Indira Gandhi Delhi Technical University for Women

(Established by Govt. of Delhi vide Act 09 of 2012)
Kashmere Gate, Delhi - 110006

DEPARTMENT OF ARTIFICIAL INTELLIGENCE & DATA SCIENCES

TWO YEAR POSTGRADUATE PROGRAMME

(M.Tech – AI & DS)

TEACHING SCHEME AND SYLLABUS

Teaching Scheme of M.Tech. AI & DS

SEMESTER I

S. No.	Code	Subject	L-T-P	Credits	Category
1.	MCS-101	Machine Learning	3-0-2	4	DCC
2.	MAI- 101	Advanced Database Management System	3-0-2	4	DCC
3.	MAI- 103	Mathematical Foundation forData Science	3-0-2	4	DCC
4.	MCS- 105	Advanced Data Structures andAlgorithms	3-0-2	4	DCC
5	GEC-101	Generic Open Elective-I	2-0-0/ 1-1-0/ 0-0-2	2	GEC
6.	DEC1 xx	Departmental Elective Course – 1	3-0-2/ 3-1-0	4	DEC
		Total Credits		22	

List of Departmental Elective Courses

Category	Course Code	Subject	Credits
Departmental Elective Course-1	MCS-103	Intelligent Data and Information Retrieval	3-0-2
	MCS-107	Agent Based Intelligent Systems	3-0-2
	MCS- 109	AI based Programming Tools	3-0-2
	MCS- 111	Knowledge Engineering	3-0-2

SEMESTER II

S. No.	Code	Subject	L-T-P	Credits	Category
1	MAI-102	Advanced Machine Learning	3-0-2	4	DCC
2	MCS-102	Deep Learning	3-0-2	4	DCC
3	DEC1xx	Departmental Elective course -2	3-0-2	4	DEC
4	DEC1xx	Departmental Elective course -3	3-0-2	4	DEC
5	DEC1xx	Departmental Elective course -4	3-0-2	4	DEC
6	ROC-102	Research Methodology and Publication Ethics	4-0-0	4	ROC
		Total credits		**24**	

List of Departmental Elective Courses

Category	Course Code	Subject	Credits
Departmental Elective course -2, Departmental Elective course -3, Departmental Elective course -4	MCS-104	Natural Language Processing	3-0-2
	MAI-104	Applications of AI in IoT	3-0-2
	MCS-110	Big Data Analytics	3-0-2
	MCS-112	Digital Image Processing	3-0-2
	MCS-114	Reinforcement Learning	3-0-2
	MCS-116	Computer Vision	3-0-2
	MCS-118	Speech Processing and Speech Recognition	3-0-2
	MAI-106	Optimizing Compilers	3-0-2
	MAI-108	Advanced Data warehousing and Data mining	3-0-2
	MAI-110	Recommendation Systems	3-0-2
	MIS-118	Machine learning in Cyber Security	3-0-2

INDIRA GANDHI DELHI TECHNICAL UNIVERSITY FOR WOMEN
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Department of Artificial Intelligence and Data Sciences

Teaching Scheme M. Tech. (Artificial Intelligence & Data Science)

Third Semester

Track-1 Course work

S. No.	Code	Subject	L-T-P	Credits	Category
1	DEC- 2xx	Departmental Elective-5	3-0-0/ 2-0-2	3	DEC
2	DEC- 2xx	Departmental Elective-6	3-0-0/ 2-0-2	3	DEC
3	GEC- 201	General Open Elective-II	2-0-0/ 1-1-0/ 0-0-4	2	GEC
4	MAI- 251	Dissertation-I	-	6	ROC
5	MAI- 253	Summer Industrial Training/ Internship	-	1	ROC
		Total credits		**15**	

Track-2 Research Project

S.N.	Code	Subject	L-T-P	Credits	Category
1	GEC- 201	Generic Open Elective-II	2-0-0/ 1-1-0/ 0-0-4	2	GEC
2	MAI- 255	Research Project Work-I		12	ROC
3	MAI- 253	Summer Industrial Training/Internship		1	ROC
		Total Credits		**15**	

Track -3 Industry Project

S.N.	Code	Subject	L-T-P	Credits	Category
1	GEC- 201	Generic Open Elective-II	2-0-0/ 1-1-0/ 0-0-4	2	GEC
2	MAI- 259	Industry Project Work-I		12	ROC
3	MAI- 253	Summer Industrial Training/Internship		1	ROC
		Total Credits		**15**	

Fourth Semester

S. No.	Code	Subject	L-T-P	Credits	Category
1.	MAI- 252	Dissertation-II/Industry Project Work-II/Research Project Work-II	-	20	ROC
		Total credits		**20**	

List of Departmental Elective Courses (New Courses may be added)

Departmental Elective Course-5 and Departmental Elective Course-6	MCS-201	Conversational AI	3-0-0
	MCS-203	Human Computer Interaction	3-0-0
	MCS-205	Ethics in AI	3-0-0
	MCS-207	Cognitive Computing	3-0-0
	MCS-209	Robotics and Applications	3-0-0
	MAI-201	Data Analytics and Visualization	2-0-2
	MIS-211	Blockchain Fundamentals	2-0-2

MACHINE LEARNING	
Course Code: MCS-101 Contact Hours: L-3 T-0 P- 2 Course Category: DCC	Credits: 4 Semester: 1

Introduction:
Machine learning (ML) is the science of getting computers to act without being explicitly programmed.Many researchers also think it is the best way to make progress towards human-level AI. This course provides a broad introduction to machine learning, data mining, and statistical pattern recognition.

Course Objectives:

- To provide an introduction to the basic principles, techniques, and applications of ML.
- To explain the strengths and weaknesses of different machine learning algorithms (relative to thecharacteristics of the application domain)
- To be able to adapt or combine some of the key elements of existing machine learning algorithms to design new algorithms as needed.

Pre-requisites:
Knowledge of programming, basic probability theory and statistics

Course Outcomes: After completion of the course, student will be able to:
CO1: Understand and apply the basic concepts of machine learning, gradient descent, regression techniques and support vector machine.
CO2: Understand, apply, and analyse various dimension reduction techniques, neural networks, decision trees and ensemble learning
CO3: Understand, apply, and evaluate KNN and Bayesian classifiers.
CO4: Understand and apply various unsupervised learning techniques and reinforcement learning techniques

Pedagogy:
The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT-I	12 Hours
Introduction to Machine Learning, Well Posed Problems, Machine Learning Process, Designing a Learning System, Types of Machine Learning, Application of Machine Learning, Features, Feature Vectors, Feature Selection and Visualization, Testing ML Algorithms (Overfitting, Training, Testing, And Validation Sets, Confusion Matrix, Accuracy Metrics, ROC Curve, Unbalanced Datasets, Measurement Precision), Discriminative Models: Least Square Regression, Gradient Descent Algorithm, Univariate and Multivariate Linear Regression, Prediction Model, probabilistic interpretation, Regularization, Logistic regression, multi class classification, Support Vector Machines	
UNIT-II	**10 Hours**
The Brain and The Neuron, Neural Networks, The Perceptron, Linear Separability, The Multi-LayerPerceptron, Forward and Back-error propagation, The Curse of Dimensionality, Dimensionality	

Reduction, Principal Component Analysis, LDA, ICA. Learning With Decision Tree, ID3, CART,Ensemble Learning, Boosting, Bagging, Random Forest.	
UNIT-III	**10 Hours**
Generative models: k-Nearest Neighbor Classification, Bayesian concept learning, Likelihood, Posterior predictive distribution, beta-binomial model, Naive Bayes classifiers, classifying documents using bag of words. Bayesian Statistics and Frequentist statistics. Directed graphical models (Bayes nets), Conditional independence, Inference.	
UNIT-IV	**10 Hours**
Unsupervised Learning, Clustering, K-Means Clustering, Hierarchical Clustering, Evaluation Parameters for Unsupervised Learning. Self-Organizing Maps. Reinforcement Learning: State and Action Spaces, Action, Policy, Markov Decision Processes, The Difference Between SARSA and Q-Learning, Uses of Reinforcement Learning. Active Learning, Inductive Learning	

Text Books

Stephen Marsland, “Machine Learning: An Algorithmic Perspective”, Chapman and Hall/CRC; 2nd or latest Edition, 2014

Bishop, C.M., “ Pattern recognition and machine learning”, Springer,2nd or latest edition,2010

Tom Mitchell, “ Machine Learning,” , McGraw Hill, 2017

Reference Books

T. Hastie, R. Tibshirani, J. Friedman. “The Elements of Statistical Learning”, 2nd or latest, 2008.

Han, Jiawei, Jian Pei, and Micheline Kamber. “Data mining: concepts and techniques.”, Elsevier, 2011.

Advanced Database Management System	
Course Code: MAI 101 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 1

Introduction

This course covers advanced aspects of database management including query optimization, distributed databases, data warehousing and data mining. There is extensive coverage and hands on work with SQL, and database instance tuning. Course covers various modern database architectures. Students learn about unstructured databases, and gain hands-on experience with MongoDB.

Course Objectives

- To give knowledge of distributed and Parallel database systems
- To know various database architectures and its implementation
- To know Query processing and optimization

Pre-requisite: Knowledge of Data Base Management Systems

Course Outcome: After studying this course students will be able to :

CO1: Understand how transactions are processed in a database.

CO2: Implement concepts of Object-Oriented database.

CO3: Tune and optimize some database applications.

CO4: Understand and analyze modern data processing paradigm such as NoSQL

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT I	10 Hours
Review of SQL, PL/SQL, Cursors and parameters, Exception Handling, procedures and functions, packages, Triggers, Improving PL/SQL performance. Obstacles to scaling up RDBMS, Difference between parallel and federated data bases. Parallel databases, performance parameters: response time, speed up and scale up, parallel database architectures, query evaluation, virtualization	
UNIT II	**10 Hours**
Distributed data bases: Peer-to-peer and master slave allocation, consistency models and replication issues, ACID versus BASE, vertical, horizontal, and hybrid fragmentation, query optimization in distributed data bases Limitations of the relational model, Schema on read versus schema on write, Complex data: arrays, tuples, bags, sets, lists. XML data bases: XML document structure, XML schema and schema design strategies, Xpath, XQuery.	
UNIT III	**12 Hours**
The MongoDB data store: master slave architecture, consistency, replication and availability in MongoDb, Data Types, Arrays, Embedded Documents. Data modelling issues, Document identity, temporal issues in MongoDB, Indexing in MongoDB, Querying with MongoDB, Comparison with XML data bases. Column versus row-oriented querying, The notion of columns and column families, The Cassandra data store, nodes, clusters and allocation, consistency, replication, and availability. Cassandra Data types, Query-oriented data modelling in Cassandra, Indexing, Querying using CQL, Comparison with relational and document stores.	
UNIT IV	**10 Hours**
Graph data bases using Neo4J, allocation, consistency, replication and availability issues in Neo4J, data types, representing 1:1, 1:N, M:N relationships and their physical storage, Indexing, the Cypher query language. Key-Value data stores, The RIAK data store, Distribution, availability, consistency, replication in RIAK, querying RIAK.	

