Scheme & Syllabus of

Master of Technology

Computer Science & Engineering

Batch 2023 onwards

By

Board of Study- CSE

Department of Academics

IK Gujral Punjab Technical University

Study Scheme and Syllabus - 2023

of

Master of Technology

Computer Science Engineering with Specialization in Artificial Intelligence & Machine Learning

- **Eligibility: B.E. / B. Tech. (CSE/ IT/ Software Engg./ Computer Engg./ Software Systems/ Information Security/ Cyber Security/ Computational Engg./ Machine learning) with atleast 50% (45% in case of candidate belonging to reserved category).**

SEMESTER - 1

Sem	Course Code	Course Name	L	T	P	Hrs	Internal	External	Total	Credits
1	MTAI-101-20	Mathematical Foundations of Computer Science	3	0	0	3	40	60	100	3
1	MTAI-102-20	Advanced Data Structures	3	0	0	3	40	60	100	3
1	MTAI-PE*	Program Elective – 1	3	0	0	3	40	60	100	3
1	MTAI-PE**	Program Elective – 2	3	0	0	3	40	60	100	3
1	MTAI-111-20	Advanced Data Structures LAB	0	0	4	4	60	40	100	2
1	MTAI-112-20	Electives Based LAB	0	0	4	4	60	40	100	2
1	MTEC-RM1-20	Research Methodology and IPR	2	0	0	2	40	60	100	2
1	MTEC-AU1-20	Audit Course 1	0	0	0	0	40	60	100	s/us
		Total	**14**	**0**	**8**	**22**	**360**	**440**	**800**	**18**

Semester-2

Sem.	Course Code	Course Name	L	T	P	Hrs	Internal	External	Total	Credits
2	MTAIML-103-23	Generative Artificial Intelligence	3	0	0	3	40	60	100	3
2	MTAI-PE10-20	Advanced Deep Learning	3	0	0	3	40	60	100	3
2	MTAI ML-PE $	Program Elective – 3	3	0	0	3	40	60	100	3
2	MTAI ML-PE $$	Program Elective – 4	3	0	0	3	40	60	100	3
2	MTAIML-113-20	Advanced Deep Learning LAB	0	0	4	4	60	40	100	2
2	MTAI-114-20	Electives Based LAB	0	0	4	4	60	40	100	2
2	MTAIML-MP1-20	Mini Project	0	0	4	4	60	40	100	2
2	MTAI ML-AU2-20	Audit Course-2	0	0	0	0	40	60	100	s/us
			12	0	12	24	380	420	800	18

SEMESTER-3

Sem	Course Code	Course Name	L	T	P	Hrs	Internal	External	Total	Credits
3	MTAI ML- PE#	Program Elective-V	3	0	0	3	40	60	100	3
3	MTAI ML- OE*-20	Open Elective	3	0	0	3	40	60	100	3
3	MTAIML-DS1-20	Dissertation Phase-I	0	0	20	20	60	40	100	10
			6	0	20	26	140	160	300	16

SEMESTER-4

Sem	Course Code	Course Name	L	T	P	Hrs	Internal	External	Total	Credits
4	MTAIML-DS2-20	Dissertation Phase-II	6	0	20	20	60	40	100	16

PROGRAMME ELECTIVE COURSES

Programme Elective-I	MTAIML-PE *	MTAI-PE1-20 Data Preparation and Analysis	MTAI-PE2-20 Data Warehousing & Mining	MTAI-PE3-20 Data Visualization
Programme Elective-II	MTAIML-PE**	MTAI-PE4-20 Advanced Machine Learning	MTAI-PE5-20 Data Science	MTAI-PE6-20 Data Security and Access Control
Programme Elective-III	MTAIML-PE $	MTAI-PE7-20 Advanced Computer Vision	MTAI-PE8-20 Pattern Recognition	MTAI-PE13-20 Big Data Analytics
Programme Elective-IV	MTAIML-PE $$	MTAIML 10-23 Advanced Computer Architecture	MTAIML-PE11-23 Statistical Natural Language Processing	MTAI-PE14-20 Distributed System
Programme Elective-V	MTAIML-PE $$$	MTAIML-PE13- 23 Social Network Analysis	MTAIML-PE14-23 Reinforcement Learning and its Applications	MTAIML-PE12-23 AI Applications of Cyber Security

OPEN ELECTIVES:

MTAIML-OE1-18 Cost Management of Engineering Projects MTAIML-OE2-18 Business Analytics
MTAIML-OE3-18 Industrial Safety MTAIML-OE4-18 Operations Research MTAIML-OE5-18 Composite Materials MTAIML-OE6-18 Waste to Energy

AUDIT COURSES I & II

MTA1ML01-18 English for Research Paper Writing
MTA1ML02-18 Disaster Management
MTA1ML03-18 Sanskrit for Technical Knowledge
MTA1ML04-18 Value Education
MTA1ML05-18 Constitution of India MTA1ML06-18 Pedagogy Studies MTA1ML07-18 Stress Management by Yoga

FIRST SEMESTER

M. Tech (Artificial Intelligence & Machine Learning)

Course Code	**MTAI-101-20**
Course Name	**Mathematical Foundations of Computer Science**
Credits	**3**
Pre Requisites	**Discrete Mathematics**

COURSE OBJECTIVE

- To understand the mathematical fundamentals that is prerequisites for a variety of courses like Data mining, Network protocols, analysis of Web traffic, Computer security, Software engineering, Computer architecture, operating systems, distributed systems, Bioinformatics, Machine learning.
- To develop the understanding of the mathematical and logical basis to many modern techniques in in for technology like machine learning, programming language design, and concurrency.
- To study various sampling and classification problems.

COURSE OUTCOMES

- After completion of course, students would be able to:
- To understand the basic notions of discrete and continuous probability.
- To understand the methods of statistical inference, and the role that sampling distributions playin those methods.
- To be able to perform correct and meaningful statistical analyses of simple to moderate complexity.

Syllabus Contents:

Unit 1:

Probability mass, density, and cumulative distribution functions, Parametric families of distributions, Expected value, variance, conditional expectation, Applications of the univariate and multivariate Central Limit Theorem, Probabilistic inequalities, Markov chains

Unit 2:

Random samples, sampling distributions of estimators, Methods of Moments and Maximum Likelihood

Unit 3:

Statistical inference, Introduction to multivariate statistical models: regression and classification problems, principal components analysis, The problem of overfitting model assessment.

Unit 4:

Graph Theory: Isomorphism, Planar graphs, graph colouring, hamilton circuits and euler cycles. Permutations and Combinations with and without repetition. Specialized techniques to solve

combinatorial enumeration problems.

Unit 5:

Computer science and engineering applications Data mining, Network protocols, analysis of Web traffic, Computer security, Software engineering, Computer architecture, operating systems, distributed systems, Bioinformatics, Machine learning.

Unit 6:

Recent Trands in various distribution functions in mathematical field of computer science for varying fields like bioinformatics, soft computing, and computer vision.

Text books:

1. Introduction to Automata Theory, Languages and Computations – J.E. Hopcroft, & J.D. Ullman, Pearson Education Asia.
2. Discrete Mathematical structures with application to Computer Science – J.P. Tremblay and R. Manohar.
3. Cryptography and Network Security, William Stallings.(Second Edition)Pearson Education Asia.

Reference books:

1. Introduction to languages and theory of computation – John C. Martin (MGH)
2. Introduction to Theory of Computation – Michael Sipser (Thomson Nrools/Cole)
3. Cryptanalysis of number theoretic Cyphers, Samuel S. Wagstaff Jr.Champan& Hall/CRC Press 2003
4. Network Security: The Complete Reference by Roberta Bragg, Mark Phodes –Ousley, Keith Strassberg Tata McGraw-Hill.

