MIT School of Computing

Syllabus

First Year M. Sc. AIML , Semester-1

Course Code	Course Title				Category
21MSAI101	Data Structures and Algorithms Analysis				Regular
Contact Hours per Week			CA	FE	Credits
L	T	P			
3	1	0	40	60	4

Prerequisite:
Basics of Data Structures, Algorithms and Programming skills

Course Objectives:

1. To analyse classic problems in various domains and techniques for designing efficient algorithms.
2. To study and apply important algorithmic design paradigms and methods of analysis.
3. To understand the different classes of problems with reference to their computation difficulties.

Syllabus Contents

Unit 1: Basics of Algorithms **(09 Hours)**

Algorithms and structured programming, analysing algorithms, asymptotic behaviour of an algorithm, Order notations, time and space complexities (polynomial, logarithmic and exponential), average and worst-case analysis, lower and upper bounds.

Unit 2: Algorithm design strategies **(09 Hours)**

Algorithm design strategies Divide and conquer (Merge sort, Quicksort, matrix multiplication). Greedy method**:** General method, knapsack problem, job sequencing with deadlines, minimum cost spanning trees).

Unit 3: Dynamic programming **(09 Hours)**

Algorithm design strategy Dynamic programming (0/1 knapsack, travelling salesman problem), Amortized Analysis.

Unit 4: Backtracking **(09 Hours)**

Algorithm design strategy Backtracking (8 - Queens problem, Sum of Subsets, Graph colouring, 0/1 Knapsack). Branch & Bound (0/1 knapsack, Travelling salesman).

Unit 5: Approximation algorithms **(09 Hours)**

Approximation algorithms: Polynomial Time Approximation Schemes. Complexity: - NP-Hard and NP-complete Problems - Cook's theorem, NP completeness reductions.

Course Outcomes:

After learning this course, students should be able:

- Ability to program data structures and use them in implementations of abstract data types.
- Ability to devise novel solutions to small scale programming challenges involving data structures and recursion.
- Ability to estimate the algorithmic complexity of simple, non-recursive programs
- Ability to perform simple inductive proofs and proofs by contradiction and reason about program correctness and invariants.

Text Books:

1. E. Horowitz, S. Sahni, Fundamentals of Computer Algorithms, Galgotia Publications, 1985.
2. Aho, J.E. Hopcroft, & J.D. Ullman, Design & Analysis of Computer Algorithms, Addition Wesley, 1974.
3. P.Berlions & P. Bizard, Algorithms - The Construction, Proof & Analysis of Programs, John Wiley & Sons, 1986.
4. K. Melhorn, Data Strucures and Algorithms, Vol. I & II, Springer Verlag, 1984.

Course Code	Course Title				Category
21MSAI10	Mathematical Foundations for Data Science				Regular
Contact hours per week			CA	FE	Credits
L	T	P			
3	1	0	40	60	4

Prerequisite: Basics of Mathematics and Basics of Data Science

Course Objectives:

1. To understand role of discrete mathematics in data science.
2. To learn probability and apply it for real life problems in Data Science.
3. To understand basis of descriptive statistics measures and hypothesis.
4. To learn linear algebra and calculus concepts and applicability in Data Science.
5. To learn different linear regression methods used in machine learning.

Course Outcomes: -

After learning this course, students shall be able to:

1. Apply measures of central tendency to analyse a payroll dataset.
2. Apply probabilistic model for credit card fraud detection.
3. Evaluate covariance and correlation of between two variables.
4. Demonstrate use eigenvalues and eigenvectors for a reducing dimension of a healthcare dataset.
5. Apply simple regression model to predict the near future sales based on a time series data.

Syllabus Contents

Unit 01: Discrete mathematics for Data Science (09 Hours)

Concept of Set, Cardinality of Set, finite, infinite and uncountable infinite sets, Basic set operations, Principle of inclusion Exclusion, Graph: Basic terminologies, representation of graph, path and circuit, graph traversal, travelling salesperson problem, Trees: Basic terminologies, search tree: Binary & M-ary tree.

Unit 02: Data Analysis & Probability Theory (09 Hours)

Data Representation, Average, Spread, Experiments, Outcomes, Events, Probability, Permutations and Combinations, Random Variables, Probability Distributions, Mean and Variance of a Distribution, Binomial, Poisson, and Hyper Geometric Distributions, Normal Distribution, Distributions of Several Random Variables.

Unit 03: Statistical Inference I (09 Hours)

Types of Statistical Inference, Descriptive Statistics, Inferential Statistics, Importance of Statistical Inference in Machine Learning, Descriptive Statistics, Measures of Central Tendency: Mean, Median, Mode, Mid-range, Measures of Dispersion: Range, Variance, Mean Deviation, Standard Deviation. Coefficient of variation: Moments, Skewness, Kurtosis, one sample

hypothesis testing, hypothesis, Testing of Hypothesis, Binomial distribution and normal distribution, Chi-Square Tests, t-test, ANOVA. Pearson Correlation.

Unit 04: Statistical Inference II **(09 Hours)**

Measure of Relationship: Covariance, Karl Pearson's Coefficient of Correlation, Measures of Position: Percentile, Z-score, Quartiles, Bayes' Theorem, Bayes Classifier, Bayesian network, Probabilistic models with hidden variables

Unit 05: Linear Algebra and Calculus **(09 Hours)**

Linear Algebra: Matrix and vector algebra, systems of linear equations using matrices, linear independence, Matrix factorization concept/LU decomposition, Eigen values and eigenvectors, Understanding of calculus: concept of function and derivative, Multivariate calculus: concept, Partial Derivatives, chain rule, the Jacobian and the Hessian

Course Outcomes:

After learning this course, students should be able:

- Summarize the concepts of linear algebra and its examples / applications
- Discuss and extend usage of concepts of linear transformation and matrices
- Express the importance of concepts of multivariate calculus in data science and ML field in real-time applications and data handling
- Summarize the importance of vectors and vector spaces related topics

Text Books:

1. Bruce, Peter, Andrew Bruce, and Peter Gedeck: Practical Statistics for Data Scientists: 50+ Essential Concepts Using R and Python, O'Reilly Media, 2020.
2. Liu, Chung Laung: Elements of Discrete Mathematics, Tata McGraw-Hill Education, 1987.
3. Heumann, Christian, Schomaker, Michael, Shalabh: Introduction to Statistics and Data Analysis with Exercises, Solutions and Applications in R, Publisher" Springer 2016.