Text Books	
1	Elmasri Ramez and Navathe Shamkant, Fundamentals of Database System, Pearson, 6th Ed. (June 2017)
2	Adam Fowler, NoSQL For Dummies, For Dummies, 1st Edition, 2015.
3	Williamson Heather , XML: The Complete Reference, 5ht Edition, McGraw-Hill Education
4	Seema Acharya, Demystifying NoSQL, Wiley, 2020
Reference Books	
1	Abraham Silberschatz, Henry F. Korth, S. Sudarshan, Database System Concepts, McGraw Hill, 6th Ed

MATHEMATICAL FOUNDATIONS FOR DATA SCIENCE	
Course Code: MAI-103 Contact Hours: L-3 T-0 P- 2 Course Category: DCC	Credits: 4 Semester: 1

Introduction: Learn about the need for data science, with emphasis on data visualization in data science.

Course Objective:

- To introduce the basic statistical formulae and visualization techniques
- To comprehend the concepts of probability, probability distribution and linear algebra
- To understand the concepts of sampling, sampling distribution and estimation
- To understand the concept of hypothesis testing

Pre-requisite: Knowledge of basics of probability

Course Outcome: At the end of the course students will be

CO1: Understand statistical formulae, visualization techniques and linear algebra concepts

CO2: Solve the real-life problem using the probability theory and linear algebra

CO3: Analyze the problem to predict the solution using the estimation theory for given samples

CO4: Develop a model using constraint and unconstrained optimization techniques.

Pedagogy: The teaching-learning of the course would be organized through lectures, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT I	12 Hours
Basics of Data Science: Introduction; Typology of problems; Importance of linear algebra, statistics and optimization from a data science perspective; Structured thinking for solving data science problems. The role of statistics, numerical and graphical methods for describing and summarizing data	
UNIT II	**10 Hours**
Linear Algebra: Matrices and their properties (determinants, traces, rank, nullity, etc.); Eigenvalues and eigenvectors; Matrix factorizations; Inner products; Distance measures; Projections; Notion of hyperplanes; half-planes.	
UNIT III	**10 Hours**
Probability and Probability distribution: Basic terminology in probability and rules, Probabilities under conditions of statistical independence and dependence, Bayes Theorem. Random variables, expected values, variance, probability distributions, model given data. Sampling and Sampling Distributions: introduction to sampling, random sampling, non-random sampling, sampling distribution of the mean, sampling distribution of the proportion, T-distribution.	
UNIT IV	**10 Hours**
Optimization: Unconstrained optimization; Necessary and sufficiency conditions for optima; Gradient descent methods; Constrained optimization, KKT conditions; Introduction to non-gradient techniques; Introduction to least squares optimization; Optimization view of machine learning. Introduction to Data Science Methods: Linear regression as an exemplar function approximation problem; Linear classification problems.	
Text Books:	
1	Sheldon M. Ross, Introduction to probability and statistics for engineers and scientist, 3rd Edition, Elsevier, 2005
2	Statistics for Management, Richard I. Levin; David S. Rubin, 7th Edition, Pearson Education
3	David M. Levine, David F. Stephan, Business Statistics-A First Course, Pearson Education, 2017
Reference Books:	
1	R. V. Hogg, J. W. McKean and A. Craig, Introduction to Mathematical Statistics, 6th Ed., Pearson Education India, 2006

ADVANCED DATA STRUCTURES AND ALGORITHMS	
Course Code: MCS 105 Contact Hours: L-3 T-0 P- 2 Course Category: DCC	Credits: 4 Semester: 1

Introduction: This course is about teaching of various data structure designs & its implementations, analyzing the various algorithm strategies and designing of new algorithmsfor various classes of problems. It is intended to be a gentle introduction to how we specify data structure, algorithms, some of the design strategies, and many of the fundamental ideas used in algorithm analysis throughout the syllabus.

Course Objective:

- To build an understanding on the basics of core and advance data structure.
- To introduce the various strategies used in the algorithm design and their analysis.
- To teach the selection of data structure for a particular problem
- To teach students, how to write complex program using dynamic data structures

Pre-requisite: Students should have some programming experience. In particular, they should understand recursive procedures and simple data structures such as arrays and linked lists. Students should have some facility with proofs by mathematical induction.

Course Outcome: After studying this course, Students will be able to:
CO1: Successfully design and implements the core and advance data structures
CO2: Successfully analyses the complexity associated with the various data structures
CO3: Analyse, design and implements the various proposed algorithm based on different algorithmic strategies.
CO4: Choose data structures for various complex problems

Pedagogy : The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT I	10 Hours
Algorithm Analysis - Methodologies for Analyzing Algorithms, Asymptotic growth rates, Amortized Analysis. **Linear Data Structures:** Arrays, Stacks, Queues, Linked lists. **Non-linear Data Structure:** Trees, Traversals, Binary Search Trees, AVL tree	
UNIT II	**10 Hours**
Graph Algorithms: DFS, BFS, Minimum Spanning Tree Algorithms, Topological sort, Strongly connected Components, Bi-connected Components, Bridges, Articulation points, AllPairs Shortest Paths, Single Source Shortest Paths. **Computational Geometry:** Convex Hull,Closest pair of points.	
UNIT III	**12 Hours**
Applications of Divide-and-Conquer, Greedy and Dynamic programming techniques - Knapsack, Median finding, Scheduling algorithms, Party planning, bitonic TSP. String matching algorithms: Z Algorithm, KMP algorithm, Rabin-Karp, Aho-Corasick, 2D queries, efficient algorithms for longest palindrome, longest common substring/subsequence.	
UNIT IV	**10 Hours**
B-trees, Suffix trees, Segment trees, Flow Networks: Ford-Fulkerson algorithm, Edmonds Karp algorithm, Applications of maximum flows - Maximum bipartite matching, minimum cost matching. NP-Completeness: Important NP-Complete Problems, Polynomial time reductions, Approximation algorithms, online algorithms	

Text Books:	
1	T. H. Cormen, C. E. Leiserson, R. L. Rivest, Clifford Stein, “Introduction to Algorithms”, 3rd Ed., PHI, 2011.
2	Michael T Goodrich and Roberto Tamassia, "Algorithm Design and Applications", Wiley, 2014.
3	Ellis Horowitz and Sartaz Sahani, “Fundamental of Computer Algorithms”, Galgotia Publications, 2009.
Reference Books:	
1	Vijay V. Vazirani, "Approximation Algorithm", Springer Science and Business Media, 2003.
2	Ellis Horowitz and Sartaz Sahani, “Fundamental of Computer Algorithms”, Galgotia Publications, 2009.
3	Michael Goodrich , Roberto Tamassia and Michael Goldwasser , “Data Structures and Algorithms in Python” ,Wiley, 2013
4	Michael T Goodrich and Roberto Tamassia, "Algorithm Design and Applications", Wiley, 2014.

INTELLIGENT DATA AND INFORMATION RETRIEVAL	
Course Code: MCS-103 Contact Hours: L-3 T-0 P- 2 Course Category: ROC	Credits: 4 Semester: 2

Introduction: Intelligent Data and Information Retrieval aims to provide application of various concepts of artificial intelligence for organizing& fetching data and information from the internet databases like search Engines. The Subject will introduce various types Intelligent data storage and processing techniques and also how to intelligently retrieve data from web sources so that the results of queries are exact and efficient.

Course Objectives:

- To understand the concepts of intelligently organizing data and fetching data from queries.
- To learn the different models for information storage and retrieval.
- To understand indexing and querying in information retrieval systems.
- To learn techniques for intelligently retrieving information from web search

Pre-requisites: Knowledge of basic databases and algorithms

Course Outcomes: Having successfully completed this course, the student will be able to

CO1: Able to organize data intelligently and fetch using FSQL
CO2: Deduce inferences from stored databases
CO3: Design algorithms for retrieving information effectively.
CO4: Retrieve information efficiently from web

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT I	12 Hours
Introduction: Introduction to data and various database Models. Data v/s information. Fuzzy Databases- Type-1 and Type-2 Fuzzy Relational Databases. Fuzzy Functional Dependency and Fuzzy Multivalued Dependency. Intelligent Query Processing using FSQL. Case studies of Fuzzy Databases.	
UNIT II	**10 Hours**
Deductive Databases- Overview of Deductive databases, datalogue notations , Clausal Forms and Horn clauses, Interpretation of Rules, datalogue programs-safety issues, use of relational operators, non-recursive queries, Evaluation of Non-recursive datalogue queries. Case studies of deductive databases	
UNIT III	**10 Hours**
Information Retrieval: Introduction of IR. Comparison between databases and IR Systems. Generic IR pipeline. Retrieval Models- Boolean Model, Vector Space Model, Probabilistic Model, Semantic Model, Fuzzy Model.Wrappers. Relevance feedback, Evaluation Measures- Precision, Recall and F-Score. Fuzzy Queries based development of Question Answering systems, Error detection and correction.	
UNIT IV	**10 Hours**
Web Search and Analysis: PageRank Algorithm, HITS algorithm. Webcontent Analysis, ontology based IR. Intelligent Web Agents. Social Search- Collaborative and conversational. Query Expansion using Fuzzy operators. Case studies:-Development of MetaSearch Engine using intelligent operators like OWA, Web crawlers, web spamming , web analytics.	
Text Books:	
1	David A. Grossman, Ophir Frieder, Information Retrieval – Algorithms and Heuristics, 2nd Edition, 2012, Springer, (Distributed by Universities Press)
2	Yates, Modern Information Retrieval Systems, Pearson Education,2014.
3	Gerald J Kowalski, Mark T Maybury, Information Storage and Retrieval Systems, Springer, 2000.
Reference Books:	
1	Soumen Chakrabarti, “Mining the Web : Discovering Knowledge from Hypertext Data” , Morgan-Kaufmann Publishers, 2002.
2	Christopher D. Manning, Prabhakar Raghavan, HinrichSchütze, “An Introduction to Information Retrieval”, Cambridge University Press, Cambridge, England, 2009.
3	Martin, J, “ Intelligent Information retrieval”, PHI publication, 3 edition, 2013

AGENT BASED INTELLIGENT SYSTEM	
Course Code: MCS 107 Contact Hours: L-3 T-0 P- 2 Course Category: DEC	Credits: 4 Semester: 1

Introduction: Agent based intelligent system provides fundamental concepts and techniques of intelligent systems. This also provides detail insight into representation and interpretation of knowledge on a computer. Several search strategies also called algorithms and control has described.