Course Code	**MTAI-102-20**
Course Name	**Advanced Data Structures**
Credits	**3**
Pre Requisites	**UG level course in Data Structures**

COURSE OBJECTIVE

1. Using hashing techniques.
2. Develop and analyze algorithms for red-black trees, B-trees and Splay trees.
3. Develop algorithms for text processing applications.
4. Identify suitable data structures and develop algorithms for computational geometry problems

COURSE OUTCOMES

1. Student should be able to come up with analysis of efficiency and proofs of correctness
2. The student should be able to choose appropriate data structures, understand theADT/libraries, and use it to design algorithms for a specific problem.
3. Students should be able to understand the necessary mathematical abstraction to solveproblems.

Unit 1

Dictionaries: Definition, Dictionary Abstract Data Type, Implementation of Dictionaries. Hashing: Review of Hashing, Hash Function, Collision Resolution Techniques in Hashing, Separate Chaining, Open Addressing, Linear Probing, Quadratic, Probing, Double Hashing, Rehashing, Extendible Hashing ,Understand the implementation of symbol table

Unit 2

Skip Lists: Need for Randomizing Data Structures and Algorithms, Search and Update Operations on Skip Lists, Probabilistic Analysis of Skip Lists, Deterministic Skip Lists

Unit 3

Trees: Binary Search Trees, AVL Trees, Red Black Trees, 2-3 Trees, B-Trees, Splay Trees

Unit 4

Text Processing: Sting Operations, Brute-Force Pattern Matching, The Boyer-Moore Algorithm, The Knuth-Morris-Pratt Algorithm, Standard Tries, Compressed Tries, Suffix Tries, The Huffman Coding Algorithm, The Longest Common Subsequence Problem (LCS), Applying Dynamic Programming tothe LCS Problem

Unit 5

Computational Geometry: One Dimensional Range Searching, Two-Dimensional Range Searching, constructing a Priority Search Tree, Searching a Priority Search Tree, Priority Range Trees, Quadtrees, k-D Trees.

Unit 6 Recent Trends in Hashing, Trees, and various computational geometry methods for efficiently solving the new evolving problem.

References:

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, 2nd Edition, Pearson, 2004.

2. M T Goodrich, Roberto Tamassia, Algorithm Design, John Wiley, 2002.

Course Code	MTEC-RM1-20
Course Name	Research Methodology and IPR
Credits	3

COURSE OBJECTIVE

To enable student to acquire knowledge of research process: gather data, implement the proposed work and collect the results and publish them.

COURSE OUTCOMES

At the end of this course, students will be able to

- Understand research problem formulation.
- Analyze research related information · Follow research ethics
- Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
- Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to bepromoted among students in general & engineering in particular.
- Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

Syllabus Contents:

Unit 1:
Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Unit 2:
Effective literature studies approaches, analysis Plagiarism, Research ethics

Unit 3:
Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

Unit 4:
Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit 5:
Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Unit 6:
New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

References:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition , "Research Methodology: A Step by Step Guide for beginners".
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.
5. Mayall , "Industrial Design", McGraw Hill, 1992.
6. Niebel , "Product Design", McGraw Hill, 1974.
7. Asimov, "Introduction to Design", Prentice Hall, 1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
9. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

Course Code	MTAI-PE1-20
Course Name	Data Preparation and Analysis
Credits	3

COURSE OBJECTIVE

To prepare the data for analysis and develop meaningful Data Visualizations

COURSE OUTCOMES

After completion of course, students would be:

1. Able to extract the data for performing the Analysis
2. Perform descriptive and comparative analysis based on data
3. Able to perform Data driven hypothesis

Syllabus Contents:

Unit 1:

Data Gathering and Preparation: Data formats, parsing and transformation, Scalability and real-time issues

Unit 2:

Data Cleaning: Consistency checking, Heterogeneous and missing data, Data Transformation and segmentation

Unit 3:

Exploratory Analysis: Descriptive and comparative statistics, Clustering and association, Hypothesis generation

Unit 4:

Visualization: Designing visualizations, Time series, Geolocated data, Correlations and connections, Hierarchies and networks, interactivity

References:

1. Making sense of Data : A practical Guide to Exploratory Data Analysis and Data Mining, by Glenn J. Myatt

Course Code	**MTAI-PE2-20**
Course Name	**Data Warehousing & Mining**
Credits	**3**

COURSE OBJECTIVE

The objective of this course is to introduce data warehousing and mining techniques. Application of data mining in web mining, pattern matching and cluster analysis is included to aware students of broad data mining areas.

COURSE OUTCOMES

After completion of course, students would be able to :

- Study of different sequential pattern algorithms.
- Study the technique to extract patterns from time series data and it application in real world.
- Can extend the Graph mining algorithms to Web mining
- Help in identifying the computing framework for Big Data

Syllabus Contents:

Unit 1:

Introduction to Data Warehousing; Data Mining: Mining frequent patterns, association and correlations; Sequential Pattern Mining concepts, primitives, scalable methods

Unit 2:

Classification and prediction; Cluster Analysis – Types of Data in Cluster Analysis, Partitioning methods, Hierarchical Methods; Transactional Patterns and other temporal based frequent patterns.

Unit 3:

Mining Time series Data, Periodicity Analysis for time related sequence data, Trend analysis, Similarity search in Time-series analysis;

Unit 4:

Mining Data Streams, Methodologies for stream data processing and stream data systems, Frequent pattern mining in stream data, Sequential Pattern Mining in Data Streams, Classification of dynamic data streams, Class Imbalance Problem; Graph Mining; Social Network Analysis;

Unit 5:

Web Mining, Mining the web page layout structure, mining web link structure, mining multimedia data on the web, Automatic classification of web documents and web usage mining; Distributed Data Mining.

Unit 6:

Recent trends in Distributed Warehousing and Data Mining, Class Imbalance Problem; Graph Mining; Social Network Analysis

References:

1. Jiawei Han and M Kamber , Data Mining Concepts and Techniques, , Second Edition, Elsevier Publication, 2011.
2. Vipin Kumar, Introduction to Data Mining - Pang-Ning Tan, Michael Steinbach, Addison Wesley, 2006.
3. G Dong and J Pei, Sequence Data Mining, Springer, 2007.

Course Code	MTAI-PE3-20
Course Name	Data Visualization
Credits	3

COURSE OBJECTIVE:

- Familiarize students with the basic and advanced techniques of information visualization and scientific visualization
- To learn key techniques of the visualization process
- A detailed view of visual perception, the visualized data and the actual visualization, interaction and distorting techniques

COURSE OUTCOMES:

On completion of the course the student should be able to

- Familiar with the design process to develop visualization methods and visualization systems, and methods for their evaluation.
- Preparation and processing of data, visual mapping and the visualization
- Have an understanding of large-scale abstract data.

Syllabus Contents:

Unit 1:

Introduction of visual perception, visual representation of data, Gestalt principles, information overloads.

Unit 2:

Creating visual representations, visualization reference model, visual mapping, visual analytics, Design of visualization applications.

Unit 3:

Classification of visualization systems, Interaction and visualization techniques misleading, Visualization of one, two and multi-dimensional data, text and text documents.

Unit 4:

Visualization of groups, trees, graphs, clusters, networks, software, Metaphorical visualization

Unit 5:

Visualization of volumetric data, vector fields, processes and simulations, Visualization of maps, geographic information, GIS systems, collaborative visualizations, Evaluating visualizations.

Unit 6:

Recent trends in various perception techniques, various visualization techniques, data structures usedin data visualization.

References:

1. WARD, GRINSTEIN, KEIM,.Interactive Data Visualization: Foundations, Techniques, and Applications. Natick : A K Peters, Ltd.
2. E. Tufte, The Visual Display of Quantitative Information, Graphics Press.

