qualifications	Ms. Jissy Liz Jose, M.Tech.					
Course Summary & Justification	Machine Learning is an extensive and rapid growing area. This course familiarizes the basics of Machine Learning. This course aims to develop the skills required for Machine Learning Technologies with use of Python to analyze data and create attractive visualizations using powerful machine learning algorithms.					
Semester	III					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total LearningHours
	Explicit Teaching Seminar, Assignments etc.	42	14	28	 36	120
Pre-requisite	Basics of programming					

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Understand various Python editors	U, A	1,2

2	Familiarize with the basic concepts of Python programming and write, test and debug Python programs	U, A,C	1,2.6
3	Familiarize with control statements, built in functions, modules and packages and implement programs	U, A, An	1,2,3
4	Understand the fundamentals of machine learning	U,A, An	1,2
5	Learn and implement Data pre-processing, classification and clustering	U, An	1,2,3, 7
6	Apply metrics to evaluate accuracy	U,A,An, S,C,E	1,2,3, 4,6, 7,10
Remember(R), Understand (U), Apply(A), Analyse (An), Evaluate(E), Create(C), Skill (S)			

COURSECONTENT

Content for Classroom transaction

Unit	Course description	Hrs	CO No.
1	Unit I	12	1,2
2	Unit II	20	2,3
3	Unit III	16	3
4	Unit IV	16	4
5	Unit V	20	5,6

COURSE CONTENT

AIM 21 O31 PYTHON FOR MACHINE LEARNING

Content for Classroom Transaction

Unit I (12 hrs)

Python interpreter, Familiarisation of various python editors - IDLE, Jupyter, Spyder etc. Fundamentals of coding- Data types, Character sets, Keywords,Variables, Assignment statements, Operators, Expressions, Type conversions, Input and Output.

Unit II (20 hrs)

Control statements, Iteration statements, Functions, Recursion, Lambda functions. Strings and number systems – String function, Handling numbers in various formats.

Unit III (16 hrs)

Lists, Tuples, Sets and Dictionaries – Basic operations and functions, Working with CSV files, Familiarisation of python packages for Machine Learning - numpy, scipy, pandas etc.

Unit IV (16 hrs)

Fundamentals of Machine Learning: Concept, Types– Supervised and Unsupervised, Challenges, Applications, Statistical Learning, Linear and Logistic Regression

Unit V (20 hrs)

Data Pre-processing- Feature Generation, Selection and Dimensionality Reduction; Classification and Clustering, Accuracy Measures and Metrics.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brainstorming lecture, Explicit Teaching, E-learning, Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Authentic learning: Library work and Group discussion, Presentation by individual student/ Group representative

AIM 21 O31 PYTHON FOR MACHINE LEARNING

Assessment Types	**Mode of Assessment** **C. Continuous Internal Assessment (CIA)** • Internal Tests– Minimum Two (Extended answers /Practical) • Seminar– ▪ Research Literature Review ▪ Report Writing ▪ Presentation • Assignment –Written, Practical, Oral Presentation and Viva • Case study / Mini project **D. Semester End Examination**

REFERENCES

1. Kenneth A Lambert., Fundamentals of Python: First Programs, 2/e, Cengage Publishing.
2. Wes McKinney, Python for Data Analysis, 2/e, Shroff / O'Reilly Publishers.
3. Ethem Alpaydin, "Introduction to Machine Learning", 4th Edition, The MIT Press.
4. Tom M. Mitchell, "Machine Learning", 1st Edition, Tata McGraw-Hill Education.