Course Objectives:

- Understand the structure of agents and define several learning mechanisms of agents.
- Dealt with the communication and cooperation within agents.
- Design the agents by learning how to plan and design the actors in the real world.

Pre-requisite: The student should have studied Data structure and algorithms with any programming language.

Course Outcomes:

CO1: Develop a computational agent with various searching techniques.
CO2: Apply the reasoning mechanisms of proposition and predicate logic to agents.
CO3: Use the learning mechanisms for an artificial agent.
CO4: Planning and acting in the Real world and logic-based agents.

Pedagogy:
The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT I	12 hrs
Introduction: The Foundation of Artificial Intelligence, The history of Artificial Intelligence. Intelligent Agents: Agents and Environments, Good Behavior: The concept of Rationality, The nature of Environments, The structure of Agents. **Solving Problems by Searching**: Problem –Solving Agents, Example Problems, Searching for Solutions, Uninformed Search Strategies, Informed (Heuristics) Search Strategies, Heuristic Functions	
UNIT II	**10 hrs**
Beyond Classical Search: Local Search in continuous Spaces, Searching with Nondeterministic actions, Searching with partial Observations, Online Search Agents and Unknown Environments. **Knowledge, reasoning, and planning:** Logical Agents, Knowledge-Based Agents, The Wumpus World, Logic, Propositional theorem proving, Effective Propositional Model Checking, Agents based on propositional logic. **Planning and Acting in the Real World**: Time, Schedules, and Resources; Hierarchical Planning, Planning and Acting in Nondeterministic Domains, Multi agent Planning.	
UNIT III	**10 hrs**
Uncertain Knowledge and reasoning: Acting under Uncertainty, Basic Probability Notaion, Inference Using Full Joint Distribution, Independence, Bayes' Rule and its use, The Wumpus World Revisited; **Probabilistic Reasoning overtime**: Inference in temporal models, Hiddden markov models, kalman filters, Dynamic Bayesian Network **Making Complex Decisions:** Combining Beliefs and Desires under Uncertainty, Utility Function, Multi attribute Utility Functions, Decision Networks, Decision –Theoretic Expert Systems, Sequential Decision problems, Value Iteration, Policy Iteration, Decision with multiple Agents: game Theory.	
UNIT IV	**10 hrs**
Robotics: Introduction, Robot Hardware, Robotic Perception, Planning to Move, Planning Uncertain Movements, Moving, Robotic Software Architectures, Application Domain; **AI: Present and Future;** Agent Components, Agent Architecture **Mathematical Background:** Complexity Analysis and 0() Notation, Vectors, Matrices and Linear Algebra, Probability Distribution, Defining Languages with Backus-Naur Form(BNF)	

Text Books	
1	Stuart Russell and Peter Norvig "Artificial Intelligence: A Modern Approach", Third Edition , Pearson, 2015
2	Nils.J.Nilsson, Principles of Artificial Intelligence, Narosa Publishing House, 1992
Reference Books	
1	Patrick Henry Winston, Artificial Intelligence, 3rd Edition, Pearson, 2008.
2	Michael Wooldridge, "An Introduction to Multi Agent System", John Wiley, 2002.

3	George F Luger, "Artificial Intelligence – Structures and Strategies for Complex Problem Solving", Pearson Education, 2009.
4	Padhy N P, "Artificial Intelligence and Intelligent Systems", Oxford University Press, 2005.

AI BASED PROGRAMMING TOOLS	
Course Code: MCS 109 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 1

Introduction: Artificial intelligence is widely applied to solve real world problems. Different programming languages are used for implementing AI programs. Now, many reusable tools are also available for facilitating the programming. These reusable tools and programminglanguages are taught in this course.

Course Objectives: This subject aims at teaching languages used for programming of AI applications. Programming tools play an important role in problems solving through Artificial intelligence methodology. It deals with all aspects of AI programming languages.

Pre-requisite: Students should have studied basic course on Artificial Intelligence and should be aware about the procedure of problem solving through AI.

Course Outcomes: After studying this course, students will be able to:
CO1: Understand the various programming languages to be used for AI and its applications.
CO2: Understand and implement the basics of python programming languages and its API for AI.
CO3: Understand the advance concepts of python including database management systems.
CO4: Understand and use the R programming language and packages for AI.

Pedagogy:
The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT I	10 Hours
Introduction: Concept of AI programming Tools. Concept of Logic Based Programming, Conventional AI Programming languages: Overview of LISP, Search Strategies in LISP, Pattern matching in LISP, Shell concept in LISP, Over view of Prolog, Production System Using Prolog. Writing programs using LISP and PROLOG.	
UNIT II	**10 Hours**
Concepts of Python Programming: Feature of python Program, Functions and Modules, Function Definition, Function Call, Variable Scope and lifetime, The return Statement, Lambda Function or Anonymous Functions, Recursive Functions, Modules, Package in Python. Tensor Flow, Pytorch.	
UNIT III	**10 Hours**
Advance Features of Python: File Handling Using PythonFile Path, Types of Files, Opening and Closing Files, Reading and Writing Files, File Positions, Renaming and Deleting Files. Implementing object-oriented Programming concepts using Python. Creating databases using Python.	
UNIT IV	**10 Hours**
Concepts of R Programming: Data Types and Operations, Flow Control, Introduction to R-Packages, Scientific Calculator Inspecting Variables, Vectors Matrices and Arrays- Lists and Data Frames, Functions & Package Strings and Factors- Flow Control and Loops- Advanced Looping-Date and Times, Charts & Graphs, Connecting R to External Interface, Elementary statistics, tests of Hypotheses.	

Text Books

1	Python Programming using problem solving Approach by Reema Thareja, Oxford University. First edition 2013
2	Richard Cotton and O'Reilly , "Learning R", Oxford Publication , first edition 2013.
3	Jeeva Josh and P Sojan lal, Introduction to Computing & Problem Solving with Python , Khanna Publication, 2nd Edition, 2016

Reference Books

1	R Jeva josh, " Python programming, Khanna Publication, first edition 2018
2	John Guttag , Introduction to Computation and Programming using Python, by, PHIPublisher, 2014
3	Dalgaard, Peter, "Introductory statistics with R", Springer Science & Business Media, 2013

KNOWLEDGE ENGINEERING	
Course Code: MCS 111 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 1

Introduction: This subject aims at handling different technical aspects of knowledge. Knowledge plays an important role in solving problems through Artificial intelligence methodology. This is advanced course and aims at teaching issues related with identifications, representation and storing knowledge.

Course objectives: This course aims at teaching students about importance of identification of knowledge. It teaches the technical methods to represent and use knowledge using inferencing. To teach students about acquisition of knowledge and related concepts.

Pre-requisite: Students should have studied basic course on artificial intelligence and should be aware about the procedure about problem solving through AI

Course Outcome: After studying this subject, students would be able to:

CO1: Identify basic components and types of knowledge.

CO2: Understand various knowledge representation methods.

CO3: Devise computer structures to store knowledge.

CO4: Understand development of knowledge intensive systems.

Pedagogy:

The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT I	10 Hours
Introduction: Concept of Knowledge Engineering, Knowledge Economy, Knowledge Management vs Knowledge Engineering, Knowledge Engineering and Artificial Intelligence, Terminology related with Knowledge Engineering, Concept of Knowledge Reuse. Concept of Knowledgebase Intensive Systems and Development of elementary Knowledge Based System	
UNIT II	11 Hours
Knowledge Acquisition and Knowledge Manipulation. Basic features of Knowledge Acquisition. Challenges in identification of Tacit Knowledge, Acquisition of Domain Knowledge, and Contextual Knowledge, Process of identification of explicit knowledge related to specific real- w o r l d problems. Acquisition of static and dynamic knowledge. Concept of Knowledge Manipulation, Basic principles of Inferencing, Methods of inferencing, Forward chaining, Backward chaining, bidirectional chaining, Factors that decides the direction of inferencing, Drawing Conclusion using Inferencing.	
UNIT III	11 Hours
Knowledge Management: Use and Reuse of Knowledge, Knowledge Management Overview, Knowledge Conversion, Knowledge Management Roles, Implications of Knowledge Management.	
UNIT IV	11 Hours
Expert System Design: Concept of Expert System, Application Domain of Expert System, Basic components of an Expert Systems, Design Methodologies of Expert Systems, Designing of inferencing module, and Input / output module. Design methodologies of Knowledge bases used in expert systems.	

Text Books:	
1	James Martin, Problem Solving using Knowledge Engineering, PHI Publication,edition 4th2017.
2	Ela Kumar, Knowledge Engineering, IK International Publication First Edition, 2017
3	Elias M. Awad, Hassan M. Ghaziri, Knowledge Management, PHI Publication, 2nd Ed., 2011
Reference Books:	
1	Skyrme David, Knowledge Centric Problem Solving, Mc Graw Hill, publication 1st edition2015.
2	Reich and Turing , " Artificial Intelligence", Mc Graw Hill, 3rd edition, 2016
3	M. Gahziri, Expert Systems Design, PHI Publication, 1st edition , 2012,

Advanced Machine Learning	
Course Code: MAI-102 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 2

Introduction: Machine learning is a subset of Artificial Intelligence (AI) which provides machines the ability to learn automatically & improve from experience without being explicitly programmed to do so. In the sense, it is the practice of getting Machines to solve problems by gaining the ability to think.

Course Objectives:

- To provide an overview of ML techniques and its applications.
- To familiarize with the working Neural Networks including activation functions.
- To provide the understanding on the class imbalance problem and different sampling techniques.
- To provide insights of evaluating different machine learning algorithms using various performance metrics.

Pre-requisite: Basic Knowledge of programming.

