# Department of Computer Science

# Syllabus
# MSc (Artificial Intelligence and Machine Learning)
# AY 2023-24

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CHRIST (Deemed to be University), Bangalore.
Karnataka, India
www.christuniversity.in

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**Department Overview**

Department of Computer Science of CHRIST (Deemed to be University) strives to shape outstanding computer professionals with ethical and human values to reshape nation's destiny. The training imparted aims to prepare young minds for the challenging opportunities in the IT industry with a global awareness rooted in the Indian soil, nourished and supported by experts in the field.

**Vision**

The Department of Computer Science endeavours to imbibe the vision of the University "**Excellence and Service"**. The department is committed to this philosophy which pervades every aspect and functioning of the department.

**Mission**

"To develop IT professionals with ethical and human values". To accomplish our mission, the department encourages students to apply their acquired knowledge and skills towards professional achievements in their career. The department also moulds the students to be socially responsible and ethically sound.

**Introduction to the Programme**

Machines are gaining more intelligence to perform human like tasks. Artificial Intelligence has spanned across the world irrespective of domains. MSc (Artificial Intelligence and Machine Learning) will enable to capitalize this wide spectrum of opportunities to the candidates who aspire to master the skill sets with a research bent. The curriculum supports the students to obtain adequate knowledge in the theory of artificial intelligence with hands-on experience in relevant domains with tools and techniques to address the latest demands from the industry. Also, candidates gain exposure to research models and industry standard application development in specialized domains through guest lectures, seminars, industry offered electives, projects, internships, etc.

**Programme Objective**

- To acquire in-depth understanding of the theoretical concepts in Artificial Intelligence and Machine Learning
- To gain practical experience in programming tools for Data Engineering, Knowledge Representation, Artificial intelligence, Machine learning, Natural Language Processing and Computer Vision.
- To strengthen the research and development of intelligent applications skills through specialization based real time projects.
- To imbibe quality research and develop solutions to the social issues.

**Ethics and Human Values**

1. Only proprietary or open source software would be used for academic teaching and learning purposes.
2. Copying of programs from internet, friends or from other sources is strictly discouraged since it impairs development of programming skills.
3. Unique Practical (Domain based) exercises ensures that the students don't involve in code plagiarism.

4. Projects undertaken by students during the course are done in teams to improve collaborative work and synergy between team members.
5. Projects involve modularization which initiates students to take individual responsibility for common goals.
6. Passion for excellence is promoted among the students, be it in software development or project documentation.
7. Giving due credit to sources during the seminar and research assignment is promoted among the students
8. The course and its design enforce the practice of good referencing technique to improve the sense of integrity.
9. Courses involving group discussions and debates on ethical practices and human values are designed to sensitize the students in dealing with customers and members within the organization.

**Programme Outcomes:**

**PO1**: Conduct investigation and develop innovative solutions for real world problems in industry and research establishments related to Artificial Intelligence and Machine Learning
**PO2**: Apply programming principles and practices for developing automation solutions to meet future business and society needs.
**PO3**: Ability to use or develop the right tools to develop high end intelligent systems
**PO4**: Adopt professional and ethical practices in Artificial Intelligence application development
**PO5**: Understand the importance and the judicious use of technology for the sustainability of the environment.

**Programme Eligibility**

- Candidates having 50% marks in any recognized university in India or Abroad recognized by UGC / AIU in any of the following UG degree

  1. Bachelor of Computer Applications
  2. Bachelor degree in Science / Engineering with any of the following Computer Science / Information Technology / Computer Technology / Data Science / Mathematics with Computer Science

- Candidates writing their final year examinations March-May are eligible to apply.

## Programme Structure

### Trimester I

| Course Code | Course Title | No. of Hrs | Marks | Credits |
|---|---|---|---|---|
| MAI131 | Mathematical Foundation for Computational Intelligence | 4 | 100 | 3 |
| MAI132 | Introduction to Statistics for Machine Learning | 4 | 100 | 3 |
| MAI133 | Foundations of Artificial Intelligence | 3 | 50 | 2 |
| MAI134 | Research Methodology (CIA only) | 3 | 50 | 2 |
| MAI171 | Machine Learning (CIA only) | 3+4 | 150 | 4 |
| MAI172 | Advanced Database Technologies (CIA only) | 3+4 | 150 | 4 |
| | Programming for AI using Python | VAC | | |
| | Holistic Education | 1 | - | 1 |
| **Total** | | **29** | **600** | **19** |

### Trimester II

| Course Code | Course Title | No. of Hrs | Marks | Credits |
|---|---|---|---|---|
| MAI231 | Knowledge Visualization | 3 | 50 | 2 |
| MAI232 | Data Engineering and Knowledge Representation | 4 | 100 | 3 |
| MAI233 | Design and Analysis of Algorithms | 4 | 100 | 3 |
| MAI271 | Java Programming (CIA Only) | 4+4 | 150 | 5 |
| MAI272 | Advanced Machine Learning (CIA Only) | 3+4 | 150 | 4 |
| MAI251 | Research Project Lab - I (CIA Only) | 3 | 50 | 1 |
| **Total** | | **29** | **600** | **18** |

### Trimester III

| Course Code | Course Title | No. of Hrs | Marks | Credits |
|---|---|---|---|---|
| MAI371 | Deep Learning (CIA Only) | 3+4 | 150 | 4 |
| MAI372 | Natural Language Processing (CIA Only) | 3+4 | 150 | 4 |
| MAI373 | Computer Vision (CIA Only) | 3+4 | 150 | 4 |
| **Elective – I (Choose any one)** | | | | |
| MAI341A | AI in Agriculture | 3 | 50 | 2 |
| MAI341B | AI in Cyber Security | | | |
| MAI341C | AI in Cognitive Sciences | | | |
| **Elective – II (Choose any one)** | | | | |
| MAI342A | Big Data Analytics | 3 | 50 | 2 |
| MAI342B | Augmented Reality and Virtual Reality | | | |
| MAI342C | Forensic Sciences | | | |
| MAI351 | Research Project Lab - II | 3 | 50 | 1 |
| | Holistic Education | 1 | - | 1 |

| **Total** | | **31** | **600** | **18** |
|---|---|---|---|---|

**Trimester IV**

| **Course Code** | **Course Title** | **No. of Hrs** | **Marks** | **Credits** |
|---|---|---|---|---|
| MAI431 | IoT for AI | 3 | 50 | 2 |
| MAI432 | Multi Agent Systems | 3 | 50 | 2 |
| MAI433 | Cloud Computing | 2+2 | 100 | 2 |
| MAI471 | Soft Computing | 3+4 | 150 | 5 |
| MAI451 | Specialization Project (AI/ML Project) | 6 | 100 | 3 |
| **Elective – III (Choose any one)** | | | | |
| MAI472A | Robotic Process Automation | 3+4 | 150 | 5 |
| MAI472B | One API | | | |
| MAI472C | Machine Learning Cloud Services | | | |
| **Total** | | **30** | **600** | **19** |

**Trimester V**

| **Course Code** | **Course Title** | **No. of Hrs** | **Marks** | **Credits** |
|---|---|---|---|---|
| MAI531 | Modern Optimization Technique | 3 | 50 | 2 |
| MAI532 | Human Computer Interaction | 4 | 100 | 3 |
| MAI571 | Designing Machine Learning Systems (MLOps) | 2+4 | 100 | 4 |
| **Elective – IV (Choose any one)** | | | | |
| MAI572A | Automated Reasoning | 3+4 | 150 | 5 |
| MAI572B | Speech Processing and Recognition | | | |
| MAI572C | Machine Learning for Data Privacy | | | |
| **Elective – V (Choose any one)** | | | | |
| MAI573A | Graph Neural Network | 3+4 | 150 | 5 |
| MAI573B | Quantum Machine Learning | | | |
| MAI573C | Distributed Machine Learning | | | |
| MAI581 | Dissertation | 3 | 50 | 1 |
| **Total** | | **30** | **600** | **20** |

**Trimester VI**

| **Course Code** | **Course Title** | **No. of Hrs** | **Marks** | **Credits** |
|---|---|---|---|---|
| MAI681 | Industry Project | | 300 | 12 |
| **Total** | | | **300** | **20** |

**Trimester – I**

## MAI131– Mathematical Foundations for Computational Intelligence

**Total Teaching Hours For Semester: 45** **No of Lecture Hours/Week:4**
**Max Marks:100** **Credits:3**

**Course Objectives**

This course aims to provide fundamental knowledge of mathematical foundations for computational Intelligence in Artificial Intelligence and Machine Learning.

**Course Outcomes**

Upon successful completion of the course, the student will be able to

CO1: Understand the concepts of Linear and Matrix Algebra, Vector spaces, eigen values and eigen vectors.
CO2: Understand the Statistical concepts and Probability theorem for AI and ML applications
CO3: Design and Develop different real time applications using different mathematical concepts. (Python, R, and other tools)

**Unit-1** **Teaching Hours: 09**
**LINEAR EQUATIONS IN LINEAR ALGEBRA**

Systems of Linear Equations-Row reduction and Echelon Forms-Vector Equations-Matrix Equation-Solution Sets of Linear Systems-Applications of Linear Systems-Linear Independence-Introduction to Linear Transformations-The Matrix of Linear Transformation-Linear Models in Business, Science and Engineering

**Unit-2** **Teaching Hours: 09**
**MATRIX ALGEBRA**

Matrix Operations-The Inverse of a Matrix-Characterizations of Invertible Matrices-Partitioned Matrices-Matrix Factorizations-The Leontief Input-Output Model-Application to Computer Graphics-Subspaces OF $R^N$-Dimension and Rank

**Unit-3** **Teaching Hours: 09**
**VECTOR SPACES, EIGEN VALUES, AND EIGEN VECTORS**

Vector Spaces and Subspaces-Null Spaces, Column Spaces and Linear Transformations-Linearly Independent Sets; Bases- Coordinate Systems-The Dimension of a Vector Space-Rank-Change of Basis-Applications to Difference Equations-Application to Markov Chains.

Eigenvectors and Eigenvalues-The Characteristics Equation-Diagonalization-Eigenvectors and Linear Transformations-Complex Eigenvalues-Discrete Dynamical Systems-Application of Differential Equations-Iterative Estimate for Eigenvalues

**Unit-4** **Teaching Hours: 09**
**DATA SHINE**

Presentation of data using graphs-Computation of central tendency and dispersion-Correlation and Regression-Case studies

**Unit-5** **Teaching Hours: 09**
**PROBABILITY**

Definition of Probability, conditional probability, Total probability theorem, Bayes theorem.

