Department of Computer science and Engineering, IGDTUW

M. Tech.- CSE (Artificial Intelligence)

First Semester

S. No.	Code	Subject	L-T-P	Credits	Category
1.	MCS- 101	Problem Solving Through AI	3-0-2	4	DCC
2.	MCS- 103	Soft Computing	3-0-2	4	DCC
3.	MCS- 105	Intelligent Data and Information Retrieval	3-0-2	4	DCC
4.	MCS- 107	Data Structures and Algorithm Analysis	3-0-2	4	DCC
5	GEC-101	Generic Open Elective-I #	2-0-0/ 1-1-0/ 0-0-2	2	GEC
6.	ROC -101	Research Methodology	3-0-0	3	ROC
		Total credits		21	

Second Semester

S. No.	Code	Subject	L-T-P	Credits	Category
1.	MIS- 102	Advances in Machine Learning	3-0-2	4	DCC
2.	MCS -104	IoT and its Applications in AI	3-1-0	4	DCC
3.	MCS- 106	Probability and Random Processes	3-1-0	4	DCC
4.	DEC1 xx	Departmental Elective Course – 1	3-0-2/ 3-1-0	4	DEC
5.	DEC1 xx	Departmental Elective Course - 2	3-0-2/ 3-1-0	4	DEC
6	ROC- 102	Research Ethics	3-0-0	3	ROC
		Total credits		23	

Third Semester

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* Dissertation -I should be preferably done in Industry by taking a real Industry problem .

S. No.	**Code**	**Subject**	**L-T-P**	**Credits**	**Category**
1.	MIS- 203	Neural network and Deep Learning	3-0-2	4	DCC
2.	DEC- 2xx	Departmental Elective-3	3-0-2	4	DEC
3.	DEC- 2xx	Departmental Elective-4	3-1-0/ 3-0-2	4	DEC
4	GEC- 201	General Open Elective-II #	2-0-0/ 1-1-0/ 0-0-2	2	GEC
5	MCS- 251	Dissertation-I * /Project work	-	8	DCC
6	MCS- 253	Industrial Training/Internship		1	DCC
		Total credits		23	

Fourth Semester

S. No.	Code	Subject	**L-T-P**	**Credits**	Category
1.	MCS- 252	Dissertation -II ***** /Project work	-	20	DCC
		Total credits		20	

* Dissertation -II should be preferably done in Industry by taking a real Industry problem.

List of Departmental Elective Courses

Category	Course Code	Subject	Credits
Departmental Elective Course-1	MCS- 108	Introduction to cognitive science	3-1-0
	MCS- 110	AI based Programming Tools	3-0-2
	MCS- 112	Knowledge Engineering	3-0-2
	MCS- 114	Cloud Computing	3-0-2
Departmental Elective Course-2	MCS- 116	Big Data Analytics	3-0-2
	MCS- 118	Parallel Algorithms	3-0-2
	MCS- 120	Knowledge Based System Design	3-0-2
	MCS- 122	Computer vision	3-1-0
Departmental Elective Course-3	MCS- 203	Digital Image Processing	3-0-2
	MCS- 205	Natural Language Processing	3-0-2
	MCS- 207	Mobile Application Development	3-0-2
	MCS- 209	Human Computer Interaction	3-0-2
	MCS- 211	Speech Processing and Speech Recognition	3-0-2
Departmental Elective Course-4	MCS- 213	Real Time Systems	3-0-2
	MCS- 215	Agent Based Intelligent Systems	3-1-0
	MCS- 217	Robotics and Applications	3-1-0
	MCS-219	Wireless Sensor Networks	3-0-2

PROBLEM SOLVING THROUGH AI	
Course Code: MCS 101 Contact Hours: L-3 T-0 P- 2 Course Category: DCC	Credits: 4 Semester: 1

Introduction: Artificial intelligence aims to understand thinking and intelligence in ways enable the construction systems that are able to reason in uncertain environments. This course will discuss fundamental concepts of Artificial intelligence and learning of how these concepts can be utilized to solve problems pertaining to Al.

Course Objective

- Demonstrative working knowledge in programming language Lips/Prolog in order to write simple programs.
- Know various Al search algorithms.
- Understand the fundamentals of knowledge representation (logic- based, frame-based, semantic nets), inference and theorem proving.
- To teach students , to reformulate any problem from AI perspective

Pre-requisite: basic knowledge of programming language fundamental concepts of mathematics and automation.