Course Outcomes: After completion of the course, student will be able to:

CO1: Identify potential applications of machine learning in practice.
CO2: Represent your data as features to serve as input to machine learning models.
CO3: Assess the model quality in terms of relevant error metrics for each task.
CO4: Utilize a dataset to fit a model to analyze new data.
CO5: Build an end-to-end application in Python that uses these machine learning techniques

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT -I	10 Hours
Data visualization: Interpretation and visualization using python programming and reporting ML results, comparing different ML algorithms. Sampling and Estimation: Sample vs Population, Sampling techniques- simple, stratified. Parameter estimation. Pre-processing techniques: Oversampling technique- SMOTE, different types of attributes, Cleaning of data: Dealing with missing data, noisy data, feature selection: Filter methods, wrapper methods, Embedded methods, Principal component analysis, Pearson Correlation method.	
UNIT- II	**10 Hours**
Supervised Machine learning review: SVM (linear and non -linear case) and different kernels like RBF, Spline, polynomial, sigmoid, linear kernel, ID3 & CART, class imbalance problem, Using Ensemble methods for performance enhancement- Bagging, Boosting- AdaBoost, XGBoost, Ridge regularization, Lasso regularization. Receiver operating characteristic Area Under the curve, applying data augmentation to deal with class imbalance.	
UNIT-III	**12 Hours**
Unsupervised Learning review: Partitioning method, K-Medoids, Density based clustering method- DBSCAN, Fuzzy Clustering, Unsupervised learning evaluation, assessing clustering tendency, measuring cluster quality.	
UNIT- IV	**10 Hours**
Multiclass classification, Semi-supervised learning, Working of Artificial neural networks (ANN), Active learning, reinforcement learning: State and Action spaces, Action, Policy, Markov Decision Processes, uses of reinforcement learning Applications and case studies: Medical area, Finance sector, Cyber security and social media.	

Text Books	
1	Jiawei Han, Micheline Kamber, Jian Pei, “Data mining Concepts and Techniques”, Morgan Kaufmann, 3rd edition, 2011
2	Stephen Marsland, “Machine Learning: An Algorithmic Perspective”, Chapman and Hall/CRC, 2nd edition, 2014
3	Tom Mitchell, “Machine Learning,” McGraw Hill, 2017
4	S. Rajasekaren and G.A. Vijayalakshmi Pai, “Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis and Applications”, Prentice Hall, 2003
Reference	
1	Shai Shalev-Shwartz and Shai Ben-David, “Understanding Machine Learning: From Theory To Algorithms” 3rd edition, 2015
2	Ethem Alpaydin, “Introduction to Machine Learning”, The MIT Press, 4th edition, 2020

Deep Learning	
Course Code: MCS-102 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 2

Introduction: Deep Learning has received a lot of attention over the past few years to solve a wide range of problems in Computer Vision and Natural Language Processing. Neural networks form the basis of deep learning. This course intends to cover fundamentals of neural networks, deep learning and application areas.

Course Objectives:

- To understand basic Neural Network Models, Learning and applications of Neural Network.
- To learn about the building blocks used in Deep Learning based solutions.
- To Introduce major deep learning algorithms, the problem settings, and their applications to solve real world problems

Pre-requisite: Working knowledge of Linear Algebra, Probability Theory and Machine Learning

Course Outcomes: On successful completion of the course, students will be able to:

CO1: Understand and apply the basic concepts of Neural Networks and gradient descent.
CO2: Understand and apply various regularization techniques, PCA, SVD and Autoencoders.
CO3: Understand, apply, and evaluate CNN , RNN and encoder decoder models
CO4: Understand and apply LSTM, Resstricted Boltzman Machine and transformer models

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Students would be encouraged to develop an understanding and implementation of various neural network and deep learning algorithms for real world problems. Use of ICT and web-based sources by using blended mode will beadopted.

CONTENTS

Research Methodology and Publication Ethics	
Course Code: ROC- 102 Contact Hours: L-4 T-0 P-0 Course Category: ROC	Credits: 4 Semester: 2

Introduction: An M.Tech/ Ph. D. may become an Instructor/Mentor/Facilitator in an Academic Institute or a Researcher in some Industry/Institute. This course is a foundation to let her optimize the time spent in research during and after M.Tech/Ph. D programme.

Course Objectives:

- To familiarize with the various steps in research.
- To familiarize with global standards in research world.
- To familiarize with global & domestic industry trends
- To familiarize with Product oriented research
- To enable the student to think rationally to formulate and solve a problem to the ultimate benefit of the society and welfare of mankind

Pre-requisite: None.

Course Outcomes: Having successfully completed this course, the student will be able to

CO1: Gain knowledge and comprehend various fundamentals of research.
CO2: Build a sound foundation of methodologies and applications of research.
CO3: Identify and analyze relationship between technical/multidisciplinary areas and integrate them for various applications.
CO4: Evaluate and apply the quantitative and qualitative aspects of research to innovate devices and processes in the constantly competitive Technologies.
CO5: Identify and evaluate the Cross functional coalition aspects.
CO6: Know how on how to take research to a product implementation.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT -I	10 Hours
Research: Types of Research, Research problem and hypothesis formulation, Systematic vs. Metaanalysis Peer Review: Stewardship of Data. Research Metrics. Research Indices. Meta Research: Impact Factor, H index, SNIP, SJP, SJR, CiteScore , EigenFactor, Article influence score, Altimetric. Standards: DOI, ISO, ISSN, ISBN. Citation databases: Web of Science, Scopus, ICI	
UNIT- II	**11 Hours**
Publication: Authorship. Conferences. Open Access. Research Report and Research paper Writing: Organizing research work into different sections of a research Paper. Research Design: Sampling Design, Data Collection and Measurement, Data analysis using R. Hypothesis Testing: Selection of Variables, Z-test, t-test, ANOVA.	
UNIT-III	**11 Hours**
Ethics: Ethical Theories: Virtue Ethics, Kant, Kohlberg Moral Development, Epistemology, Research on Human subjects, Nuremberg Code, Declaration of Helsinki. Scientific Misconduct: Plagiarism, COPE, WAME. Law: Patent Act, Copyright Act. Conflict of Interest. Sarbanes Oxley Act.	
UNIT- IV	**10 Hours**
Case studies: Milgram experiment, Stanford prison experiment, Henrietta Lacks, Plutonium experiment, Tuskegee Syphilis Experiment, and Plastic Fantastic. The case studies are not limited to these. The instructor may include more as per the contemporary cases. Stress Management: Interpersonal Skills. Team Work.	
Books	
1	C R Kothari and Gaurav Garg," Research Methodology: Methods and Techniques", New Age International Publishers, 2019
2	Machedo, Research Methodology in Management and Industrial Engineering, Springer, 2020
3	Gatrell, Research design and proposal writing in spatial science, Springer, 2020
4	Deb, Engineering Research Methodology A Practical Insight for Researchers, Springer, 2019

Natural Language Processing	
Course Code: MCS-104 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 2

Introduction: Natural Language Processing is a branch of Artificial Intelligence which deals with processing of Natural Language Text with the help of AI and Machine Learning Techniques. All Social Networking sites and Search Engines have to rely on NLP Techniques for efficient processing. This course will focus on discussing various phases of NLP for processing text in different language with a focus on English and Hindi Language.

Course Objectives:

- Understand various phases of NLP
- Learn the various applications of NLP
- Solve various real-world problems and Case studies, with a special focus onEnglish Language and Hindi Language.

Pre-requisite: The student should have studied Fundamentals of Data Mining and Artificial Intelligence.

Course Outcomes: After completion of the course, student will be able to:

CO1: Understand the Various phases of Natural Language Processing.

CO2: Understand deploying various applications of Text Processing.

CO3: Process Text of different Languages to draw useful inferences

CO4: Develop AI based Applications of NLP.

Pedagogy:
The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT -I	12 Hours
Introduction: Need for Processing Natural languages, Phases &Issues in NLP and Complexity of Processing NLP, General Characteristics of Natural language, Brief history and Challenges in Indian Languages, Levels of NLP, NLP tasks in syntax, semantics and pragmatics. Tokenization, Morphology, Sentences, Markup schemas, Grammatical Tagging, stemming and Lemmatization, Word Count, Zipf's Law.	
UNIT- II	**10 Hours**
Lexical Resources & POS Tagging for Natural Language Processing: Knowledge Base for NLP, Wordnet: English Wordnet, Hindi Wordnet, Fuzzy Hindi Wordnet. Synsets and all different Relationships in Wordnet. Wordnet as a lexical Ontology. Part of Speech Tagging, Different Parts of Speech, ambiguities and challenges, Standard Tagsets. Derivation of POS Tagging Formula, Accuracy, measurement and word categories of POS, Using Graphs for WSD, Rough Sets for WSD. CASE STUDY: Solving POSTagging using Wordnet.	
UNIT-III	**10 Hours**
Word Sense Disambiguation: Overview of Supervised and Unsupervised Learning, Pseudowords, Supervised Disambiguation, Dictionary-based Disambiguation, Unsupervised Disambiguation, Word Sense. Using Graphs for WSD. WSD in Hindi Language. Knowledge sources in WSD, Applications of WSD, WSD Evaluation.	
UNIT- IV	**10 Hours**
Named Entity Recognition & Probabilistic Models: Introduction, Techniques and current Trends Different Types of Named Entities. English and Hindi NER. Standard Tagsets for NER in English and Hindi Language. NER For Indian Languages. CASE STUDIES for NERin Hindi Language. Hidden Markov Model and N-Gram Model. Cases Studies based on HMM and N- Gram.	

Text Books	
1	Jurafsky, Dan and Martin, James, "Speech and Language Processing", Second Edition, Prentice Hall, 2008
2	Daniel Jurafsky, James H. Martin,"Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech", Pearson Publication, 2014.
3	AksharBhartati, Sangal and Chaitanya," Natural language processing", Eastern Economy Edition, PHI, New Delhi, 1996.
Reference Books	
1	P.Syal and D.V.Jindal, "An introduction to Linguistics: language grammar and semantics, Eastern Economy Edition", PHI, 2007.
2	Lawrence Rabiner And Biing-Hwang Juang, "Fundamentals of Speech Recognition", Pearson Education, 2003.
4	U.S.Tiwari and Tanveer Siddiqui, "Natural Language Processing and Information Retrieval", Oxford University Press,2008.

Applications of AI in IoT	
Course Code: MAI-104 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 2

Introduction: Internet of Things is the new technology emerging in every domain such as transportation, smart home, smart city, smart agriculture, robotics etc. In this course architecture of the IoT systems are taught. It also deals with IoT interfaces for various applications and its networking protocols in order to develop efficient systems. n this course Design and development of IoT based application for real world applications will also be covered.

Course Objectives: This course aims at understanding of IoT, its architecture and applications development for solving real world problems, Network and IoT protocols and its Application development, Interfacing of various sensors, IO devices and data processing and Development of AI based IoT Application Development.

Pre-requisite: The student should have studied Fundamentals of Computer/ Computer organization and any programming language.

