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SCHEME OF EXAMINATION
&
SYLLABI

for

Master of Technology (Two Year Degree Programme)
(I and II Year)

Offered by
University School of Automation and Robotics (USAR)

w.e.f. Academic Session 2023-24

GURU GOBIND SINGH
INDRAPRASTHA
UNIVERSITY

Guru Gobind Singh Indraprastha University Sector 16C, Dwarka, Delhi – 110 078 [INDIA]
www.ipu.ac.in

With effect from academic session 2023-24

Introduction

This document describes the curriculum of the Master of Technology in Artificial Intelligence and Data Science that is offered at the University School of Automation and Robotics. The programme name is inline with the AICTE approved nomenclature of courses (Reference Sl. No. 28, Page 105, Approval Process Handbook 2022-23). In the event of any difficulty of implementation, and / or interpretation of any clause of the document, the same may be brought to the notice of Dean of the University School of Automation and Robotics. The decision of the Dean, University School of Automation and Robotics shall be final and implemented to resolve the issue. The same shall be put up in the subsequent meeting of the Board of Studies of the University School of Automation and Robotics for its approval. If the decision of the Board of Studies of the University School of Automation and Robotics is at variance with the decision taken earlier by the Dean of the School, the decision of the Board shall be effective from the date of the approval by the Board of Studies. In the interim period (between the approval of the Dean, of the School and the Board of Studies approval), the decision already taken by the Dean of the school shall stand.

Course / Paper Group Codes:
BS: Basic Science
HS: Humanities, social science, management
PC: Programme Core, that is course / paper offered in the discipline of the programme as a compulsory paper.
PE: Programme Elective, that is course / paper offered in the discipline of the programme as an elective paper.
OA: Open area elective offered by other school or other schools or Swayam / MOOCS

Acronyms:
APC: Academic programme committee comprising of all faculty of the school.
L: Number of Lecture hours per week
T/P: Number of Practical/Tutorial Hours per week
C: Number of credits assigned to a course / paper
NUES: An evaluation scheme in which evaluation is conducted by a committee, a teacher or a group of teacher as described in the scheme of study.
COE: Controller of Examinations of the Examinations Division of the University.

M.Tech in Artificial Intelligence and Data Science (AI&DS)

Programme Educational Objectives

The M.Tech(AI&DS) programme is meant to develop the students ability:-

PEO1: To demonstrate a deep understanding of the foundational principles, theories, and practices of artificial intelligence and data science, including machine learning, deep learning, natural language processing, and computer vision.

PEO2: To apply advanced statistical and computational methods to analyze, model, and extract insights from large and complex data sets, and to develop innovative solutions to challenging problems in a range of domains, such as healthcare, finance, marketing, and social media.

PEO3: To design and implement intelligent systems and applications that can learn, reason, and interact with humans and the environment.

PEO4: To communicate effectively, both orally and in writing, about technical concepts, research findings, and ethical considerations related to artificial intelligence and data science, and to engage in interdisciplinary discussions with stakeholders from diverse backgrounds and perspectives.

PEO5: To stimulate students for life-long learning with enthusiasm and commitment to improve knowledge and competence continuously.

Program Specific Outcomes

PO1: Pursue further academic and research opportunities in related fields, as well as engage in continuous learning and professional development, to keep pace with the rapid advances and changing landscapes of artificial intelligence and data science.

PO2: An ability to design and implement intelligent systems and applications that can interact with humans and the environment, and that can learn, reason, and adapt to changing circumstances and user preferences.

PO3: Students should be able to demonstrate application of statistical and computational methods to process, clean, transform, and visualize large and heterogeneous data sets, and to extract insights, patterns, and trends that can inform decision-making and drive innovation.

PO4: Analyze, design, and develop advanced algorithms and models for machine learning, deep learning, natural language processing, and computer vision, and evaluate their performance in terms of accuracy, efficiency, and robustness.

PO5: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice

PSO-PEO Matrix*
Filled on a scale of 1 to 3 (3=High; 2=Moderate; 1=Low; '-'for no correlation)

Course Outcomes	PEO1	PEO2	PEO3	PEO4	PEO5
PO1	3	2	2	1	3
PO2	2	2	3	1	2
PO3	2	3	2	1	1
PO4	2	3	2	2	2
PO5	1	1	2	3	2

Master of Technology
Artificial Intelligence and Data science
Regular Programme

First Semester

Group	Paper Code	Paper	L	T/ P	Credits
Theory Papers (Core)					
PC	MEAD-601	Advanced Data Structures and Algorithms	**4**	**-**	**4**
PC	MEAD-603	Mathematics for AI	**4**	**-**	**4**
Elective 1 (Choose One)					
PE	MEAD-605	Principles of AI	**4**	**-**	**4**
PE	MEAD-607	Knowledge Representation & Reasoning	**4**	**-**	**4**
Elective 2 (Choose One)					
PE	MEAD-609	Statistical Methods for Data Science	**4**	**-**	**4**
PE	MEAD-611	Data Visualisation and Interpretation	**4**	**-**	**4**
Open Area Electives					
OA	MEAD-609	Research Methodology and IPR		**2**	**1**
OA	MEAD-611	Human Values and Ethics#*		**2**	**1**
Practical / Viva voce					
PC	MEAD-651	Lab-I		**4**	**2**
PC	MEAD-653	Lab-II		**4**	**2**
PE	MEAD-655	Lab-III		**4**	**2**
PE	MEAD-657	Lab-IV		**4**	**2**
PC	MEAD-659	Term Paper -I*			**2**
		TOTAL	**16**	**20**	**28**

*****NUES: The evaluation shall be conducted by a duly constituted committee of teachers by the APC of the school / department /institution. The marks shall be awarded out of 100 (maximum marks).

#Subjects such as: Constitution of India, stress Management by Yoga, Sanskrit for Technical Knowledge, Value Education etc.

Master of Technology
Artificial Intelligence and Data science
Regular Programme

Second Semester

Group	Paper Code	Paper	L	T/ P	Credits
Theory Papers (Core)					
PC	MEAD-602	Computer Vision	**4**	**-**	**4**
PC	MEAD-604	Neural Network and Deep Learning	**4**	**-**	**4**
Elective 3 (Choose One)					
PE	MEAD-606	Machine Learning	**4**	**-**	**4**
PE	MEAD-608	Data Warehousing and Data mining	**4**	**-**	**4**
Elective 4 (Choose One)					
PE	MEAD-610	Big Data Framework	**4**	**-**	**4**
PE	MEAD-612	Cloud computing	**4**	**-**	**4**
PE	MEAD-614	GPU computing	**4**	**-**	**4**
Open Area Electives					
OA	MEAD-616	Open Electives#*		**2**	**1**
Practical / Viva voce					
PC	MEAD-652	Lab-V		**4**	**2**
PC	MEAD-654	Lab-VI		**4**	**2**
PE	MEAD-656	Lab-VII		**4**	**2**
PE	MEAD-658	Lab-VIII		**4**	**2**
PC	MEAD-660	Term Paper II*	**-**	**-**	**2**
		TOTAL	**16**	**18**	**27**

Open Area electives offered on Swayam /MOOCS
*****NUES: The evaluation shall be conducted by a duly constituted committee of teachers by the APC of the school / department /institution. The marks shall be awarded out of 100 (maximum marks).

Master of Technology
Artificial Intelligence and Data science
Regular Programme

Third Semester

Group	Paper Code	Paper	L	T/ P	Credits
Theory Papers					
Elective 5 (Choose One)					
PE	MEAD-701	Natural Language Processing and Text Analysis	**4**	**-**	**4**
PE	MEAD-703	Social Network Analysis	**4**	**-**	**4**
Elective 6 (Choose One)					
PE	MEAD-705	Recommender Systems	**4**	-	**4**
PE	MEAD-707	Intelligent Information Retrieval	**4**	-	**4**
Open Area					
OA	MEAD-709	Technical Writing		**2**	**1**
Practical					
PE	MEAD-751	Lab-IX		**4**	**2**
PE	MEAD-753	Lab-X		**4**	**2**
PC	MEAD-755	Major Research Project Part – I**			**10**
		TOTAL	**8**	**10**	**23**

*****NUES: The evaluation shall be conducted by a duly constituted committee of teachers by the APC of the school / department /institution. The marks shall be awarded out of 100 (maximum marks).