Course Code	MTAI-PE4-20
Course Name	Advanced Machine Learning
Credits	3

COURSE OBJECTIVE

- To learn the concept of how to learn patterns and concepts from data without being explicitlyprogrammed in various IOT nodes.
- To design and analyse various machine learning algorithms and techniques with a modernoutlook focusing on recent advances.
- Explore supervised and unsupervised learning paradigms of machine learning.
- To explore Deep learning technique and various feature extraction

strategies.COURSE OUTCOMES

After completion of course, students would be able to:

- Extract features that can be used for a particular machine learning approach in various IOTapplications.
- To compare and contrast pros and cons of various machine learning techniques and to get aninsight of when to apply a particular machine learning approach.
- To mathematically analyse various machine learning approaches and paradigms.

Syllabus Contents:

Unit 1:

Supervised Learning (Regression/Classification): Basic methods: Distance-based methods, Nearest-Neighbours, Decision Trees, Naive Bayes Linear models: Linear Regression, Logistic Regression, Generalized Linear Models. Support Vector Machines, Nonlinearity and Kernel Methods. Beyond Binary Classification: Multi-class/Structured Outputs, Ranking

Unit 2:

Unsupervised Learning: Clustering: K-means/Kernel K-means. Dimensionality Reduction: PCA and kernel PCA. Matrix Factorization and Matrix Completion. Generative Models (mixture models and latent factor models)

Unit 3:

Evaluating Machine Learning algorithms and Model Selection, Introduction to Statistical Learning Theory, Ensemble Methods (Boosting, Bagging, Random Forests)

Unit 4:

Sparse Modeling and Estimation, Modeling Sequence/Time-Series Data, Deep Learning and Feature Representation Learning

Unit 5:

Scalable Machine Learning (Online and Distributed Learning) A selection from some other advanced topics, e.g., Semi-supervised Learning, Active Learning, Reinforcement Learning, Inference in Graphical Models, Introduction to Bayesian Learning and Inference

Unit 6:

Recent trends in various learning techniques of machine learning and classification methods for IOT applications. Various models for IOT applications.

References:

1. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer 2009 (freely available online)
3. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007.

Course Code	**MTAI-PE5-20**
Course Name	**Data Science**
Credits	**3**

COURSE OBJECTIVE

- Provide you with the knowledge and expertise to become a proficient data scientist.
- Demonstrate an understanding of statistics and machine learning concepts that are vital for datascience;
- Produce Python code to statistically analyse a dataset;
- Critically evaluate data visualisations based on their design and use for communicating stories from data.

COURSE OUTCOMES

On completion of the course the student should be able to

- Explain how data is collected, managed and stored for data science;
- Understand the key concepts in data science, including their real-world applications and the toolkit used by data scientists;
- Implement data collection and management scripts using MongoDB

Syllabus Contents:

Unit 1:

Introduction to core concepts and technologies: Introduction, Terminology, data science process, data science toolkit, Types of data, Example applications.

Unit 2:

Data collection and management: Introduction, Sources of data, Data collection and APIs, Exploring and fixing data, Data storage and management, Using multiple data sources.

Unit 3:

Data analysis: Introduction, Terminology and concepts, Introduction to statistics, Central tendencies and distributions, Variance,Distribution properties and arithmetic, Samples/CLT, Basic machine learning algorithms, Linear regression, SVM, Naive Bayes.

Unit 4:

Data visualisation:Introduction, Types of data visualisation,Data for visualisation:Data types, Data encodings, Retinal variables, Mapping variables to encodings, Visual encodings.

Unit 5:

Applications of Data Science,Technologies for visualisation, Bokeh (Python)

Unit 6:

Recent trends in various data collection and analysis techniques, various visualization techniques, application development methods of used in data science.

References:

1. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk fromthe Frontline. O'Reilly.
2. Jure Leskovek, Annand Rajaraman and Jeffrey Ullman. Mining of Massive Datasets. v2.1, Cambridge University Press

Course Code	MTAI-PE6-20
Course Name	Data Security and Access Control
Credits	3

COURSE OBJECTIVE

The objective of the course is to provide fundamentals of database security. Various access control techniques mechanisms were introduced along with application areas of access control techniques.

COURSE OUTCOMES

After completion of course, students would be:

- In this course, the students will be enabled to understand and implement classical models andalgorithms
- They will learn how to analyse the data, identify the problems, and choose the relevantmodels and algorithms to apply.
- They will further be able to assess the strengths and weaknesses of various access controlmodels and to analyse their behaviour.

Syllabus Contents:

Unit1:

Introduction to Access Control, Purpose and fundamentals of access control, brief history, Policies of Access Control, Models of Access Control, and Mechanisms, Discretionary Access Control (DAC), Non-Discretionary Access Control, Mandatory Access Control (MAC). Capabilities and Limitations of Access Control Mechanisms: Access Control List (ACL) and Limitations, Capability List and Limitations.

Unit 2:

Role-Based Access Control (RBAC) and Limitations, Core RBAC, Hierarchical RBAC, Statically Constrained RBAC, Dynamically Constrained RBAC, Limitations of RBAC. Comparing RBAC to DAC and MAC Access control policy.

Unit 3:

Biba'sintrigity model, Clark-Wilson model, Domain type enforcement model, mapping the enterprise view to the system view, Role hierarchies- inheritance schemes, hierarchy structures and inheritance forms, using SoD in real system Temporal Constraints in RBAC, MAC AND DAC. Integrating RBAC with enterprise IT infrastructures: RBAC for WFMSs, RBAC for UNIX and JAVA environments Case study: Multi line Insurance Company

Unit 4:

Smart Card based Information Security, Smart card operating systemfundamentals, design and implantation principles, memory organization, smart card files, file management, atomic operation, smart card data transmission ATR, PPS Security techniques- user identification, smart card security,

quality assurance and testing, smart card life cycle-5 phases, smart card terminals.

Unit 5:

Recent trends in Database security and access control mechanisms. Case study of Role-Based Access Control (RBAC) systems.

Unit 6:

Recent Trends related to data security management, vulnerabilities in different DBMS.

References:

1. Role Based Access Control: David F. Ferraiolo, D. Richard Kuhn, RamaswamyChandramouli.
2. http://www.smartcard.co.uk/tutorials/sct-itsc.pdf : Smart Card Tutorial.

Audit Courses:

Course Code	**MTEC-AU1-18**
Course Name	**English for research paper writing**
Credits	**0**

COURSE OBJECTIVE

This course is to develop skills in effective English writing to communicate the research work

COURSE OUTCOMES

At the end of this course Students will be able to:

- Understand that how to improve your writing skills and level of readability
- Learn about what to write in each section
- Understand the skills needed when writing a Title
- Ensure the good quality of paper at very first-time submission

Syllabus Contents:

Unit 1
Planning and Preparation, Word Order, breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

Unit 2
Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

Unit 3
Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

Unit 4
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

Unit 5

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

Unit 6
Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

Recommended Books :

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book.
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

Course Code	MTEC-AU1-18
Course Name	Disaster Management
Credits	0

COURSE OBJECTIVE

This course is to develop skills in helping society during natural disasters and how to manage.

COURSE OUTCOMES

At the end of this course **s**tudents will be able to:

- Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in

Syllabus Contents:

Unit 1

Introduction: Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.

Unit 2

Repercussions Of Disasters And Hazards: Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War AndConflicts.

Unit 3

Disaster Prone Areas In India Study Of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special ReferenceTo Tsunami; Post-Disaster Diseases And Epidemics.

Unit 4

Disaster Preparedness And Management Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.

Unit 5

Risk Assessment Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.