Random Variables: Continuous and discrete random variable-Definition probability mass function- Probability density function - Expectation and variance-Standard discrete distributions-Bernoulli, binomial, Poisson and geometric-Standard continuous distributions-Normal and Exponential.

**Essential Reading**

[1] David C. Lay, Steven R. Lay, and Judi J. McDonald, “Linear Algebra and Its Applications”, Pearson, Fifth Edition,2016.
[2]Gupta S.C & Kapoor V.K, “Fundamentals of Mathematical statistics”, Sultan Chand & sons, 2020.
[3]Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, “An Introduction to Statistical Learning with Applications in R” Springer, Second Edition,2021

**Recommended Reading**

[1] Douglas C Montgomery, George C Runger, “Applied Statistics and Probability for Engineers”, Wiley student edition, 2004.
[2] RSN Pillai: Statistics Theory and Practice. S. Chand Edition 8,2018

**MAI232 - Introduction to Statistics for Machine Learning**

**Total Teaching Hours/Trimester: 45** **No. of Lecture Hours/Week: 4**
**Max Marks: 100** **Credits: 3**

**Course Description:**
This course is designed to teach the basic statistical concepts. This will help students to develop an understanding of random variables, probability distributions, and high-dimensional random variables, as well as sampling distributions and inferential statistics.

**Course Outcome:** After completion of this course, the students will be able to

CO1: Understand the probability concepts applied to random data.
CO2: Apply various probability distributions to both continuous and discrete data.
CO3: Formulate testing of hypothesis procedures

**Unit I:** **Teaching Hours: 9**
**INTRODUCTION TO DATA AND DESCRIPTIVE MEASURES**
Data - qualitative and quantitative data: binary, categorical, continuous - measures of central tendency - measures of dispersion – skewness

**Unit II:** **Teaching Hours: 9**
**PROBABILITY AND RANDOM VARIABLE**
Random experiment - events - probability - classical definition - addition rule - random variable: discrete and continuous - expectation – bivariate and multivariate random vectors: definition – expectation and covariance matrix (only statement)

**Unit III:** **Teaching Hours: 9**
**PROBABILITY DISTRIBUTIONS**
Probability distributions for discrete data: Bernoulli - binomial - Poisson – multinomial
Probability distributions for continuous data: Normal – logistic distribution – multivariate normal: pdf and mean vector and covariance matrix (only statement)

**Unit IV:** **Teaching Hours: 9**
**STATISTICAL INFERENCE FOR NUMERICAL DATA**
Population and sample - parameter and statistic – sampling error - sampling distributions: chi-square, t, F (only definition and statement of applications) – hypotheses: null and alternative – types of errors – level of significance – p-value - test statistics – critical region
One sample and two sample t-test – ANOVA (only hypothesis, the test statistic and numerical illustration)

**Unit V:** **Teaching Hours: 9**

**STATISTICAL INFERENCE FOR CATEGORICAL DATA**

Inference for single proportions – Inference for two proportions - testing for the goodness of fit using chi-square – Testing for independence (two-way tables)

**Essential Reading:**

1. Barr, Christopher, David M. Diez, and Cetinkaya Rundel. OpenIntro statistics. (2019).

**Recommended Reading:**

1. Gupta S.C and Kapoor V.K, Fundamentals of Mathematical Statistics, 12th edition, Sultan Chand & Sons, New Delhi, 2020.
2. Mood A.M, Graybill F.A and Boes D.C, Introduction to the Theory of Statistics, 3rd edition, McGraw Hill, New Delhi, 2017.

## MAI133-Foundations of Artificial Intelligence

**Total Teaching Hours For Semester:30** **No of Lecture Hours/Week:3**
**Max Marks:50** **Credits:2**

### Course Objectives

This course aims at developing an understanding about the fundamental concepts in defining and simulating perception, identifying the problems where AI is required. And the different AI techniques available to define and explain learning algorithms

### Course Outcomes

Upon successful completion of the course, the student will be able to

**CO1:** Express the modern view of AI and its foundation
**CO2:** Illustrate Search Strategies with algorithms and Problems.
**CO3:** Implement Proportional logic and apply inference rules.

**Unit-1** **Teaching Hours: 5**

**INTRODUCTION TO AI**

Introduction to AI, The Foundations of AI, AI Technique -Tic-Tac-Toe. Problem characteristics, Production system characteristics, Production systems: 8-puzzle problem.

**Unit-2** **Teaching Hours: 5**

**INTELLIGENT AGENTS**

Intelligent Agents: Agents and Environments, Good Behavior: The concept of rationality – The nature of Environments, The Structure of Agents -Expert Systems-Types of Expert Systems

**Unit-3** **Teaching Hours: 8**

**LOCAL SEARCH ALGORITHM**

Searching: Uninformed search strategies – Breadth first search, depth first search. Generate and Test, Hill climbing, simulated annealing search, Greedy best first search, A* search, AO* search

**Unit-4** **Teaching Hours: 7**

**KNOWLEDGE REPRESENTATION**

Propositional logic - syntax & semantics - First order logic. Inference in first order logic, propositional Vs. first order inference, unification & lifts, Clausal form conversion, Forward chaining, Backward chaining, Resolution

**Unit-5** **Teaching Hours: 5**

**ETHICS AND SOCIAL IMPLICATIONS OF AI**

Ethical Considerations on AI – bias – privacy – philosophical challenge in human judgement – faulty algorithms - Social Implications of AI – Case studies Planning and Acting in the Real World

## Essential Reading

[1] E. Rich and K. Knight, Artificial Intelligence, 3rd Edition, New york: TMH, 2019

[2] S. Russell and P. Norvig, Artificial Intelligence A Modern Approach, 3rd Edition, Pearson Education, 2019.

## Recommended Reading

[1] Eugene Charniak and Drew McDermott, Introduction to Artificial Intelligence, 2nd Edition. Pearson Education, 2005.

[2] George F Luger, Artificial Intelligence Structures and Strategies for Complex Problem Solving, 4th Edition. Pearson Education, 2008

[3] N.L. Nilsson, Artificial Intelligence: A New Synthesis, 1st Edition. Morgan Kaufmann, 2000

# MAI134: Research Methodology

**Total Teaching Hours For Semester:30** **No of Lecture Hours/Week:3**
**Max Marks:50** **Credits:2**

**Course Objectives**

The research methodology module is intended to assist students in planning and carrying out research projects. The students are exposed to the principles, procedures and techniques of implementing a research project. The course starts with an introduction to research and carries through the various methodologies involved. It continues with finding out the literature using computer technology, basic statistics required for research and ends with linear regression.

**Course Outcomes**

**CO1:** Define research and describe the research process and research methods
**CO2:** Understand and apply basic research methods including research design, data analysis, and interpretation

**Unit-1** **Teaching Hours:8**

**Research Methodology**

Defining research problem - selecting the problem - necessity of defining the problem - techniques involved in defining a problem- Ethics in Research.

**Unit-2** **Teaching Hours:8**

**Research Design**

Principles of experimental design

Working with Literature: Importance, finding literature, using your resources, managing the literature, keep track of references, using the literature, literature review.

On-line Searching: Database – SCIFinder – Scopus - Science Direct - Searching research articles - Citation Index - Impact Factor - H-index etc.

**Unit-3** **Teaching Hours:7**

**Research Data**

Measurement of Scaling: Quantitative, Qualitative, Classification of Measure scales, Data Collection, Data Preparation.

**Unit-4** **Teaching Hours:7**

**Report Writing**

Scientific Writing and Report Writing: Significance, Steps, Layout, Types, Mechanics and Precautions, Latex: Introduction, text, tables, figures, equations, citations, referencing, and templates (IEEE style), paper writing for international journals, Writing scientific report.

**Essential Reading**

[1] C. R. Kothari, *Research Methodology Methods and Techniques*, 3rd. ed. New Delhi: New Age International Publishers, Reprint 2014.
[2] Zina O'Leary, *The Essential Guide of Doing Research*, New Delhi: PHI, 2005.

**Recommended Reading**

[1] J. W. Creswell, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, 4thed. SAGE Publications, 2014.
[2] Kumar, *Research Methodology: A Step by Step Guide for Beginners*, 3rd. ed. Indian: PE, 2010.

## PROGRAMMING FOR AI USING PYTHON

**Total Teaching Hours For Semester:45 No of Lecture Hours/Week:4**

**Course Objectives**

The course deals with various python packages and teaches how to apply relevant python AI packages and also Gain hands-on learning in identifying, defining, designing and implementing the AI packages to various domain.

**Course Outcomes**

CO1: Understand the basic concepts and techniques of Artificial Intelligence through python programming.
CO2: Develop skills of using recent artificial intelligence packages for solving practical problems.
CO3: Apply and Develop Python AI Packages in the domain of NLP,Computer Vision, Time Series Analysis and Data Science.

**Unit-1 Teaching Hours: 9**

**INTRODCTION TO PYTHON PACKAGES**

Introduction-Creating and Exploring Packages- Understanding __init__.py-Importing Python Packages-Installing Packages Locally and Globally-Types of packages-Various ways of accessing the packages-package vs module-Python Package Index (PyPI)- List Packages In A Console With Pip and Pipenv

**Unit-2 Teaching Hours: 9**

**PACKAGES ON LOGIC PROGRAMMING**

Introduction-How to solve problems with Logic Programming-Building the Logic-Propositional Logic-FirstOrder Logic-ClausalForm Logic-Packages: Kanren-SymPy-ProLog-Solving Zebra puzzle, Sudoku and N-queen using Logic Programming

**Unit-3 Teaching Hours: 9**

**DATA PREPARATION AND VISULAIZATION PACKAGES**

**3.1 Data Preparation Packages**

Preprocessing the Data using NumPy and Sklearn.preprocessing-Techniques for preprocessing: Binarization-Mean Removal-Scaling and Normalization

**3.2 Data Visualization Packages**

Introduction to Data Visualization-Data Visualization Packages: Matplotlib-Seaborn-ggplot-Bokeh

**Unit-4** **Teaching Hours: 9**

**NATURAL LANGUAGE PROCESSING PACKAGES**

Introduction to NLP-NLTK Package-gensim and pattern package-Tokenization Packages: sent_tokenize-word_tokenize-WordPuncttokenizer-Stemming Packages: PorterStemmer-LancasterStemmer-Snowball Stemmer-Lemmatization Packages: WordNetLemmatizer