** The research project guidelines shall be issued separately by the school with the approval of the Dean, USAR

Master of Technology
Artificial Intelligence and Data science
Regular Programme

Fourth Semester

Group	Paper Code	Paper	L/P	Credits
PC	MEAD-752	Major Research Project Part – II** Or Internship**	-	**25**
		TOTAL		**25**

***NUES: Non University Exam System**

NOTE:

The total number of credits of the Programme M. Tech. = 103.

Each student shall be required to appear for examination in all courses, but for the award of the degree a student shall be required to earn the minimum of 100 credits out of 103.

However, papers with evaluation on NUES basis may be dropped towards counting for total credits of 100 to award M. Tech. Degree.

DETAILED SYLLABUS

FOR

SEMESTER-I

MEAD-601 Advanced Data Structures and Algorithms L T/P C

4 0 4

Marking Scheme:
Teachers Continuous Evaluation and End Term Theory Examiantion: As per per university examination norms from time to time
Instruction to Paper Setters: **Maximum Marks**: As per University norms

Question No. 1 should be compulsory and cover the entire syllabus. This question may have objective or short answer type questions. Apart from Question No. 1, rest of the paper shall consist of four sections as per the units given in the syllabus. Every section should have two questions. However, student may be asked to attempt only 1 question from each section.

Course Objectives:

1. The course aims to teach students advanced data structures and algorithms like red-black trees, B-trees, AVL trees, graph algorithms, greedy, divide & conquer etc.
2. Students should be able to analyze the running time of algorithms and understand how to design efficient algorithms for a given problem.
3. Students should be able to apply advanced data structures and algorithms to solve complex problems in computer science and related fields.
4. The course aims to improve the student's programming skills.

Course Outcomes:

1. Ability to apply data structure in different problem scenarios
2. Ability to analyse the time complexity of algorithms
3. Ability to understand and apply different problems solving approaches using algorithms
4. Ability to implement different algorithms and data structures.

Mapping of Course Outcome to Programme Outcome ((scale 1: low, 2: Medium, 3: High)					
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	2	2	1	1
CO2	2	3	3	3	1
CO3	3	3	3	3	2
CO4	1	1	2	1	3

UNIT - I

Elementary Data Structure: Arrays, Expressions, Linked list, Polynomials; Representation and Operations binary search Trees and operations, AVL trees, augmented data structure, Red Black Trees and properties

UNIT - II

Overview of Divide-and-Conquer, Dynamic Programming and Greedy Algorithms, Comparison of dynamic programming and Greedy algorithm with Knapsack as case study Theoretical foundation of greedy algorithm, Matroids and Greedy methods, A Task Scheduling problem as a Matroid.

UNIT-III

Graph representation and implementation, searching of a graph, application of BFS and DFS Data structure for Sets, Disjoint Set and Union – find problem and implementation, Basic Hash function and collision resolution Hash Tables (Universal Hashing, Perfect Hashing) implementation and Applications, Sorting and Searching techniques.

UNIT - IV

Traversal algorithms, Tree, Spanning tree generation Algorithms,

Computational Geometry: Line segments properties, determining whether any pair of segment intersects, Finding a convex hull, finding the closest pair of points

Textbooks:

1. T. H. Cormen, C. E. Leiserson, R.L. Rivest, C. Stein. Introduction to Algorithms, 3rd Edition, PHI, 2009
2. Ellis Horowitz, Sartaj Sahni & Anderson-Freed. Fundamentals of Data Structures, 2nd Edition, Universities Press,2008

Reference books:

1. Weiss, Mark Allen. Data structures and algorithm analysis. 2nd Edition, Pearson Education India,1996.
2. Robert L. Kruse, Bruce P. Leung. Data Structures and Program Design in C. 2nd Edition, Pearson Education, 2006.
3. M. Goodrich, R. Tamassia, and D. Mount, Data Structures and Algorithms in C++. 2nd Edition, Wiley, 2014.

MEAD-603 Mathematics for AI

L	T/P	C
4	0	4

Marking Scheme:
Teachers Continuous Evaluation and End Term Theory Examiantion: As per per university examination norms from time to time
Instruction to Paper Setters: **Maximum Marks**: As per University norms

Question No. 1 should be compulsory and cover the entire syllabus. This question may have objective or short answer type questions. Apart from Question No. 1, rest of the paper shall consist of four sections as per the units given in the syllabus. Every section should have two questions. However, student may be asked to attempt only 1 question from each section.

Course Objectives:

1. To understand the mathematical concepts and techniques necessary for working with AI algorithms and models.
2. To make students learn to apply linear algebra, calculus, probability theory, and graph theory to solve AI problems.
3. To learn about calculus and its application in AI, including optimization, derivatives, and gradients.
4. To develop critical thinking skills and the ability to evaluate and analyze mathematical concepts and techniques in the context of AI.

Course Outcomes:

1. Ability to use techniques necessary for working with AI algorithms and models.
2. Ability to apply linear algebra, calculus, probability theory, and graph theory to solve AI problems.
3. Ability to use mathematical tools and software for solving AI problems.
4. Students will be prepared to take advanced courses in AI, machine learning, and related fields.

Mapping of Course Outcome to Programme Outcome ((scale 1: low, 2: Medium, 3: High)					
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	3	3	3	1
CO2	3	3	3	3	1
CO3	2	3	2	2	2
CO4	3	2	3	2	1

UNIT - I

Linear Algebra: Matrices and Determinants, Gauss Elimination, Linear Independence. Rank of a Matrix. Vector Space. Solutions of Linear Systems and concept of Existence, Uniqueness, Determinants. Cramer's Rule, Gauss–Jordan Elimination. The Matrix Eigenvalue Problem, Determining Eigenvalues and Eigenvectors, Eigenbases. Diagonalization. Quadratic Forms.Cayley – Hamilton Theorem

UNIT - II

Calculus: Continuity and differentiability, derivative of composite functions, chain rule, derivative of some common functions- logarithmic, exponential, trigonometric and inverse trigonometric**.** Applications of derivatives. Vector and matrix calculus, derivatives of scalar and vector valued functions, Gradient algorithms and convex functions

UNIT - III

Vector Calculus: Vector and Scalar Functions and Their Fields. Derivatives, Curves. Arc Length. Curvature. Torsion, Gradient of a Scalar Field. Directional Derivative, Divergence of a Vector Field, Curl of a Vector Field, Line Integrals, Path Independence of Line Integrals, Double Integrals, Green's Theorem in the Plane, Surfaces for Surface Integrals, Surface Integrals, Triple Integrals, Stokes Theorem. Divergence Theorem of Gauss.

UNIT - IV

Vector spaces: The n dimensional vectors, vector spaces, subspaces, spanning sets, linear dependence of vectors, basis and dimensions, linear transformation, null space and range space of a linear transformation, rank and nullity, rank and nullity theorem, inverse of a linear transformation, composition of linear map, matrices of a linear transformation and its transpose, the minimal polynomial

Textbooks:

1. Strang G. Linear algebra and its applications. Belmont, CA: Thomson, Brooks/Cole; 2006.
2. Deisenroth MP, Faisal AA, Ong CS. Mathematics for machine learning. Cambridge University Press; 2020.

Reference books:

1. Aggarwal CC, Aggarwal LF, Lagerstrom-Fife. Linear algebra and optimization for machine learning. Springer International Publishing; 2020.
2. Boyd S, Boyd SP, Vandenberghe L. Convex optimization. Cambridge university press; 2004.

MEAD-605 Principles of AI

L	T/P	C
4	0	4

Marking Scheme:
Teachers Continuous Evaluation and End Term Theory Examiantion: As per per university examination norms from time to time
Instruction to Paper Setters: **Maximum Marks**: As per University norms Question No. 1 should be compulsory and cover the entire syllabus. This question may have objective or short answer type questions. Apart from Question No. 1, rest of the paper shall consist of four sections as per the units given in the syllabus. Every section should have two questions. However, student may be asked to attempt only 1 question from each section.

Course Objectives:

1. The course aims to teach students the basics principles of Artificial Intelligence and how AI Evolve over the decades
2. The course aims to teach heuristics and uninformed searching techniques
3. Students would be exposed to different ways of knowledge representations and reasoning approaches
4. The course aims to teach the students Ethics in AI

Course Outcomes:

1. Ability to understand the AI principles applicable in different AI enabled applications
2. Ability to apply heuristic search techniques for problem solving
3. Ability to represent different type of knowledge effectively and to reason out in the presence of uncertain knowledge.
4. Students will understand the ethical application of AI techniques.