Unit 6

Disaster Mitigation Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

Recommended Books :

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues andstrategies" New Royal book Company.
2. Sahni, Pardeep Et.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
3. Goel S. L. , Disaster Administration And Management Text And Case Studies" ,Deep & Deep Publication Pvt. Ltd., New Delhi.

Course Code	MTEC-AU1-18
Course Name	Sanskrit For Technical Knowledge
Credits	0

COURSE OBJECTIVE

This course is to develop

- A working knowledge in illustrious Sanskrit, the scientific language in the world
- Learning of Sanskrit to improve brain functioning
- Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
- The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

COURSE OUTCOMES

At the end of this course students will be able to

- Understanding basic Sanskrit language
- Ancient Sanskrit literature about science & technology can be understood
- Being a logical language will help to develop logic in students

Syllabus Contents:

Unit 1
Alphabets in Sanskrit, Past/Present/Future Tense, Simple Sentences.
Unit 2
Order, Introduction of roots, Technical information about Sanskrit Literature.

Unit 3
Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

Recommended Books :

1. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

Course Code	MTEC-AU1-18
Course Name	Value Education
Credits	0

COURSE OBJECTIVE

This course is to develop

- Value of education and self- development
- Imbibe good values in students
- Let the should know about the importance of

characterCOURSE OUTCOMES

At the end of this course students will be able to

- Knowledge of self-development
- Learn the importance of Human values
- Developing the overall personality

Syllabus Contents:

Unit 1

Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism, Moral and non- moral valuation. Standards and principles, Value judgements.

Unit 2

Importance of cultivation of values, Sense of duty, Devotion, Self-reliance, Confidence, Concentration, Truthfulness, Cleanliness, Honesty, Humanity, Power of faith, National Unity, Patriotism, Love for nature, Discipline.

Unit 3

Personality and Behavior Development - Soul and Scientific attitude, Positive Thinking. Integrity and discipline, Punctuality, Love and Kindness, Avoid fault Thinking, Free from anger, Dignity of labour, Universal brotherhood and religious tolerance, True friendship, Happiness Vs suffering, love for truth, Aware of self-destructive habits, Association and Cooperation, Doing best for saving nature.

Unit 4

Character and Competence –Holy books vs Blind faith, Self-management and Good health, Science of reincarnation, Equality, Nonviolence ,Humility, Role of Women, All religions and same message, Mind your Mind, Self-control, Honesty, Studying effectively.

Recommended Books:

1. Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi

Laboratories

Course Code **MTAI-111-20**
Course Name **Advanced Data structures LAB**
Credits: 02 **Hours: 04**

Syllabus Contents:

Programs may be implemented using JAVA

Expt. 1:

WAP to store k keys into an array of size n at the location computed using a hash function, loc = key % n, where k<=n and k takes values from [1 to m], m>n. To handle the collisions use the following collision resolution techniques:

a. Linear probing
b. Quadratic probing
c. Double hashing/rehashing
d. Chaining

Expt. 2:

WAP for Binary Search Tree to implement following operations:

a. Insertion
b. Deletion
    i. Delete node with only child
    ii. Delete node with both children
c. Finding an element
d. Finding Min element
e. Finding Max element
f. Left child of the given node
g. Right child of the given node
h. Finding the number of nodes, leaves nodes, full nodes, ancestors, descendants.

Expt. 3:

WAP for AVL Tree to implement following operations: (For nodes as integers)

a. Insertion: Test program for all cases (LL, RR, RL, LR rotation)
b. Deletion: Test Program for all cases (R0, R1, R-1, L0, L1, L-1)
c. Display: using set notation.

Expt. 4:

WAP to implement Red-Black trees with insertion and deletion operation for the given input data as Integers/Strings

Expt. 5:

WAP to implement insertion, deletion, display and search operation in m-way B tree (i.e. a non-leaf node can have at most m children) for the given data as integers.

Expt. 6:

WAP that implements Kruskal"s algorithm to generate minimum cost spanning tree

Expt. 7:

WAP to perform string matching using Knuth-Morris-Pratt algorithm for pattern matching.

Expt. 8:

WAP to perform string matching using Boyer-Moore algorithm.

Expt. 9:

WAP to implement 2-D range search over computational geometry problem

Expt. 10:

WAP on latest efficient algorithms on trees for solving contemporary problems.

Mini Project:

Student has to do a project assigned from course contents in a group of two or three students. Theteam will have to demonstrate as well as have to give a presentation of the same.

Course Code	**MTAI-112-20**
Course Name	**Elective Based Lab**
Credits:02	**Hours: 04**

Elective - I

Data Preparation, Analysis and Data Visualization

Course Objectives:

- To introduce data structures in Python.
- To familiarize with different kinds of data and file formats.
- To gain knowledge on data preprocessing and data visualization.
- To acquaint with supervised and unsupervised learning algorithms.
- To explore various case studies.

Course Outcomes:

Upon completing this course, students will be able to:

- Identify appropriate data structures for storing and processing the data.
- Work with multiple kinds of data and various file formats.
- Preprocess raw data and visualize the data.
- Apply supervised and unsupervised algorithms.
- Provide solutions to real world problems using machine learning algorithmsDemonstrate the usage of Python data structures.

List of Experiments:

1. Demonstrate the usage of Python data structures
2. Explore various kinds of data like time series, text, etc.
3. Perform file handling operations in Python for various file formats.
4. Apply various preprocessing techniques on any two datasets.
5. Visualise data using packages matplotlib, seaborn, etc., and provide your inference.
6. Build Classifiers and perform prediction.
7. Demonstrate various Clustering Techniques.
8. Predict if a loan will get approved or not.
9. Predict the price of a house (Boston Housing Dataset).
10. Classify text documents according to their labels.

Datasets:

1. https://www.kaggle.com/datasets
2. https://www.csie.ntu.edu.tw/~cjlin/libsvmtools/datasets/ multilabel.html#siam-competition2007
3. https://archive.ics.uci.edu/ml/index.php

Data Warehousing & Mining

List of Experiments:

1. Build Data Warehouse and Explore WEKA
2. Data Mining Query Languages
3. Perform data preprocessing tasks and Demonstrate performing association rule mining ondata sets and demonstrate performing classification on data set.
4. Classification by decision tree induction
    a. Bayesian Classification
    b. Classification by Back propagation
5. Demonstrate performing clustering on data sets
6. Demonstrate performing Regression on data sets
7. Demonstration of clustering rule process on dataset iris.arff using simple k-means
8. Partitioning Methods, Density-Based Method and Grid-Based Methods

The following operation has to be performed using any database tools:

- Granting Roles and Privileges.
- Implementation of various constraints.
- performance tuning
- Creation of Index.
- Storage Management
- Recovery
- Hands on Testing with Database Administration tools- DBA studio
- Locking techniques
- Database Replication Management
- Distributed catalog management, query processing and Updating distributed data
- Distributed transactions, concurrency control and recovery.

Elective - II

Advanced Machine learning

Programs may be implemented using PYTHON

Expt. 1:

Study of platform for Implementation of Assignments. Download the open source software of your interest. Document the distinct features and functionality of the software platform.

Expt. 2:

Supervised Learning – Regression Generate a proper 2-D data set of N points. Split the data set into Training Data set and Test Data set.

i) Perform linear regression analysis with Least Squares Method.
ii) Plot the graphs for Training MSE and Test MSE and comment on Curve Fitting and Generalization Error.
iii) Verify the Effect of Data Set Size and Bias-Variance Trade off.
iv) Apply Cross Validation and plot the graphs for errors.

v) Apply Subset Selection Method and plot the graphs for errors. Describe your findings in each case.