**Unit-5** **Teaching Hours: 9**

**COMPUTER VISION AND TIME SERIES ANALYSIS PACKAGES**

Introduction-Installing OpenCV-Gray Scaling-Image Translation-Scaling and resizing-Basic concepts of Time Series Analysis-Time Series Analysis Packages: Pandas-hmmlearn-PyStruct-CVXOPT-Handling, Slicing and Extracting Statistic from Time Series Data using Pandas

**Text Books and Reference Books**

[1] Artificial Intelligence Programming with Python: From Zero to Hero,Perry Xiao,Wiley Publisher,1st Edition,2022

[2] Artificial Intelligence with Python: Your complete guide to building intelligent apps using Python 3.x,Alberto Artasanchez and Prateek Joshi,Packt Publisher,2nd Edition,2020

**Essential Reading / Recommended Reading**

[1] Artificial Intelligence with Python, Teik Toe Teoh and Zheng Rong,Springer Book Series,2022

[2] Machine Learning with PyTorch and Scikit-Learn: Develop machine learning and deep learning models with Python,Sebastin Raschka,Yuxi Liu and Vahid Mirjalili, Packt Publisher,1st Edition,2022

**Web Resources:**

1. https://www.tutorialspoint.com/artificial_intelligence_with_python/artificial_intelligence_with_python_tutorial.pdf
2. https://archive.ics.uci.edu
3. https://pypi.org/

# MAI 171 – MACHINE LEARNING

**Total Teaching Hours For Semester: 75** **No of Lecture Hours/Week:3+4**
**Max Marks:150** **Credits:4**

**Course Objectives**

This course is designed to introduce the principles and design of machine learning techniques. This course aims to provide foundations for conceptual aspects of machine learning algorithms along with their applications to solve real world problems.

**Course Outcomes**
CO1: Understand the basic principles of machine learning models.
CO2: Evaluate and prepare data for machine learning models.
CO3: Formulate machine learning problems and their solutions
CO4: Evaluate different models used for classification

**Unit-1** **Teaching Hours: 15**

**INTRODUCTION TO DATA PREPROCESSING:**

Getting to Know your data: Data Objects and Attribute Types, Measuring Data Similarity and Dissimilarity – Data Preprocessing: An Overview – Data Cleaning – Data Integration – Data Reduction – Data Transformation – Data Discretization.

**INTRODUCTION TO MACHINE LEARNING:**

Origins of Machine Learning – Basic learning process – Machine Learning in Practice – Types of Machine Learning Algorithms

**Lab Exercises:**

1. Data Exploration for identifying different datasets
2. Preprocessing the dataset using normalization techniques

**Unit-2** **Teaching Hours: 15**

**RULE BASED MACHINE LEARNING**

Mining Frequent Patterns, Associations and Correlations - Basic Concepts - Frequent Itemset Mining Methods – Pattern Evaluation Methods

**Lab Exercises:**

1. Identify frequent itemsets using Apriori Algorithm
2. Generate FP Tree for a transaction dataset

**Unit-3** **Teaching Hours: 15**

**ADVANCED PATTERN MINING:**

Pattern Mining – Pattern Mining in Multilevel, Multidimensional space – Constraint-based Frequent Pattern Mining – Mining High-Dimensional Data and Colossal Patterns – Mining Compressed or Approximate Patterns – Pattern Exploration and Application

**Lab Exercises:**

1. Explore generating multilevel association rules
2. Explore multidimensional associations

**Unit-4** **Teaching Hours: 15**

**SUPERVISED LEARNING I:**

Classification – Basic Concepts – Decision Tree Induction – Bayes Classification Methods – Rule-Based Classification – Model Evaluation and Selection – Techniques to improve Classification Accuracy.

**Lab Exercises:**

1. Demonstrate Naïve Bayes classifier
2. Construct Decision Tree for a dataset and identify the order of attributes

**Unit-5** **Teaching Hours: 15**

**SUPERVISED LEARNING II:**

Bayesian Belief Networks – Support Vector Machines – Classification using Frequent Patterns – Lazy Learners – Self Study: Additional topics regarding classification

**Lab Exercises:**

1. Explore SVM Classifier
2. Demonstrate Lazy Learner

**Text Books and Reference Books**

[1] Data Mining Concept and Techniques, Jiawei Han, Micheline Kamber, Jian Pie, Morgan and Kaufmann Publisher, Third Edition, 2012

[2] Data Mining Techniques, Arun K Pujari, Second Edition, Universities Press India Pvt. Ltd. 2010

Note: Python libraries like MLxtend and Scikit Learn can be used for lab exercises

**Essential Reading / Recommended Reading**

[1] Data Mining: Practical Machine Learning Tools and Techniques, Ian H. Witten, Eibe Frank, Mark A. Hall, Morgan and Kaufmann Publisher, Third Edition, 2014
[2] Introduction to Machine Learning, E. Alpaydin, 3rd Edition, MIT Press, 2014.
[3] Machine Learning with R: Expert techniques for predictive modeling, Brett Lantz, 3rd Edition, Packt Publishing, 2019

## MAI172 – ADVANCED DATABASE TECHNOLOGIES

**Total Teaching Hours For Semester: 75** **No of Lecture Hours/Week:3+4**
**Max Marks:150** **Credits:4**

**Course Objectives**

To provide a strong foundation for database application design and development by introducing the fundamentals and advanced concepts of database technologies.

**Course Outcomes**

CO1: Understand the basic concepts of database management systems, structured query language, transactions, and related database facilities.
CO2: Analyze the database requirements and develop the logical design of the database.
CO3: Design NoSQL database applications using storing, accessing, and querying.
CO4: Develop new applications in databases based on knowledge of existing techniques.

**Unit-1** **Teaching Hours: 15**

**DATABASE SYSTEM CONCEPTS AND CONCEPTUAL MODELING**

Data models, schemas and instances, DBMS architecture and data independence, Database languages and interfaces, database system environment, and Classification of DBMS. Using High-Level Conceptual Data Models for Database Design - Entity Types, Entity Sets, Attributes, and Keys - Relationship Types, Relationship Sets, Roles, and Structural Constraints, Enhanced Entity Relationship Model - SQL Data Definition and Data Types, Specifying Constraints in SQL, Basic Retrieval Queries in SQL, Additional features of SQL. Complex Queries, Triggers, Views, and Schema Modification More Complex SQL Retrieval Queries, Specifying Constraints as Assertions and Actions as Triggers, Views (Virtual Tables) in SQL, Schema Change Statements in SQL.

**Lab Exercises:**

1. DDL, DML, and TCL commands

2. Use of integrity constraints and referential integrity.

**Unit-2** **Teaching Hours: 15**

**RELATIONAL DATA MODEL, DATABASE DESIGN, AND INTRODUCTION TO FILE ORGANIZATION**

Design Guidelines for Relation Schemas - Functional Dependencies - Normal Forms Based on Primary Keys - Second and Third Normal Forms - Boyce-Codd Normal Form – Multivalued Dependency and Fourth Normal Form - Join Dependencies and Fifth Normal Form – Inference Rules, Equivalence and Minimal Cover - Properties of Relational Decompositions - Nulls and Dangling Tuples - File Organization - Organization of Records in Files - Ordered Indices - B+ Tree Index Files - Static Hashing - Bitmap Indices.

**Lab Exercises:**

3. Data Retrieval using JOINS

4. Subqueries and Correlated queries

**Unit-3** **Teaching Hours: 15**

**TRANSACTION PROCESSING, CONCURRENCY CONTROL, AND RECOVERY**

Transaction - Introduction to transaction processing- transaction and system concept- Desirable properties of the transaction- Transaction support in SQL- concurrency control techniques – Two-phase Locking techniques for concurrency- Concurrency Control Based on Timestamp Ordering. Recovery Concepts- NO-UNDO/REDO Recovery Based on Deferred Update- Recovery Techniques Based on Immediate Update- Shadow Paging.

**Lab Exercises:**

5. Views in SQL

6. Stored Procedures and Triggers

**Unit-4** **Teaching Hours: 15**

**DISTRIBUTED DATABASES AND NOSQL SYSTEMS**

Distributed databases: Distributed Database concepts- Types - Data Fragmentation- Replication- Allocation Techniques. Overview of Transaction Management - Overview of Concurrency Control and Recovery.NOSQL Databases-Introduction to NOSQL Systems, The CAP Theorem, Document-Based NOSQL Systems and MongoDB, NOSQL Key-Value Stores, Column-Based or Wide Column NOSQL Systems, NOSQL Graph Databases.

**Lab Exercises:**

7. NOSQL CRUD operations

8. .NOSQL Aggregate functions

**Unit-5** **Teaching Hours: 15**

**NoSQL STORES AND INDEXING AND ORDERING DATA SETS**

Accessing Data from Column-Oriented Databases Like HBase-Querying Redis Data stores-Querying in Neo4J-Changing Document Databases-Schema Evolution in Column-Oriented Databases-HBase Data Import and Export-Data Evolution in Key/Value Stores-Map-Reduce-Basic Map-Reduce-Map-Reduce Calculations-2 stage example. Indexing and Ordering Data Sets-Essential Concepts Behind A Database Index-Indexing and Ordering in MongoDB-Creating and Using Indexes in MongoDB-Indexing and Ordering in CouchDB-Indexing in Apache Cassandra-Indexing and Ordering in Neo4J.

**Lab Exercises:**

9. NoSQL data IMPORT and EXPORT

10. MAP-REDUCE in NoSQL

**Essential Reading**

[1] Elmasri & Navathe, Fundamentals of Database Systems, Addison-Wesley, 7th Edition, 2021.

[2] Shashank Tiwari, *Professional NoSQL*, Wrox Press, Wiley, 2021, ISBN: 978-0-470-94224-6

**Recommended Reading**

[1] Korth F. Henry and Silberschatz Abraham, Database System Concepts, McGraw Hill, 6th Edition, 2010.

[2] O'neil Patric, O'neil Elizabeth, Database Principles, Programming and Performance, Argon Kaufmann Publishers, 2nd Edition, 2002.

[3] Ramakrishnan and Gehrke, Database Management System, McGraw-Hill, 3rd Edition, 2003.

[4] Gaurav Vaish, Getting Started with NoSQL, Packt Publishing, 2013.

**Web Resources:**

1. www.w3cschools.com
2. https://learnsql.com/
3. https://www.mongodb.com
4. https://achouettz.firebaseapp.com › professional-NoSQL-by-Shashank-tiwari

**Trimester – II**

## MAI231– Data Visualization

**Total Teaching Hours For Semester: 30** **No of Lecture Hours/Week:3**
**Max Marks:50** **Credits:2**

**Course Objectives**

Data visualization techniques allow people to use their perception to better understand the data. The goal of this course is to introduce students to data visualization which includes principles and techniques.