Course Outcomes: After studying this course students will be able to:

CO1: Identify a real world problem and design a solution for solving the same using the concepts of IOT

CO2: Develop Interface of various sensors, I/O devices and I/O peripherals with N /W Protocols

CO3: Implement AI based/ IoT based Mobile Application Development

CO4: Deploy and test the solution designed

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT -I	11 Hours
Introduction to IoT: Architectural Overview of IoT: Components of IoT, Block Diagram, Design principles. Applications of IoT and its Infrastructure: AI Applications in IoT, Sensing, Actuation, Devices, Gateways. Introduction to IoT Programming Environments and Languages. Data Management, Business Processes in IoT.	
UNIT- II	**11 Hours**
IoT Interfacing: Component selection criterion for Implementing IoT application, Hardware Components- Computing (NodeMCU, Raspberry Pi), Communication, Sensing, Actuation, I/O interfaces. Software Components- Programming API's (using Python). Sensors interfacing: Interfacing of Temperature, humidity, light, accelerometer, ultrasonic, IR/PIR, Camera etc. Communication and I/O components Interfacing: Bluetooth, WiFi, GSM, Displays and touch sensor etc.	
UNIT-III	**10 Hours**
IoT Networking: Basics of Networking, Design Principles for the Web Connectivity for connected- Devices, PHY/MAC layer: IEEE 802.11, IEEE 802.15, ZigBee, Bluetooth low energy, Wi-Fi. Network layer: IPv4, IPv6. Transport Layer: TCP, UDP. Application layer: HTTP, CoAP, XMPP.	
UNIT- IV	**10 Hours**
AI based IoT Application Development: Solution framework for IoT applications- Implementation of Device integration, Data acquisition, Organization and integration and analytics. Device data storage- Unstructured data storage on cloud/local server, authorization of devices, role of Cloud in IoT, Security aspects in IoT. Case Study: Smart Cities, Smart Homes, Automobiles, Industrial IoT, Agriculture etc.	
Text Books	
1	Adrian McEwen and Hakim Cassimally," Designing the Internet of Things", Wiley Publication, 2013
2	Pethuru Raj and Anupama C. Raman, " The Internet of Things: Enabling Technologies, Platforms, and Use Cases", (CRC Press) Auerbach publication, 2017.
3	Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach", Universities Press, August 2014.
Reference Books	
1	Andrew Minteer, "Analytics for the Internet of Things (IoT), Packt Publications, Jul 2017
2	Giacomo Veneri , Antonio Capasso , "Hands-On Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0", 2018

Big Data Analytics	
Course Code: MCS-110 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 2

Introduction: The explosion of social media and the computerization of every aspect of social and economic activity resulted in creation of large volumes of mostly unstructured data: web logs, videos, speech recordings, photographs, e-mails, Tweets, and similar. Today, we have the ability to reliably and cheaply store huge volumes of data, efficiently analyze them, and extract business and socially relevant information. The key objective of this course is to familiarizethe students with most important information technologies used in manipulating, storing, and analyzing big data.

Course Objective: To familiarize the students with important Information Technologies usedin manipulating, storing, and analyzing big data.

Pre-requisite: Programming Language, like SQL, and exposure to Linux Environment.

Course Outcome: After studying this course, students will be able to:

CO1: Identify Big Data and its Business Implications.
CO2: List the components of Hadoop and Hadoop Eco-System
CO3: Access and Process Data on Distributed File System
CO4: Manage Job Execution in Hadoop Environment
CO5: Develop Big Data Solutions using Hadoop Eco System

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

Digital Image Processing	
Course Code: MCS-112 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 2

Introduction: Digital image processing deals with processing of images which are digital in nature. Some of the important applications of image processing in the field of science and technology include computer vision, remote sensing, feature extraction, face detection, forecasting, optical character recognition, finger-print detection, optical sorting medical image processing, and morphological imaging. This course will introduce various image processing techniques, algorithms and their applications.

Course Objectives:

- Learn digital image fundamentals.
- Be exposed to simple image processing techniques.
- Be familiar with image compression and segmentation techniques.
- Learn to represent image in form of features.

Pre-requisite: Basic Concepts of Mathematics

Course Outcome: After completion of the course, student will be able to:

CO1: Understand the need for image transforms, different types of image transforms and their properties.
CO2: Develop any image processing application.
CO3: Learn different causes for image degradation and overview of image restoration techniques.
CO4: Understand the need for image compression and to learn image compression techniques.
CO5: Learn different feature extraction techniques for image analysis and recognition

Pedagogy:
The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

Reinforcement Learning	
Course Code: MCS-114 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 2

Introduction: Reinforcement learning is concerned with building programs that learn how to predict and act in a stochastic environment, based on past experience. It was applied in a variety of fields such as robotics, pattern recognition, personalized medical treatment, drug discovery, speech recognition, computer vision, and natural language processing. This course covers fundamental principles and techniques in reinforcement learning.

Course Objective:

- To provide an introduction to reinforcement learning and its practical applications
- To train the students to frame reinforcement learning problems and to tackle algorithms from dynamic programming, Monte Carlo and temporal-difference learning

Pre-requisite: Basic statistics and linear algebra, Python programming

Course Outcome: After completion of the course, student will be able to:

CO1: Understand key features of Reinforcement Learning (RL).
CO2: Decide, formulate, design, and implement given application as RL problem.
CO3: Implement common RL algorithms and evaluate them using relevant metrics.

Pedagogy:
The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT -I	10 Hours
Introduction to RL: Course logistics and overview, Introduction to Reinforcement Learning (RL), Origin and history of RL research, RL and its connections with other ML branches. Linear algebra overview, Probability overview, Sequential Decision Making, Modelling the world, Components of a reinforcement learning agent, Taxonomy of reinforcement learning agents. Introduction to Instance based learning	
UNIT- II	**11 Hours**
Markov Decision Processes and Bandit Algorithms, Policy Gradient Methods & Introduction to Full RL, Reinforcement Learning Problems, MDP Formulation, Bellman Equations & Optimality Proofs, Markov Processes, Markov Reward Processes, Markov Decision Processes, Bellman Equation, Bandit Algorithms (UCB, PAC, Median Elimination, Policy Gradient), Contextual Bandits.	
UNIT-III	**10 Hours**
Dynamic Programming & Temporal Difference Methods, DQN, Fitted Q & Policy Gradient Approaches, Introduction to Dynamic Programming, Policy Evaluation (Prediction), Policy Improvement, Policy Iteration, Hierarchical Reinforcement Learning, Value Iteration, Generalized Policy Iteration, Hierarchical RL: MAXQ, Asynchronous Dynamic Programming, Efficiency of Dynamic Programming, Temporal Difference Prediction, Why TD Prediction Methods, On-Policy and Off-Policy Learning, Q-learning, Reinforcement Learning in Continuous Spaces, SARSA	
UNIT- IV	**11 Hours**
Value Function, Bellman Equation, Value Iteration, and Policy Gradient Methods, Value Function, Bellman Equations, Optimal Value Functions, Bellman Optimality Equation, Optimality and Approximation, Value Iteration, Introduction to Policy-based Reinforcement Learning: Policy Gradient, Monte Carlo Policy Gradients, Generalized Advantage Estimation (GAE), Monte Carlo Prediction, Monte Carlo Estimation of Action Values, Monte Carlo Control, Monte Carlo Control without Exploring Starts, Incremental Implementation, Policy optimization methods (Trust Region Policy Optimization (TRPO) and Proximal Policy, Optimization (PPO))	
Text Books	
1	Richard S. Sutton and Andrew G. Barto, “Reinforcement Learning: An Introduction”, 2nd Edition, MIT Press. 2017.
2	Kevin P. Murphy,” Machine Learning: A Probabilistic Perspective”, MIT Press, 2012.
Reference Books	
1	Mohit Sewak, “Deep Reinforcement learning: Frontiers of Artificial Intelligence”. Springer, 2019
2	Sugiyama, Masashi, “Statistical reinforcement learning: modern machine learning approaches”, Chapman and Hall/CRC, 2015
3	Csaba Szepesvari, "Algorithms for Reinforcement Learning", Morgan and Claypool, 2010.

Computer Vision	
Course Code: MCS-116 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 2

Introduction: This course briefs about image processing techniques required for computer vision, Image formation process, Image analysis, generate 3D model from Images, video processing and Image motion computation. Also introduces the computer vision techniques.

Course Objective: In this course students will learn basic principles of image formation, image processing algorithms and different algorithms for 3D reconstruction and recognition from single or multiple images (video). This course emphasizes the core vision tasks of sceneunderstanding and recognition. Applications to 3D modeling, video analysis, video surveillance, object recognition and vision based control will be discussed.

Pre-requisite: A course in Programming and Mathematics is a prerequisite to study this course.

Course Outcome: After completion of the course, student will be able to:

CO1: To understand and determine the basic image processing techniques and image formation models required for computer vision.

CO2: To understand and apply image pre-processing, edge detection and motion estimation

CO3: To classify, discover and perform shape representation, segmentation and object recognition techniques for various computer vision applications

CO4: To apply computer vision techniques in various real-world applications

Pedagogy:

The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT -I	11 Hours
Introduction: Image Processing, Computer Vision and Computer Graphics, What is Computer Vision - Low-level, Mid-level, High-level, Overview of Diverse Computer Vision Applications: Document Image Analysis, Biometrics, Object Recognition, Tracking, Medical Image Analysis, Content-Based Image Retrieval, Video Data Processing, Multimedia, Virtual Reality and Augmented Reality Image Formation Models: Monocular imaging system, Radiosity: The 'Physics' of Image Formation, Radiance, Irradiance, BRDF, color etc, Orthographic & Perspective Projection, Camera model and Camera calibration, Binocular imaging systems, Multiple views geometry, Structure determination, shape from shading , Photometric Stereo, Depth from Defocus , Construction of 3D model from images.	
UNIT- II	**10 Hours**
Image Processing and Feature Extraction: Image Preprocessing, Image Representations (continuous and discrete) , Edge detection. Motion Estimation: Regularization theory, Optical computation, Stereo Vision, Motion estimation, Structure from motion.	
UNIT-III	**11 Hours**
Shape Representation and Segmentation: Contour based representation, Region based representation, Deformable curves and surfaces, Snakes and active contours, Level set representations, Fourier and wavelet descriptors, Medial representations, Multi Resolution analysis. Object recognition: Hough transforms and other simple object recognition methods, Shape correspondence and shape matching, Principal component analysis, Shape priors for recognition	
UNIT- IV	**10 Hours**
Image Understanding: Pattern recognition methods, HMM, GMM and EM Applications: Photo album – Face detection – Face recognition – Eigen faces – Active appearance and 3D shape models of faces Application: Surveillance – foreground- background separation – particle filters – Chamfer matching, tracking, and occlusion – combining views from multiple cameras – human gait analysis Application: In-vehicle vision system: locating roadway – road markings – identifying road signs – locating pedestrians.	
Text Books	
1	D. Forsyth and J. Ponce," Computer Vision - A modern approach", Prentice Hall publication McGraw-Hill publication, first edition, 2012
2	E. Trucco and A. Verri, Introductory Techniques for 3D Computer Vision, Prentice Hall first edition 2001.
3	R. C. Gonzalez, R. E. Woods, "Digital Image Processing" Pearson , 2007.
Reference Books	
1	D. H. Ballard, C. M. Brown, "Computer Vision. Prentice-Hall", Englewood Cliffs, 1982.
2	Richard Szeliski, "Computer Vision: Algorithms and Applications (CVAA)". Springer series 2010
3	Sonka, Hlavac, and Boyle. Thomson," Image Processing, Analysis, and Machine Vision", Mc Graw Hill Publication 2001

Speech Processing and Speech Recognition	
Course Code: MCS-118 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 2

Introduction: Speech processing and speech recognition (MCS 211) is a post graduate level course which gives an introduction about Speech Fundamentals methods, speech analysis and detailed study of speech models for speech processing and speech recognition**.** Apart from classical algorithms this course also includes current State of the Art concepts such as role of Deep neural networks in this domain.