Mapping of Course Outcome to Programme Outcome ((scale 1: low, 2: Medium, 3: High)					
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	3	1	1
CO2	2	3	3	3	2
CO3	3	3	3	3	2
CO4	1	1	2	2	3

UNIT - I

Overview: foundations, scope, problems, and approaches of AI. AI Evolution: Turing's Work, Turing Test, Alternative test
Intelligent agents: reactive, deliberative, goal-driven, utility-driven, and learning agents, Artificial Intelligence programming techniques

UNIT-II

Problem-solving through Search: forward and backward, state-space, blind, heuristic, problem-reduction, A, A*, AO*, minimax, constraint propagation, neural, stochastic, and evolutionary search algorithms, Beyond Classical Search, Parallel Search, Search Engines, sample applications.

UNIT-III

Knowledge Representation and Reasoning: Foundations of knowledge representation and reasoning, representing and reasoning about objects, relations, events, actions, time, and space; Logic Concepts & Logic Programming, Prolog, Understanding of clauses and predicated, Recursion, backtracking and cut. Creating knowledge base using prolog.
Planning: planning as search, partial order planning, construction and use of planning graphs

UNIT-IV

Representing and Reasoning with Uncertain Knowledge: probability, connection to logic, independence, Bayes rule, bayesian networks, probabilistic inference.
Decision-Making: basics of utility theory, decision theory, sequential decision problems, elementary game theory, sample applications.
Machine Learning and Knowledge Acquisition: learning from memorization, examples, explanation, and exploration. Ethics in AI

Textbooks:

1. Stuart Russel, and Peter Norvig, "Artificial intelligence: A Modern Approach", Pearson Education Limited, 4th Edition, 2010.
2. E. Rich, K. Knight. S. B. Nair, "Artificial lntelligence", McGraw-Hill Publishing Company Limited, New Delhi, 3'd Edition ,2017.

Reference books:

1. Mark Watson, "Practical Artificial lntelligence Programming with Java", Leanpub, 5th Edition, 2020.
2. lvan Bratko, "Prolog Programming for Artificial Intelligence", Pearson Education, 5th Edition, 2011.

MEAD-607 Knowledge Representation & Reasoning L 4 T/P 0 C 4

Marking Scheme:
Teachers Continuous Evaluation and End Term Theory Examiantion: As per per university examination norms from time to time
Instruction to Paper Setters: **Maximum Marks**: As per University norms Question No. 1 should be compulsory and cover the entire syllabus. This question may have objective or short answer type questions. Apart from Question No. 1, rest of the paper shall consist of four sections as per the units given in the syllabus. Every section should have two questions. However, student may be asked to attempt only 1 question from each section.

Course Objectives:

1. The course aims to introduce students to the concepts of knowledge representation and reasoning.
2. To make students learn about different knowledge representation languages, such as propositional logic, first-order logic, and ontologies.
3. To understand principles of reasoning, such as deduction, abduction, and induction.
4. To understand the applications of knowledge representation and reasoning in various fields, such as expert systems, natural language processing, and robotics.

Course Outcomes:

1. Ability to understand and apply different knowledge representation languages to represent knowledge in various domains.
2. Ability to understand and apply different reasoning techniques to reason about the knowledge represented in different knowledge representation languages.
3. Ability to evaluate and analyze different knowledge representation and reasoning techniques for different applications.
4. Students will have the understanding of the applications of knowledge representation and reasoning in various fields.

Mapping of Course Outcome to Programme Outcome ((scale 1: low, 2: Medium, 3: High)					
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	2	2	2	1
CO2	3	2	3	2	1
CO3	3	3	3	2	2
CO4	3	2	2	2	3

UNIT - I

Introduction to Knowledge Representation and Reasoning: Definition of Knowledge Representation and Reasoning, Types of knowledge and their representation, Knowledge-based systems and their components, Knowledge representation languages, Issues in Knowledge Representation and Reasoning

UNIT - II

Logic-based Knowledge Representation and Reasoning: Propositional Logic: syntax, semantics and inference rules, First-order Logic: syntax, semantics and inference rules, Inference techniques: Forward Chaining, Backward Chaining and Resolution, Semantic networks and Frames, Description Logic and its applications, Common sense reasoning using logic

UNIT - III

Rule-based Knowledge Representation and Reasoning: Introduction to rule-based systems, Rule syntax, semantics, and reasoning techniques, Production systems and expert systems, Rule induction and learning, Fuzzy logic and its application in rule-based systems.

UNIT - IV

Ontologies and Knowledge Engineering: Introduction to Ontology and its role in Knowledge Representation and Reasoning, Ontology languages: RDF, OWL and their differences
Ontology engineering methodologies, Applications of ontologies: Semantic Web, Bioinformatics and E-commerce, Knowledge acquisition techniques, Evaluation and Validation of knowledge-based systems

Text Books:

1. Brachman RJ, Levesque HJ, Reiter R, editors. Knowledge representation. MIT press; 1992.
2. Allemang D, Hendler J. Semantic web for the working ontologist: effective modeling in RDFS and OWL. Elsevier; 2011.

Reference Books:

1. Fagin R, Halpern JY, Moses Y, Vardi M. Reasoning about knowledge. MIT press; 2004.
2. Sowa JF. Conceptual structures: information processing in mind and machine. Addison-Wesley Longman Publishing Co., Inc.; 1984.

MEAD-609 Statistical Methods for Data Science L 4 T/P 0 C 4

Marking Scheme:
Teachers Continuous Evaluation and End Term Theory Examiantion: As per per university examination norms from time to time
Instruction to Paper Setters: **Maximum Marks**: As per University norms

Question No. 1 should be compulsory and cover the entire syllabus. This question may have objective or short answer type questions. Apart from Question No. 1, rest of the paper shall consist of four sections as per the units given in the syllabus. Every section should have two questions. However, student may be asked to attempt only 1 question from each section.

Course Objectives:

1. To understand the fundamental concepts of statistics, including probability theory, random variables, probability distributions, and statistical inference.
2. To learn about the different types of data and how to describe and summarize data using graphical and numerical methods.
3. To understand the principles of statistical hypothesis testing and how to test hypotheses using appropriate tests and procedures.
4. To develop critical thinking skills and the ability to evaluate statistical claims and arguments in data science.

Course Outcomes:

1. Ability to describe and summarize data using appropriate statistical methods.
2. Ability to design experiments and test hypotheses using appropriate statistical methods.
3. Ability to analyze data using regression models and other statistical techniques.
4. Students will develop solid foundation in statistical methods and be prepared to take more advanced courses in data science or related fields.

Mapping of Course Outcome to Programme Outcome ((scale 1: low, 2: Medium, 3: High)					
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	3	3	3	1
CO2	2	3	3	3	1
CO3	3	3	2	2	2
CO4	3	2	3	2	2

UNIT - I

Introduction and types of Data - Basic definitions, Introduction and types of Data: Understanding data, Classification of data, Scales of measurement, Describing Categorical Data - Frequency distributions, Charts of categorical data, Mode and Median
Describing Numerical Data - Frequency Tables for numerical data, Mean, Median and Mode, Measures of dispersion- Range, variance and standard deviation, Percentiles, Quartiles, and Interquartile range
Association between two categorical variables, Relative frequencies, Association between two numerical variables - Scatterplot, Describing association, Covariance, Correlation, Fitting a line, Association between categorical and numerical variables

UNIT - II

Permutation and Combination, Basic Principles of Counting, Probability: Basic Definition, Properties of Probability, Independent exhaustive events, Conditional and Joint Probability, Random Variables, Probability Distribution: discrete and Continuous, Probability Mass Function, Discrete random variables - Cumulative distribution function

UNIT - III

Multiple random variables: Two random variables, Multiple random variables and distributions, Independence, Functions of random variables - Visualization, functions of multiple random variables, Expected value of a random variable, Scatter plots and spread, Variance and standard deviation, Covariance and correlation, Inequalities, Multiple continuous random variables, Jointly Gaussian random variables Probability models for data

UNIT - IV

Estimation and Inference, Bayesian estimation, Hypothesis testing, Time series based Forecasting: Introduction to Time Series, Time Series Analysis, Time Series Forecasting Methods

Textbooks:

1. James G, Witten D, Hastie T, Tibshirani R. An introduction to statistical learning. New York: springer; 2013.
2. Casella G, Berger RL. Statistical inference. Cengage Learning; 2021.

Reference books:

1. Gelman A, Carlin JB, Stern HS, Dunson DB, Vehtari A, Rubin DB. Bayesian data analysis. CRC press; 2013.
2. Levin RI. Statistics for management. Pearson Education India; 2011.