Students will learn the value of visualization, specific techniques in information visualization and scientific visualization.

**Course Outcomes**

CO1:Understand the usage of various visualization structures like tables,tree,network etc.,

CO2: Evaluate information visualization systems and other forms of visual presentation for their effectiveness

CO3: Design and build data visualization system

**Unit-1** **Teaching Hours: 6**

Value of Visualization – What is Visualization and Why do it: External representation – Interactivity – Difficulty in Validation. Data Abstraction: Dataset types – Attribute types – Semantics. Task Abstraction – Analyze, Produce, Search, Query.

**Unit-2** **Teaching Hours: 6**

Four levels of validation – Validation approaches – Validation examples. Marks and Channels. Rules of thumb – Arrange tables: Categorical regions – Spatial axis orientation – Spatial layout density. Arrange spatial data:

**Unit-3** **Teaching Hours: 6**

Geometry – Scalar fields – Vector fields – Tensor fields. Arrange networks and trees: Connections, Matrix views – Containment. Map color: Color theory, Color maps and other channels.

**Unit-4** **Teaching Hours: 6**

Manipulate view: Change view over time – Select elements – Changing viewpoint – Reducing attributes. Facet into multiple views: Juxtapose and Coordinate views

**Unit-5** **Teaching Hours: 6**

Partition into views – Static and Dynamic layers – Reduce items and attributes: Filter – Aggregate. Focus and context: Elide – Superimpose – Distort – Case studies.

**Essential Reading**

[1] Tamara Munzner, Visualization Analysis and Design, A K Peters Visualization Series, CRC Press, 2014.
[2] Scott Murray, Interactive Data Visualization for the Web, O'Reilly, 2013.

**Recommended Reading**

[1] Alberto Cairo, The Functional Art: An Introduction to Information Graphics and Visualization, New Riders, 2012
[2] Nathan Yau, Visualize This: The FlowingData Guide to Design, Visualization and Statistics, John Wiley & Sons, 2011.

Note:

- Any two or more tools can be used for the implementation of data visualization techniques
- It can be lab oriented paper (1T + 2L)
- Minimum two types of visualization techniques can be implemented per unit
- Detailed list will be available in the course plan based on the selected tool.

# MAI232 – DATA ENGINEERING AND KNOWLEDGE REPRESENTATION

**Total Teaching Hours For Semester: 45** **No of Lecture Hours/Week:3**
**Max Marks:100** **Credits:3**

**Course Objectives**

To provide a foundational knowledge of data engineering and knowledge representation.
To store , retrieve, analyze and design data for various applications
To represent different sorts of knowledge, such as uncertain or incomplete knowledge,

**Course Outcomes**

CO1: To store and retrieve data effectively
CO2: To analyze the data from different sources
CO3: To analyze and design knowledge based systems

**Unit-1** **Teaching Hours: 9**

**DATA ENGINEERING and DATA MODELS**

**Data Engineering**

Introduction to Data Engineering - Data Engineering versus Data Science – Data Engineering tools– Data Engineering Lifecycle

**Data Models**

Data Systems – Reliability – Scalability – Maintainability -Data Models and Query Languages. - Relational Model Versus Document Model - Query Languages for Data -Query Languages for Data,Declarative Queries on the Web ,MapReduce Querying ,Graph-Like Data Models Property Graphs ,The Cypher Query Language ,Graph Queries in SQL ,Triple-Stores and SPARQL

**Unit-2** **Teaching Hours: 9**

**BUILDING DATA PIPELINES**

Introduction – Data Engineering ecosystem - Building data pipelines—Extract, Transform, Load -ETL Process – Data Structures related to Database – Other data integration methods – Benefits and Challenges of ETL – ETL tools

**Data Warehousing** - Stars and Snowflakes: Schemas for Analytics- Column-Oriented Storage - Column Compression -Sort Order in Column Storage - Writing to Column-Oriented Storage

**Unit-3** **Teaching Hours: 9**

**DATA STORAGE AND RETRIEVAL**

**Data Storage and Retrieval Non Relational data**

Non Relational data – NoSQL- Language-Specific Formats JSON, XML, and Binary Variants - Modes of Dataflow Dataflow Through Databases

**DATA in Distributed systems**

Data in distributed systems – Partitioning and Replication - Partitioning of Key-Value Data - Partitioning and Secondary Trouble with Distributed Systems- Faults and Partial Failures - Unreliable Networks - Unreliable Clocks

**Unit-4** **Teaching Hours: 9**

**Knowledge Representation**

Knowledge Representation - Ontological Engineering - Categories and Objects . Events - Mental Events and Mental Objects - Reasoning Systems for Categories - Reasoning with Default Information Uncertain knowledge and reasoning- Quantifying Uncertainty - Acting under Uncertainty - Basic Probability Notation

**Unit- 5** **Teaching Hours: 9**

**Knowledge Representation in an uncertain domain**

Probabilistic Reasoning-Representing Knowledge in an Uncertain Domain -The Semantics of Bayesian Networks -Efficient Representation of Conditional Distributions -Exact Inference in Bayesian Networks -Relational and First-Order Probability Models

**Text Books and Reference Books**

[1] Martin Kleppmann, Designing Data-Intensive Applications - The Big Ideas Behind Reliable, Scalable,and Maintainable Systems, first edition, O'Reilly ,2017
[2] S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 3rd Edition, Pearson Education, 2019.

**Essential Reading / Recommended Reading**

[1] Ted Malaska , Rebuilding Reliable Data Pipelines Through Modern Tools , first edition, O'Reilly, 2019
[2] Paul Crickard, Data Engineering with Python, first edition, Packt Publishing,2020
[3] Ronald J. Brachman, Hector J. Levesque, KNOWLEDGE REPRESENTATION AND REASONING, Elsevier , 2004
[4] S.L. Kendal and M. Creen An Introduction to Knowledge Engineering, Springer, 2007

**Web Resources:**

1. https://www.coursera.org
2. https://nptel.ac.in/noc/courses/noc18/SEM1/noc18-cs18/

## MAI233– Design and Analysis of Algorithms

**Total Teaching Hours For Semester: 45** **No of Lecture Hours/Week:4**
**Max Marks:100** **Credits:3**

**Course Objectives**

This core course covers principles of algorithm design, elementary analysis of algorithms, and fundamental data structures. The emphasis is on choosing appropriate data structures and designing correct and efficient algorithms to operate on these data structures.

**Course Outcomes**

Students will be able to:

CO1. Analyze the complexity of polynomial algorithms.

CO2. Apply various design strategies for solving problems

CO3. Distinguish NP hard and NP complete problems from other problems

**Unit-1** **Teaching Hours: 12**

Algorithms as technology – Analyzing and Designing algorithms – Asymptotic notations – Recurrences – Methods to solve recurrences – Heap Sort - Quick Sort – Sorting in linear time – Radix sort – Selection in linear time. Introduction: Algorithms, Pseudo code for expressing algorithms, performance analysis Space complexity, Time Complexity, Asymptotic notation- Big oh notation, omega notation and theta notation

**Unit-2** **Teaching Hours: 12**

Divide and conquer methodology – Multiplication of large integers – Strassen's matrix multiplication – Greedy method – Prim's algorithm – Kruskal's algorithm – algorithm for Huffman codes, Knapsack problem, Spanning trees, Minimum cost spanning trees, Single source shortest path problem.

**Unit-3** **Teaching Hours: 12**

Dynamic Programming: General method, applications- Matrix chained multiplication, Optimal binary search trees, 0/1 Knapsack problem, All pairs shortest path problem, Traveling sales person problem, Reliability design.

**Unit-4** **Teaching Hours: 12**

Backtracking: General method, Applications- n-queue problem, Sum of subsets problem, Graph coloring, Hamiltonian cycles.

**Unit-5** **Teaching Hours: 12**

Branch and Bound: General method, applications- Travelling sales person problem, 0/1 Knapsack problem- LC branch and Bound solution, FIFO branch and Bound solution. NP-Hard and NP-Complete Problems: Basic concepts, Non deterministic algorithms, NP-Hard and NP Complete classes

**Text Books and Reference Books**

[1] Fundamentals of Computer Algorithms, Ellis Horowitz, SartajSahni and Rajasekharan, Universities press

[2] Design and Analysis of Algorithms, P. h. Dave,2nd Edition, Pearson Education

**Essential Reading / Recommended Reading**

[1] Introduction to the Design And Analysis of Algorithms A Levitin Pearson Education

[2] Algorithm Design foundations Analysis and Internet examples, M.T.Goodrich and R Tomassia John Wiley and sons

[3] Design and Analysis of Algorithms, S. Sridhar, Oxford Univ.Press

[4] Design and Analysis of Algorithms ,Aho , Ulman and Hopcraft , Pearson Education.

[5] Foundations of Algorithms, R. Neapolitanand K.Naimipour , 4th edition

**Web Resources:**

4. www.w3cschools.com
5. https://archive.ics.uci.edu

# MAI 271 – JAVA PROGRAMMING

**Total Teaching Hours For Semester: 90** **No of Lecture Hours/Week: 4+4**
**Max Marks:150** **Credits:5**

**Course Objectives**

This course will help the learner to gain sound knowledge in object-oriented principles, GUI application development, web application development and enterprise application development by using different features of Java technologies.

**Course Outcomes**

CO1: Understanding and applying the principles of object-oriented programming in the construction of robust, maintainable programs.
CO2: Analyze the various societal and environmental problems critically to apply the concepts of generic, lambda and collections.
CO3: Develop sustainable and innovative GUI/Web based/Enterprise solutions for real-time problems.

**Unit-1** **Teaching Hours: 18**

**INTRODUCTION TO OBJECT ORIENTED PROGRAMMING (OOP) AND CLASSES**

**Introduction to Object Oriented Programming (OOP)**

Object-Oriented Programming (OOP) Principles- Class Fundamentals - Declaring Objects - Introducing Methods - Overloading methods – Constructors - Parameterized Constructors - this Keyword.

**Class Features**

Garbage Collection - the finalize () Method - Introducing Access Control - Understanding static - Introducing nested and inner classes - String class - String Buffer Class - Command Line Arguments.

**Lab Exercises:**

1. Identify a domain of your choice, list out ten entities in the domain. For each entity, identify minimum 10 attributes and assign the data type for each attribute with proper justification.