MAHATMA GANDHI UNIVERSITY
School of Artificial Intelligence and Robotics
M Sc Artificial Intelligence and Machine Learning

AIM 21 C41 MAJOR PROJECT PHASE II AND COMPREHENSIVE VIVA-VOCE

School Name	School of Artificial Intelligence & Robotics					
Programme	M.Sc. Artificial Intelligence and Machine Learning					
Course Name	Major Project Phase II and Comprehensive Viva-voce					
Type of Course	Core					
Course Code	AI M 21 C41					
Names of Academic Staff & Qualifications	Prof. Dr. Bindu V R, Ph.D					
Course Summary &Justification	This course empowers students to enhance their skills, broaden their perspectives, and refine their ability to tackle real-life research problems and challenges, allowing them to showcase their mastery of advanced AI, ML and DL concepts. Through the major project, students engage in hands-on research and development, tackling real-world AI and ML challenges while applying advanced methodologies and techniques. The project encourages interdisciplinary collaboration, fostering connections between AI/ML and other domains such as healthcare, finance, and robotics, thereby preparing students for diverse career opportunities. The comprehensive viva-voce, which covers the entire syllabi of all the four semesters and its assessment ensures that students not only possess theoretical knowledge but also the practical skills and critical thinking abilities necessary to succeed in the AI and ML industry. By emphasizing practical implementation and evaluation, the project equips students with the skills necessary to address complex challenges and make impactful contributions to the rapidly evolving focussed areas.					
Semester	IV					
Total Student LearningTime (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Self-practicing, Experimental lab sessions	--	90	360	150	600

MAHATMA GANDHI UNIVERSITY
School of Artificial Intelligence and Robotics
M Sc Artificial Intelligence and Machine Learning

AIM 21 C41 MAJOR PROJECT PHASE II AND COMPREHENSIVE VIVA-VOCE

Pre-requisite	Knowledge in Artificial Intelligence, Machine Learning and Deep Learning

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Identify technically and economically feasible problems of social relevance, significant research gaps within the field of artificial intelligence and machine learning, laying the foundation for their project.	U, A	1,2
2	Recognize and survey the relevant literature for getting exposed to related solutions, conduct a thorough analysis of requirements, select appropriate design methodologies, and create adaptable, reusable solutions with minimal complexity using modern tools and advanced programming techniques.	U, A, An,E,S	3,4
3	Conduct independent research and experimentation, critical thinking, evaluation, and innovation in tackling complex AI and ML challenges.	U, A,C, An,E, S	4,6,3
4	Effectively communicate their project objectives, methodologies, and findings. Prepare technical report and deliver presentation.	U, A, An, C, E ,S	5,6,7
5	Uphold ethical standards and professional conduct throughout the project, demonstrating integrity, accountability, and respect for intellectual property rights and privacy considerations.	U, A, An, C, E	1,2,6,8, 9,10
6	Exhibit a comprehensive viva-voce session, understanding of the subject matters on Artificial intelligence and Machine Learning covered throughout the course. Respond effectively to unexpected questions or challenges posed during the viva.	U, R, A, C, An, E, S	1,2,6,8 7,9, 10

Remember (R), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S)

COURSE CONTENT

MAHATMA GANDHI UNIVERSITY
School of Artificial Intelligence and Robotics
M Sc Artificial Intelligence and Machine Learning

AIM 21 C41 MAJOR PROJECT PHASE II AND COMPREHENSIVE VIVA-VOCE

Content for Classroom Transaction

With guidance from an Internal Guide (a faculty member of the school), students are tasked with choosing a topic within the realm of Artificial Intelligence, identifying research gaps, and conducting independent research in their chosen area. The project offers opportunities for collaboration with industry or other academic institutions, leading to contributions that advance knowledge within the field. Upon completing the course, the student must submit a comprehensive project report encompassing all studies, methodologies, and findings. Additionally, they are required to present their work in a clear and effective manner during the project evaluation process and attend the comprehensive viva-voce, based on the courses covered in the entire programme.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** E-learning, Active co-operative learning, Inquiry- based instruction, Authentic learning, Experiential Learning, Library work and Group discussions.
Assessment Types	**Mode of Assessment:** **Continuous Internal Assessment (CIA)** • Three Internal Reviews **External Assessment** • External Evaluation • Comprehensive Viva-voce