Expt. 3:

Supervised Learning – Classification Implement Naïve Bayes Classifier and K-Nearest Neighbour Classifier on Data set of your choice. Test and Compare for Accuracy and Precision.

Expt. 4:

Unsupervised Learning Implement K-Means Clustering and Hierarchical clustering on proper data set of your choice. Compare their Convergence.

Expt. 5:

Dimensionality Reduction Principal Component Analysis-Finding Principal Components, Variance and Standard Deviation calculations of principal components.

Expt. 6:

Supervised Learning and Kernel Methods Design, Implement SVM for classification with proper data set of your choice. Comment on Design and Implementation for Linearly non-separable Dataset.

Mini Project:

Student has to do a project assigned from course contents in a group of two or three students. Theteam will have to demonstrate as well as have to give a presentation of the same.

Data Science

Programs may be implemented using Matlab/Python/R

Expt. 1: Introduction to R

This Cycle introduces you to the use of the R statistical package within the Data Science and Big Data Analytics environment. After completing the tasks in this cycle you should able to:

a. Read data sets into R, save them, and examine the contents.

Tasks you will complete in this Cycle include:

a. Invoke the R environment and examine the R workspace.
b. Created table and datasets in R.
c. Examine, manipulate and save datasets.
d. Exit the R environment.

Expt. 2: Basic Statistics and Visualization This Cycle introduces you to the analysis of data using the R statistical package within the Data Science and Big Data Analytics environment. After completing the tasks in Tins Cycle you should able to:

a. Perform summary (descriptive) statistics on the datasets.
b. Create basic visualizations using R both to support investigation of the data as well as exploration of the data.
c. Create plot visualizations of the data using a graphics package.

Tasks you will complete in this Cycle include:

a. Reload datasets into the R statistical package.
b. Perform summary statistics on the data.
c. Remove outliers from the data.
d. Plot the data using R.

e. Plot the data using lattice and ggplot.

Expt. 3: K-means Clustering This Cycle is designed to investigate and practice K-means Clustering. After completing the tasks in This Cycle you should able to:

a. Use R functions to create K-means Clustering models.
b. Use ODBC connection to the database and execute SQL statements and load datasets from the database in an R environment.
c. Visualize the effectiveness of the K-means Clustering algorithm using graphic capabilities in R.
d. Use the ODBC connection in the R environment to create the average household income from the census database as test data for K-means Clustering.
e. Use R graphics functions to visualize the effectiveness of the K-means Clustering algorithm.

Expt. 4: Association Rules This Cycle is designed to investigate and practice Association Rules. After completing the tasks in This Cycle you should able to:

a. Use R functions for Association Rule based models.

Tasks you will complete in this Cycle include:

a. Use the R-Studio environment to code Association Rule models.
b. Apply constraints in the Market Basket Analysis methods such as minimum thresholds on support and confidence measures that can be used to select interesting rules from the set of all possible rules.
c. Use R graphics "arules" to execute and inspect the models and the effect of the various thresholds.

Expt. 5: Linear Regression

This Cycle is designed to investigate and practice linear regression. After completing tha tasks in ThisCycle you should able to:

a. Use R functions for Linear Regression (Ordinary Least Squares - OLS).
b. Predict the dependent variables based on the model.
c. Investigate different statistical parameter tests that measure the effectiveness of themodel.

Tasks you will complete in This Cycle include:

a. Use the R-Studio environment to code OLS models
b. Review the methodology to validate the model and predict the dependent variable for aset of given independent variables
c. Use R graphics functions to visualize the results generated with the mode.

Expt. 6: Naïve Bayesian Classifier This Cycle is designed to investigate and practice NaiveBayesian classifier. After completing the tasks in This Cycle you should able to:

a. Use R functions for Naïve Bayesian Classification

b. Apply the requirements for generating appropriate training data
c. Validate the effectiveness of the Naïve Bayesian Classifier with the big data

Tasks you will complete in Tins Cycle include:

a. Use R-Studio environment to code the Naïve Bayesian Classifier
b. Use the ODBC connection to the "census" database to create a training data set for Naïve Bayesian Classifier from the big data.
c. Use the Naive Bayesian Classifier program and evaluate how well it predicts the results using the training data and then compare the results with original data.

Expt. 7: Decision Trees This Cycle is designed to investigate and practice Decision Tree (DT) models covered in the course work. After completing the tasks in This Cycle you should able to:

a. Use R functions for Decision Tree models.
b. Predict the outcome of an attribute based on the model. Tasks you will complete in This Cycle include:

a. Use the R-Studio environment to code Decision Tree Models.
b. Build a Decision Tree Model based on data whose schema is composed of attributes.
c. Predict the outcome of one attribute based on the model.

Mini Project: Student has to do a project assigned from course contents in a group of two or three students. The team will have to demonstrate as well as have to give a presentation of the same.

Data Security and Access Control

List of experiments will be decided by the instructor based on current research trends / ongoing projects.

SECOND SEMESTER

M. Tech CSE (Artificial Intelligence and Machine Learning)

Generative AI

Course Code: MTAIML-103-23

Credit: 3

Course Objectives:

1. Explain the core principles and concepts of generative artificial intelligence.
2. Explore various types of generative modelling techniques.
3. Develop skills in implementing and training generative models.
4. Encourage critical thinking about the ethical implications of generative AI.

UNIT 1: Overview of Generative AI: Introduction to Neural Network based Language Models- Recurrent Neural Networks, Gated Recurrent Unit, Encoder-Decoder Networks, Probability and Statistics for Generative AI- Bayesian networks, Markov chains.

UNIT 2: Transformers and Large Language Models (LLMs): Language Models, Transformer Architecture, Motivation for Transformer, Architecture, Encoder-Decoder Architecture, Attention, Position-wise Feed-Forward Networks, Advantages and Limitations of Transformer Architecture**.**

UNIT 3: Networks and Models: Autoencoders, Variational Autoencoders, latent space, Generative Adversarial Networks (GANs)- Deep Convolutional GAN (DCGAN),Wasserstein GAN, Conditional GAN, Autoregressive Models- Long Short-Term Memory Network (LSTM), Diffusion Models- Types of Diffusion Models, Architecture,Latent Diffusion Model (LDM), Benefits and Significance.

UNIT 4: Applications and Ethical Implications: Applications - ChatGPT Architecture, Google Bard, Claude 2, Falcon AI, LLaMa 2, Dolly 2, DALL-E 2,Midjourney. Ethics- Bias and Fairness in Generative Models.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- CO1: Define and explain the core concepts, principles, and applications ofgenerative AI.
- CO2: Analyze and compare different generative modeling techniques.

- CO3: Design basic generative models.
- CO4: Evaluate the performance of generative models.
- CO5: Identify the ethical implications of generative AI

Textbooks:

- Generative Deep Learning: A Practical Guide by David Foster
- Applied Generative AI for Beginners: Practical Knowledge on Diffusion Models,ChatGPT, and Other LLMs by Akshay Kulkarni, Adarsha Shivananda, Anoosh Kulkarni and Dilip Gudivada

Reference Books:

- Generative AI by Tom Taulli
- Deep Learning by Ian Goodfellow, Yoshua Bengio, and Aaron Courville
- Generative Adversarial Networks: An Introductory Guide by Luke Metz
- Autoencoders: Neural Networks for Unsupervised Learning by Ian Goodfellow

Advanced Deep Learning Course Code: MTAI-PE10-20 Credit: 3

COURSE OBJECTIVE:

The objective of this course is to introduce students through some of the latest techniques in deep learning. The focus of the course will be hands on and the students should be able to design intelligent deep learning systems for solving the problems in the area of their interests.

COURSE OUTCOMES:

After completion of course, students would be:

Identify machine learning techniques suitable for a given

problem**.**Apply Dimensionality reduction techniques.