2. Implement the concept of class, data members, member functions and access specifiers, function overloading and constructor overloading
3. Implement the features of static keyword, command line argument, String class and String Buffer class

**Unit-2** **Teaching Hours: 18**

**INHERITANCE, INTERFACES & PACKAGES AND MULTITHREADING IN JAVA**

**Inheritance in Java**

Inheritance Basics - Multilevel Hierarchy- Using super - Method overriding - Dynamic Method Dispatch- Abstract keyword- Using final with inheritance - The Object Class.

**Interfaces and Packages**

Inheritance in java with Interfaces – Defining Interfaces - Implementing Interfaces - Extending Interfaces- Creating Packages - CLASSPATH variable - Access protection - Importing Packages - Interfaces in a Package.

**Multithreading Java**

Thread Model - Life cycle of a Thread - Java Thread Priorities - Runnable interface and Thread Class- Thread Synchronization – Inter Thread Communication.

**Lab Exercises:**

4. Implement the concept of inheritance, super, abstract and final keywords.

5. Implement the concept of package and interface.

6. Implement the concept of multithreading.

**Unit-3** **Teaching Hours: 18**

**GENERICS, LAMBDA AND THE COLLECTIONS FRAMEWORK**

**Generics**

Generics Concept - General Form of a Generic Class – Bounded Types – Generic Class Hierarchy - Generic Interfaces – Restrictions in Generics.

**Lambda Expression**

Introduction to Lambda expression- Block Lambda Expressions - Generic Functional Interfaces - Passing lambda expressions as arguments - Lambda expressions and exceptions- Lambda expressions and variable capture.

**The Collections Framework**

The Collections Overview – Collection Interface – List Interface – Set Interface – SortedSet Interface – Queue Interface - ArrayList Class – LinkedList Class – HashSet Class – Using an

Iterator – The For Each Statement. Working with maps – The map interfaces, the map classes. Comparators- the collection algorithms

**Lab Exercises:**

7. Implement the concept of Generics
8. Implement the concept of the lambda expression
9. Implement the concept of a collection framework

**Unit-4** **Teaching Hours: 18**

**JAVA BEANS AND JDBC**

**JDBC**

Introduction to JDBC- Connecting to the database- Basic JDBC Operations – Essential JDBC Classes – JDBC Drivers – JDBC-ODBC Bridge – Connecting to a database with driver manager – JDBC database URL.

**JAVA BEANS**

Java beans - Advantages of Beans – Introspection- Bound and Constrained Properties – Persistence – Customizers - The JavaBeans API.

**JAVA SWING**

Swing Basics – Components and Containers – JLabel and ImageIcons- JTextField – Swing Buttons – JTabbedPane – JScrollPane – JList – JComboBox – JTable – Swing Menus.

**Lab Exercises:**

10. Implement the concept of JDBC and Java Beans
11. Implement the features of java swing package

**Unit-5** **Teaching Hours: 18**

**JAVA SERVLETS & JSP**

**JAVA SERVLETS**

Servlets Basics – Life Cycle of a Servlet –A Simple Servlet - The Servlet API – Servlet Interfaces – Generic Servlet Class- HttpServletRequest Interface – HttpServeltResponse

**JSP**

The JSP development model – component of jsp page – Page directive – Action – scriptlet – JSP expression, JSP Syntax and semantics, JSP in XML.

**Lab Exercises:**

12. Implement the concept of java servlets
13. Implement the concept of JSP

**Text Books and Reference Books**

[1] Schildt Herbert, Java : The Complete Reference, Tata McGraw- Hill, 11 th Edition,2019
[2] The complete reference JSP 2.0, Tata McGraw- Hill, 2nd Edition, Phil Hanna
[3] Cay S Horstmann, Core Java Volume 1 Fundamentals, Prentice Hall, 11th Edition, 2018.

## MAI 272 – ADVANCED MACHINE LEARNING

**Total Teaching Hours For Semester: 75** **No of Lecture Hours/Week:3+4**
**Max Marks:150** **Credits:4**

**Course Objectives**

This course covers the most popular machine learning algorithms such as regression techniques with a modern outlook focusing on the recent advances and examples. It also aims to provide the foundations for dimensionality reduction techniques and clustering techniques with their applications to solve real world problems.

**Course Outcomes**

CO1: Demonstrate classification and clustering techniques
CO2: Evaluate different models used for feature selection
CO3: Understand the strengths and weaknesses of many popular machine learning techniques.
CO4: Design and implement various machine learning algorithms in a range of real-world applications

**UNIT-1** **Teaching Hours: 15**

**REGRESSION METHODS**

Understanding Regression: Simple Linear regression - Ordinary least squares estimation - Gradient Descent - multiple linear regression - Multivariate linear regression – Polynomial regression – Regularization – Ridge and Lasso Regression - Understanding regression trees and model trees - Logistic regression - Bias and Variance Trade-off – Overfitting and underfitting models.

**Self-Study:** Support Vector Regression, Decision Tree Regression – Random Forest Regression

**Lab Exercises:**

1. Implement various types of linear regression techniques
2. Explore non-linear regression techniques

**Unit-2** **Teaching Hours: 15**
**DIMENSIONALITY REDUCTION**

Factor Analysis, Low Variance Filter, High Correlation Filter, Backward Feature Elimination – Forward Feature Selection – Principal Component Analysis – Factor Analysis – Multidimensional Scaling - Linear Discriminant Analysis – Independent Component Analysis – Isomap – Maximum Relevance Minimum Redundancy

**Self-Study: - Combining Multiple Learners**

**Lab Exercises:**
1. Demonstrate Feature selection
2. Explore and compare PCA, LDA and ICA techniques

**Unit-3** **Teaching Hours: 15**
**Unsupervised Learning:**

**Cluster Analysis -** Partitioning Methods – K-Means – K-Medoids – Hierarchical Methods – Agglomerative Vs Divisive – Distance measures in algorithmic methods – BIRCH – Chameleon – Probabilistic Hierarchical Clustering – Evaluation of Clustering: Assessing clustering Tendency – Determining the Number of Clusters – Measuring Clustering Quality

**Lab Exercises:**
1. Demonstrate K-Means algorithm with optimum number of clusters
2. Demonstrate Hierarchical clustering
3. Evaluate quality of clusters

**Unit-4** **Teaching Hours: 15**
**Reinforcement Learning**

Introduction – Single State Case: K-Armed Bandit – Elements of Reinforcement Learning – Model-Based Learning – Temporal Difference Learning – Generalization – Partially Observable States

**Self-study and Discussion:** Case Studies and recent applications.

**Lab Exercises:**
1. Explore model based reinforcement learning

**Unit-5** **Teaching Hours: 15**
**Neural Networks:** Application scope of Neural Networks – Fundamental Concept of ANN: The Artificial Neural Network – Biological Neural Network – Comparison between Biological neuron and Artificial Neuron – Evolution of Neural Network. Basic models of

ANN – Learning Methods – Activation Functions – Importance Terminologies of ANN – Single / Multilayer perceptron

**Lab Exercises:**

1. Calculate the output of a simple neuron using binary and bipolar sigmoidal activation functions
2. Demonstrate classification using MLP

**Text Books and Reference Books**

[1] Introduction to Machine Learning, E. Alpaydin, 3rd Edition, MIT Press, 2014.

[2] Data Mining Concept and Techniques, Jiawei Han, Micheline Kamber, Jian Pie, Morgan and Kauf

[3] S.N.Sivanandam, S. N. Deepa, Principles of Soft Computing, Wiley-India, 3rd Edition,2018.

Note: Scikit learn python library can be used for lab exercises.

**Essential Reading / Recommended Reading**

[1] Reinforcement Learning: An Introduction, Richard S. Sutton and Andrew G. Barto, Bradford Books, 2018

[3] Machine Learning with R: Expert techniques for predictive modeling, Brett Lantz, 3rd Edition, Packt Publishing, 2019

**Web Resources**

[1] Hal Daumé III, A Course in Machine Learning (CIML), 2017 (freely available online)

# MAI251 – RESEARCH PROJECT LAB - I

**Total Teaching Hours For Semester: 30** **No of Lecture Hours/Week:3**
**Max Marks:50** **Credits:1**

**Course Objectives**

This course is intended to carry out supervised research in a particular domain. The students are expected to identify, formulate and analyze the research problem. The students are also expected to conduct critical review of literature, choosing the study design, deciding on the sample design, become proficient in tools to solve the research problem. Students are expected to adhere research ethical practices at every phase of development and submit the intermediate reports.

**Course Outcomes**

CO1: Identify and formulate the research problem in the chosen domain.
CO2: Analyze the research gaps and propose the novel solutions to the chosen problem.

The students are expected to carry out the following:

- Identify the background of research and conduct critical review of literature to understand the context.
- Identification of research gaps
- Formulate research questions/Objectives and hypothesis based on the research problem.
- Methodology or approach intended to be adopted in the execution of the research
- Expected outcome of research

**References**

1. Relevant literature for the research problem.

## Trimester – III

## MAI 371 – DEEP LEARNING

**Total Teaching Hours For Semester: 75** **No of Lecture Hours/Week:3+4**
**Max Marks:150** **Credits:4**

**Course Objectives**

The main objective of this course is to make students comfortable with the tools and techniques required to handle large datasets. Several libraries and datasets publicly available will be used to illustrate the application of these algorithms. This will help students develop the skills required to gain experience of doing independent research and study.

**Course Outcomes**

CO1: Recognize the basic concepts and techniques of deep learning.
CO2: Evaluate and prepare to apply deep learning algorithms.
CO3: Apply deep learning models for applications.
CO4: Identify appropriate tools to implement the solutions to problems related for deep learning.