Reference Books:

1. Douglas C. Montgomery, George C. Runger: Applied Statistics and Probability for Engineers, 2018, Wiley.
2. Robert V. Hogg. Allen T. Craig: Introduction to Mathematics, Statistics, Pearson Education.
3. Richard A. Johnson, Irwin Miller, John Freund: Probability and Statistics for Engineers.
4. Irwin Miller, Marylees Miller: Mathematical Statistics with Applications, Pearson Education.
5. Pierre Lafaye de Micheaux, Rémy Drouilhet, Benoit Liquet: The R Software-Fundamentals of Programming and Statistical Analysis, Springer 2013.

MOOC Courses:

● Essentials of Data Science with R Software - Probability and Statistical Inference by Prof. Shalabh, IIT Kanpur.

Course Code	Course Title				Category
21MSAI103	Foundations of Artificial Intelligence				Regular
Contact Hours per week			CA	FE	Credits
L	T	D/P			
3	0	2	40	60	5

Course Prerequisites: Probability, Statistics, Automata and Languages

Course Objectives:

- To learn and understand basic artificial intelligence concept
- To explore different problem solving and searching techniques
- To learn and understand the basics of machine learning.

Syllabus Contents

Unit 1: Introduction to Artificial Intelligence (09 Hours)

Introduction to Artificial Intelligence, History, AI models, Learning aspects, Intelligent Agents, Rational Agent, PEAS Representation, Environment types.

Unit 2: Problem Solving and Search (09 Hours)

Problem space and search, Uninformed search methods – Breadth First Search, Uniform Cost Search, Depth First Search, Depth Limited Search. Heuristic search methods - Best first, A*, AO*

Unit 3: Knowledge and Reasoning (09 Hours)

Knowledge Representation, Propositional Logic, Predicate Logic, Fuzzy logic, Representing Knowledge using rules, Frame systems, Semantic networks, Uncertainty and methods, Bayesian Probability, Probabilistic reasoning

Unit 4: Constraint Satisfaction Problems and Planning (09 Hours)

CSP as Search Problem, Backtracking Search for CSP, forward checking, Constraint Propagation. Planning components, Blocks world, Goal Stack Planning

Unit 5: Machine Learning and Applications (09 Hours)

Perceptron, Perceptron Learning, Introduction to Machine Learning, Supervised and unsupervised methods, Basics of Pattern Recognition, classification, regression, Decision trees, basics of natural language processing, application areas of AI.

Course Outcomes:

After learning this course, students should be able:

- Able to apply knowledge of artificial intelligent to solve real world problems
- Able demonstrate the knowledge of problem solving and reasoning
- Able to apply machine learning approaches to develop intelligent applications

Text Books:

1. Stuart Russell and Peter Norvig (1995), “Artificial Intelligence: A Modern Approach”, Third edition, Pearson, 2003.
2. Elaine Rich and Kevin Knight “Artificial Intelligence”, Tata McGraw Hill, 1991

Reference Books:

1. Patrick Henry Winston, “Artificial Intelligence”, Addison-Wesley, 1992
2. Jiaweihan, MichelineKamber, "Data Mining: Concepts and systems", Morgan Kaufmann Publishers
3. Machine Learning,TomMitchell,McGraw Hill, 1997,ISBN: 978-0-070-42807-2

Course Code	Course Title				Category
21MSAI104	Supervised Learning				Regular
Contact Hours per Week			CA	FE	Credits
L	T	P			
3	0	2	40	60	4

Prerequisite: Artificial Intelligence, Data Science

Course Objectives:

1. To introduce students to the basic concepts and techniques of supervised Learning.
2. To learn the various types of regression methods
3. To become familiar with inductive classification and Instance based learning
4. To develop an ability to provide solution to real world problems
5. To develop python code for different regression and classification method

Syllabus Contents

Unit 1: Introduction to machine learning (09 Hours)

A brief Introduction to machine learning, Goals and applications of machine learning. Aspects of developing a learning system: training data, concept representation, function approximation. Difference between AI-Machine Learning-Deep Learning. Types of machine learning techniques: Supervised, unsupervised, semi-supervised and reinforcement learning. Introduction to Regression and classification.

Unit 2: Regression (09 Hours)

Definition of regression, Types of regression (univariant, multivariant, ridge, lasso, and polynomial regression), logistic regression. Operation on dataset: Training, Testing, Validations. Deal with the outliers. Implementation in python.

Unit 3: Classification (09 Hours)

Bayesian Learning, Naive Bayes classifier: introduction to probabilistic model. logistic regression, Decision Tree Learning, Representing concepts as decision trees. Recursive induction of decision trees. Picking the best splitting attribute: entropy and information gain. Searching for simple trees and computational complexity. Overfitting, noisy data, and pruning.

Unit 4: Instance-Based Learning (09 Hours)

Constructing explicit generalizations versus comparing to past specific examples. k-Nearest-neighbour algorithm. Case-based learning. Support Vector Machines (SVM): Kernels for learning non-linear function, implementation.

Unit 5: Artificial Neural Networks (09 Hours)

Neurons and biological motivation. Linear threshold units. Perceptron: representational limitation and gradient descent training. Multilayer networks and backpropagation. Hidden layers and constructing intermediate, distributed representations. Overfitting, learning network structure, recurrent networks.