Design application using machine learning techniques.

Syllabus Contents:

Unit 1:

MACHINE LEARNING BASICS: Learning Algorithms, Capacity, Overfitting, and Underfitting, Hyperparameters and Validation Sets, Estimators, Bias and Variance, Maximum Likelihood Estimation, Bayesian Statistics, Supervised and Unsupervised Learning algorithms, Stochastic Gradient Descent, Building a ML algorithm, Challenges and Motivation to Deep learning

Unit 2:

DEEP FORWARD NETWORKS: Learning XOR, Gradient -based Learning, Hidden Units, Architecture Design, Back-propagation and other Differentiation algorithms

Unit 3:

REGULARIZATION FOR DEEP LEARNING: Parameter Norm Penalties, Norm Penalties as constrained Optimization, Regularization and under -constrained problems, dataset Augmentation, Noise robustness, semi-supervised learning, multitask learning, Early stopping, parameter tying and setting, sparse presentations, bagging and other ensemble methods, dropout, adversarial training, tangent distance, prop and manifold tangent classifier

Unit 4:

OPTIMIZATION FOR TRAINING DEEP MODELS: Difference between learning and pure optimization, Challenges in NN optimization, Basic algorithms, parameter Initialization strategies, Algorithms with adaptive learning rates, approximate second order methods, Optimization strategiesand meta algorithms

Unit 5:

CONVOLUTIONAL NETWORKS: Convolution operation, Motivation, pooling, convolution and pooling as an infinitely strong prior, variants of basic convolution function, structured outputs, data types, efficient convolution algorithms, random or unsupervised features

Unit 6:

SEQUENCE MODELING: Recurrent and recursive nets: Unfolding computational graphs, recurrent neural networks, bidirectional RNNs, Encoder-decoder Sequece-to-sequence Architectures, Deep recurrent networks, recursive neural networks, challenge of long-term dependencies, echo state networks, leaky units and other strategies for multiple time scales, Long Short -term Memory (LSTM) and other gated RNNs

Unit 7:

PRACTICAL METHODOLOGY AND APPLICATIONS: Performance metrics, default baseline models, determining whether to gather more data, selecting hyperparameters, debugging strategies, multidigit number recognition, large scale deep learning, applications in computer vision and NLP, Applications of deep learning in speech recognition, natural language processing, and other application areas of commercial interest.

Text Books:

1. Deep Learning, Ian Goodfellow, Yoshua Bengio and Aaron Courville, published by MIT Press, UK, 2017 Series
2. Deep Learning with Keras: The Textbook by Antonio Gulli and Sujit Pal, Packt Publishing Ltd, Birmingham, UK, April 2017

References:

Deep Learning with TensorFlow, The Textbook by Giancarlo Zaccone, Md. Rezaul Karim, and Ahmed Menshawy, Packt Publishing Ltd, Birmingham, UK, April 2017.

List of experiments will be decided by the instructor based on current research trends/ongoing projects.

Program Elective-III

Advanced Computer Vision

Course Code: MTAI-PE7-20

Credit: 3

COURSE OBJECTIVE

- Be familiar with both the theoretical and practical aspects of computing with images. Have described the foundation of image formation, measurement, and analysis. Understand the geometric relationships between 2D images and the 3D world.
- Grasp the principles of state-of-the-art deep neural networks.

COURSE OUTCOMES:

After completion of course, students would be able to:

- Describe and analyze the main research challenges in the field of computer vision.
- Developed the practical skills necessary to build computer vision applications.
- Design network structure and loss functions in cases where problems need to be solved using deep learning techniques.

Syllabus Contents:

Unit 1:

Overview, computer imaging systems, lenses, Image formation and sensing, Image analysis, pre- processing and Binary image analysis

Unit 2:

Edge detection, Edge detection performance, Hough transform, corner detection

Unit 3:

Segmentation, Morphological filtering, Fourier transform

Unit 4:

Feature extraction, shape, histogram, color, spectral, texture, using CVIP tools, Feature analysis, feature vectors, distance /similarity measures, data preprocessing

Unit 5:

Pattern Analysis: Clustering: K-Means, K-Medoids, Mixture of Gaussians Classification: Discriminant Function, Supervised, Un-supervised, Semi supervised Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA, and Non-parametric methods.

Unit 6:

Recent trends in Activity Recognition, computational photography, Biometrics, The Challenges of Computer Vision, Computer Vision Applications.

Note: List of experiments will be decided by the instructor based on current research trends / ongoing projects.

References:

1. Computer Vision: Algorithms and Applications by Richard Szeliski.
2. Deep Learning, by Goodfellow, Bengio, and Courville.
3. Dictionary of Computer Vision and Image Processing, by Fisher et al.

Pattern Recognition

Course Code: MTAI-PE8-20

Credit: 3

COURSE OUTCOMES:

At the end of this course, students will be able to:

- Apply methods from the pattern recognition for new complex applications
- Analyze and breakdown problem related to the complex pattern recognition system
- Design and develop a pattern recognition system for the specific application

Syllabus Contents:

Unit 1:

INTRODUCTION: Overview of Pattern Recognition- Relations of PR with other Systems, PR Applications, Different Approaches to Pattern Recognition- Statistical Approach to PR, Syntactic Approach to PR, Neural Approach to PR, Examples of PR Approaches. Other Approaches to PR.

Unit 2:

STRUCTURE OF PR SYSTEM: Abstract Representation of PR Mappings, Structure of PR System, Patterns and Feature s, Feature Extraction Examples, Object Description and Classification, Figure Recognition, Numerical Results and Analysis. Feature Vector and Feature Space, training and Learning in PRSystem.

Unit 3:

STATISTICAL PATTERN RECOGNITION: Introduction, Gaussian Case and Class Dependency, Discriminate Function, Examples, Classifier Performance,

Unit 4:

TRAINING: Parametric Estimation and Supervised Learning, Maximum Likely Hood Estimation, Bayesian Parameter Estimation Approach , Parzen Windows, Direct Classification Using Training set., Unsupervised Learning and Clustering, Clustering for Unsupervised Learning and Classification

Unit 5:

SYNTACTIC PATTERN RECOGNITION: Overview of Syntactic Pattern Recognition, Grammar Based Approaches and Applications, Examples of String Generation as Pattern Description, 2-D line Drawing Description Grammar, Character Description using PDL, Object Description using Projected Cylinder Models, Block World Description Models, Heuristic Generation of Grammars,

Unit 6:

RECOGNITION OF SYNTACTIC DESCRIPTION: Recognition by Matching, Recognition by Parsing, CYK Parsing Algorithm, Augmented Transition Nets in Parsing, Graph Based structure representation, Structured Strategy to Compare Attributed Graphs.

Unit 7:

NEURAL PATTERN RECOGNITION: Introduction to Neural Networks,, Neural Network Structure for PR Applications, Physical Neural Networks, ANN Model, NN Based PR Association, Matrix Approaches and Examples

Unit 8:

FEED FORWARD NEURAL NETWORKS: Training by Back Propagation, Hope field Approach to Neural Computing, Other related Neural Approaches and Extensions

Text Book:

1. Pattern Recognition- Statistical, Structural and Neural Approaches, Rober.J. Shelkoff, JohnWiley & Sons, NY1992,ISBN0-471-52974-5

References:

1. Neural Networks for pattern recognition, Christopher M.Bishop Oxford UniversityPress.
2. Pattern Classification, Richard O.Duda ,Wiley IndiaEdition

List of experiments will be decided by the instructor based on current research trends/ongoing projects.