**Unit-1** **Teaching Hours: 15**

**DEEP FEEDFORWARD NETWORKS**

An overview of ANN, Back Propagation Neural Networks, Deep Feedforward Networks: Deep network for Universal Boolean function representation, classification and Approximation, perceptron Learning, Perceptron with activation functions

**Lab Exercises:**

1. Demonstrate MLP in Keras/Tensorflow
2. Demonstrate Deep Feedforward Network

**Unit-2** **Teaching Hours: 15**

**REGULARIZATION FOR DEEP MODELS**

Regularization for Deep models: L2 and L1 Regularization, Constrained Optimization and Under- Constrained, Early Stopping, Parameter Tying and Parameter Sharing, Sparse representations, Dropout

**Lab Exercises:**

1. Demonstrate Regularization L1 for Deep learning model
2. Demonstrate Regularization L2 for Deep learning model

**Unit-3** **Teaching Hours: 15**

**CONVOLUTIONAL NEURAL NETWORK**

The Convolution Operation, Pooling, Structured Outputs, Variants of convolution, Variants of CNN – ImageNet, Alexnet, VGG16, ResNet, Applications in Computer Vision

**Lab Exercises:**

1. Demonstrate Convolution Neural Network
2. Demonstrate VGG16 or ResNet

**Unit-4** **Teaching Hours: 15**

**RECURRENT NEURAL NETWORKS**

Sequence Processing, Unfolding Computational Graphs, Training recurrent networks

The Long Short-Term Memory (LSTM), Optimization for Long- Term Dependencies, Encoder-Decoder Sequence-to-Sequence processing

**Lab Exercises:**

1. Demonstrate Recurrent Neural Network
2. Demonstrate Short-Term Long Memory (LSTM)

**Unit-5** **Teaching Hours: 15**

**AUTOENCODERS**

The architecture of autoencoders - relationship between the Encoder, Bottleneck, and Decoder, how to train autoencoders? Types of autoencoders: Undercomplete autoencoders, Sparse autoencoders, Contractive autoencoders, Denoising autoencoders, Variational Autoencoders

**Lab Exercises:**

1. Demonstrate Sparse Autoencoders
2. Demonstrate Contractive Autoencoders

**Text Books and Reference Books**

[1] Deep Learning by Ian Goodfellow, Yoshua Bengio, Aaron Courville. MIT Press 2016.

**Essential Reading / Recommended Reading**

[1] Deep Learning with Python by Francois Chollet. 2nd Edition, Manning Publications Co., 2020

[2] Introduction to Deep Learning by Eugene Charniak. The MIT Press 2019

[3] Dive into Deep Learning by Aston Zhang, Zack C. Lipton, Mu Li, Alex J. Smola. 2019

**Web Resources:**

1. https://www.deeplearningbook.org/
2. https://archive.ics.uci.edu/ml/datasets.php

## MAI372– Natural Language Processing

**Total Teaching Hours For Semester: 75** **No of Lecture Hours/Week:3+4**
**Max Marks:150** **Credits:4**

### Course Objectives

Students who complete this course will gain a foundational understanding in natural language processing methods and strategies. They will also learn how to evaluate the strengths and weaknesses of various NLP technologies and frameworks as they gain practical experience in the NLP toolkits available. Students will also learn how to employ literary-historical NLP-based analytic techniques like stylometry, topic modeling, synsetting and named entity recognition in their personal research.

### Course Outcomes

CO1: To understand various approaches on syntax and semantics in NLP.

CO2: To apply various methods to discourse, generation, dialogue and summarization using NLP.

CO3: To analyze various methodologies used in Machine Translation, machine learning techniques used in NLP including unsupervised models

**Unit-1** **Teaching Hours: 15**

**INTRODUCTION**

Introduction to NLP- Background and overview- NLP Applications -NLP hard Ambiguity- Algorithms and models, Knowledge Bottlenecks in NLP- Introduction to NLTK, Case study.

**Lab Exercises:**

1. Write a program to tokenize text.
2. Write a program to count word frequency and to remove stop words.

**Unit-2** **Teaching Hours: 15**

**PARSING AND SYNTAX**

Word Level Analysis: Regular Expressions, Text Normalization, Edit Distance, Parsing and Syntax- Spelling, Error Detection and correction-Words and Word classes- Part-of Speech Tagging, Naive Bayes and Sentiment Classification: Case study.

**Lab Exercises:**

3. Write a program to program to tokenize Non-English Languages
4. Write a program to get synonyms from WordNet

**Unit-3** **Teaching Hours: 15**

**SMOOTHED ESTIMATION AND LANGUAGE MODELLING**

N-gram Language Models: N-Grams, Evaluating Language Models -The language modelling problem

**Semantic Analysis and Discourse Processing**

Semantic Analysis: Meaning Representation-Lexical Semantics- Ambiguity-Word Sense Disambiguation. Discourse Processing: cohesion-Reference Resolution- Discourse Coherence and Structure.

**Lab Exercises:**

5. Write a program to get Antonyms from WordNet
6. Write a program for stemming non-English words

**Unit-4** **Teaching Hours: 15**

**NATURAL LANGUAGE GENERATION AND MACHINE TRANSLATION**

Natural Language Generation: Architecture of NLG Systems, Applications. Machine Translation: Problems in Machine Translation-Machine Translation Approaches. Evaluation of Machine Translation systems. Case study: Characteristics of Indian Languages.

**Lab Exercises:**

7. Write a program for lemmatizing words Using WordNet
8. Write a program to differentiate stemming and lemmatizing words

**Unit-5** **Teaching Hours: 15**

**INFORMATION RETRIEVAL AND LEXICAL RESOURCES**

Information Retrieval: Design features of Information Retrieval Systems-Classical, Non-classical, Alternative Models of Information Retrieval – valuation Lexical Resources: Word Embeddings - Word2vec-Glove.

**Unsupervised Methods in Nlp**

Graphical Models for Sequence Labelling in NLP.

**Lab Exercises:**

9. Write a program for POS Tagging.
10. Write a program to implement Word Embeddings.
11. Case study-based program (IBM) or Sentiment analysis or ChatGpt

**Text Books and Reference Books**

[1] Speech and Language Processing, Daniel Jurafsky and James H., 3rd Edition, Martin Prentice Hall, 2023.

[2] Foundations of Statistical Natural Language Processing. Cambridge, MA: MIT Press,1999.

**Essential Reading / Recommended Reading**

[1] Roland R. Hausser, Foundations of Computational Linguistics: Human computer Communication in Natural Language, Springer, 2014.

[2] Steven Bird, Ewan Klein and Edward Loper, Natural Language Processing with Python, O'Reilly Media, First edition, 2009.

**Web Resources:**

[1] https://web.stanford.edu/~jurafsky/slp3/

[2] https://nptel.ac.in/courses/106101007/

[3] NLTK – Natural Language Tool Kit- http://www.nltk.org

# MAI 373 – COMPUTER VISION

**Total Teaching Hours For Semester: 75** **No of Lecture Hours/Week:3+4**
**Max Marks:150** **Credits:4**

**Course Objectives**

The Objective of this course is to cover the basic theory and algorithms that are widely used in computer vision. Develop hands-on experience in using computers to process images for image enhancement, restoration, filtering and feature extraction to recognize objects.

**Course Outcomes**

Upon successful completion of the course the student would

CO1: Describe the theoretical background of image processing.
CO2: Design various image enhancement methods and filtering techniques
CO3: Apply restoration, compression and segmentation methods in both frequency and spatial domain.
CO4: Perform feature extraction and classification using real time dataset.

**Unit-1** **Teaching Hours: 15**

**INTRODUCTION TO DIGITAL IMAGE PROCESSING :**

Fundamentals: Fundamental Steps in Image Processing, Elements of Digital Image Processing System, Image Sampling and Quantization, Basic relationships: Neighbors, Connectivity, Distance Measures between pixels, Image formation model, Grayscale and Color images representation, Introduction to Digital Video.

**Lab Exercises:**

1. Program to perform Resize, Rotation of binary, Gray-scale and color images using various methods.
2. Demonstrate frame extraction from the video and display the color components of the images.

**Unit-2** **Teaching Hours: 15**

**IMAGE ENHANCEMENT**

**Spatial Domain**

Gray Level Transformations, point operations, Histogram Processing, Histogram equalization, Basics of Spatial Filters, Smoothening and Sharpening Spatial Filters.

**Frequency Domain**

Introduction to Fourier Transform and the frequency Domain, Smoothing and Sharpening, Frequency Domain Filters, DCT, Homomorphic Filtering

**Lab Exercises:**

3. Program to implement various image enhancement techniques using Built-in and user defined functions.
4. Program to implement Linear Spatial Filtering using Built-in and user defined functions
5. Program to implement Low and High Pass Filtering of images in frequency domain.

**Unit-3** **Teaching Hours: 15**

**IMAGE RESTORATION AND IMAGE COMPRESSION**

A model of the Image Degradation / Restoration Process, Noise Models, Restoration in the presence of Noise, Periodic Noise Reduction by Frequency Domain Filtering.

Image Compression models: Huffman coding, Run length coding, LZW coding, JPEG.

**Lab Exercises:**

6. Program to implement Non-Linear Spatial Filtering using Built-in and user defined functions
7. Demonstrate denoising of the images

**Unit-4** **Teaching Hours: 15**

**IMAGE SEGMENTATION AND REPRESENTATION**

Point, Line and Edge detection, Thresholding – Basic global thresholding, optimum global thresholding using Otsu's Method. Region Based Segmentation – Region Growing and Region Splitting and Merging. Representation – Chain codes, Polygonal approximations using minimum perimeter polygons.

**Lab Exercises:**

8. Demonstrate Edge detection using various methods.
9. Perform frame extraction from the video and display the color components of the images.

**Unit-5** **Teaching Hours: 15**

**DESCRIPTION AND OBJECT RECOGNITION**

Boundary descriptors – Fourier descriptors, regional descriptors –Topological descriptors.

Introduction to Patterns and Pattern Classes: Minimum distance classifier, K-NN classifier. Object detection and recognition – Face recognition (Eigen faces).

**Lab Exercises:**

10. Program to demonstrate Fourier descriptors
11. Extracting feature descriptors from the image dataset.
12. Implement image classification using extracted relevant features.

**Text Books and Reference Books**

[1] Digital Image Processing, R. C. Gonzalez & R. E. Woods, Pearson Education, 4th Edition, 2018.

[2] Fundamental of Digital Image Processing, A.K. Jain, PHI, 4th Edition, 2011.

[3] Digital Image Processing Using MATLAB, Rafael C. Gonzalez, Richard E. Woods and Steven L Eddins, PHI, 2nd Edition, 2017.

[4] Computer Vision: Algorithms and Applications, Richard Szeliski, Springer Science & Business Media, 2nd Edition, 2022.

**Essential Reading / Recommended Reading**

[1] Digital Image Processing: An algorithmic approach, M. A. Joshi, PHI, 2nd Edition 2009.

[2] Digital Image Processing and analysis, B.Chanda, D. DuttaMajumdar, PHI, 1st Edition, 2011.

# MAI351 – RESEARCH PROJECT LAB - II

**Total Teaching Hours For Semester: 30** **No of Lecture Hours/Week:3**
**Max Marks:50** **Credits:1**

**Course Objectives**

The students are expected to reveal the core competency aimed by this course which includes development of effective solution to the chosen problem, deployment of solution and research findings. The students are expected to submit the final report as well as they are expected to defend their research work.