MEAD-611 Data Visualisation and Interpretation L T/P C

4 0 4

Marking Scheme:
Teachers Continuous Evaluation and End Term Theory Examiantion: As per per university examination norms from time to time
Instruction to Paper Setters: **Maximum Marks**: As per University norms

Question No. 1 should be compulsory and cover the entire syllabus. This question may have objective or short answer type questions. Apart from Question No. 1, rest of the paper shall consist of four sections as per the units given in the syllabus. Every section should have two questions. However, student may be asked to attempt only 1 question from each section.

Course Objectives:

1. The course aims to introduce students to the fundamental concepts of data visualization and interpretation.
2. To make students learn about different types of data and how to choose appropriate visualizations for different data types and analysis goals.
3. To understand principles of effective data visualization, including color, typography, and layout design.
4. To understand the ethical and legal issues related to data visualization and interpretation.

Course Outcomes:

1. Ability to choose appropriate visualizations for different types of data and analysis goals.
2. Ability to create effective visualizations using different visualization tools and software.
3. Ability to critically evaluate and analyze different visualization techniques and their effectiveness.
4. Students will have critical thinking skills and the ability to apply visualization techniques to communicate insights effectively.

Mapping of Course Outcome to Programme Outcome ((scale 1: low, 2: Medium, 3: High)					
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	2	2	2	1
CO2	3	2	3	2	1
CO3	2	3	3	3	2
CO4	3	2	2	2	3

UNIT - I

Introduction to Data Visualization: Data visualization and its importance in data analysis, Perception and cognition in data visualization, Types of data and appropriate visual representations, Visualization tools and software (e.g., Tableau, R, Python)

UNIT - II

Design Principles and Techniques: The Grammar of Graphics and its principles Design principles for effective data visualization (e.g., color, typography, layout) Techniques for creating effective visualizations (e.g., chart types, mapping, storytelling)

UNIT - III

Interactive Visualization: Principles of interactive visualizations and their benefits, Types of interactions (e.g., filtering, sorting, highlighting), Designing and implementing interactive visualizations using tools

UNIT - IV

Data interpretation and communication: Data interpretation and analysis, Effective communication of data insights, Ethical considerations in data visualization and communication, Best practices for presenting and sharing data visualizations (e.g., presentations, reports, dashboards)

Textbooks

1. Embarak DO, Embarak, Karkal. Data analysis and visualization using python. Berkeley, CA, USA: Apress; 2018.
2. Knaflic CN. Storytelling with data: A data visualization guide for business professionals. John Wiley & Sons; 2015.
3. Munzner T. Visualization analysis and design. CRC press; 2014.

Reference Books:

1. Wilkinson L. The grammar of graphics. Springer Berlin Heidelberg; 2012.
2. Healy K. Data visualization: a practical introduction. Princeton University Press; 2018.

DETAILED SYLLABUS

FOR

SEMESTER-II

MEAD-602 Computer Vision	L	T/P	C
	4	0	4

Marking Scheme:
Teachers Continuous Evaluation and End Term Theory Examiantion: As per per university examination norms from time to time
Instruction to Paper Setters: **Maximum Marks**: As per University norms

Question No. 1 should be compulsory and cover the entire syllabus. This question may have objective or short answer type questions. Apart from Question No. 1, rest of the paper shall consist of four sections as per the units given in the syllabus. Every section should have two questions. However, student may be asked to attempt only 1 question from each section.

Course Objectives:

1. The course aims to introduce students to the fundamental concepts and techniques of computer vision, including image processing, image analysis, and pattern recognition.
2. To make students learn about image representation and feature extraction, including edge detection, texture analysis, and feature matching.
3. To understand object detection and recognition techniques, including template matching, sliding window methods, and deep learning-based methods.
4. To develop critical thinking skills and the ability to evaluate and analyze computer vision techniques and algorithms.

Course Outcomes:

1. Ability to use fundamental concepts and techniques of computer vision.
2. Ability to apply image processing and analysis techniques for feature extraction and classification.
3. Ability to implement object detection and recognition algorithms, including deep learning-based methods.
4. Students will be prepared for advanced courses and research in computer vision and related fields..

Mapping of Course Outcome to Programme Outcome ((scale 1: low, 2: Medium, 3: High)					
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	3	3	1
CO2	3	3	3	2	1
CO3	3	3	3	2	2
CO4	3	2	2	3	2

UNIT - I

Introduction:What is computer vision? Image formation: Geometric primitives and transformations, Photometric image formation, The digital camera

Image processing: Point operators, Linear filtering, More neighborhood operators, Fourier transforms, Pyramids and wavelets, Geometric transformations, Global optimization

UNIT - II

Feature detection and matching: Points and patches, edge detection and linking and lines
Segmentation: Active Contours, Split and merge, mean shift and mode finding
Feature-based Alignment: 2D and 3D based alignment, Pose estimation and Geometrics intrinsic Calibration
Structure from motion: Triangulation, two frame structure from motion, factorisation and bundle adjustment, constrained structure and motion.

UNIT - III

Dense Motion Estimation: Translational alignment, parametric and spline based motion, optical flow layered motion
Image Stiching and Computational Photography

UNIT - IV

Stereo correspondence, Image based rendering, 3D constructions and Object recognition

Textbooks:

1. Szeliski R. Computer vision: algorithms and applications. Springer Nature; 2022.
2. Forsyth DA, Ponce J. Computer vision: a modern approach. prentice hall professional technical reference; 2002.

Reference books:

1. Prince SJ. Computer vision: models, learning, and inference. Cambridge University Press; 2012.
2. Bradski G, Kaehler A. Learning OpenCV: Computer vision with the OpenCV library. O'Reilly Media, Inc.; 2008.

MEAD-604 Introduction to Neural Networks & Deep Learning

L	T/P	C
4	0	4

Marking Scheme:
Teachers Continuous Evaluation and End Term Theory Examiantion: As per per university examination norms from time to time
Instruction to Paper Setters: **Maximum Marks**: As per University norms Question No. 1 should be compulsory and cover the entire syllabus. This question may have objective or short answer type questions. Apart from Question No. 1, rest of the paper shall consist of four sections as per the units given in the syllabus. Every section should have two questions. However, student may be asked to attempt only 1 question from each section.

Course Objectives:

1. The course aims to introduce students to the concepts of neural networks and deep learning.
2. To make students learn about different neural network architectures, such as feedforward neural networks, convolutional neural networks, and recurrent neural networks.
3. To understand principles of deep learning, such as backpropagation, regularization, and optimization.
4. To understand the applications of neural networks and deep learning in various fields, such as healthcare, finance, and robotics.

Course Outcomes:

1. Ability to understand and apply different neural network architectures to solve real-world problems.
2. Ability to apply different deep learning techniques to train neural networks for different applications.
3. Ability to evaluate and analyze different neural network and deep learning techniques for different applications.
4. Students will develop understanding of the applications of neural networks and deep learning in various fields.

UNIT-I

Mapping of Course Outcome to Programme Outcome ((scale 1: low, 2: Medium, 3: High)					
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	3	3	1
CO2	3	3	3	2	1
CO3	3	3	3	2	2
CO4	3	3	3	3	2

Basic principles of Artificial Neural Network (ANN): Principles of ANN design, Basic network structure, Perceptron's input output principles, the Adaline.
The perceptron: single layer, multilayer perceptron, Madaline, Back propagation learning procedure, derivation of BP algorithms, modified BP algorithm, Case study of XOR, character recognition.
Hopfield networks: Binary Hopfield networks, Bidirectional associative memory principle, Walsh function, Network stability, continuous Hopfield models

UNIT-II

Counter Propagation NN: Kohonen self-organising map layer and Grossberg Layer, Training of layers, application of Counter Propagation NN in character recognition
LAMSTAR Network: Basic principle, detailed outline of LAMSTAR Network, Forgetting Feature, LAMSTAR as data analysis tool
Adaptive Resonance Theory NN (ART NN): The ART network structure, setting up of the ART network, Properties of ART
Statistical training of NN: Annealing methods, Simulated annealing by Boltzman training of weights, Stochastic determination, Cauchy training of NN

UNIT-III

Deep Feedforward Networks: Regularization for Deep Learning, Optimization for training Deep Models
Convolutional Neural Networks: Convolution operation, motivation behind CNN, Pooling, Variants of basic convolution function, Efficient convolution algorithms, unsupervised features, Neuroscientific basis for Convolution networks
Sequence Modelling: Recurrent Neural Networks (RNNs), Bidirectional RNNs, Encoder-decoder sequence-to-sequence architecture, Deep recurrent networks, Recursive NN, Challenges of long term dependencies, Echo state networks, leaky units, Long Short Term Memory, Gated Recurrent Units,

UNIT-IV

Linear Factor models, Autoencoders, Representational learning, Structures probabilistic models for Deep learning, Montecarlo methods, Deep Generative Models, Generative Adversarial Networks, Multi-task Deep Learning, Multi-view Deep Learning
Textbooks:

1. Bengio Y, Goodfellow I, Courville A. Deep learning. Cambridge, MA, USA: MIT press; 2017.
2. Géron A. Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow. O'Reilly Media, Inc.; 2022.