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

- Develop the Ability to choose knowledge representation method for different problems
- Learn about reasoning and machine learning techniques to real word problems.
- Know how to builds simple knowledge based system.
- Understand the process of Problem solving through AI perspective

Pedagogy: Classroom teaching which focuses on developing understanding of students to digest the concepts of subject with large number of examples.

UNIT I	10 Hours
Introduction : Al problems Task Domains of Al, Al Techniques: search knowledge, abstraction. Introduction to intelligent program and intelligence agents. Problem solving: basic problem solving Method: state space search, problem characteristics, production systems characteristics, issues in design of intelligent search algorithm.	
UNIT II	**11 Hours**
Heuristic search techniques : Hill climbing techniques, best first search, A* search, problem Reduction: AO* search, constraint satisfaction, means-end Analyst. Programming Languages: Fundamental and concepts of programming languages like prolog or Lips. Relationship of Language with knowledge presentation and inferences.	
UNIT III	**11 Hours**
Knowledge Representation: Knowledge Representation issues. Knowledge Representation using predicate logic: Unification resolution. Rule based systems: Forwarded versus backward reasoning conflict resolution. Structured knowledge Representation: Semantic Nets, Frames, conceptual dependency, scripts.	
UNIT IV	**10 Hours**
Learning from observation: Inductive learning decision trees, computational learning Theory Explanation based learning Applications: Environmental scince, Robotics, Aerospace, Medical Science etc.	

Text Books	
1	Stuart j. Russell and peter Norvig, Artificial Intelligence,- A Modern Approach , Pearson 2nd Edition 2009.
2	E. Rich and K. Knight, "Artificial Intelligence", TMH, 2nd ED.,1992.
3	Ela Kumar," Artificial Intelligence ", I.K. International Publishing House, 2011.
Reference Books	
1	P.H. Winston, " Artificial Intelligence," Pearson Education, 3rd Edition,2002
2	D.W. Patterson, "Introduction to Al and Expert Systems ", PHI,1992
3	Lugar, Artificial intelligence, PHI publication, 2015 , second edition

Suggestive Lab exercises to be done (More programs can be added in the list).

The language for implementation can be chosen to be any out of C / R / Python / Lisp/ Prolog.

1. Write a program to implement the recursion.
2. Write a program implement forward chaining.
3. Write a program create a dynamic link list.
4. Write a program create a circular link list.
5. Write a program implement A* algorithm.
6. Write a program implement best first search.
7. Write a program to implement Min Max search.
8. Write a program to implement Tic Tac Toe game.
9. Write a program perform the alpha beta pruning.
10. Write a program implement merge sort on two input data list
11. Write a program in python to implement bidirectional search
12. Write a program to implement backward chaining

SOFT COMPUTING	
Course Code: MCS 103 Contact Hours: L-3 T-0 P- 2 Course Category: DCC	Credits: 4 Semester: 1

Introduction: Soft Computing aims to introduce intelligent computing techniques for real world problem solving where the conventional hard computing techniques do not work. The course will solving real world problems when the data is imprecise in nature and the boundaries are non precise. Further the course will introduce to make learning systems and different techniques to optimize the results

Course Objective:

- To appreciate the need of Soft Computing Techniques for solving real world problem which cannot be solved by conventional hard computing techniques.
- To learn different types of sets which can handle imprecise data values.
- To develop systems which have learning capabilities.
- To learn techniques to optimize the results and find the optima.

Pre-requisite: Knowledge of basic Mathematics and Algorithms

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

- Able to realize importance and apply Soft Computing techniques for real world problem solving
- Able to represent the imprecise information using sets and develop inference systems based on these.
- Develop learning systems
- Learn and practice various optimization algorithms for real world problems solving

Pedagogy: Classroom teaching which focuses on developing understanding of students to digest the concepts of subject with large number of examples.