**Course Outcomes**

CO1: Analyze proposed solutions to the identified research problem.
CO2: Develop a solution to the problem and analyze results.

**The students are expected to carry out the following:**

- Collect the data to acquire the information required to answer the research issues.
- Develop and deploy the novel solution to the identified problem.
- Prepare a research report and defend the research work done.
- Publish Article in National or International conference/UGC CARE List journal / WoS / Scopus Indexed journal publication.

**References**

1. Relevant solutions for the research problem.

## MAI341A – AI in Agriculture

**Total Teaching Hours For Semester: 30** **No of Lecture Hours/Week:3**
**Max Marks:50** **Credits:2**

**Course Objectives**

To explore the current and potential applications of AI and various technologies in agriculture, such as crop monitoring, yield prediction, soil analysis, Plant Disease Identification and pest control to improve the agriculture productivity in India

**Course Outcomes**

CO1: To Understand the basic concepts and techniques of artificial intelligence and how they can be applied in the field of agriculture.
CO2: To develop skills in the design and implementation of AI & IoT-based agriculture systems.

**Unit-1** **Teaching Hours: 6**

**Smart Farming using Artificial Intelligence**

Introduction – Role of AI in advanced farming - Role of IoT in advanced farming - Role of Robotics in advanced farming – Smart Farming – Smart Agriculture – AI in Agriculture - How Data Analytics Transforming Agriculture – Agricultures Data Analytics Benefits – Challenges of AI in Agriculture - Case Study

**Unit-2** **Teaching Hours: 6**

**Precision Agriculture**

History of Precision Agriculture – Introduction – Components – Tools and Techniques – Site Specific Crop Management – VRA & VRT – Adoption of Smart Precision Agriculture - Modern Day Agriculture – Smart Precision Agriculture – Agriculture Digital Farming – Benefits – Soil Management – High Accuracy in Disease prediction, Detection and Control – Application of WSN in Precision Agriculture

**Unit-3** **Teaching Hours: 6**

**AI and Data Analytics in Agriculture**

Prediction of Crop Yield and Pest Disease Infestation – Prediction system for Cropyield and livestock – Climate Condition Monitoring and Automated Systems – Decision Making system for Crop Selection based on Soil.

**Unit-4** **Teaching Hours: 6**

**Agriculture Data Mining and Information Extraction**

Introduction – Data Mining Techniques in Farming – Case Studies in Agricultural Data Mining – Research Challenges – Machine Learning and its Application in Food Processing and Preservation.

**Unit-5** **Teaching Hours: 6**

**Modern Agricultural Applications using AI**

Introduction – Smart farming Tools – Technological Advancements – Climate – Smart Agriculture – Evolution of Cutting Edge Technologies that are revolutionizing the Agriculture in India – Smart Farming Applications - Future Scope and Challenges.

**Text Books and Reference Books**

[1]Artificial Intelligence and Smart Agriculture Technology, Utku Gose, V B Surya Prasath, Hossain, Subrato Bharati, Prajoy Podder, CRC Press,1st Edition 2022

[2]AI, Edge and IoT-based Smart Agriculture, Ajith Abraham, Sujata Dash, Joel J.P.C. Rodrigues, Academic Press, 2021,Agriculture 5.0,Latief Ahmad, Firasath Nabi,CRC Press 2021

**Essential Reading / Recommended Reading**

[1]Smart farming technologies for sustainable Agricultural Development, Digital Computer Fundamentals, Floyd, Thomas L, Pearson International, 11th Edition, 2015

[2]Smart farming technologies for sustainable Agricultureal Development, Poonia, Ramesh C., Gao, Xiao-Zhi, Raja, Linesh,IGI Global, 2018

**Web Resources:**

6. Smart Farming Technologies for Sustainable Development (smartertechnologies.com)
7. Smart Farming And Its Technologies Application In Agriculture (eos.com)

# MAI341B – AI in Cyber Security

**Total Teaching Hours For Semester: 30** **No of Lecture Hours/Week:3**
**Max Marks:50** **Credits:2**

**Course Objectives**

To select suitable ethical principles and commit to professional responsibilities and human values and contribute value and wealth for the benefit of the society.

**Course Outcomes**

**CO1:** Identify existing legal framework and laws on cyber security.

**CO2:** Apply the security aspects of social media platforms and ethical aspects associated with use of social media.

**Unit 1** **Teaching Hours: 6**

**Introduction to AI for Cyber security:**

Applying AI in cyber security-The evolution from expert systems to data mining and AI-The different forms of automated learning-The characteristics of algorithm training and Optimization-Beginning with AI via Jupyter Notebooks-Introducing AI in the context of cyber security.

**Unit 2** **Teaching Hours: 6**

**AI for Cyber Security Arsenal**:

Classification-Regression-Dimensionality Reduction-Clustering-Video anomaly detection Natural Language processing (NLP) for Social media analysis-Large-scale image Processing.

**Unit 3**

**Detecting Cyber Security Threats with AI:** **Teaching Hours: 6**

How to detect spam with Perceptron's- Image spam detection with support vector machines (SVMs)-Phishing detection with logistic regression and decision Trees-Spam detection with Naive Bayes-Spam detection adopting NLP

**Unit 4**

**Protecting Sensitive Information and Assets:** **Teaching Hours: 6**

Authentication abuse Prevention-Account Reputation Scoring-User authentication with keystroke Recognition-Biometric authentication with facial recognition.

**Unit 5**

**Fraud Prevention with AI Solutions:** **Teaching Hours: 6**

How to leverage machine learning (ML) algorithms for fraud Detection-How bagging and boosting techniques can improve an algorithm's Effectiveness-How to analyze data with Jupyter Notebook-How to resort to statistical metrics for results evaluation.

**Text Books and Reference Books**

[1] Security in the Digital Age: Social Media Security threats and Vulnerabilities by Henry A. Oliver, Create Space Independent Publishing Platform.

[2] Information Security Governance, Guidance for Information Security Managers by W. KragBrothy, 1st Edition, Wiley Publication.

[3] Auditing IT Infrastructures for Compliance By Martin Weiss, Michael G. Solomon, 2nd Edition, Jones Bartlett Learning.

**Essential Reading / Recommended Reading**

[1] Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Sumit Belapure and Nina Godbole, Wiley India Pvt. Ltd.

[2] Data Privacy Principles and Practice by Natraj Venkataramanan and Ashwin Shriram, CRC Press.

**Web Resource:**

1. https://www.nist.gov/cyberframework

# MAI341C– AI in Cognitive Sciences

**Total Teaching Hours For Semester: 30** **No of Lecture Hours/Week:3**
**Max Marks:50** **Credits:2**

**Course Objectives**

It is designed to be a challenging course, involving significant independent work, readings, assignments, and projects. It covers structured knowledge representations, as well as knowledge-based methods of problem solving, planning, decision-making, and learning in cognitive system with help of AI models.

**Course Outcomes**

CO1: To understand the basics and fundamental concepts, methods, and prominent issues in knowledge-based artificial intelligence
CO2: To understand the specific skills and abilities needed to apply those concepts to the design of knowledge-based AI agents
CO3: To find the relationship between knowledge-based artificial intelligence and the study of human cognition.

**Unit-1** **Teaching Hours: 6**

**Introduction and Fundaments**

Introduction to Knowledge-Based AI – Where KB AI fits into AI as a whole - Cognitive systems: what are they? - AI and cognition: how are they connected?

Fundamentals- Semantic Networks - Generate & Test - Means-Ends Analysis - Problem Reduction - Production Systems

**Unit-2** **Teaching Hours: 6**

**Common Sense Reasoning and Planning**

Frames - Understanding - Common Sense Reasoning - Scripts - Logic - Planning

**Unit-3** **Teaching Hours: 6**

**Learning and Analogical Reasoning**

Learning by Recording Cases - Incremental Concept Learning - Classification - Version Spaces & Discrimination Trees- Case-Based Reasoning - Explanation-Based Learning - Analogical Reasoning

**Unit-4** **Teaching Hours: 6**

**Visuospatial Reasoning and Design & Creativity**

Constraint Propagation - Visuospatial Reasoning- Configuration - Diagnosis - Design - Creativity

**Unit-5** **Teaching Hours: 6**

**Metacognition**

Learning by Correcting Mistakes - Meta-Reasoning - AI Ethics

**Text Books and Reference Books**

*Artificial Intelligence: A Modern Approach*. Stuart J., and Peter Norvig. 2nd ed. Upper Saddle River, N.J.: Prentice Hall/Pearson Education, 2003. ISBN: 0137903952

**Essential Reading / Recommended Reading**

[3] Cognitive Computing Recipes: Artificial Intelligence Solutions Using Microsoft cognitive Services and TensorFlow, Adnan Masood and Adnan Hasami, Paper back, Import,March-2019

# MAI342A-BIG DATA ANALYTICS

**Total Teaching Hours For Semester: 30** **No of Lecture Hours/Week:3**
**Max Marks:50** **Credits:2**

**Course Description and Course Objectives**

The student can understand the Big Data Platform and its Use cases and get an overview of Apache Hadoop. The course will provide HDFS Concepts and Interfacing with HDFS and the student can understand Map Reduce Jobs. It provides knowledge in NOSQL Data Base, Apache Hadoop architecture, ecosystem, and explores related applications including HDFS, Spark, and MapReduce with Hive and Pig.

**Course Outcomes**
CO1: To explore the fundamental concepts of big data analytics.
CO2: Provide an overview of Apache Hadoop with NOSQL and REDIS Data Store
CO3: Understand Map Reduce Jobs/spark framework for processing Big Data for Analytics.

**Unit-1** **Teaching Hours:6**

**INTRODUCTION TO BIG DATA ANALYTICS**

Big Data Overview: Data Structures - Analyst Perspective on Data Repositories - State of the Practice in Analytics - Current Analytical Architecture - Drivers of Big Data - Emerging Big Data Ecosystem and a New Approach to Analytics - Key Roles for the New Big Data Ecosystem - Examples of Big Data Analytics.

**Unit-2** **Teaching Hours:8**

**NOSQL BIG DATA MANAGEMENT**

NoSQL Definition and introduction - Document databases – MongoDB - Storing data and accessing data from MongoDB - Querying MongoDB - Document store internals - MongoDB reliability and durability - Horizontal scaling - CRUD operations in MongoDB - Creating and using indexes in MongoDB.