Big Data Analytics

Course Code: MTAI-PE13-20

Credit: 3

COURSE OBJECTIVE:

1. Understand big data for business intelligence.
2. Learn business case studies for big data analytics.
3. Understand nosql big data management.
4. Perform map-reduce analytics using Hadoop and related tool

COURSE OUTCOMES:

After completion of course, students would be:

- Understand the key issues in big data management and its associated applications inintelligent business and scientific computing.
- Interpret business models and scientific computing paradigms, and apply software tools forbig data analytics.
- Achieve adequate perspectives of big data analytics in various applications like recommendersystems, social media applications etc.

Syllabus Contents:

Unit 1:

What is big data, why big data, convergence of key trends, unstructured data, industry examples of big data, web analytics, big data and marketing, fraud and big data, risk and big data, credit risk management, big data and algorithmic trading, big data and healthcare, big data in medicine, advertising and big data, big data technologies, introduction to Hadoop, open source technologies, cloud and big data, mobile business intelligence, Crowd sourcing analytics, inter and trans firewall analytics

Unit 2:

Introduction to NoSQL, aggregate data models, aggregates, key-value and document data models, relationships, graph databases, schema less databases, materialized views, distribution models, sharding, master-slave replication, peer peer replication, sharding and replication, consistency, relaxing consistency, version stamps, map-reduce, partitioning and combining, composing map-reduce calculations.

Unit 3:

Data format, analyzing data with Hadoop, scaling out, Hadoop streaming, Hadoop pipes, design of Hadoop distributed file system (HDFS), HDFS concepts, Java interface, data flow, Hadoop I/O, data integrity, compression, serialization, Avro, file-based data structure

Unit 4:

Map Reduce work flows, unit tests with MR Unit, test data and local tests, anatomy of MapReduce job run, classic Map-reduce, YARN, failures in classic Map-reduce and YARN, job scheduling, shuffle and sort, task execution, MapReduce types, input formats, output format.

Unit 5:

Hbase, data model and implementations, Hbase clients, Hbase examples, praxis.Cassandra,

Cassandra data model, Cassandra examples, Cassandra clients, Hadoop integration.

Unit 6:

Pig, Grunt, pig data model, Pig Latin, developing and testing Pig Latin scripts. Hive, data types and file formats, HiveQL data definition, HiveQL data manipulation, HiveQL queries.

Reference:

1. Michael Minelli, Michelle Chambers, and Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013.
2. P. J. Sadalage and M. Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", Addison-Wesley Professional, 2012.
3. Tom White, "Hadoop: The Definitive Guide", Third Edition, O'Reilley, 2012.
4. Eric Sammer, "Hadoop Operations", O'Reilley, 2012.
5. E. Capriolo, D. Wampler, and J. Rutherglen, "Programming Hive", O'Reilley, 2012.
6. Lars George, "HBase: The Definitive Guide", O'Reilley, 2011.
7. Eben Hewitt, "Cassandra: The Definitive Guide", O'Reilley, 2010.
8. Alan Gates, "Programming Pig", O'Reilley, 2011.

Programme Elective-IV

ADVANCED COMPUTER ARCHITECTURE

Course Code: MTAIML 10-23

Credit: 3

Unit 1:

Fundamentals of Processors: Instruction set architecture; single cycle processors, hardwired and micro-coded FSM processors; pipelined processors, multi-core processors; resolving structural, data, control and name hazards; analyzing processor performance.

Unit 2:

Fundamentals of Memories: memory technology; direct-mapped, associative cache; write- through and write-back caches; single-cycle, FSM, pipe-lined cache; Analyzing memory performance.

Unit 3:

Advanced Processors: Superscalar execution, out-of-order execution, register renaming, memory disambiguation, dynamic instruction scheduling, branch prediction, speculative execution; multithreaded, VLIW and SIMD processors.

Unit 4:

Advanced Memories: non-blocking cache memories; memory protection, translation and virtualization; memory synchronization, consistency and coherence.

Recommended Books:

1. Computer Architecture: A Quantitative Approach, by J.L Hennessy and D.A Patterson.

2. Digital Design and Computer Architecture, by D.M Harris and S.L Harris.

Statistical Natural Language Processing

Course Code: MTAIML-PE11-23

Credit: 3

Course Contents:

UNIT 1: Introduction to Natural Language, linguistics fundamentals. Language Models: n-grams, smoothing, class-based, brown clustering, Sequence Labeling: HMM, MaxEnt, CRFs, related applications of these models e.g. Part of Speech tagging.
UNIT 2: Parsing: CFG, Lexicalized CFG, PCFGs, Dependency parsing. Distributional Semantics: distributional hypothesis, vector space models. Distributed Representations: Neural Networks (NN), Backpropogation, Softmax, Hierarchical Softmax.
UNIT 3: Word Vectors: Feedforward NN, Word2Vec, GloVE, Contextualization (ELMo, etc.), Subword information (FastText, etc.)
UNIT4: Deep Models: RNNs, LSTMs, Attention, CNNs, applications in language. Sequence to Sequence models: machine translation and other applications, transfer learning and applications

References:

- Speech and Language Processing, Daniel Jurafsky, James H.Martin
- Foundations of Statistical Natural Language Processing, CH Manning, H Schutz
- Natural Language Understanding, James Allen
- Introduction to Natural Language Processing, Jacob Eisenstein

Distributed System

Course Code: MTAI-PE14-20
Credit: 03

COURSE OBJECTIVE:

To introduce the fundamental concepts and issues of managing large volume of shared data in parallel and distributed environment, and to provide insight into related research problems.

COURSE OUTCOMES:

After completion of course, students would be:

- Understand Distributed Computing techniques, Synchronous and Processes.
- Apply Shared Data access and Files concepts.
- Design a distributed system that fulfills requirements with regards to key distributed systems properties.

Syllabus Contents:

Unit 1:

INTRODUCTION Distributed data processing; What is a DDBS; Advantages and disadvantages of DDBS; Problem areas; Overview of database and computer network concepts DISTRIBUTED DATABASE MANAGEMENT SYSTEM ARCHITECTURE Transparencies in a distributed DBMS; Distributed DBMS architecture; Global directory issues.

Unit 2:

DISTRIBUTED DATABASE DESIGN Alternative design strategies; Distributed design issues; Fragmentation; Data allocation SEMANTICS DATA CONTROL View management; Data security; Semantic Integrity Control QUERY PROCESSING ISSUES Objectives of query processing; Characterization of query processors; Layers of query processing; Query decomposition; Localization of distributed data.

Unit 3:

DISTRIBUTED QUERY OPTIMIZATION Factors governing query optimization; Centralized query optimization; Ordering of fragment queries; Distributed query optimization algorithms TRANSACTION MANAGEMENT The transaction concept; Goals of transaction management; Characteristics of transactions; Taxonomy of transaction models CONCURRENCY CONTROL: concurrency control in centralized database systems; Concurrency control in DDBSs; Distributed concurrency control algorithms; Deadlock management

Unit 4:

RELIABILITY: Reliability issues in DDBSs; Types of failures; Reliability techniques; Commit protocols; Recovery protocols.

Unit 5:

PARALLEL DATABASE SYSTEMS: Parallel architectures; parallel query processing and optimization; load balancing.

Unit 6:

ADVANCED TOPICS Mobile Databases, Distributed Object Management, Multi-databases References:

1. Principles of Distributed Database Systems, M.T. Ozsu and P. Valduriez, Prentice-Hall, 1991.
2. Distributed Database Systems, D. Bell and J. Grimson, Addison-Wesley, 1992.

Elective-V
Social Network Analysis
MTAIML-PE13- 23 **Credit: 3**

Syllabus;

Unit1: Unit-I: INTRODUCTION

Introduction to Semantic Web: Limitations of current Web, Development of Semantic Web, Emergence of the Social Web – Social Network analysis: Development of Social Network Analysis, Key concepts and measures in network analysis, Electronics sources for network analysis: Electronic discussion networks, Blogs and online communities, Web-based networks, Applications of Social Network Analysis.