UNIT I	Hrs. 10
Introduction of soft computing: Soft computing vs. hard computing, various types of soft computing techniques, applications of soft computing. Concept Of Uncertainty : Presence of uncertainty in real world problems, handling uncertain knowledge, Bayesian Classifiers, Perplexed bayes classifiers.	
UNIT II	**Hrs. 11**
Fuzzy sets and fuzzy logic: Introduction to fuzzy logic, classical and fuzzy sets, overview of fuzzy sets, membership function, fuzzy rule generation, operations on fuzzy sets: compliment, intersection, union, combinations on operations, aggregation operation. Fuzzy Extension Principles, Defuzzification. Fuzzy Rule bases, Development of Fuzzy Logic based Expert Systems. CASE STUDIES	
UNIT III	**Hrs.11**
Neural Networks &Rough Sets: Overview of biological neurons, Mathematical model of Neuron, Perceptron and Multi Layer Perceptron, Learning in Artificial Neural Networks; Supervised, Unsupervised and Competitive Learning paradigms; Learning rules and Functions, Back propagation algorithm, Rough Sets. Upper and Lower Approximations, Boundary Region, Decision Tables and Decision Algorithms. Properties of Rough Sets. Rough Membership, Reducts. Discernibility Matrix and Discernibility Functions. Generation of Inference Rules. CASE STUDIES	
UNIT IV	**Hrs.10**
Evolutionary Algorithms and Hybrid Algorithms: Introduction, Evolutionary algorithms - Genetic Algorithm: History, terminology, biological background, creation of offspring, working principles of genetic algorithms, fitness function, Roulette wheel selection, Boltzmann selection, cross over mutation, inversion, deletion, and duplication, generation cycle , Swarm Optimization –Part Swarm Optimization and Ant Colony Optimization.Differential Evolutionary Algorithm. **Hybrid Algorithms**, Neuro Fuzzy, Fuzzy Evolutionary etc.	

Text Books	
1	Principles of Soft Computing - Deepa Shivandan Das, 2012, JohnWiley Publication.
2	Fuzzy Logic: A spectrum of Theoretical and Practical issues, Paul P. Wang, publication 2004.
3	Fuzzy Sets, Fuzzy logic, and Fuzzy Systems: Selected Papers- Lotfi Asker Zadeh, George J. Kilr, Bo yuan,2005.
Reference Books	
1	Introduction of Soft Computing- Neuro Fuzzy and Genetic Algorithms, Samir Roy Udit Chakraborty, Pearson Education, 2013.
2	D.W. Patterson, "Introduction to Al and Expert Systems ", third edition PHI,2016
3	Nature-Inspired Metaheuristic Algorithms: Second Edition , Xin-She Yang, Luniver press, 2010

Suggestive List of experiments (More programs can be added to this list)

1. Write a program To implement Baye's classifier for classification of sample data.

2. Write a program to implement perplexed Baye's classifier for analysis of textual data.

3. Write a program to implement a Fuzzy Set and compute Union, intersection and complementation of members. Your program should take input from the screen.

4. Develop an Expert System in MATLAB Toolbox for Inferencing using Fuzzy Inference Rules.

5. Write a program to develop a multilayered perceptron.

6. Write a program to compute discernibility matrix and discernibility function. Generate Inference Rules and eliminate inconsistent inference Rules.

7. Implement genetic algorithm and solve Travelling salesman Problem for five nodes. Display the number of iterations used to reach the optimal solution.

8. Implement Differential Evolutionary Algorithm to solve forecasting problems.

9. Implement Ant Colony Optimization Algorithm for optimizing results.

10. Implement Particle Swarm Optimization Algorithm On Task Allocation Problem.

INTELLIGENT DATA AND INFORMATION RETRIEVAL	
Course Code: MCS 105 Contact Hours: L-3 T-0 P- 2 Course Category: DCC	Credits: 4 Semester: 1

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 Objective:

- 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-requisite: Knowledge of basic databases and algorithms

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

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

Pedagogy: Classroom teaching which focuses on developing understanding of students to digest the concepts of subject with large number of examples.

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	Information Retrieval – Algorithms and Heuristics, David A. Grossman, Ophir Frieder, 2nd Edition, 2012, Springer, (Distributed by Universities Press)
2	Modern Information Retrieval Systems, Yates, Pearson Education,2014.
3	Information Storage and Retrieval Systems, Gerald J Kowalski, Mark T Maybury, Springer, 2000.
Reference Books:	
1	Mining the Web : Discovering Knowledge from Hypertext Data, Soumen Chakrabarti Morgan-Kaufmann Publishers, 2002.
2	An Introduction to Information Retrieval, Christopher D. Manning, Prabhakar Raghavan, HinrichSchütze, , Cambridge University Press, Cambridge, England, 2009.
3	Martin, J " Intelligent Information retrieval: PHI publication, 3rd edition, 2013

Suggestive List of experiments (More programs can be added to this list)