Understanding Key/Value Stores in Memcached and Redis-Eventually Working with Column-Oriented Databases-HBase Distributed Storage Architecture.

**Unit- 3** **Teaching hours:5**

**UNDERSTANDING MAPREDUCE**

Introduction to Hadoop and MapReduce Programming Hadoop Overview, HDFS (Hadoop Distributed File System), Processing– Data with Hadoop, Managing Resources and Applications with Hadoop YARN (Yet Another Resource Negotiator). Introduction to MAPREDUCE Programming: Introduction, Mapper, Reducer, Combiner, Partitioner, Searching, Sorting, Compression

**Unit-4** **Teaching Hours:5**

**HIVE**

Introduction to Hive - Hive Architecture - Characteristics - Comparison with RDBMS (Traditional Database) – HIVE modes – HIVE Server2(HS2) - Hive Data Types and File

Formats - Hive Data Model - Hive Integration and Workflow Steps -Hive Built-in Functions - HiveQL - HiveQL. Data Definition Language (DDL) - HiveQL. Data Manipulation Language (DML) - HiveQL for Querying the Data - Aggregation - Join - Group by Clause.

**Unit -5** **Teaching Hours:6**

**SPARK**

Introduction - Spark and Big Data Analytics Spark - Introduction to Big Data Tool-Spark - Introduction to Data Analysis with Spark - Spark SQL - Using Python Advanced Features with Spark.

**Essential Reading**

[1] Raj Kamal, Preeti Saxena, Big Data Analytics, Introduction to Hadoop, Spark, and Machine-Learning, McGraw-Hill India, 2019.
[2] Boris lublinsky, Kevin t. Smith, Alexey Yakubovich, Professional Hadoop Solutions, Wiley, 2015.
[3] Gaurav Vaish, Getting Started with NoSQL, Packt Publishing,2013.
[4] High performance spark by Holden Karau and Rachel Warren published by O'Reilly Media 2017.

**Recommended Reading**

[1] Pethuru Raj, Anupama Raman, Dhivya Nagaraj and Siddhartha Duggirala, High-Performance Big-Data Analytics: Computing Systems and Approaches, Springer, 2015.
[2] Jonathan R. Owens, Jon Lentz and Brian Femiano, Hadoop Real-World Solutions Cookbook, Packt Publishing, 2013.
[3] Garry Turkington, Hadoop Beginner's Guide, Packt Publishing, 2013.
[4] John Sharp, Data Access for Highly-Scalable Solutions: Using SQL, NoSQL, and Polyglot Persistence,Microsoft,2013

## MAI342B – AUGMENTED REALITY AND VIRTUAL REALITY (AR/VR)

**Total Teaching Hours For Semester: 30** **No of Lecture Hours/Week:3**
**Max Marks:50** **Credits:2**

**Course Objectives**

This course will introduce students to the concepts and applications of Augmented Reality and Virtual Reality technologies. Students will learn the fundamentals of AR/VR, the differences between the two, and how to create AR/VR applications. The course will cover a variety of topics such as AR/VR hardware, software, 3D modeling, user interfaces, and interaction design.

**Course Outcomes**

CO1: Understand the fundamentals of AR/VR
CO2: D Understand the process to create AR/VR Applications
CO3; Develop user interfaces for AR/VR

**Unit-1** **Teaching Hours: 6**

**Introduction to AR/VR**

Overview of AR/VR, Brief history of AR/VR, Differences between AR and VR, Advantages and Disadvantages of AR/VR, Applications of AR/VR

**AR/VR Hardware and Software**

AR/VR devices, software and sensors, VR headsets and controllers, AR/VR software platforms, AR/VR development tools.

**Unit-2** **Teaching Hours: 6**

**AR/VR Design Principles**

Interaction design principles for AR/VR, User interface design for AR/VR, Human factors in AR/VR design

**AR/VR Content Creation**

Introduction to 3D modeling, Creating 3D assets for AR/VR, creating models for AR/VR, adding interactivity to AR/VR experiences, Texturing and lighting for AR/VR. Using Unity3D or Unreal Engine for AR/VR development.

**Unit-3** **Teaching Hours: 6**

**AR/VR Development**

Designing intuitive interfaces for AR/VR, User interface considerations for different AR/Vr devices, Developing AR/VR applications, AR/VR programming languages, AR/VR frameworks and libraries, Best practices for AR/VR UI.

**AR/VR Deployment**

Testing and debugging AR/VR applications, Deploying AR/VR applications to devices, AR/VR best practices

**Unit-4** **Teaching Hours: 6**

**AR/VR Project Development**

AR/VR emerging technologies, potential future applications, challenges and opportunities.

## Unit-5 **Teaching Hours: 6**

Students will work on their AR/VR projects - AR/VR Project Presentation - Students will present their AR/VR projects to the class - Industry Visit/ Experiential Learning

# MAI342C – FORENSIC SCIENCES

**Total Teaching Hours For Semester: 30** **No of Lecture Hours/Week:3**
**Max Marks:50** **Credits:2**

**Course Objectives**

To provide extensive knowledge about computer forensic and recognize diverse aspects of forensics science. It is also used to acquire the knowledge to examine and analyze evidence from image, video, email, data, document, mobile and network.

**Course Outcomes**

CO1: Develop fundamental knowledge and skills required to understand contemporary computer forensics.
CO2: Design and develop solutions for complex forensic problems

**Unit-1** **Teaching Hours: 6**

**Contemporary Computer Crime:**
Web-Based Criminal Activity: Interference with Lawful Use of Computer. Malware: Viruses and Worms-DoS and DDoS Attacks- Botnets and Zombie Armies- Spam- Ransomware and the Kidnapping of Information. Theft of Information, Data Manipulation, and Web Encroachment: Traditional Methods of Proprietary Information Theft-Trade Secrets and Copyrights- Political Espionage. Terrorism: Cyberterrorism- Threatening and Harassing Communications-Cyberstalking and Cyber harassment- Cyberbullying.

**Unit-2** **Teaching Hours: 6**

**Image and video forensics:**

Image Forensics: Importance of image forensic detection, Active Methods: Digital watermarking, digital signatures. Passive methods: Image source identification, image tamper detection.

Video Forensics: Active approaches, Blind approaches: copy-move, splicing, Frame insertion, frame deletion, frame duplication, frame replacing, frame shuffling

**Unit-3** **Teaching Hours: 6**

**E-Mail and Web Forensics**

Opening Pandora's Box of E-Mail-Following the route of e-mail packets- Becoming Exhibit A- Scoping Out E-Mail Architecture: E-mail structures- E-mail addressing- E-mail lingo-E-mail in motion- Seeing the E-Mail Forensics Perspective: Dissecting the message-

Expanding headers- Checking for e-mail extras- Extracting e-mail from clients- Getting to know e-mail file extensions- Copying the e-mail- Printing the e-mail- Investigating Web-Based Mail- Searching Browser Files- Looking through Instant Messages

**Unit-4** **Teaching Hours: 6**
**Data and Document Forensics**

Delving into Data Storage- Finding Digital Cavities Where Data Hides- Extracting Data- Rebuilding Extracted Data- Document Forensics: Finding Evidential Material in Documents: Metadata- Honing In on CAM (Create, Access, Modify) Facts- Discovering Documents.

**Unit-5** **Teaching Hours: 6**
**Mobile & Network Forensics**

Mobile Forensics: Keeping Up with Data on the Move- Making a Device Seizure- Cutting-Edge Cellular Extractions- Network Forensics: Mobilizing Network Forensic Power- Identifying Network Components- Saving Network Data.

Wiretap Act-Communications Assistance for Law Enforcement Act-Foreign Intelligence Surveillance Act-Comprehensive Crime Control Act-Electronic Communications Privacy Act and the Privacy Protection Act.

**Text Books and Reference Books**

Computer Forensics and Cyber Crime an Introduction, Marjie T. Britz, Pearson education, 3rd Edition, 2013.

Handbook of Digital Forensics of Multimedia Data and Devices, Anthony T. S. Ho, Shujun Li, Wiley-IEEE Press, 1st edition, 2016.

Linda Volonino and Reynaldo Anzaldu, Computer Forensics for Dummies, Wiley Publishing, 2nd Edition 2018

**Essential Reading / Recommended Reading**

[4] Photo Forensics, Hany Farid, The MIT Press, 1st Edition, 2019.

[5] Fake Photos, Hany Farid, The MIT Press, 1st Edition, 2019.

[6] The Practice of Crime Scene Investigation, John Horswell, CRC Press, 2016.

**Trimester IV**

| Course Code | Course Title | No. of Hrs | Marks | Credits |
|---|---|---|---|---|
| MAI431 | IoT for AI | 3 | 50 | 2 |
| MAI432 | Multi Agent Systems | 3 | 50 | 2 |
| MAI451 | Cloud Computing | 2+2 | 100 | 2 |
| MAI471 | Soft Computing | 3+4 | 150 | 5 |
| MAI481 | Specialization Project (AI/ML Project) | 6 | 100 | 3 |
| **Elective – III (Choose any one)** | | | | |
| MAI341A | Robotic Process Automation (UiPath) | 3+4 | 150 | 5 |
| MAI341B | One API (Intel) | | | |
| MAI341C | Machine Learning Cloud Services (AWS) | | | |
| **Total** | | **30** | **600** | **19** |

**Trimester V**

| Course Code | Course Title | No. of Hrs | Marks | Credits |
|---|---|---|---|---|
| MAI531 | Modern Optimization Technique | 3 | 50 | 2 |
| MAI532 | Human Computer Interaction | 4 | 100 | 3 |
| MAI571 | Designing Machine Learning Systems (MLOps) | 2+4 | 100 | 4 |
| **Elective – IV (Choose any one)** | | | | |
| MAI572A | Automated Reasoning | 3+4 | 150 | 5 |
| MAI572B | Speech Processing and Recognition | | | |
| MAI572C | Machine Learning for Data Privacy | | | |
| **Elective – V (Choose any one)** | | | | |
| MAI573A | Graph Neural Network | 3+4 | 150 | 5 |
| MAI573B | Quantum Machine Learning | | | |
| MAI573C | Distributed Machine Learning | | | |
| MAI581 | Dissertation | 3 | 50 | 1 |
| **Total** | | **30** | **600** | **20** |

**Trimester VI**

| Course Code | Course Title | No. of Hrs | Marks | Credits |
|---|---|---|---|---|
| MAI681 | Industry Project | | 300 | 12 |
| **Total** | | | **300** | **20** |