Reference Books:

1. Buduma N, Buduma N, Papa J. Fundamentals of deep learning. " O'Reilly Media, Inc."; 2022.
2. Aggarwal C., Neural Networks and Deep Learning: A Textbook, Springer; 1st ed. 2018.

MEAD-606 Machine Learning

L	T/P	C
4	0	4

Course Objectives:

Marking Scheme:
Teachers Continuous Evaluation and End Term Theory Examiantion: As per per university examination norms from time to time
Instruction to Paper Setters: **Maximum Marks**: As per University norms Question No. 1 should be compulsory and cover the entire syllabus. This question may have objective or short answer type questions. Apart from Question No. 1, rest of the paper shall consist of four sections as per the units given in the syllabus. Every section should have two questions. However, student may be asked to attempt only 1 question from each section.

1. The course aims to introduce students to the fundamental concepts of machine learning, including supervised and unsupervised learning, reinforcement learning, and deep learning.
2. To make students learn different types of machine learning algorithms, such as decision trees, logistic regression, support vector machines, k-nearest neighbours, and neural networks.
3. To understand principles of model selection, evaluation, and optimization, including cross-validation, regularization, and hyperparameter tuning.
4. To use different machine learning tools and software, such as scikit-learn, TensorFlow, or PyTorch, to implement machine learning algorithms and evaluate their performance.

Course Outcomes:

1. Ability to apply different machine learning algorithms to solve real-world problems.
2. Ability to evaluate and optimize machine learning models using different evaluation metrics and techniques.
3. Ability to use different machine learning tools and software to implement machine learning algorithms and evaluate their performance.
4. Students will be prepared to use machine learning techniques for solving real-world problems in various fields.

Mapping of Course Outcome to Programme Outcome ((scale 1: low, 2: Medium, 3: High)					
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	3	2	3	1
CO2	3	3	3	2	1
CO3	2	3	2	2	2
CO4	3	2	1	3	3

UNIT - I

Introduction: Definition of learning systems, Goals and applications of machine learning, Aspects of developing a learning system, Concept Learning and general to specific ordering]
Decision Tree Learning: Decision Tree representation, appropriate problems for decision tree learning, decision tree learning algorithm, Issues in decision tree learning, Picking the best splitting attribute: entropy and information gain. Searching for simple trees and computational complexity. Occam's razor. Overfitting, noisy data, and pruning
Ensemble Learning: Using committees of multiple hypotheses. Bagging, boosting, and DECORATE. Active learning with ensembles.

UNIT - II

Experimental Evaluation of Learning Algorithms: Measuring the accuracy of learned hypotheses. Comparing learning algorithms: cross-validation, learning curves, and statistical hypothesis testing
Computational Learning Theory: Models of learnability: learning in the limit; probably approximately correct (PAC) learning. Sample complexity: quantifying the number of examples needed to PAC learn. Computational complexity of training. Sample complexity for finite hypothesis spaces. PAC results for learning conjunctions, kDNF, and kCNF. Sample complexity for infinite hypothesis spaces, Vapnik-Chervonenkis dimension
Rule Learning: Propositional and First-Order: Translating decision trees into rules. Heuristic rule induction using separate and conquer and information gain. First-order Horn-clause induction (Inductive Logic Programming) and Foil. Learning recursive rules. Inverse resolution, Golem, and Progol.

UNIT - III

Artificial Neural Networks: Neurons and biological motivation, Linear threshold units, Perceptrons: representational limitation and gradient descent training, Multilayer networks and back propagation, Hidden layers and constructing intermediate, distributed representations, Overfitting, learning network structure, recurrent networks.

Support Vector Machines: Maximum margin linear separators. Quadratic programming solution to finding maximum margin separators. Kernels for learning non-linear functions.
Bayesian Learning: Probability theory and Bayes rule. Naive Bayes learning algorithm. Parameter smoothing. Generative vs. discriminative training. Logisitic regression. Bayes nets and Markov

UNIT - IV

Instance-Based Learning: Constructing explicit generalizations versus comparing to past specific examples. k-Nearest-neighbor algorithm. Case-based learning.

Clustering and Unsupervised Learning: Learning from unclassified data. Clustering. Hierarchical Aglomerative Clustering. k-means partitional clustering. Expectation maximization (EM) for soft clustering. Semi-supervised learning with EM using labeled and unlabled data.
Reinforcement Learning: Q learning, non deterministic rewards and actions, Temporal difference learning

Textbooks:

1. Mitchell TM. Machine learning. New York: McGraw-hill; 2007.
2. Zhou ZH. Machine learning. Springer Nature; 2021.

Reference books:

1. Bishop CM, Nasrabadi NM. Pattern recognition and machine learning. New York: springer; 2006.
2. Mohri M, Rostamizadeh A, Talwalkar A. Foundations of machine learning. MIT press; 2018.

MEAD-608 Data Warehousing and Data Mining L T/P C

4 0 4

Marking Scheme:
Teachers Continuous Evaluation and End Term Theory Examiantion: As per per university examination norms from time to time
Instruction to Paper Setters: **Maximum Marks**: As per University norms Question No. 1 should be compulsory and cover the entire syllabus. This question may have objective or short answer type questions. Apart from Question No. 1, rest of the paper shall consist of four sections as per the units given in the syllabus. Every section should have two questions. However, student may be asked to attempt only 1 question from each section.

Course Objectives:

1. The students would made to understand the concepts, principles, and techniques of data warehousing, including data modelling, schema design, and data integration
2. The course aims to teach the process of ETL (Extract, Transform, Load) and its role in populating a data warehouse.
3. Students would be exposed to data mining techniques, including classification, clustering, association rules, and anomaly detection.
4. The course aims to teach the students, the ethical, legal, and social implications of data warehousing and data mining, including privacy, security, and data protection.

Course Outcomes:

1. Ability to understand data modelling, schema design, and data integration
2. Ability to populate a data warehouse and apply the process of ETL
3. Ability to apply data mining techniques on large data sets
4. Ability to appreciate the ethical, legal and social implications of data warehousing and importance of data privacy.

Mapping of Course Outcome to Programme Outcome ((scale 1: low, 2: Medium, 3: High)					
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	3	1	1
CO2	3	3	3	3	2
CO3	3	3	3	3	2
CO4	3	3	3	3	2

UNIT - I

Introduction to Data Warehousing: Definition and concept of Data Warehousing, Data Warehouse architecture and components, Differences between operational and analytical systems, Types of Data Warehouses

Data Modelling for Data Warehousing: Conceptual, logical and physical modeling, Star schema, snowflake schema, Data warehouse design considerations and best practices

Extract, Transform, Load (ETL) Processes: ETL definition and concept, ETL tools and techniques

UNIT - II

OLAP and Multidimensional Modeling: OLAP definition and concept, Types of OLAP, Multidimensional data model, Measures, dimensions, hierarchies and cubes, OLAP operations and types

UNIT - III

Data Mining Techniques: Definition and concept of Data Mining, Data Mining process and steps

Data Mining algorithms and techniques: Classification, Partition based and hierarchal Clustering

UNIT - IV

Data Mining algorithms and techniques: Association and prediction

Business Intelligence and Reporting: Introduction to Business Intelligence (BI), BI tools and applications

Textbooks:

1. Han J, Pei J, Tong H. Data mining: concepts and techniques. Morgan kaufmann; 2022.
2. Ponniah P. Data warehousing fundamentals for IT professionals. John Wiley & Sons; 2011.