1. Write a Program in Fuzzy SQL to create Type-1 Fuzzy Relations
2. Implement Fuzzy Selection and Fuzzy Projection operation in Fuzzy Relations.
3. Create a Program in Prolog to generate a Deductive database
4. Enter atleast 10 queries and draw inferences from the deductive database.
5. Write a program to implement information retrieval via Vector Space Model . Your program should also calculate Precision & Recall.
6. Write a program to implement information retrieval via Fuzzy Model. Your program should also calculate Precision & Recall.
7. Write a program to for query expansion . Your programs should also compare precision and recall values, before and after query expansion.
8. Write a program to extract information from meta search Engines.
9. Write a program to implement error correction using Edit Distance and n-gram methods.
10. Write a program to implement disambiguation in Information Retrieval Query. Calculate Precision & Recall.

DATA STRUCTURES AND ALGORITHM ANALYSIS

Course Code: MCS 107 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 algorithms for 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 :

- Successfully design and implements the core and advance data structures
- Successfully analyses the complexity associated with the various data structures
- Analyse, design and implements the various proposed algorithm based on different algorithmic strategies.
- Choose data structures for various complex problems

Pedagogy : Classroom teaching which focuses on developing understanding of students to digest the concepts of subject with large number of examples.

UNIT I	10 Hours
Algorithms performance analysis: Time and space complexity, Asymptotic Notations, Complexity Analysis Examples. **Linear Data Structures:** Arrays, Stacks, Queues, Linked lists, **Recursion:** Solving recurrences.	
UNIT II	**10 Hours**
Non-linear Data Structure: Trees, Traversals, Binary Search Trees, AVL tree, B-trees, B+ Tree, Red Black Tree. **Graph Algorithms:** DFS, BFS, Minimum Spanning Tree Algorithms, Shortest path Algorithms.	
UNIT III	**12 Hours**
Sorting and Searching Algorithms: Quick Sort, Merge Sort, Heap sort; Linear Search and Binary Search. **Hashing:** Hashing Functions, Collision Resolution Techniques	
UNIT IV	**10 Hours**
Algorithm Strategies: Greedy paradigm with examples. Divide and conquer paradigm with examples. Dynamic-programming paradigm with examples. **NP Completeness:** P, NP, NP-complete, NP-Hard categories of problems, Cook's theorem.	
Text Books:	
1	Y. Langsam et. al., "Data Structures using C and C++", Second Edition, PHI,2015
2	E. Horowitz, S. Sahani, Anderson-Freed "Fundamentals of Data Structures in C", Second Edition, University Press, 2008
3	T. H. Cormen, C. E. Leiserson, R. L. Rivest, Clifford Stein, "Introduction to Algorithms", 3rd Ed., PHI, 2011.
Reference Books:	
1	R. L. Kruse, B. P. Leung, C. L. Tondo, "Data Structures and program design in C", PHI, 2010.
2	Ellis Horowitz and Sartaz Sahani, "Fundamental of Computer Algorithms", Galgotia Publications, 2009.
3	A. V. Aho, J. E. Hopcroft, J. D. Ullman, "The Design and Analysis of Computer Algorithms", Addition Wesley, 2009.
4	D. E. Knuth, "The Art of Computer Programming", 2nd Ed., Addison Wesley,2011.

Suggestive List of experiments (More programs can be added to this list)

1. Write a program that Implement Single Link List with following operations: i) Insertion of a node at first node, at any position and at end of list. ii) Deletion of a node at start, at middle and at end of list. iii) Display the link list. iv) Count the number of nodes in the link list. v) Search a node in the link list. vi) Sort the link list. vii) Reverse the link list.
2. Write a program that Implement Stack and queue with all primitive operations by using Array.
3. Write a program that Implement Stack and Queue with all primitive operations by using link list.
4. Write a program that Implement doubly link list with primitive operations: (i) Create a doubly linked list (ii Insert a new node to the left of the node. (iii) Delete the node of a given data. (iv) Display the contents of the list.
5. Write a program that Implement Circular link list with primitive operations. (i) Creation of the Circular list (ii) Insertion of the node (iii) Deletion an element (iv) Display the list
6. Write a program that Implement Binary Search Technique.
7. Write a program that Implement AVL tree and Red Black Tree.
8. Write a program that Implement Binary Tree and its Traversal.
9. Write a program that Implement BFS & DFS over a graph.
10. Write a program that Implement shortest path algorithms.
11. Write a program that Implement Quick Sort, Merge Sort and Heap Sort.
12. Write a program that implement Disjoint Set Data Structure
13. Write a program that implements Knapsack Problem.
14. Write a program that implements Huffman Coding
15. Write a program to implement Prim’s and Kruskal's Algorithm
16. Write a program to implement Matrix Chain Multiplication Algorithm
17. Write a program to implement Longest Common Subsequence Algorithm.
18. Write a program to implement All Pair Shortest Path Algorithm.