Course Objectives:

- Understand the fundamental concepts of speech processing
- Explore various speech models using different state of the art and current approaches.
- Study the role of Deep Neural Network in speech recognition

Pre-requisite: Fundamentals of Artificial Intelligence.

Course Outcomes: After completion of the course, student will be able to:
CO1: Understand Speech production system
CO2: Understand various speech Analysis techniques
CO3: Build speech Models using HMM
CO4: Appreciate deployment of Deep neural networks for Speech recognition systems

Pedagogy:
The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

Optimizing Compilers	
Course Code: MAI-106 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 2

Introduction: This course provides the complete description about inner working of a compiler. This course focuses mainly on the design of compilers and optimization techniques. It also includes the design of Compiler writing tools. This course also aims to convey the language specifications, use of regular expressions and context free grammars behind the design of compiler.

Course Objectives:

- To Introduce the concepts of language translation and compiler design
- To impart the knowledge of practical skills necessary for constructing a compiler

Pre-requisite: Programming in C.

Course Outcomes: After completion of the course, student will be able to:

CO1: Understand the concepts and different phases of compilation
CO2: Apply various code optimizing transformations.
CO3: Design a compiler for a small subset of C language.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT -I	11 Hours
Overview: Overview of Lexical analyzer, Syntax analyzer, Semantic analysis	
UNIT- II	**10 Hours**
Intermediate code generation and Parallelization: Intermediate languages – Graphical representations, Three Address code, Quadruples, Triples. Assignment statements, Boolean expressions. Compiler Challenges for High-Performance Architectures, Dependence and its Properties, Parallelization and Vectorization	
UNIT-III	**11 Hours**
Code Optimization and Generation: Principal sources of optimization, Loop optimization, Data flow analysis, Issues in the design of a code generator. A simple code generator.	
UNIT- IV	**10 Hours**
Scheduling and Allocation: Scheduling, Register allocation & Assignment Case Studies: Case studies of compilers	
Text Books	
1	Randy Allen and Ken Kennedy, "Optimizing compilers for modern architectures", Morgan Kaufmann Publishers, 2001
2	Steven S. Muchnick, "Advanced Compiler Design and implementation", Morgan Kaufmann, 1997
3	A. V. Aho, R. Sethi, & J. D. Ullman, "Compilers: Principles, Techniques &Tools", Pearson Edu., 2011
Reference Books	
1	A. I Hollub," Compiler Design in C", Pearson Education India, 1st edition,2015
2	K. C. Louden, "Compiler Construction – Principles and Practice", Cengage Learning Indian Edition, 2006.

Advanced Data Warehousing and Data mining	
Course Code: MAI-108 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 2

Introduction: Data warehousing is a method of organizing and compiling data into one database, whereas data mining deals with fetching important data from databases. Data mining attempts to depict meaningful patterns through a dependency on the data that is compiled inthe data warehouse.

Course Objective: The objective of the subject is to facilitate the student with the basics of Data Warehouse and Data Mining, to study algorithms and computational paradigms that allow computers to find patterns and regularities in databases, perform prediction and forecasting, and generally improve their performance through interaction with data.

Pre-requisite: Database systems.

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

CO1: Understand Data preprocessing and data quality.

CO2: Extracts insights, monitor performance and improve decision making.

CO3: Interpret the implementation of Datawarehouse and analyze various preprocessing techniques.

CO4: Analyze algorithms for data mining.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT -I	10 Hours
Review of Data Warehousing: Introduction to Data Warehousing: Evolution of Data Warehousing, Data Warehousing concepts, Benefits of Data Warehousing, Comparison of OLTP and Data Warehousing, Why Have a Separate Data Warehouse, Problems of Data Warehousing. Data Warehousing Architecture Architecture: Operational Data and Data store, Load Manager, Warehouse Manager, Query Manager, Detailed Data, Lightly and Highly summarised Data, Archive/Backup Data, Meta-Data, 2-tier, 3-tier and 4-tier data warehouse architecture	
UNIT- II	**10 Hours**
Multidimensional Data Modeling Principles of dimensional modeling: From Tables and Spreadsheets to Data Cubes, the STAR schema, STAR Schema Keys, Advantages of the STAR Schema Dimensional Modeling: Updates to the Dimension tables, miscellaneousdimensions, the snowflake schema, Fact Constellations, aggregate fact tables, families of STARS, Measures: Their Categorization and Computation, Concept Hierarchies, OLAP Operations in the Multidimensional Data Model, A Starnet Query Model for Querying Multidimensional Databases	
UNIT-III	**12 Hours**
Data Warehouse Implementation, Efficient Computation of Data Cubes, Indexing OLAP Data, Efficient Processing of OLAP Queries, Metadata repository, Data warehouse back-end tools and utilities Data Preprocessing Why preprocess the data? Data cleaning, Missing values, Noisy data, Inconsistent data, Data integration and transformation, Data reduction: Data cube aggregation,Dimensionality reduction, Data compression, Numerosity reduction Discretization and concept hierarchy generation for numeric data and categorical data	
UNIT- IV	**10 Hours**
Data Mining Basics: What is Data Mining, the knowledge discovery process, OLAP versus data mining, data mining and the data warehouse, Major Data Mining Techniques, Cluster detection, decision trees, memory-based reasoning, link analysis, neural networks, genetic algorithms, moving into data mining, Data Mining Applications, Benefits of data mining, applications in retail industry, applications in telecommunications industry, applications in banking and finance.	
Text Books	
1	Jiawei Han, Jian Pei and Hanghang Tong," Data Mining - Concepts and Techniques", Morgan Kaufmann, 2022
2	Paul Raj Poonia, "Fundamentals of Data Warehousing", John Wiley & Sons, 2003.
Reference Books	
1	W. H. Inmon, "Building the operational data store", 2nd Ed., John Wiley, 1999
2	Pang- Ning Tan, Michael Steinbach, Anuj Karpatne and Vipin Kumar, Introduction to Data Mining, Pearson, 2021

Recommendation Systems	
Course Code: MAI-110 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 2

Introduction: In the current age of information overload, recommender systems offer personalized access for users to efficiently search information and make choices online. This course introduces recommender systems' major concepts, methodologies, evaluation design, and user experiences. A variety of real-world applications are included, such as those deployed in e-commerce sites and social networks.

Course Objective:

- To understand the basic concepts such as user preference and prediction.
- To learn variety of typical recommendation approaches.
- To understand system evaluation design and metrics
- To get the knowledge of human roles in system implementation and user-centered evaluation.

Pre-requisite: Data structures and basic knowledge of programming languages like C, C++.

Course Outcome: Upon successful completion of this course, students will be able to:
CO1: Describe basic concepts behind recommender systems.
CO2: Explain a variety of approaches for building recommender systems.
CO3: Interpret the system evaluation methods from both algorithmic and users' perspectives
CO4: Demonstrate the applications of recommender systems in various domains.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT -I	12 Hours
Introduction and basic taxonomy of recommender systems (RSs), traditional and non-personalized RSs, overview of data mining methods for recommender systems- similarity measures, classification, clustering, SVMs, dimensionality reduction, overview of convex and linear optimization principles Content-based recommendation High level architecture of content-based systems, Advantages and drawbacks of content-based filtering, Item profiles, discovering features of documents, Obtaining item features from tags, Representing item profiles, Methods for learning user profiles, Similarity based retrieval, Classification algorithms.	
UNIT- II	**10 Hours**
Collaborative Filtering (CF)-based RSs: a systematic approach Nearest-neighbor collaborative filtering (CF), userbased and item-based CF, and comparison, components of neighborhood methods (rating normalization, similarity weight computation, and neighborhood selection), attacks on collaborative recommender systems.	
UNIT-III	**10 Hours**
Advanced topics: Network aspects of content RSs Recommender systems for video content distribution. Implications of recommender systems in 5G wireless networks. RSs for optimizing wireless network performance. Case studies (i) Joint content recommendationsand content caching in small cells wireless networks (ii) The interplay of RSs and User access point association.	
UNIT- IV	**10 Hours**
Applications of RSs RSs for content media, social media and communities Music and video RSs. Datasets. Group recommender systems. Social recommendations. Recommending friends: link prediction models. Similarities and differences of RSs with task assignment in mobile crowd sensing, social network diffusion awareness in RSs.	
Text Books	
1	Jannach D., Zanker M. and FelFering A.," Recommender Systems: An Introduction", Cambridge University Press, 2011
2	Ricci F., Rokach L., Shapira D., Kantor B.P., "Recommender Systems Handbook", Springer, 2011
3	Manouselis N., Drachsler H., Verbert K., Duval E., "Recommender Systems For Learning", Springer , 2013
4	C.C. Aggarwal, "Recommender Systems: The Textbook, Springer", 2016
Reference Books	
1	Michael D. Ekstrand, John T. Riedl, and Joseph A. Konstan. Collaborative Filtering Recommender Systems, Now Publishers Inc, 2011.
2	Aggarwal, Charu C. Recommender Systems: The Textbook. Springer 2016.

Machine Learning in Cyber Security	
Course Code: MIS-118 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 2

Introduction: We are witnessing numerous attacks on cyber systems. In this course, we shall study application of machine learning, the most popular branch of artificial intelligence, to detect attacks in cyberspace, thereby equipping the students with an important perspective to secure cyber systems.

Course Objective:

- Introduce cyber systems in different domains with the objective of securing cyber systems using machine learning.
- Help the students to engineer and build a secure cyber system using machine learning and deep learning.

Pre-requisite: Programming, Machine Learning.

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

CO1: Understand the key features (aspects) to extract from cyber systems from a securityperspective.