Reference books:

1. G. K. Gupta. lntroduction to Data Mining with Case Studies. Easter Economy Edition. Prentice Hall of lndia; 2006.
2. Tan PN, Steinbach M, Kumar V. Introduction to data mining. Pearson Education India; 2016.
3. Berson A, Smith SJ. Data warehousing, data mining, and OLAP. McGraw-Hill, Inc.; 1997.
4. Soman KP, Diwakar S, Ajay V. Data mining: theory and practice [with CD]. PHI Learning Pvt. Ltd.; 2006.

MEAD-610 Big Data Frameworks

L	T/P	C
4	0	4

Marking Scheme:
Teachers Continuous Evaluation and End Term Theory Examiantion: As per per university examination norms from time to time
Instruction to Paper Setters: **Maximum Marks**: As per University norms Question No. 1 should be compulsory and cover the entire syllabus. This question may have objective or short answer type questions. Apart from Question No. 1, rest of the paper shall consist of four sections as per the units given in the syllabus. Every section should have two questions. However, student may be asked to attempt only 1 question from each section.

Course Objectives:

1. The course aims to introduce students to the fundamental concepts of big data, including the three Vs (volume, velocity, and variety), and the challenges of big data processing and analysis.
2. To make students learn about different big data frameworks, such as Hadoop, and Spark and their architecture and components.
3. To learn to use different big data tools and software, such as Hadoop MapReduce, Spark SQL, and Hive, to process and analyze big data.
4. To develop critical thinking skills and the ability to evaluate and analyze different big data frameworks and their effectiveness.

Course Outcomes:

1. Ability to apply different big data frameworks to process and analyze large datasets.
2. Ability to design and implement big data applications that can scale to handle large datasets.
3. Ability to use different big data tools and software to process and analyze big data.
4. Students will be prepared to use big data frameworks for solving real-world problems in various fields.

Mapping of Course Outcome to Programme Outcome ((scale 1: low, 2: Medium, 3: High)					
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	2	2	2	1
CO2	2	3	3	2	1
CO3	3	3	3	2	3
CO4	3	2	2	3	3

UNIT - I

Introduction to Big Data: Principles of Big data, Challenges of processing big data, Big data skill and sources of Big Data, Data Acquisitions: web APIs, open data sources, Data APIs and Web scrapping, Data quality and transformation: Data imputation, Data Transformations, outlier and anomalies

UNIT - II

Introduction to Hadoop: evolution of Hadoop, Hadoop and its components, comparison with other systems, Hadoop distribution and vendors, Hadoop releases, HDFS, HDFS architecture, Hadoop Architecture, Hadoop installation and cluster configuration

UNIT-III

Map Reduce: Map reduce framework, Map and reduce task, partitioners and combiners, Map reduce programming, map only and reduce only program, Map reduce streaming, Map reduce on image dataset, Introduction to HBase, HBase Admin
Introduction to Hive: the hive data-ware house, working with Hive QL

UNIT-IV

Introduction to Apache spark: Apache spark APIs for large scale data processing, Resilient distributed databases, Map reduce with spark, working of spark with and without Hadoop, Spark SQL
Introduction to Kafka: Working with Kafka using spark, spark streaming architecture, setting up Kafka Producer and Consumer.

Textbooks:

1. White T. Hadoop: The definitive guide. O'Reilly Media, Inc.; 2012.
2. Kienzler R. Mastering Apache Spark 2. x. Packt Publishing Ltd; 2017.

Reference books:

1. Bengfort B, Kim J. Data analytics with Hadoop: an introduction for data scientists. O'Reilly Media, Inc.; 2016.
2. Minni S. Apache Kafka Cookbook. Packt Publishing Ltd; 2015.

MEAD-612 Cloud Computing

L	T/P	C
4	0	4

Marking Scheme:
Teachers Continuous Evaluation and End Term Theory Examiantion: As per per university examination norms from time to time
Instruction to Paper Setters: **Maximum Marks**: As per University norms Question No. 1 should be compulsory and cover the entire syllabus. This question may have objective or short answer type questions. Apart from Question No. 1, rest of the paper shall consist of four sections as per the units given in the syllabus. Every section should have two questions. However, student may be asked to attempt only 1 question from each section.

Course Objectives:

1. The course aims to introduce students to the fundamental concepts, advantages, and novel applications of cloud computing. Provide an overview of different cloud types and their characteristics.
2. To make students explore cloud computing architecture and virtualization.
3. To make students learn identity and access management in the cloud and challenges related to identity and access management (IAM) in cloud services. Introduce relevant IAM standards and protocols .
4. To develop critical thinking skills and the ability to evaluate and analyze security management and privacy issues in the cloud and to understand audit, compliance, and security-as-a-cloud

Course Outcomes:

1. Ability to describe the concepts, benefits, and novel applications of cloud computing. Identify different types of clouds and their characteristics.
2. Students will be able to evaluate risk and challenges associated with cloud computing.
3. Ability to comply with the security management standards in the cloud.
4. Ability to assess security considerations at various levels including infrastructure, network, host, application and data security

Mapping of Course Outcome to Programme Outcome ((scale 1: low, 2: Medium, 3: High)					
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	2	2	2	1
CO2	2	3	3	2	1
CO3	3	3	3	2	3
CO4	3	2	2	3	3

UNIT - I

Introduction to Cloud Computing Online Social Networks and Applications, Cloud introduction and overview, Different clouds, Risks, Novel applications of cloud computing
Cloud Computing Architecture Requirements, Introduction Cloud computing architecture, On Demand Computing Virtualization at the infrastructure level, Security in Cloud computing environments, CPU Virtualization, A discussion on Hypervisors Storage Virtualization Cloud Computing Defined, The SPI Framework for Cloud Computing, The Traditional Software Model, The Cloud Services Delivery Model

UNIT - II

Cloud Deployment Models Key Drivers to Adopting the Cloud, The Impact of Cloud Computing on Users, Governance in the Cloud, Barriers to Cloud Computing Adoption in the Enterprise
Security Issues in Cloud Computing: Infrastructure Security, Infrastructure Security: The Network Level, The Host Level, The Application Level, Data Security and Storage, Aspects of Data Security, Data Security Mitigation Provider Data and Its Security
Identity and Access Management: Trust Boundaries and IAM, IAM Challenges, Relevant IAM Standards and Protocols for Cloud Services, IAM Practices in the Cloud, Cloud Authorization Management

UNIT-III

Security Management in the Cloud Security Management Standards, Security Management in the Cloud, Availability Management: SaaS, PaaS, IaaS Privacy Issues Privacy Issues, Data Life Cycle, Key Privacy Concerns in the Cloud, Protecting Privacy, Changes to Privacy Risk Management and Compliance in Relation to Cloud Computing, Legal and Regulatory Implications, U.S. Laws and Regulations, International Laws and Regulations

UNIT-IV

Audit and Compliance Internal Policy Compliance, Governance, Risk, and Compliance (GRC), Regulatory/External Compliance, Cloud Security Alliance, Auditing the Cloud for Compliance, Security-as-a-Cloud

ADVANCED TOPICS Recent developments in hybrid cloud and cloud security.

Textbooks:

1. Buyya, Rajkumar, James Broberg, and Andrzej M. Goscinski, eds. Cloud computing: Principles and paradigms. John Wiley & Sons, 2010.
2. Erl, Thomas, Ricardo Puttini, and Zaigham Mahmood. Cloud computing: concepts, technology & architecture. Pearson Education, 2013.

Reference books:

1. John Rhoton. Cloud Computing Explained: Implementation Handbook for Enterprises, Recursive Limited. 2nd ed.; 2009.
2. Tim Mather. Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance (Theory in Practice). O'Reilly Media; 2009.

MEAD-614 GPU Computing

L	T/P	C
4	0	4

Marking Scheme:
Teachers Continuous Evaluation and End Term Theory Examiantion: As per per university examination norms from time to time
Instruction to Paper Setters: **Maximum Marks**: As per University norms Question No. 1 should be compulsory and cover the entire syllabus. This question may have objective or short answer type questions. Apart from Question No. 1, rest of the paper shall consist of four sections as per the units given in the syllabus. Every section should have two questions. However, student may be asked to attempt only 1 question from each section.

Course Objectives:

1. The course aims to introduce students to the fundamental concepts of GPU computing, including parallel processing, GPU architecture, and the role of GPUs in accelerating computationally intensive tasks.
2. To familiarize students with GPU programming languages such as CUDA or OpenCL and GPU-accelerated libraries.
3. To learn to design and implement parallel algorithms that take advantage of the massive parallelism offered by GPUs.
4. To evaluate GPU performance and scalability.