RESEARCH METHODOLOGY

Course Code: ROC 101 Contact Hours: L-3 T-0 P- 0 Course Category: ROC	Credits: 3 Semester: 1

Introduction: The course introduced the students to the research world. They will understand how to read and interpret a research papers. Also this course will make then understand how to write their own research proposals,

Course Objectives:

The purpose is to align the M. Tech. students with the research process of the rest of the world so that when they go for higher studies either in university or industry, they should be aware of how to communicate their research to the rest of the world and how to read and interpret the research work of others. The students will also become aware of metrics of how to evaluate the quality of different research works. The practical statistical tools will enhance their skills to apply mathematical tools to their research to interpret results and communicate in a common jargon.

Course Outcomes: Having successfully completed this course, the students will be able to write their own research proposal. They will also have familiarity with research journals, how do the whole process works right from draft of a research paper to reviewer comments and publishing. Pedagogy: Classroom teaching which focuses upon relating the textbook concepts with real world phenomena, along with regular tutorial classes to enhance the problem-solving ability.

UNIT I	**Hrs. 10**
Objectives and Motivation of Research, Types of Research, Research Approaches, Significance of Research. Research Methods verses Methodology. Research and Scientific Method, Important of Research Methodology. Research Process, Criteria of Good Research, Problems Encountered by Researchers in India, Benefits to the society in general. Defining the Research Problem: Definition of Research Problem, Problem Formulation, Necessity of Defining the Problem. Technique involved in Defining a Problem.	
UNIT II	**Hrs. 10**
Literature Survey: Importance of Literature Survey, Sources of Information, Assessment of Quality of Journals and Articles, Information through Internet. Significance of ISSN, DOI, Impact Factor, Citations. Rules of Citation. Research Design: Meaning of Research Design, Need of Research Design, Feature of a Good Design, Important Concepts Related to Research Design, Different Research Designs, Basic Principles of Experimental Design, Developing a Research Plan, Design of Experimental Set up. Use of Standards.	

UNIT III	Hrs.11
Descriptive Statistics. Points of Central tendency. Measures of Variability. Measures of relationship. Inferential Statistics-Estimation, Hypothesis Testing. How to read data from multiple files. Interpretation of Data: Univariate Analysis. Tests for significance: Chi square, t-test. Regression modeling. Direct and Interaction effects, ANOVA, F-test, Time Series analysis, Autocorrelation and Autoregressive modeling Inferential statistics: Normal Curve, Confidence Interval, Typel and Type 2 errors.	
UNIT IV	**Hrs.10**
Research Report Writing: Format of the Research report. Style of writing repo References Bibliography/Webliography, Technical paper writing Joumal report writing. Survey Methods: Questionnaire method: Types of Questionnaires: Process of Questionnaire Designing , Advantages and Disadvantages of Questionnaire Method. Objectives and Motivation of Research, Types of Research, Research Approaches, Significance of Research, Research Methods verses Methodology, Research and Scientific Method, Important of Research Methodology, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India, Benefits to the society in general. Defining the Research Problem: Definition of Research Problem, Problem Formulation. Necessity of Defining the Problem, Technique involved in Defining a Problem.	
Text Books	
1	C.R Kothari, “Research Methodology, Methods & Technique”; New Age International Publishers, 2004
2	R. Ganesan, "Research Methodology for Engineers", MJP Publishers, 2011
Reference Books	
1	Y.P. Agarwal, "Statistical Methods: Concepts, Application and Computation", Sterling Publs., Pvt., Ltd., New Delhi, 2004
2	Vijay Upagade and Aravind Shende, "Research Methodology", S. Chand & Company Ltd., New Delhi, 2009

ADVANCES IN MACHINE LEARNING	
Course Code: MIS 102 Contact Hours: L-3 T-0 P- 2 Course Category: DCC	Credits: 4 Semester: 2