Course Outcomes:

After learning this course, students should be able:

- Distinguish training, testing and validation set
- Experiment different types of regression algorithm
- Experiment different types of classification algorithm

- Test the model built with regression algorithms
- Test the model built with regression algorithms

Text Books:

1. Ethem Alpaydin, ―Introduction to Machine Learning 3e (Adaptive Computation and Machine Learning Series), Third Edition, MIT Press, 2014
2. Stephen Marsland, ―Machine Learning – An Algorithmic Perspective‖, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014

Reference Books:

1. Peter Flach, ―Machine Learning: The Art and Science of Algorithms that Make Sense of Data‖, First Edition, Cambridge University Press, 2012.
2. Jason Bell, ―Machine learning – Hands on for Developers and Technical Professionals‖, First Edition, Wiley, 2014
3. Tom M Mitchell, ―Machine Learning‖, First Edition, McGraw Hill Education, 2013.

Course Code	Course Title				Category
21MSAI111	Python Programming Laboratory				Regular
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**T**	**P**			
0	**0**	**2**	**40**	**60**	**1**

Prerequisite:
Basic Knowledge of Computer Programming, Understanding of Object Oriented Concepts.

Course Objectives:

1. To acquire programming skills in core Python
2. To acquire Object Oriented Skills in Python
3. To develop the skill of designing Graphical user Interfaces in Python
4. To develop the ability to write database applications in Python
5. To create the ability to model, solve and interpret physical and engineering problems

Assignments:

1. To Write a Python program to compute the GCD of two numbers
2. To Write a Python program to find the exponentiation
3. To write a Python program to evaluate the Fibonacci series for n terms
4. Write a Python program to get the factorial of a non-negative integer
5. Write a Python program for Simple Calculator
6. To write a Python program to perform Swapping of two numbers
7. Write a Python program to print all substrings of a given string
8. Programs That Take Command Line Arguments (Word Count)
9. Find The Most Frequent Words In A Text Read Date: From A File
10. To simulate Python MYSQL
11. To write a Python program to simulate bouncing ball using pygame

Course Outcomes:
After learning this course, students should be able:

- Learn the fundamental concepts in Python and its application in real-time computing scenario.
- Implement the fundamental Scientific computing, Data Visualization and Algorithmic Libraries in Python.
- Implement and demonstrate Deep Learning Packages like Tensorflow, Keras , pytorch.
- Demonstrate a python project in any of the industry application using Machine Learning algorithms.

Text Books:

1. Learning Python: Mark Lutz, O'Really Publication
2. Beginning Python: From Novice to Professional, Magnus Lie Hetland, PaperBack
3. Python in a Nutshell, Alex Martello, O'Really Publication

Reference Books:

1. Michael Urban and Joel Murach, Python Programming, Shroff/Murach, 2016
2. Michel Dawson, "Python Programming for Absolute Beginners" , Third Edition, Course Technology Cengage Learning Publications, 2013, ISBN 978-1435455009

Course Code	Course Title				Category
21MSAI112	Data Structures and Algorithms Analysis Laboratory				Regular
Contact Hours per Week			CA	FE	Credits
L	T	P			
0	0	2	40	60	1

Prerequisite:
Programming skills in any of the Object-Oriented Programming Language like C++ / Python/ Java

Course Objectives:
Analysis and implementation of classic problems in various domains and techniques for designing efficient algorithms.
Study and implement important algorithmic design paradigms.
Understand and implement the different classes of problems with reference to their computation difficulties.

List of Assignments:

1. Write program to perform different operations on Matrices like (Addition, Subtraction, Multiplication Transpose of Matrix, etc…)
2. Write program to find maximum and Minimum number from the given set of numbers using Divide and Conquer techniques.
3. Write program to perform Strassen's Matrix multiplication using Divide and Conquer techniques.
4. Write program to sort given data set using Merge sort or Quicksort to demonstrate Divide and Conquer techniques.
5. Write program to find shortest path in the given graph using Dijkstra algorithm to demonstrate Greedy method techniques.
6. Write program to find Minimum Cost Spanning Tree for the given graph using Prims or Kruskal algorithm to demonstrate Greedy method techniques.
7. Write program for 0/1 Knapsack problem to determine maximum profit using Dynamic Programming method techniques
8. Write program for Travelling Salesman problem to demonstrate Dynamic Programming method techniques
9. Write program for 8 - Queens problem to demonstrate Backtracking method techniques
10. Write program for Graph coloring problem to demonstrate Backtracking method techniques

Candidates can write their programs in any of the Object-Oriented Programming Language Like (C++/ Python/ Java etc…).

Course Outcomes:
After learning this course, students should be able:

- Be able to design and analyze the time and space efficiency of the data structure ·
- Be capable to identity the appropriate data structure for given problem ·
- Have practical knowledge on the applications of data structures

Text Books:

1. E. Horowitz, S. Sahni, Fundamentals of Computer Algorithms, Galgotia Publications, 1985.
2. Aho, J.E. Hopcroft, & J.D. Ullman, Design & Analysis of Computer Algorithms, Addition Wesley, 1974.

3. P.Berlions & P. Bizard, Algorithms - The Construction, Proof & Analysis of Programs, John Wiley & Sons, 1986.
4. K. Melhorn, Data Strucures and Algorithms, Vol. I & II, Springer Verlag, 1984.

Course Code	Course Title				Category
21MSAI121	**Mini Project - 1**				**Project**
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**T**	**P**			
0	**0**	**2**	**40**	**60**	**1**

Prerequisite:
Software Engineering and Software Project Management, Programming skills

Course Objectives:

- To apply the knowledge for solving realistic problem
- To develop problem solving ability
- To evaluate alternative approaches, and justify the use of selected tools and methods,
- To consider relevant social, ethical and legal issues,
- To work in TEAM and learn professionalism.
- To follow SDLC meticulously and meet the objectives of proposed work
- To test and validate rigorously before deployment of system
- To consolidate the work as furnished report.