Course Outcomes:

1. Ability to understand architecture and capabilities of GPUs for parallel processing.
2. Ability to program GPUs using GPU programming languages and frameworks such as CUDA or Open CL.
3. Ability to optimize and tune GPU programs fro improved performance and efficiency.
4. Students will be able to apply GPU accelerations in relevant domains.

Mapping of Course Outcome to Programme Outcome ((scale 1: low, 2: Medium, 3: High)					
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	2	2	2	1
CO2	2	3	3	2	1
CO3	3	3	3	2	3
CO4	3	2	2	3	3

UNIT - I

Introduction: History, Graphics Processors, Graphics Processing Units, GPGPUs. Clock speeds, CPU / GPU comparisons, Heterogeneity, Accelerators, Parallel programming, CUDA OpenCL / OpenACC, Hello World Computation Kernels, Launch parameters, Thread hierarchy, Warps / Wavefronts, Thread blocks / Workgroups, Streaming multiprocessors, 1D / 2D / 3D thread mapping, Device properties, Simple Programs

UNIT - II

Memory: Memory hierarchy, DRAM / global, local / shared, private / local, textures, Constant Memory, Pointers, Parameter Passing, Arrays and dynamic Memory, Multi-dimensional Arrays, Memory Allocation, Memory copying across devices, Programs with matrices, Performance evaluation with different memories

UNIT-III

Synchronization: Memory Consistency, Barriers (local versus global), Atomics, Memory fence. Prefix sum, Reduction. Programs for concurrent Data Structures such as Worklists, Linked-lists. Synchronization across CPU and GPU Functions: Device functions, Host functions, Kernels functions, Using libraries (such as Thrust), and developing libraries.

UNIT-IV

Support: Debugging GPU Programs. Profiling, Profile tools, Performance aspects Streams: Asynchronous processing, tasks, Task-dependence, Overlapped data transfers, Default Stream, Synchronization with streams. Events, Event-based Synchronization - Overlapping data transfer and kernel execution, pitfalls.
Case studies: : Image Processing, Graph algorithms, Simulations, Deep Learning
Advanced Topics: Dynamic parallelism, Unified Virtual Memory, Multi-GPU processing, Peer access, Heterogeneous processing

Textbooks:

1. Kirk, David B., and W. Hwu Wen-Mei. Programming massively parallel processors: a hands-on approach. Morgan kaufmann, 2016.
2. Sanders, Jason, and Edward Kandrot. CUDA by example: an introduction to general-purpose GPU programming. Addison-Wesley Professional, 2010.

Reference books:

1. Wilt, Nicholas. The cuda handbook: A comprehensive guide to GPU programming. Pearson Education, 2013.
2. Munshi, Aaftab, et al. OpenCL programming guide. Pearson Education, 2011.

DETAILED SYLLABUS

FOR

SEMESTER-III

MEAD-701 Text Analytics & Natural Language Processing L T/P C

4 0 4

Marking Scheme:
Teachers Continuous Evaluation and End Term Theory Examiantion: As per per university examination norms from time to time
Instruction to Paper Setters: **Maximum Marks**: As per University norms Question No. 1 should be compulsory and cover the entire syllabus. This question may have objective or short answer type questions. Apart from Question No. 1, rest of the paper shall consist of four sections as per the units given in the syllabus. Every section should have two questions. However, student may be asked to attempt only 1 question from each section.

Course Objectives:

1. To make students learn about different text analytics techniques, such as text classification, sentiment analysis, and information extraction.
2. To make students understand the principles of natural language processing, such as part-of-speech tagging, syntactic parsing, and semantic analysis.
3. To understand the applications of text analytics and natural language processing in various fields, such as customer service, social media analysis, and healthcare.
4. To develop critical thinking skills and the ability to evaluate and analyze different text analytics and natural language processing techniques.

Course Outcomes:

1. Ability to understand and apply different text analytics techniques to analyze and classify text data.
2. Ability to apply different natural language processing techniques to process and understand natural language text.
3. Ability to evaluate and analyze different text analytics and natural language processing techniques for different applications.
4. Students will be prepared for advanced courses and research in natural Language processing and text analysis.

Mapping of Course Outcome to Programme Outcome ((scale 1: low, 2: Medium, 3: High)					
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	3	2	2	1
CO2	2	3	3	3	1
CO3	3	2	2	3	2
CO4	3	2	1	2	2

UNIT - I

Language in Cognitive Science: Definitions of language, Language as a rule-governed dynamic system, Knowledge of language, Modes of language: spoken and written, Language system as expression and content
Language Analysis and Computational Linguistics: What is Language Analysis?, Form, Function and Meaning in Language Analysis, Levels of Linguistic Analysis: Phonetics, Phonology, Morphology, Syntax, Semantics, Discourse, Pragmatics, Lexicology
Shallow Parsing and Tools for NLP: Morphological Analysis, Tokenization & PoS Tagging, Chunking & Multi word expression (MWE), Named-Entity Recognition, Lemmatizer & Stemming, Morphological Synthesis
Deep Parsing and Tools for NLP: Syntactic Parsing Techniques and algorithms, Semantic Parsing, Information Extraction, Automatic Summarization, Anaphora Resolution, Pragmatics and Discourse analysis

UNIT - II

Text Classification: Bag of words representation. Vector space model and cosine similarity. Relevance feedback and Rocchio algorithm. Versions of nearest neighbor and Naive Bayes for text, Text Classification Using Support Vector Machine (SVM), Statistical Parsing
Language Learning: Classification problems in language: word-sense disambiguation, sequence labelling. Hidden Markov models (HMM's). Veterbi algorithm for determining most-probable state sequences, Training the parameters of HMM's. Use of HMM's for speech recognition.

UNIT - III

NLP with ANN: Issues in using ANN with text, understanding word and sentence embedding, Introduction to NLTK, Binary encoding, TF, TF-IDF encoding, Latent Semantic analysis encoding, Latent Dirichlet Allocation, Word2Vec models (Skip-gram, CBOW, Glove, one hot Encoding), Sequence-to-sequence models (Seq2Seq) - GloVe: Global Vectors for Word Representation

UNIT - IV

Speech Processing: Articulatory Phonetics, Speech Sounds and Phonetic Transcription, Acoustic Phonetics, Phonology, Computational Phonology, Automatic Speech Recognition (ASR), Speech Recognition Approaches, Text to Speech (TTS) system, Speech Synthesis Approaches
NLP Applications: Lexicon, Dictionaries, thesaurus, Transliteration, Spell Checker, Grammar Checker, Domain identification, Language identification, Auto suggest/ Auto complete, Machine Translation, Question answering & dialogue agents, OCR, Hand Writing Recognition, Sentiment analysis

Textbooks:

1. Bird S, Klein E, Loper E. Natural language processing with Python: analyzing text with the natural language toolkit. " O'Reilly Media, Inc."; 2009.
2. Thanaki J. Python natural language processing. Packt Publishing Ltd; 2017.

Reference books:

1. Hardeniya N, Perkins J, Chopra D, Joshi N, Mathur I. Natural language processing: python and NLTK. Packt Publishing Ltd; 2016.
2. Srinivasa-Desikan B. Natural Language Processing and Computational Linguistics: A practical guide to text analysis with Python, Gensim, spaCy, and Keras. Packt Publishing Ltd; 2018.

MEAD-703 Social Network Analysis L T/P C

4 0 4

Marking Scheme:
Teachers Continuous Evaluation and End Term Theory Examiantion: As per per university examination norms from time to time
Instruction to Paper Setters: **Maximum Marks**: As per University norms Question No. 1 should be compulsory and cover the entire syllabus. This question may have objective or short answer type questions. Apart from Question No. 1, rest of the paper shall consist of four sections as per the units given in the syllabus. Every section should have two questions. However, student may be asked to attempt only 1 question from each section.

Course Objectives:

1. The course aims to introduce students to different network metrics, such as centrality, clustering coefficient, and degree distribution.
2. To make students understand the principles of network visualization and modelling.
3. To learn about different social network analysis techniques, such as community detection, link prediction, and influence analysis.
4. To understand the applications of social network analysis in various fields, such as sociology, marketing, and healthcare.