Unit-II: MODELLING, AGGREGATING AND KNOWLEDGE REPRESENTATION

Ontology and their role in the Semantic Web: Ontology-based knowledge Representation, Ontology languages for the Semantic Web: Resource Description Framework, Web Ontology Language, Modelling and aggregating social network data: State-of-the-art in network data representation, Ontological representation of social individuals, Ontological representation of social relationships, Aggregating and reasoning with social network data, Advanced representations.

Unit-III: EXTRACTION AND MINING COMMUNITIES IN WEB SOCIAL NETWORKS

Extracting evolution of Web Community from a Series of Web Archive, Detecting communities in social networks, Definition of community, Evaluating communities, Methods for community detection and mining, Applications of community mining algorithms, Tools for detecting communities social network infrastructures and communities, Decentralized online social networks – Multi-Relational characterization of dynamic social network communities.

Unit-IV: HUMAN BEHAVIOR AND PRIVACY ISSUES

Understanding and predicting human behavior for social communities, User data management, Inference and Distribution, Enabling new human experiences, Reality mining, Awareness – Privacy in online social networks, Trust in online environment, Trust models based on subjective logic, Trust network analysis, Trust transitivity analysis, Combining trust and reputation, Trust derivation based on trust comparisons, Attack spectrum and counter measures.

Unit-V: VISUALIZATION AND APPLICATIONS OF SOCIAL NETWORKS

Graph theory, Centrality, Clustering, Node-Edge Diagrams, Matrix representation, Visualizing online social networks, visualizing social networks with matrix-based representations, Matrix and Node-Link Diagrams, Hybrid representations, Cover networks – Community welfare – Collaboration networks – Co-Citation networks.

TEXT BOOKS:

1. Peter Mika, —Social Networks and the Semantic Web, First Edition, Springer 2007.

2. Borko Furht, —Handbook of Social Network Technologies and Applications, 1st Edition, Springer, 2010.

REFERENCES:

1. Guandong Xu ,Yanchun Zhang and Lin Li,-Web Mining and Social Networking–Techniques and applications, First Edition, Springer, 2011.

2. Dion Goh and Schubert Foo,-Social information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively, IGI Global Snippet, 2008.

3. Max Chevalier, Christine Julien and Chantal Soulé-Dupuy, Collaborative and Social Information Retrieval and Access: Techniques for Improved user Modelling, IGI Global Snippet, 2009.

4. John G. Breslin, Alexander Passant and Stefan Decker, -The Social Semantic Web, Springer, 2009.

Reinforcement Learning and its Applications
MTAIML-PE14- 23 **Credit: 3**

UNIT-I:

Introduction: Deep Reinforcement Learning, Suitability of RL, Components of Reinforcement Learning - Agent, Environment, Observations, Actions, Example-The Bandit Walk Environment, Agent-Environment interaction cycle, MDP (Markov Decision Process): The engine of the Environment-States, Actions, Transition Function, Reward Signal

UNIT-II:

Planning: Objective of a decision making agent-environment, Plan, Optimal policy, Comparison of Policies, Bellman Equation/State-Value Function, Action-Value Function, Action-Advantage Function, Optimality. Exploitation and Exploration of Reinforcement Learning: Bandits- Single-state decision problem (Multi-Armed Bandit(MAB) problem), The cost of exploration, Approaches to solve MAB environments, Greedy Strategy, Random Strategy, Epsilon-Greedy Strategy, Decaying Epsilon-Greedy Strategy, Optimistic Initialization strategy, Strategic exploration, Softmax exploration strategy, Upper confidence bound (UCB) equation strategy, Thompson sampling

UNIT-III:

Model Free Reinforcement Learning: Monte Carlo Prediction (MC), First-Visit MC (FVMC), Every-Visit MC (EVMC), Temporal Difference Learning (TD), Learning to estimate from multiple steps, N-step TD learning, Forward-view TD(λ), Backward-view TD(λ), Generalized policy iteration(GPI), Monte Carlo control, SARSA: On-Policy TD control, Q-learning: Off-Policy TD control, Double Q-learning, SARSA(λ), Watkins's Q(λ). Model Based Reinforcement Learning: Dyna-Q, Trajectory sampling.

UNIT-IV:

Value Based Reinforcement Learning: Deep reinforcement learning agents with sequential feedback, evaluative feedback, sampled feedback, Function Approximation for Reinforcement Learning- high-dimensional state and action spaces, continuous state and action spaces, state-value function and action-value function with and without function approximation, Neural Fitted Q (NFQ), Deep Q-Network (DQN), Double Deep-Q Networks(DDQN), Dueling DDQN, Prioritized Experience Replay (PER).

UNIT-V:

Policy Based Reinforcement Learning: Policy Gradient and Actor-Critic Methods—REINFORCE Algorithm and Stochastic Policy Search, Vanilla Policy Gradient(VPG), Asynchronous Advantage Actor-Critic (A3C), Generalized Advantage Estimation (GAE), Advantage Actor-Critic(A2C), Deep Deterministic Policy Gradient (DDPG), Twin-Delayed DDPG (TD3), Soft Actor-Critic (SAC), proximal policy optimization (PPO).

TEXT BOOKS:

1. Miguel Morales, Grokking Deep Reinforcement Learning, Manning Publications, 2020.

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REFERENCE BOOKS:

1. Richard S. Sutton and Andrew G. Barto, Reinforcement learning: An Introduction,
Second Edition, MIT Press, 2019.
2. Marco Wiering, Martijn van Otterlo(Ed),Reinforcement Learning, State-of-the-Art,
Adaptation, Learning, and Optimization book series, ALO, volume 12, Springer, 2012.
3. Keng, Wah Loon, Graesser, Laura, Foundations of Deep Reinforcement Learning:
Theory and Practice in Python, Addison Wesley Data & Analytics Series, 2020.
4. Francois Chollet, Deep Learning with Python, Manning Publications, 2018.

Artificial Intelligence applications of Cyber Security
MTAIML-PE12- 23 **Credit: 3**

Unit 1:

Introduction: Role of AI in Cyber Security and Security Framework: Artificial Intelligence in

Cyber Security, Challenges and Promises, Security Threats of Artificial Intelligence, Use-Cases: Artificial Intelligence Email Observing, Basics of manipulation of Data.

Unit 2:

Machine Learning in Security: Introduction to Machine Learning, Applications of Machine Learning in Cyber Security Domain, Machine Learning: tasks and Approaches, Anomaly Detection, Privacy Preserving Nearest Neighbour Search, Machine Learning Applied to Intrusion Detection, Online Learning Methods for Detecting Malicious Executables

Unit 3:

Deep Learning in Security: Introduction to deep learning, Cyber Security Mechanisms Using Deep Learning Algorithms, Applying deep learning in various use cases, Network Cyber threat Detection

Unit 4:

Artificial Intelligence in Cyber Security: Model Stealing & Watermarking, Network Traffic Analysis, Malware Analysis, AI intrusion detection

Text/Reference Books

1. Gupta, Brij B., and Quan Z. Sheng, eds. Machine learning for computer and cyber security: principle, algorithms, and practices. CRC Press, 2019.

2. Artificial Intelligence and Data Mining Approaches in Security Frameworks Editor(s):Neeraj Bhargava, Ritu Bhargava, Pramod Singh Rathore, Rashmi Agrawal, 2021.

3. Tsai, Jeffrey JP, and S. Yu Philip, eds. Machine learning in cyber trust: security, privacy, and reliability. Springer Science & Business Media, 2009.