Syllabus Contents

Phase I (First half of semester)

This is an integral part of the Project work. In this, the student shall complete the partial work of the Project which will consist of problem statement, literature review, SRS, Model and Design. The student is expected to complete the project at least up to the design phase.

Phase II (Second half of semester) – the student shall complete the remaining project work which consists of Selection of Technology and Tools, Installations, UML implementations, testing, Results, performance discussions using data tables per parameter considered for the improvement with existing/known algorithms/systems and comparative analysis and validation of results and conclusions.

The student shall prepare and submit the report of Project work in standard format for satisfactory completion of the work that is the duly certified by the concerned guide and head of the Department/Institute.

Assessment:

The examinee will be assessed by a panel of examiners of which one is necessarily an external examiner. The assessment will be broadly based on work undergone, content delivery, presentation skills, documentation, question-answers and report.

Reference Books:

1. Project Management, A Systems Approach to Planning, Scheduling, and Controlling Eighth Edition, Harold Kerzner. John Wiley & Sons, Inc. https://books.mec.biz/tmp/books/55F1OL4WQC7HL2OBCGHS.pdf
2. Smarter Study Guides How to write Dissertations & Project Reports Kathleen McMillan and Jonathan Weyers, Pearson Education Limited. http://dlderakhtejavidan.ir/dl/Books/General/How%20to%20Write%20Dissertations%20&%20Project%20Reports.pdf

Course Code	Course Title				Category
20MTIA231	DESIGN THINKING FOR STRATEGIC INNOVATION				AEC
Contact Hours per Week			CA	FE	Credits
L	T	D/P			
2	0	2	40	60	3

Course Objectives:

1. To enable the students to learn the various aspects of innovation and methods of fostering Innovation
2. To recognize the qualities of entrepreneurs that contributed to their success
3. To develop understanding about entrepreneurship
4. To orient students for their own venture setup To boost start-ups

Syllabus Contents

Unit 1: Promoting Innovation (09 Hours)

Identifying Opportunities Based on Trend, Factors Driving Competitive Advantages, Divergent v/s Convergent Thinking, Idea Management System, Innovation and Creativity-An Introduction, Types of Innovation, Design Thinking and Entrepreneurship, Steps of Innovation Management, Challenges of Innovation.

Unit 2: Managing Innovation (09 Hours)

Technological Innovation and Entrepreneurship, Innovation, market and IP, Open innovation and IP, Trademark, Patent & copyright, IP strategy for start-up and MSME, Technological Innovation Management Planning, Technology Forecasting, Sustainability Innovation and Entrepreneurship, Forms of Legal Entities.

Unit 3: Strategies for Commercializing Innovation (09 Hours)

Commercialisation and Disruption as Success Drivers, Lean Start-up, Marketing for Start-ups, Business Model Failure: Reasons and Remedies, , Features of Winning Business Models, Managing Investors for Innovation, Funding New Venture, Human Resource Management-planning, job analysis, training, recruitment and selection, Growth Strategies.

Unit 4: Entrepreneurship (09 Hours)

Economic Contributions of Entrepreneurs, Entrepreneurship, Motivation and Types of Entrepreneurship, Vision, Mission and Values, Entrepreneurial Qualities, Entrepreneurship Inspiring Stories, Analysing the Current Business Scenario, Myths and Realities around Entrepreneurship, Causes of Failure of Start-ups.

Unit 5: Institutional Support Towards the Development of Entrepreneurship (09 Hours)

Technical consultancy organizations, Government policies for small scale enterprises, Incubators, research parks, Institutional Support and Policies, India as A Start-up Nation, Start-up Case Studies.

Course Outcomes:

After learning this course, students should be able:

1. Spot opportunities for innovation
2. Segment and analyse opportunities
3. Acquire entrepreneurial skills
4. Evaluate and select models for new ventures
5. Understand the innovation, start up and entrepreneurial framework

6. Design, evaluate, and implement business strategies
Text Books: 1. Robin Lowe and Sue Marriott, Enterprise: Entrepreneurship and Innovation Concepts, Contexts and Commercialization 2. John Bessant and Joe Tidd, Innovation and Entrepreneurship **References:** 1. Rabindra N. Kanungo "Entrepreneurship and innovation", Sage Publications, New Delhi, 1998 2. Peter F. Drucker, Innovation and Entrepreneurship

MIT School of Computing

Syllabus

First Year M. Sc. AIML , Semester-2

Course Code	Course Title				Category
21MSAI201	Research Methodology				Regular
Contact Hours Per Week			CA	FE	Credits
L	T	P			
3	1	0	40	60	4

Prerequisite:

- No specific prerequisite

Course Objectives:

- To understand Process of Research and Research Methodology.
- To implement research process for real life example.

Unit 1: Fundamentals of Research **(09 Hours)**

Introduction-Meaning of Research, Objectives & Motivation, Types of Research & Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Research Process, Problems Encountered by Researchers in India; **Defining a Research Problem**:- Research problem, Bringing clarity and focus to your research problem, significance of formulating research problem, Considerations in selecting a research problem, Steps in formulating a research problem.