Course Outcomes:

1. Ability to apply different network metrics to analyze social networks.
2. Ability to visualize and model social networks using appropriate tools and techniques.
3. Ability to different social network analysis techniques to detect communities, predict links, and analyze influence.
4. Students will be prepared for advanced courses and research in application of Social Network Analysis

Mapping of Course Outcome to Programme Outcome ((scale 1: low, 2: Medium, 3: High)					
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	2	2	2	1
CO2	3	3	3	2	1
CO3	3	3	3	2	2
CO4	3	2	2	2	2

UNIT-I

Basic Concepts of Social Networks: The social networks perspective, historical and theoretical foundation, fundamental concepts in network analysis, analysing relationships, from relationships to networks, social networks vs Link analysis, power of informal networks, Social network data
Mathematical representations of Social Networks: Notation for social network data, Graph and matrices

UNIT-II

Structural and Locational Properties: Centrality and Prestige, Non-directional and directional Structural balance and Transitivity, clusterability, generalisation of clusterability, Cohesive subgroups, Affiliations and overlapping subgroups

UNIT-III

Roles and Positions: Structural equivalence, Positional analysis, Block models
Analysing relations association among relations: Relational Algebra, Network Positions and Roles

UNIT-IV

Dyadic and Triadic Methods: Dyads, simple distribution, statistical analysis of number of arcs, conditional uniform distribution, Statistical analysis of number of mutuals, Triads, Distribution of triads census, Testing structural hypothesis.
Statistical Dyadic interaction models: Statistical analysis of single relational networks, Stochastic block models and Goodness-of-fit indices

Textbooks:

1. Wasserman, Stanley, and Katherine Faust. Social network analysis: Methods and applications. Cambridge University Press; 1994.
2. Borgatti SP, Everett MG, Johnson JC. Analyzing social networks. Sage; 2018.

Reference books:

1. Hanneman, Robert A. and Mark Riddle. Introduction to social network methods. University of California, Riverside; 2005.

MEAD-705 Recommender System

L	T/P	C
4	0	4

Marking Scheme:
Teachers Continuous Evaluation and End Term Theory Examiantion: As per per university examination norms from time to time
Instruction to Paper Setters: **Maximum Marks**: As per University norms Question No. 1 should be compulsory and cover the entire syllabus. This question may have objective or short answer type questions. Apart from Question No. 1, rest of the paper shall consist of four sections as per the units given in the syllabus. Every section should have two questions. However, student may be asked to attempt only 1 question from each section.

Course Objectives:

1. The course aims to introduce students to the concepts of recommender systems.
2. To make students learn about different types of recommender systems, such as collaborative filtering, content-based filtering, and hybrid recommender systems.
3. To understand principles of recommendation algorithms, such as matrix factorization, clustering, and association rule mining and different evaluation metrics for recommender systems, such as precision, recall, and F1 score.
4. To understand applications of recommender systems in various fields, such as e-commerce, entertainment, and social media.

Course Outcomes:

1. Ability to different types of recommender systems to recommend items to users.
2. Ability to understand and apply different recommendation algorithms to generate recommendations.
3. Ability to evaluate and analyze different recommender system techniques using appropriate evaluation metrics.
4. Ability to develop critical thinking skills and to evaluate and analyze different recommender system techniques.

Mapping of Course Outcome to Programme Outcome ((scale 1: low, 2: Medium, 3: High)					
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	2	2	1
CO2	3	3	3	2	2
CO3	3	3	3	2	2
CO4	3	2	2	3	1

UNIT-I

Introduction to Recommender Systems (RS): Goals of RS, Basic models of RS, Challenges in RS
Collaborative filtering: Key properties of rating matrices, user and item based nearest recommendation, predicting ratings, neighborhood-based methods (clustering, dimensionality reduction, regression modelling and graph models), Model based collaborative filtering, Content-based, knowledge based, ensemble based and hybrid recommender system

UNIT-II

Evaluating Recommender Systems: Explanations in recommender systems, General properties of evaluation research, popular evaluation designs, goals of evaluation design design issues in offline recommender evaluation, accuracy metrics in offline evaluation.
Context, time and location sensitive RS: Multidimensional approach, context pre-filtering, post filtering, contextual modelling, temporal collaborative filtering, discrete temporal models, location aware recommender systems

UNIT-III

Structural recommendations in networks Ranking algorithms, recommendations by collective classification, recommending friends: link prediction, social influence analysis and viral marketing
Social and trust centric RS: Multidimensional models for social context, network centric and trust centric methods, user interaction in social recommenders

UNIT-IV

Attack-resistant RS: Trade-offsAttack models, Types of attacks, detecting attacks on RS, strategies for robust RS, Online consumer decision making
Learning to rank, multi-armed bandit algorithms, group RS, multi criteria RS, Active learning in RS, privacy in RS, Recommender systems and the next-generation web

Textbooks:

1. Jannach D., Zanker M. and FelFering A., Recommender Systems: An Introduction, Cambridge University Press, 1st ed., 2011.
2. Aggarwal CC. Recommender systems. Cham: Springer International Publishing; 2016.

Reference books:

1. Manouselis N., Drachsler H., Verbert K., Duval E., Recommender Systems For Learning, Springer; 2013.
2. Ricci F., Rokach L., Shapira D., Kantor B.P., Recommender Systems Handbook, Springer; 2011.

MEAD-707 Intelligent Information Retrieval L 4 T/P 0 C 4

Marking Scheme:
Teachers Continuous Evaluation and End Term Theory Examiantion: As per per university examination norms from time to time
Instruction to Paper Setters: **Maximum Marks**: As per University norms Question No. 1 should be compulsory and cover the entire syllabus. This question may have objective or short answer type questions. Apart from Question No. 1, rest of the paper shall consist of four sections as per the units given in the syllabus. Every section should have two questions. However, student may be asked to attempt only 1 question from each section.

Course Objectives:

1. The course aims to introduce students to different types of information retrieval systems, such as search engines, question-answering systems, and recommender systems.
2. To make students understand the principles of information retrieval, such as indexing, querying, and relevance ranking.
3. To understand different information retrieval techniques
4. To understand the applications of information retrieval in various fields, such as healthcare, finance, and e-commerce.

Course Outcomes:

1. Ability to apply different types of information retrieval systems to retrieve relevant information.
2. Ability to understand and apply different information retrieval techniques to process and analyze text data.
3. Ability to evaluate and analyze different information retrieval techniques using appropriate evaluation metrics.
4. Students will be prepared for advanced courses and research in intelligence information retrieval systems

Mapping of Course Outcome to Programme Outcome ((scale 1: low, 2: Medium, 3: High)					
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	2	2	3	1
CO2	3	3	3	2	1
CO3	3	3	3	2	2
CO4	3	2	2	3	2

UNIT-I

Introduction and Modelling: Information retrieval problem, Classic Information retrieval, set theoretic models, algebraic models. Probabilistic models, Structured text retrieval models, Models for browsing, Basic Tokenizing, Indexing, and Implementation of Vector-Space Retrieval
Retrieval performance Evaluation: Recall and precision, alternative measures, Standard test collections, evaluation of ranked and unranked retrieval sets, reference collections

UNIT-II

Query Operations and Query Languages: Keyword based querying, Pattern matching, Structural queries, User relevance feedback, query expansion and reformulation, Automatic local and global analysis.
Text Properties and languages: Document preprocessing, Document clustering, text compression, XML retrieval, Probabilistic information retrieval, language model based retrieval.

UNIT-III

Automated text categorisation: learning for categorisation, learning issues, learning algorithms (Bayesian, NN, Rocchio, Ripper, nearest neighbour, SVM, evaluation of text classification.
Automated text clustering, clustering in information retrieval, evaluation of clustering, K-means, model-based clustering, Hierarchical clustering
Recommender systems: collaborative filtering & content based recommending

UNIT-IV

Web search: Web characteristics, Search engines, Browsing, metasearches, searching using hyperlinks, web spidering, web crawling and indexes, Link analysis: web as a graph, PageRank, Hubs and authorities

Textbooks:

1. Buttcher, Stefan, Charles LA Clarke, and Gordon V. Cormack. *Information retrieval: Implementing and evaluating search engines*. Mit Press, 2016.
2. Schütze, Hinrich, Christopher D. Manning, and Prabhakar Raghavan. *Introduction to information retrieval*. Vol. 39. Cambridge: Cambridge University Press, 2008

Reference books:

1. Ceri, Stefano, et al. Web information retrieval. Springer Science & Business Media, 2013.
2. Ricardo, Baeza-Yates, and Ribeiro-Neto Berthier. "Modern information retrieval: the concepts and technology behind search." Addison-Wesley Professional, 2011.
3. Croft, W. Bruce, Donald Metzler, and Trevor Strohman. Search engines: Information retrieval in practice. Vol. 520. Reading: Addison-Wesley, 2010.