Introduction: Machine learning is the science of getting computers to a new science of getting computers to act without being explicitly programmed. Many researchers also think it is the best way to make progress towards 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 Machine Learning
- To explain the strengths and weaknesses of different machine learning algorithms (relative to the characteristics 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, Discrete Mathematics (Set Theory, Graph Theory, Logic), Basic Probability Theory and Statistics, and Data Structures and Algorithms

Course Outcomes:

- Gain a broad understanding of machine learning algorithms and their use in data driven knowledge discovery and program synthesis.
- Identify, formulate and solve machine learning problems that arise in practical applications.
- Obtain an understanding of the current state of the art in machine learning and be able to begin to conduct original research in machine learning.

Pedagogy: Lecture delivery via discussions, whiteboard, slideshows, lab-work with case studies in Matlab/Python implementation

UNIT I	Hrs. 12
Introduction to Machine Learning, Well Posed Problems, Machine Learning Process, Designing a Learning System, Types of Machine Learning, Application of Machine Learning, Prospectives and Issues In 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), Turning Data into Probabilities (The Naive Bayes' Classifier). Some	

Radio Statistics The Brain And The Neuron, Neural Networks. The Perceptron. Linear Separability And Regression (Linear And Logistic Regression). The Multi-layer Perceptron, Forward And Back-error propagation, Radial Basis Functions And Splines The Curse On Dimensionality. Dimensionality Reduction. Principle Component Analysis Linear Discriminant Inalysis (DA) Factor Analysis. Independent components Analysis (ICA).

UNIT II **Hrs. 10**

Probabilistic Learning. Gaussian Mixture Models. Nearest Neighbour Methods. Support Vector Machines. Optimal Separation. Kernels, Svm Algorithm And Extension Learning With Decision Tree ID3 CARL Ensembling Learning Boosting. Bain Random Forest Different Ways To Combine Classifiers. Opumization And Search Techniques - Going Downhill. Least-Squares Optimisation. Search Approaches (Exhaustive Search. Greedy Search. Hill Climbing).

UNIT III **Hrs.10**

Tonary Learning, Genetic Algorithm. Generating Offspring. Genetic Programming, Particle Swam Optimization. unsupervised Learning, Clustering. Mixture Models, K-Means Clustering. Hierarchical clustering. Distributional Clustering. Self-Organising Map (SOM). Evaluation Parameters For Unsupervised Learning. Reinforcement Learning: State And Action Spaces. Action, Policy, Markov Decision Processes. The Difference Between SARSA And Q-Learning. Uses Of Reinforcement Learning

UNIT IV **Hrs.10**

Markov Chain Monte Carlo (MCMC) Methods, Graphical Models, Bayesian Networks, Hidden Markov Models (HMMS), Tracking Methods. Advance Machine Learning Techniques - Gaussian Process Regression, Energetic Learning: The Hopfield Network, The Boltzmann Machine, Restricted Boltzmann Machine (RBM) Deep Learning- Deep Belief Networks(DBN), Convolution Neural Networks (CNN).

Text Books

1	Chapman & Hall, Machine Learning: An Algorithmic Perspective, CRCF Press, Second Edition, 2015
2	Christopher Bishop, Pattern Recognition and Machine Learning. Springer, 2nd Edition 2010
3	Tom Mitchell, Machine Learning, McGraw Hill, 2017

Reference Books

1	T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2e, 2008.
2	Han, Jiawei, Jian Pei, and Micheline Kamber, Data Mining: Concepts and Techniques. Elsevier, 2011.

IOT AND ITS APPLICATION IN AI

Course Code: MCS 104 Contact Hours: L-3 T-0 P- 2 Course Category: DCC	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 **u**nderstanding 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:

- Understand the architecture and applications development for solving real world problems using IoT.
- Understand deploying smart applications on different IoT platforms.
- Develop Interface of various sensors, I/O devices and I/O peripherals with N / W Protocols
- Develop AI based/ IoT based Mobile Application Development

Pedagogy: The course will be taught with lectures, demonstrations, lab exercises and mini project with case studies.

UNIT I	**11 Hrs**
Introduction to IoT Architectural Overview: Design principles and needed capabilities, AI Applications inIoT Applications, Sensing, Actuation, Basics of Networking, M2M and IoT Technology Fundamentals- Devices and gateways, Data management, Business processes in IoT, Everything as a Service(XaaS), Role of Cloud in IoT, Security aspects in IoT.	