Unit 2: Research Design & Sampling **(09 Hours)**

Meaning, Need and Types of research design, Features of Good Design, Important concepts of research design, Different research designs, Basic Principles of research designs & important experimental designs. **Design of Sample Surveys**: - Sample design, Sampling & Non-sampling errors, Sample Surveys vs. Census Surveys, Types of Sampling Designs, Probability & Non-probability Sampling

Unit III: Measurement and Scaling Techniques **(09 Hours)**

Measurement in Research, Measurement Scales, Sources of Error in Measurement, Sound Measurement Test, Technique of Developing Measurement Tools, Scaling, Meaning of Scaling, Scale Classification Bases, Important Scaling Techniques, Multidimensional Scale, Scale Construction Techniques,

Unit IV: Data Collection & Analysis: **(09 Hours)**

Collection of Primary Data, Observation Method, Interview Method, Experiments & Surveys, Collection of Secondary Data, selecting appropriate method for Data Collection, Case study method,

Data Preparation process, Descriptive statistics, and Sampling & Statistical Inference; Chi-Square Tests, Anova Technique-one way & two ways, Latin square design, ANOCOVA, Sign Tests, Wilcoxon Signed Rank Sum Test for single population, Mann Whitney U Test, Run Tests, Linear Regression Analysis.

Unit V: Hypothesis Testing and Report Writing: (09 Hours)

Hypothesis, Hypothesis Testing, Test Statistics & Critical Regions, Critical value & Decision Rules, Procedure for Hypothesis Testing, Hypothesis Testing for Testing Mean, Proportion & Variance, Hypothesis Testing for Difference of Two Mean, two proportions & two Variances, P-Value Approach, Power of the Test, Limitations of the Tests of Hypothesis, Report writing: Meaning, Techniques and Precautions in Interpretation, Significance of Report Writing, Different steps in Report Writing, Report Layout, Types of Reports, Oral presentation, Mechanics & Precautions for Writing Research Reports.

Course Outcomes:

After learning this course, students should be able:

- Able to understand Process of Research and Research Methodology.
- Able to implement research process for real life example.

References:

1. Research Methodology: Methods and Techniques by C. R. Kothari, New Age International Publishers, ISBN:81-224- 1522-9.
2. Research Methodology a step-by- step guide for beginners by Ranjit Kumar, SAGE

<table>
<tr><th>Course Code</th><th colspan="3">Course Title</th><th>Category</th></tr>
<tr><td>21MSAI202</td><td colspan="3">Information Retrieval</td><td>Regular</td></tr>
<tr><td colspan="3">Contact Hours Per Week</td><td rowspan="2">CA</td><td rowspan="2">FE</td><td rowspan="2">Credits</td></tr>
<tr><td>L</td><td>T</td><td>D/P</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>40</td><td>60</td><td>4</td></tr>
<tr><td colspan="6">Prerequisite:
Good domain knowledge of recent trends</td></tr>
<tr><td colspan="6">Course Objectives:
Identify, understand and discuss current, real-world issues.
Distinguish and integrate differing forms of knowledge and academic disciplinary approaches
Student should be able to apply communication skills to effectively promote ideas, goals or products.</td></tr>
<tr><td colspan="6">Unit 1: Introduction (09 Hours)
Basic Concepts of IR, Data Retrieval & Information Retrieval, IR system block diagram. Automatic Text Analysis: Luhn's ideas, Conflation Algorithm, Indexing and Index Term Weighing, Probabilistic Indexing, Automatic Classification. Measures of Association, Different Matching Coefficient, Classification Methods, Cluster Hypothesis, Clustering Algorithms, Single Pass Algorithm, Single Link Algorithm, Rocchio's Algorithm
Unit 2: Storage and Searching Techniques (09 Hours)
Storage: Inverted file, Suffix trees & suffix arrays, Signature Files, Scatter storage or hash addressing, clustered files.IR Models: Basic concepts, Boolean Model, Vector Model Searching strategies: Boolean Search, Serial search, cluster based retrieval, Query languages, Types of queries, Patterns matching, structural queries.
Unit 3: Retrieval Performance Evaluation and Ontology (09 Hours)
Performance evaluation: Precision and recall, alternative measures Ontology: Ontology based information sharing, Ontology languages for semantic web, Ontology creation.
Unit 4: Distributed and Multimedia IR (09 Hours)
Distributed IR: Introduction, Collection Partitioning, Source Selection, Query Processing, web issues. MULTIMEDIA IR: Introduction, Data Modelling, Query languages, Generic multimedia indexing approach, One dimensional time series, two dimensional colour images, Automatic feature extraction
Unit 5: Web Searcher and Recommender System (09 Hours)
Searching the Web: Challenges, Characterizing the Web, Search Engines, Browsing, Mata-searchers, Web crawlers, Meta-crawler, Web data mining, finding needle in the Haystack, searching using Hyperlinks, Page ranking algorithms. Collaborative Filtering and Content Based Recommendation of Documents and Products, Information Extraction and Integration: Extracting Data from Text. Semantic Web, Collecting and Integrating Specialized Information on the web.</td></tr>
</table>

Course Outcomes:

After learning this course, students should be able:

- Student should be able to understand the concept of Information retrieval.
- Student should be able to deal with storage and retrieval process of text and multimedia data.
- Student should be able to evaluate performance of any information retrieval system.

Text Books:

1. Yates &Neto, "Modern Information Retrieval", Pearson Education, ISBN 81-297-0274-6.
2. Heiner Stuckenschmidt, Frank van Harmelen, “Information Sharing on the Semantic Web”, Springer International Edition, ISBN 3-540-20594-2.

Reference Books:

1. Christopher D. Manning, Prabhakar Raghavan and Hinrich Schutze “Introduction to Information Retrieval”, Cambridge University Press, ISBN 978-0-521-86571-5.
2. Mark leven, “Introduction to search engines and web navigation”, John Wiley and sonsInc., ISBN 9780-170-52684-2.
3. V. S. Subrahamanian, Satish K. Tripathi “Multimedia information System”, Kulwer Academic Publisher.
4. Chabane Djeraba,”Multimedia mining A highway to intelligent multimedia documents”, Kulwer Academic Publisher, ISBN 1-4020-7247-3.