CO2: Apply the concepts of machine learning to secure cyber systems.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

CONVERSATIONAL AI	
Course Code:MCS - 201 Contact Hours:L-3 T-0 P- 0 Course Category: DEC	Credits: 3 Semester: 3

Introduction: The science and art of creating conversational AI spans multiple areas in computer science. Throughout the course, students will learn advances in these areas to create state-of-the art conversational virtual assistants

Course Objective

- To provide clear understanding of state-of-the art conversational virtual assistants.
- To provide the knowledge and skills necessary to effectively design and develop virtual assistants using tools.

Pre-requisite: Machine Learning, Deep Learning

Course Outcome: After completion of the course, student will be able to:
CO1: Understand Basic Programming concepts to work with chat bots
CO2: Build and deploy domain specific chatbots
CO3: Integrate the Virtual Assistants with third party APIs

Pedagogy:
The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT I	11 Hours
Introduction to virtual assistants and their platforms, Chatbots, application of chat bots, motivations for chatbots, relevance of chatbot with industry. Introduction to Watson Assistant: Watson Assistant components, Intents, Entities, Dialog, Dos and Don'ts of dialog design. Building Our Chatbot:Intents and Entities Creating a workspace, Defining Chit Chat intents, Defining Domain-Specific intents, Defining entities	
UNIT II	10 Hours
Building Our Chatbot Dialog : The default Welcome and Anything else nodes, Creating Chit Chat dialog, Simple conditions and responses, handling complex dialog flow, trying out and exporting our chatbot.	
UNIT III	10 Hours
Deploying Our Chatbot: Deploying our chatbot on WordPress, Installing and configuring the Watson Assistant plugin, Finding and fixing problems, more advanced concepts, Analyzing chatbot conversations	
UNIT IV	11 Hours
Introduction to Microsoft Bot, RASA and Google Dialogflow, Microsoft Bot Framework, Introduction to QnAMaker, Introduction to LUIS, Introduction to RASA, RASA Core, RASA NLU, Introduction to Dialog flow. Integration with Third party APIs, Connecting to an Enterprise Data Store, Deployment to Cloud.	

Text Books

1	Andrew Freed, "Conversational AI: Chatbots that work, Manning Publications,2021
2	Galitsky, Boris. Developing Enterprise Chatbots. Springer International Publishing, 2019.
3	Janarthanam, Srini. Hands-on chatbots and conversational UI development: Build chatbots and voice user interfaces with Chatfuel, Dialogflow, Microsoft Bot Framework,Twilio, and Alexa Skills. Packt Publishing Ltd, 2017.

Reference Books

1	Singh, Abhishek, Karthik Ramasubramanian, and Shrey Shivam. " Building an Enterprise Chatbot.", Springer, Apress, 2019
2	Michael McTear, Conversational Ai: Dialogue Systems, Conversational Agents, and chatbots (Synthesis Lectures on Human Language Technologies), Morgan & Claypool (2020)
3	Kelly III, John E., and Steve Hamm. Smart machines: IBM's Watson and the era ofcognitive computing, Columbia University Press, 2013.

HUMAN COMPUTER INTERACTION	
Course Code:MCS 203 ContactHours: L-3 T-0 P-0 Course Category: DEC	Credits: 3 Semester: 3

Introduction: Human Computer Interaction (HCI) is an interdisciplinary field that integrates theories and methodologies from computer science, psychology, design, and many other areas. This course provides a basic understanding of Human interfaces, their design principles, tools as well as interfaces through thought process.

Course Objectives:

- Learn the foundations of Human Computer Interaction.
- Be familiar with the design technologies for computer interaction and guidelines for webuser interface.
- Learn the ecosystem and tools of mobile Human Computer interaction.

Pre-requisite: Programming skill in some programming language

Course Outcomes: After completion of the course, student will be able to:

CO1: Design and Development processes and life cycle of Human Computer Interaction.
CO2: Analyze product usability evaluations and testing methods.
CO3: Apply the interface design standards/guidelines for cross cultural and disabled users.
CO4: Categorize, Design and Develop Human Computer Interaction in proper architecturalstructures.

Pedagogy:

The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT I	12 hrs
HCI foundations- Input–output channels, Human memory, Thinking: reasoning and problem solving, Emotion, Individual differences, Psychology and the design of interactive systems, Text entry devices, Positioning, pointing and drawing, Display devices, Devices for virtual reality and 3D interaction, Physical controls, sensors and special devices, Paper: printing and scanning Designing- Programming Interactive systems- Models of interaction, Frameworksand HCI, Ergonomics, Interaction styles, Elements of the WIMP interface, The context of the interaction, Experience, engagement and fun, Paradigms for interaction.	
UNIT II	10 hrs
Cantered design and testing- Interaction design basics-The process of design, User focus, Scenarios, Navigation design, Screen design and layout, Iteration and prototyping, Design for non-Mouse interfaces, HCI in the software process, Iterative design and prototyping, Design rules, Principles to support usability, Standards and Guidelines, Golden rules and heuristics, HCI patterns Implementation support - Elements of windowing systems, Programming the application, Using toolkits.	
UNIT III	10 hrs
User interface management systems, Evaluation techniques, Evaluation through expert analysis, Evaluation through user participation, Universal design, User support Models and Theories - Cognitive models, Goal and task hierarchies, Linguistic models, The challenge of display-based systems, Physical and device models, Cognitive architectures.	
UNIT IV	10 hrs
Collaboration and communication - Face-to-face communication, Conversation, Text-based communication, Group working, Dialog design notations, Diagrammatic notations, Textual dialog notations, Dialog semantics, Dialog analysis and design Human factors and security - Groupware, Meeting and decision support systems, Shared applications and artifacts, Frameworks for groupware Implementing synchronous groupware, Mixed, Augmented and Virtual Reality.	
Text Books	
1	A Dix, Janet Finlay, G D Abowd, R Beale., Human-Computer Interaction, 3rd Edition, Pearson, ,2008.
2	Shneiderman, Plaisant, Cohen and Jacobs, Designing the User Interface: Strategies for Effective Human Computer Interaction, 5th Edition, Pearson , 2010.
Reference Books	
1	Brian Fling, “Mobile Design and Development”, First Edition , O Reilly Media Inc., 2009

2	Bill Scott and Theresa Neil, “Designing Web Interfaces”, First Edition, O Reilly, 2009
3	Jeff Johnson, “Designing with the Mind in Mind: Simple Guide to Understanding User Interface Design Guidelines”, 2nd edition, Elsevier., 2010.
4	Ben Shneiderman, Catherine Plaisant, Maxine Cohen, Steven Jacobs, "Designing the User Interface", 5th Edition, Pearson Education, 2013.

ETHICS IN AI	
Course Code:MCS - 205 Contact Hours: L-3 T-0 P-0 Course Category: DEC	Credits: 3 Semester: 3

Introduction: An increased reliance on sophisticated AI systems for vital societal functions gives rise to ethical questions regarding usage and management. The course focuses on various areas of moral relevance for autonomous systems and AI. This course deals with various ethical aspects of AI systems to create a Trustworthy AI system.

Course Objective

- To Study the need for Trustworthiness of AI systems
- To understand the ethical aspects of AI systems to create a Trustworthy AI system.
- To study the algorithms to mitigate bias and algorithms on explain ability of ML systems.

Pre-requisite: Machine Learning

Course Outcome: After completion of the course, student will be able to

CO1: Understand the ethical issues in artificial intelligence (AI)·

CO2: Analyze an AI/ML system for its explain ability, robustness and fairness·

CO3: Understand the role of AI systems in the context of Human Society and Trusted decision making·

Pedagogy:
The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web- based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT I	10 Hours
AI and its ethical relevance, Machine Ethics, Autonomous systems, Trustworthy AI, Broad Principles of Trustworthiness, Fairness, Accountability, Sustainability, and Transparency; Difference between each of these aspects	
UNIT II	10 Hours
Bias and Types of Bias in AI systems, Identifying and mitigating bias in an AI system, Various bias mitigation methods and algorithms, Data fairness, Design fairness, Outcome fairness, Implementation fairness Fairness evaluation methods and algorithms - Algorithmic Fairness and other Fairness Methodologies	
UNIT III	10 Hours
Accountability; Answerability and Auditability; Sustainability; Safety; Accuracy, Robustness of AI systems - methods and techniques, Reliability of AI systems - methods and techniques, Verification of AI/ML systems, Ethics and Accountability in AI, Role of AI in Human Society and co-existence	
UNIT IV	12Hours
Explainable AI–Explanation in decision trees/Random Forests. Explanation of Linear classifiers by weights, Sparse models, Naive Bayes classifiers etc. Blackbox / whitebox / Greybox techniques – In the area of image/video classification, fine grained classification, vision and language, autonomous driving etc.,CAM, Grad-CAM, Grad-CAM++, LIME, Guided LIME, and their algorithms	
Text Books	
1	Mark Coeckelbergh ,"AI Ethics" , MIT Press, 2020.
2	Paula Boddington," Towards a Code of Ethics for Artificial Intelligence (Artificial Intelligence: Foundations, Theory, and Algorithms)", springer, 2017
3	Dennis Rothman, "Hands-On Explainable AI (XAI) with Python: Interpret, visualize, explain, and integrate reliable AI for fair, secure, and trustworthy AI apps", Packt Publishing Ltd 2020
Reference Books	
1	John Havens, "Heartificial Intelligence: Embracing Our Humanity to Maximize Machines", Tarcher Perigee; Latest edition 2016
2	S. Matthew Liao, "Ethics of Artificial Intelligence", OUP USA, 2020
3	Silvie Spreeuwenberg. "AIX: Artificial Intelligence needs eXplanation: Why and how transparency increases the success of AI solutions", LibRT: the Lab for Intelligent Business Rules Technology, 2019
4	Wendell Wallach , Colin Allen , "Moral Machines: Teaching Robots Right from Wrong ",OUP USA, 2010

COGNITIVE COMPUTING

Course Code: MCS 207	Credits: 3
Contact Hours: L-3 T-0 P-0 Course Category: DEC	Semester: 3

Introduction: This course explores the area of cognitive computing and its implications for today's world of big data analytics and evidence-based decision making. Topics covered include: cognitive computing design principles, natural language processing, knowledge representation, Students will have an opportunity to build cognitive applications, as well as explore how knowledge-based artificial intelligence and deep learning are impacting the field of data science.

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Course Objective: To develop algorithms that use AI and machine learning along with human interaction and feedback to help humans make choices/decisions and to understand how Cognitive computing supports human reasoning by evaluating data in context and presenting relevant findings along with the evidence that justifies the answers.

Pre-requisite: A course on AI

Course Outcome: After completing this course, the students will be able to:

CO1: Understand basics of Cognitive Computing and its differences from traditionalApproaches of Computing.