Course Code	Course Title				Category
21MSAI203	Exploratory Data Analysis				Regular
Contact Hours Per Week			CA	FE	Credits
L	T	P			
3	0	2	40 (25+15)	60	4

Prerequisite:

- No specific prerequisite

Course Objectives:

- Perform EDA as an important activity in Data Analysis
- Perform the analysis of data with different visualization techniques.

Unit I: Introduction **(09 Hours)**

Exploratory Data Analysis Process, Why EDA? , Types of Data, Quantitative and qualitative analysis od data, Handling Categorical variables: One hot encoding, Label encoding, Data Pre-processing : Missing values, Why feature scaling ? Feature Scaling, Types of Scalars.

Unit II: Univariate Analysis **(09 Hours)**

Introduction, Data Description, Unordered categorical variables, ordered categorical variables, quantitative variables univariate analysis, quantitative variables summary metrics, Introduction to data visualization, Basic visualization tools: Histogram, Bar Chart, line plot, plotting with matplotlib and seaborn Categorical Data: Tables, Bar chart, Pie chart, Quantitative data, Histogram, Numerical summaries, Box plot

Unit III: Bivariate Analysis and Multi-variate Analysis **(09 Hours)**

Bivariate analysis on Continuous and categorical variables, Plotting aggregate values across categories, Plotting distributions across categories, Bivariate distributions- Plotting pairwise relationships, Multi-variate data visualization

Unit IV: Data Collection & Analysis **(09 Hours)**

Components of a plot, data visualization toolkit, functionalities of plots, sub plots, Basic visualization tools: Histogram, Bar Chart, plotting with matplotlib and seaborn.

Unit V: Plotting Univariate and Bivariate Data **(09 Hours)**

Plotting Univariate Data:

Categorical Data: Tables, Bar chart, Pie chart, Quantitative data, Histogram, Numerical summaries, Box plot

Plotting Bivariate data: Plotting aggregate values across categories, plotting distributions across categories, Bivariate distributions- Plotting pairwise relationships

Course Outcomes:

After learning this course, students should be able:

- Analyse the essentials and challenges of exploratory data visualization
- Differentiate between the univariate, bi-variate and multivariate analysis of data
- Explore the different the essential exploratory techniques for analyzing and visualizing structured and unstructured data and categorical data
- Apply the concepts of data visualization in case study based problem solving

Text Books:

3. Exploratory Data Analysis by John W. Tukey
4. Making Sense of Data I: A Practical Guide to Exploratory Data Analysis and Data Mining by Glenn J. Myatt, Wiley Publications

Course Code	Course Title				Category
21MSAI204	Unsupervised Learning				Core
Contact Hours Per Week			CA	FE	Credits
L	T	P			
3	0	2	40 (25+15)	60	4

Prerequisite: Artificial Intelligence, Data Science

Course Objectives:

1. To introduce students to the basic concepts and techniques of Unsupervised Learning.
2. To learn the various types of clustering methods
3. To understand how unsupervised learning can be used to improve supervised prediction.
4. To develop an ability to provide solution to real world problems

Syllabus Contents

Unit 1: Introduction to unsupervised learning **(09 Hours)**

A brief Introduction to unsupervised learning, Goals and applications of unsupervised learning, Basic mathematics review: probability, loss function, likelihood, regressions, Supervised Learning & Algorithms, Classification: linear models Kernel method: support vector machines, Types of unsupervised learning.

Unit 2: Clustering techniques **(09 Hours)**

Clustering Techniques: k-means, Hierarchical, Agglomerative Clustering, k-means partitional clustering, Gaussian Mixture Models: Expectation maximization (EM) for soft clustering, Density-Based Clustering. Distribution Model-Based Clustering.

Unit 3: Dimensionality reduction techniques **(09 Hours)**

Feature selection, Feature extraction, Principal Component Analysis (PCA), Probabilistic PCA, Kernel PCA, Independent Component Analysis (ICA), Non-negative matrix factorization (NMF), Linear discriminant analysis (LDA), Generalized discriminant analysis (GDA), Missing Values Ratio, Low Variance Filter.

Unit 4: Association Rule Learning **(09 Hours)**

Association rule learning: introduction to association rule learning, Apriori, Eclat, F-P Growth Algorithm, Applications of Association Rule Learning: Market Basket Analysis, Medical Diagnosis, Protein Sequence.

Unit 5: Deep Networks & Learning **(09 Hours)**

Deep Network & Learning, Neural network, Deep belief networks, deep architecture, Convolutional deep belief networks, Boltzmann Machine, Energy-based model.

Course Outcomes:

Students will be able to:

1. Summarize the details of ML, types of learning, distance measures and its applications
2. Associate the importance of dimensionality reduction techniques in systems based on unsupervised learning
3. Distinguish, interpret and apply association and clustering algorithms in various real time systems
4. Associate the need and application of incremental clustering algorithms

5. Extend clustering theories and algorithms for time series, graph data analysis and also in semi-supervised and deep learning approach.

Text Books:

1. Ethem Alpaydin, ―Introduction to Machine Learning 3e (Adaptive Computation and Machine Learning Series)‖, Third Edition, MIT Press, 2014
2. Stephen Marsland, ―Machine Learning – An Algorithmic Perspective‖, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014

Reference Books:

1. Peter Flach, ―Machine Learning: The Art and Science of Algorithms that Make Sense of Data‖, First Edition, Cambridge University Press, 2012.
2. Jason Bell, ―Machine learning – Hands on for Developers and Technical Professionals‖, First Edition, Wiley, 2014
3. Tom M Mitchell, ―Machine Learning‖, First Edition, McGraw Hill Education, 2013.

Course Code	Course Title				Category
21MSAI205	Fuzzy Computing				Elective
Contact Hours Per Week			CA	FE	Credits
L	T	P			
3	0	0	40	60	3

Prerequisite:

- **Student must have knowledge of Fundamental Mathematics.**
- **Student must know the basics of Neural Networks.**
- **Students should know MATLAB.**

Course Objectives:

- To deal with the uncertainty that is inherent in any pattern recognition task.
- To introduce soft computing techniques which can deal with uncertainty in real world problems.
- To learn problem solving using natural optimization techniques.
- To explore application areas of soft computing technique.

Unit 1: Introduction (8 Hours)

Introduction to Soft Computing, Characteristics of Soft computing, Significance of Soft computing, Applications of Soft computing techniques, Intelligent systems- Machine intelligence, Meaning of intelligence, Dynamics of intelligence, Intelligent machines, Basic concepts of Fuzzy logic, Difference between crisp and fuzzy sets, Operations on Fuzzy sets- Examples.

Unit 2: Fuzzy Logic I (9 Hours)

Fuzzy relations, Properties of Fuzzy Relations, Fuzzy membership functions, Features of Fuzzy membership functions, Membership Value Assignment, Fuzzy proposition, Fuzzy implications, , uncertainty, Fuzzification, Defuzzification, Fuzzy logic controller- Steps in Designing FLC, Applications of Fuzzy logic.

Case Study- fuzzy logic as a tool to analyse relationship between client satisfaction and project importance, fuzzy image processing, intelligence appliances using fuzzy logic.

Unit 3: Fuzzy Logic II and Rough Set Theory (10 Hours)

Fuzzy inferences, Introduction to Fuzzy type-2 Fuzzy clustering method: soft clustering, fuzzy c-means clustering method, Neuro-fuzzy systems, Rough set theory, Indiscernibility Relations, Rough Approximation, Rough set theory for clustering- Rough K-means Clustering Algorithms.

Case study- Fuzzy type-2 for time-series forecasting in fashion, Utilization of Rough K-means clustering for recommender system, library data, travel guide information.

Unit 4: Evolutionary Computing (10 Hours)

Evolutionary Computing, Optimization problem solving - finding best solution, minimum seeing algorithms, natural optimization methods, Genetic algorithm- fitness function, crossover, mutation.

Case study- Genetic algorithm for scheduling problems e.g. bus driver scheduling, Nurse scheduling.

Unit 5: Optimization methods and soft computing for smart machine design (08 Hours)

Other evolutionary computing methods such as: ant colony optimization, swarm optimization- PSO. Soft computing for smart machine design- Intelligent machines, intelligent control, Hierarchical architecture, Development steps. Soft Computing for decision support system, data compression,

bioinformatics, automotive systems and manufacturing.
Case study: PSO for wireless sensor networks.

Course Outcomes:

After learning this course, students should be able:

- Gain knowledge of soft computing domain
- Use soft techniques to solve real world problems
- Gain knowledge of Fuzzy logic, Rough set theory, and evolutionary techniques.
- Explore applicative areas of Soft Computing Techniques.

Text Books:

1. Soft Computing and Intelligent Systems Design, Fakhreddine O. Karray and Clarence De
2. Silva, Pearson, 2004
3. Principles of Soft Computing, S. N. Sivanandam, S. N. Deepa, John Wiley & Sons, 2007

Reference Books:

1. Fuzzy Logic: A Pratical approach, F. Martin, Mc neill, and Ellen Thro, AP Professional, 2000.
2. Fuzzy Logic with Engineering Applications, Third Edition Thomas, Timothy Ross, John Wiley & Sons,2010
3. Neuro- Fuzzy and Soft Computing, J.S. Jang, C.T. Sun, E. Mizutani, PHI Learning Private Limited.
4. A First Course in Fuzzy Logic, Third Edition, Hung T. Nguyen, Elbert A. Walker, Taylor & Francis Group, LLC, 2008 7.
5. Introduction to Fuzzy Logic using MATLAB, S. N. Sivanandam , S.Sumathi, S. N. Deepa, Springer Verlag, 2007.

<table>
<tr><th>Course Code</th><th colspan="4">Course Title</th><th>Category</th></tr>
<tr><td>21MSAI221</td><td colspan="4">Technical Seminar</td><td>Seminar</td></tr>
<tr><td colspan="3">Contact Hours Per Week</td><td rowspan="2">CA</td><td rowspan="2">FE</td><td rowspan="2">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>4</td><td>40</td><td>60</td><td>2</td></tr>
<tr><td colspan="6">Prerequisite:
Good domain knowledge of recent trends</td></tr>
<tr><td colspan="6">Course Objectives:
Identify, understand, and discuss current, real-world issues.
Distinguish and integrate differing forms of knowledge and academic disciplinary approaches
Student should be able to apply communication skills to effectively promote ideas, goals or products.</td></tr>
<tr><td colspan="6">Seminar based on state-of-the art in the selected electives/current trends/innovations/research. The presentation and the report should cover motivation, mathematical modelling, data-table discussion and conclusion. The reports should be prepared using LATEX derivative.
To maintain the quality of the seminar work it is mandatory on the seminar guides to maintain a progressive record of the seminar details which shall include the discussion agenda, outcomes achieved through discussions, corrective actions and comments on the progress report as per the plan submitted by the students including dates and timing, along with the signature of the student as per the class and teacher time table (as additional teaching load); such record of progressive work shall be referred by the examiners during evaluation.</td></tr>
<tr><td colspan="6">Course Outcomes:
After learning this course, students should be able:
Demonstrate expert knowledge
Studying major works
Showcasing Improved oral and written communication skills</td></tr>
</table>

Course Code	Course Title				Category
21MSAI222	Mini Project - 2				Projects
Contact Hours Per Week			CA	FE	Credits
L	T	P			
0	0	2	40	60	1

Prerequisite:
Software Engineering and Software Project Management, Programming skills

Course Objectives:

- To apply the knowledge for solving realistic problem
- To develop problem solving ability
- To evaluate alternative approaches, and justify the use of selected tools and methods,
- To consider relevant social, ethical and legal issues,
- To work in TEAM and learn professionalism.
- To follow SDLC meticulously and meet the objectives of proposed work
- To test and validate rigorously before deployment of system
- To consolidate the work as furnished report.