CO2: Plan and use the primary tools associated with cognitive computing.

CO3: Plan and execute a project that leverages Cognitive Computing.

Pedagogy:

The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT I	10 Hours
Introduction: Cognitive science and cognitive Computing with AI, Cognitive Computing, Cognitive Psychology, The Architecture of the Mind, The Nature of Cognitive Psychology, Cognitive architecture, Cognitive processes, The Cognitive Modeling Paradigms, Declarative / Logic based Computational cognitive modeling, connectionist models, Bayesian models. Introduction to Knowledge-Based AI , Human Cognition on AI , CognitiveArchitectures	
UNIT II	11 Hours
Cognitive Computing with Inference and Decision Support Systems: Intelligent Decision making, Fuzzy Cognitive Maps, Learning algorithms: Non linear Hebbian Learning – Data driven NHL - Hybrid learning, Fuzzy Grey cognitive maps, Dynamic Random fuzzy cognitive Maps.	
UNIT III	11 Hours
Cognitive Computing with Machine Learning: Machine learning Techniques for cognitive decision making, Hypothesis Generation and Scoring, Natural Language Processing, Representing Knowledge, Taxonomies and Ontologies, Deep Learning.	
UNIT IV	10 Hours
Case Studies: Cognitive Systems in health care, Cognitive Assistant for visually impaired, AI for cancer detection, Predictive Analytics, Text Analytics, Image Analytics, Speech Analytics, IBM Watson	
Text Books	
1	Hurwitz, Kaufman, and Bowles, Cognitive Computing and Big Data Analytics, Wiley, First edition, 2015
2	Masood, Adnan, Hashmi, Adnan ,Cognitive Computing Recipes-Artificial Intelligence Solutions Using Microsoft Cognitive Services and TensorFlow, 2015
Reference Books	
1	Peter Fingar, Cognitive Computing: A Brief Guide for Game Changers, PHI Publication, 2015
2	Gerardus Blokdyk ,Cognitive Computing Complete Self-Assessment Guide, 2018
3	Rob High, Tanmay Bakshi, Cognitive Computing with IBM Watson: Build smart applications using Artificial Intelligence as a service, IBM Book Series, 2019

ROBOTICS AND APPLICATIONS	
Course Code: MCS 209	Credits: 3
Contact Hours: L-3 T-0 P-0 Course Category: DEC	Semester: 3

Introduction: The study of robotics concerns itself with the desire to synthesize some aspects of human function by the use of mechanisms, sensors, actuators, and computers. This subject provides an important background material to students involved in understanding the basic functionalities of robotics.

Course Objectives:

- Learn types of robotics, fundamentals of robotics
- Learn languages used to program robots
- Learn sensing system for a robot and safety of robots.

Pre-requisite: Basic concepts of mathematics

Course Outcomes: After completing this course, the students will be able to:

CO1: Understand the basics of robotics and its fundamentals.
CO2: Understand deploying robotics applications and sensor nodes.
CO3: Understand usage of robotics principles in real life environment.

Pedagogy:
The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web- based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT I	10 hrs
Introduction to Robotics: Classification of Robots, Characteristics and performance, advantages and disadvantages of a Robot, Basic Control Systems Concepts and Models, Controllers, Control System Analysis, Robot Activation and Feedback Components, Power Transmission Systems.	
UNIT II	11 hrs
Robotics Kinematics: Position Analysis, Robots as Mechanism, Matrix Representation, Transformation Matrices, Forward and Inverse Kinematics. Actuators: Characteristics of Actuating Systems, Actuating Devices and Control. Robot End Effectors: Types, Mechanical Grippers, Tools and Interface	
UNIT III	11 hrs
Machine Vision: Introduction, Sensing and Digitizing Function, Image Processing and Analysis. Robot Programming: Programming Methods, Robot program as a path in space, Motion Interpolation, Commands and Branching. Basics of Robot Languages, Motion Commands and Program Control Subroutine.	
UNIT IV	10 hrs
Sensing system for a robot: Introduction, Sensor Characteristics, Types of sensors, machine 8 vision, Artificial intelligence, Control techniques Robot safety: Introduction, potential safety hazards, safety guidelines. Applications and Future of Robotics: Latest current applications and future manufacturing applications of robotics system.	
Text Books	
1	John J Craig, “Introduction to Robotics: Mechanics and Control”, Third Edition, Pearson education, 2009
2	Y. Koren “Robotics for Engineers”, McGraw Hill Publications, 1985
Reference Books	
1	Mikell P Groover, Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, “Industrial Robotics, Technology programming and Applications", McGraw Hill, 2012.
2	S.R. Deb, “Robotics Technology and flexible automation”, Tata McGraw-Hill Education, 2009
3	Richard D. Klafter, Thomas A, Chri Elewski, Michael Negin, "Robotics Engineering an Integrated Approach", PHI Learning, 1989

DATA ANALYTICS AND VISUALIZATION	
Course Code:MAI 201 Contact Hours: L-2 T-0 P-02 Course Category: DEC	Credits: 3 Semester: 3

Introduction: Data visualization is the graphical representation of information and data in a pictorial or graphical format. Data analytics is the process of analyzing data sets in order to make decision about the information they have, increasingly with specialized software and system.

Course Objectives:

- Familiarize how data can be presented to various stakeholders.
- Understand the lifecycle of data analysis.
- Understand the concepts of Predictive modelling
- Understand different data visualization techniques.

Pre-requisite: Mathematical Foundation for Data Science

Course Outcomes: After completing this course, the students will be able to:

CO1: Identify and understand different techniques for data analysis.
CO2: Interpret the lifecycle of data analysis from understanding to deployment.
CO3: Analyze and demonstrate predictive modeling and its applications.
CO4: Create effective data visualization using different visualization tools and techniques to visualize data.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT I	12 hrs
Data Analytic Thinking: The Ubiquity of Data Opportunities, Data Processing and "Big Data", From Big Data 1.0 to Big Data 2.0, Data and Data Science Capability as a Strategic Asset, Business Problems to Data Mining Tasks, Business Understanding.	
UNIT II	10 hrs
Data Analytics : Data Understanding, Data Preparation, Modeling, Evaluation, Deployment, Analytic techniques and technologies, Importance of context, Choosing an effective visual, Dissecting model visuals, Case studies.	
UNIT III	10 hrs
Introduction to Predictive Modelling: Sample data, Learn a model, Make predictions, Some Applications of Predictive Modeling.	
UNIT IV	10 hrs
Data visualization techniques: Univariate and Multivariate plots, pros and cons of data visualization, Data Visualization Tools, Case studies.	
Text Books	
1. Gareth James, Daniell Witten, Trevor Hastie, Robert Tibshirani ,"An Introduction to Statistical Learning with Applications in R" , Latest Edition , Springer, 2021	
2. Foster Provost, Tom Fawcett, "Data Science for Business", O'Reilley, Latest Edition, 2013	
Reference Books	
1. Ben Jones, "Communicating Data with Tableau", O'Reilley, 2014	
2. Storytelling with Data: A Data Visualization Guide for Business Professionals, Cole Nussbaumer Knaflic, Wiley, 2015	
3. https://www.coursera.org/learn/data-analyze-visualize	

BLOCKCHAIN FUNDAMENTALS

Course Code:MIS 211 Contact Hours: L-2 T-0 P-2 Course Category: DEC	Credits: 3 Semester: 3

Introduction: Blockchain can be described as a data structure that holds transactional records and while ensuring security, transparency, and decentralization. You can also think of it as a chain or records stored in the forms of blocks which are controlled by no single authority. A blockchain is a distributed ledger that is completely open to any and everyone on the network. Once an information is stored on a blockchain, it is extremely difficult to change or alter it. Blockchain andCryptocurrency is vastly discussed now days in all research domains to bring the decentralization. This course is to understand Blockchain and its main application cryptocurrency.

Course Objectives:

- To build expertise in Blockchain and Distributed Ledger Technology
- To understanding basics of Cryptocurrency - Bitcoin
- To understanding Smart Contracts

Pre-requisite: Basics of Elliptic Curve Cryptography, Decentralized and Distributed Computing, Peer-to-Computing, distributed Computing, Basic knowledge of programming.

Course Outcome: The students will be able to

CO1: Get expertise in Blockchain and Distributed Ledger Technology
CO2: Get Hands-on PoC experience across major Blockchain Platforms
CO3: Exposure to Blockchain Use Cases across Domains

Pedagogy:

The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web- based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT I	7 hrs
Basics: Distributed Database, Two General Problem, Byzantine General problem and Fault Tolerance, Hadoop Distributed File System, Distributed Hash Table, ASIC resistance, Turing Complete. Cryptography: Hash function, Digital Signature - ECDSA, Memory Hard Algorithm, Zero Knowledge Proof.	
UNIT II	7 hrs
Blockchain: Introduction, Advantage over conventional distributed database, Blockchain Network, Mining Mechanism, Distributed Consensus, Merkle Patricia Tree, Gas Limit, Transactions and Fee, Anonymity, Reward, Chain Policy, Life of Blockchain application, Soft & Hard Fork, Private and Public blockchain	
UNIT III	7 hrs
Distributed Consensus: Nakamoto consensus, Proof of Work, Proof of Stake, Proof of Burn, Difficulty Level, Sybil Attack, Energy utilization and alternate. Cryptocurrency: History, Distributed Ledger, Bitcoin protocols - Mining strategy and rewards, Ethereum - Construction, DAO, Smart Contract, GHOST, Vulnerability, Attacks, Sidechain, Name coin	
UNIT IV	7 hrs
Cryptocurrency Regulation: Stakeholders, Roots of Bitcoin, Legal Aspects - Cryptocurrency Exchange, Black Market and Global Economy. Blockchain Applications: Internet of Things, Medical Record Management System, Domain Name Service and future of Blockchain	
Text books	
1. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Princeton University Press, 2016.	
2. Wattenhofer, The Science of the Blockchain, 2016	
3. Josh Thompson, 'Blockchain: The Blockchain for Beginnings, Guild to Blockchain Technology and Blockchain Programming', Create Space Independent Publishing platform, 2017	
4. Chad Steel, "Windows Forensics", Wiley India, 2006	
5. Nelson, B, Phillips, A, Enfinger, F, Stuart, C., "Guide to Computer Forensics and Investigations, Thomson Course Technology, ISBN: 0-619-21706-5.	
Reference books	
1. Satoshi Nakamoto, Bitcoin: A Peer-to-Peer Electronic Cash System	

2. Nicola Atzei, Massimo Bartoletti, and Tiziana Cimoli, A survey of attacks on Ethereum smart contracts