Syllabus Contents

Phase I (First half of semester)
This is an integral part of the Project work. In this, the student shall complete the partial work of the Project which will consist of problem statement, literature review, SRS, Model and Design. The student is expected to complete the project at least up to the design phase.

Phase II (Second half of semester) – the student shall complete the remaining project work which consists of Selection of Technology and Tools, Installations, UML implementations, testing, Results, performance discussions using data tables per parameter considered for the improvement with existing/known algorithms/systems and comparative analysis and validation of results and conclusions.

The student shall prepare and submit the report of Project work in standard format for satisfactory completion of the work that is the duly certified by the concerned guide and head of the Department/Institute.

Assessment:
The examinee will be assessed by a panel of examiners of which one is necessarily an external examiner. The assessment will be broadly based on work undergone, content delivery, presentation skills, documentation, question-answers and report.

Reference Books:

1. Project Management, A Systems Approach to Planning, Scheduling, and Controlling Eighth Edition, Harold Kerzner. John Wiley & Sons, Inc. https://books.mec.biz/tmp/books/55F1OL4WQC7HL2OBCGHS.pdf
2. Smarter Study Guides How to write Dissertations & Project Reports Kathleen McMillan and Jonathan Weyers, Pearson Education Limited. http://dlderakhtejavidan.ir/dl/Books/General/How%20to%20Write%20Dissertations%20&%20Project%20Reports.pdf

Course Code	Course Title			Category
21MSEC001	English Communication			Core
Contact Hours Per Week			CA	Credits
L	T	D/P		
1	1	0	50	02

Prerequisite: Basic Proficiency in English at the Graduation Level

Course Objectives:

1. To help students acquire social understanding, develop their social skills and help them talk about likes and dislikes in formal as well as informal ways. To help students master various techniques of communication in professional world and enhance their listening skills.
2. To help students enrich vocabulary with the help of various word games, activities and dictionary skills
3. To help students develop their grammar and syntax.
4. To help students develop various strategies of reading, such as, skimming, scanning, analysing, and criticizing, to help them develop reading comprehensions, reports, news articles and scientific texts and to help them write effectively.
5. To enhance holistic development of students in the area of Soft Skills and improve their employability skills. To introduce business etiquette and grooming to students, to develop their negotiation skills and to teach them voice modulations.

Unit 1: Effective Communication (09 Hours)

Communication Skills, Types of Communication, Process of Communication, 7 Cs of Communication, Importance of Communication, Barriers to Effective Oral Communication, Cross-cultural Communication, listening effectively, Types of Listening, Importance and Barriers to Listening, Word Stress, Intonation, Basics of Conversational Skills, Body Language, Presentation Skills.

Unit 2: Vocabulary Building (05 Hours)

Lexical Sets, Word Games, Synonyms and Antonyms, Activators, Use of Dictionary, Idioms, Phrases and Proverbs.

Unit 3: Enriching Grammatical Competence (05 Hours)

Use of the Parts of Speech in sentence composition, Use of Articles for maintaining the rhythm of English, Use of Tenses in day-to-day communication and academic writing, Use of Active and Passive Voice, Use of Reported Speech in formal communication, Use of Question Tags, Use of Modal Auxiliaries and Common Errors.

Unit 4: Reading and Writing Effectively (05 Hours)

Types of Reading Techniques, Reading Comprehensions, three pass approach to reading papers, Essentials of Writing, Paragraph Writing, Letter and E-mail Writing, Report writing.

Unit 5: Introduction to Soft skills (05 Hours)

Soft Skills, Self-Awareness, Team Work, Leadership, Emotional Intelligence, Group Discussion, Presentation Skills, Time and Stress Management, Etiquette and Grooming.

Course Outcomes:

After learning this course, students should be able:

1. To communicate fluently on and off the campus. They should be able to implement the social skills learnt in the classroom in outside world.
2. To choose and apply suitable words from different varieties of English in day to day communication effectively.

3. To apply grammatical rules correctly and effectively in real life situations.
4. To use strategies of reading and writing in their respective academic reading as well as writing.
5. To understand various soft skills and etiquette of the business world and apply them in their professional life.

References:

1. Dutt et.al. : A Course in Communication Skills, Foundation, 1st Edition
2. Lynch: Listening, Cambridge, 1st edition, ISBN- 0521707757
3. S. Aggarwal: Essential Communication Skills, Ane Books pvt. Ltd, ISBN- 8180522806
4. Jennings: Communication Basics, Cengage Learning, 1st edition, ISBN- 8131515206
5. Raymund Murphy: Essential Grammar in Use, Cambridge, 3rd Edition
6. Michael Swan: Practical English Usage, Oxford, 3rd Edition, ISBN-13: 978-0194420983
7. Communication Skills and Soft Skills: An Integrated Approach by Suresh Kumar E., Shrihari P. and Savitri J., 2011.
8. The Power of Communication: Skills to Build Trust, Inspire Loyalty, and Lead Effectively, by Helio Fred Garcia, 2012
9. Technical Writing for Dummies by Sheryl Lindell-Roberts, 2010.
10. Understanding Body Language by Alan Pease.
11. Essential Interviewing: A Programmed Approach to Effective Communication, by David R. Evans, Margaret T. Hearn, Max R. Uhlemann and Allen E. Ivey, 2010
12. Killer Presentations: Power the Imagination to Visualise Your Point – With Power Point, by Nicholas B. Oulton, 2007