UNIT II	11 Hrs
IoT Interfacing : Components 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/Node.js/Arduino). **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 Hrs**
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, 6LoWPAN. Transport Layer: TCP, UDP. Application layer: HTTP, MQTT, CoAP, XMPP, AMQP.	
UNIT IV	**10 Hrs**
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, Authentication, authorization of devices. Case Study: Smart Cities and Smart Homes, Connected Vehicles, Industrial IoT, Agriculture, Activity Monitoring.	

Text Books

1	Adrian McEwen and Hakim Cassimally" Designing the Internet of Things, , Wiley Publication, Nov 2013
2	Pethuru Raj and Anupama C. Raman , (CRC Press) , he Internet of Things: Enabling Technologies, Platforms, and Use Cases", by, Auerbach publication Feb 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, 29 Nov 2018
3	David ,Hanes, Salgueiro Gonzalo, IoT Fundamentals: Networking Technologies, Protocols and Use Cases for the Internet of Things by Pearson 16 August 2017
4	Surya Durbha, Jyoti Joglekar, Internet of Things, Oxford University Press 2019.

PROBABILITY AND RANDOM PROCESSES	
Course Code: MCS 106 Contact Hours: L-3 T-1 P-0 Course Category: DCC	Credits: 4 Semester: 2

Introduction: This course provides necessary basic concepts in probability and random processes for applications such as Artificial intelligence. The aim of the course to understand the basic concept of probability, one and two dimensional random variables and to introduce some standard distributions applicable to engineering which can describe real life phenomenon. This course helps to understand the basic concepts of random processes which are widely used in IT fields.

Course Objective: To provide a detailed treatment of techniques used in mathematics regarding probability and random processes and to introduce the students to the techniques of dealing with uncertainties.

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

Course outcomes: After studying this course, students would be able to :

- Understand the axiomatic formulation of modern Probability Theory and think of random variables as an intrinsic need for the analysis of random phenomena.
- Characterize probability models and function of random variables based on single & multiples random variables.
- Evaluate and apply moments & characteristic functions and understand the concept of inequalities and probabilistic limits.
- Understand the concept of random processes and determine covariance and spectral density of stationary random processes.
- Demonstrate the specific applications to Poisson and Gaussian processes.

Pedagogy: Classroom teaching which focuses on developing understanding of students to understand the concepts of subject larger number of examples and presentations and lab exercises.

UNIT I	Hrs. 10
Introduction to Probability: Sets and set operations, probability space, conditional probability and Bayes theorem, combinatorial probability and sampling models.	
UNIT II	**Hrs. 11**
Random Variables: Discrete random variables, probability mass function, probability distribution function, example random variables and distributions continuous random variables, probability density function, probability distribution function, example distributions Joint	

distributions, functions of one and two random variables, moments of random variables conditional distribution, densities and moments, characteristic functions, Markov, Cheby-shev and Chernoff bounds.

UNIT III **Hrs.11**

Sequence of Random Variables and Convergence: Random sequences, Almost sure (a.s.) convergence and strong law of large numbers convergence in mean square sense with examples from parameter estimation convergence in probability with examples convergence in distribution central limit theorem. Random processes, stationary processes, mean and covariance functions, ergodicity, linear filtering of random processes

UNIT IV **Hrs.10**

Monte Carlo Processes: Concept of Monte Carlo processes. Analysis of Monte Carlo processes , power spectral density, examples of Monte Carlo processes. Applications of Monte Carlo Processes. Random processes: white noise process and white noise sequence, Gaussian process, Poisson process, Markov process.

Text Books

1	Geoffrey Grimmett, Probability and Random Processes, , Oxford University Press , 3rd edition 2001.
2	Henry Stark and John W. Woods, Probability and Random Processes with Applications to Signal Processing, Prentice Hall, 3rd Edition 2001.

References Books

1	Papoulis, A. Probability, Random Variables and Stochastic Processes, Mc Graw Hill , First edition , 2010
2	G.P. Beaumont, Probability and Random Variables, John Wiley and Sons. 2010.

INTRODUCTION TO COGNITIVE SCIENCE

Course Code: MCS 108 Contact Hours: L-3 T-1 P-0 Course Category: DEC	Credits: 4 Semester: 2

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 should be studied by students , to study this course.

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

- Understand basics of Cognitive Computing and its differences from traditional Approaches of Computing.
- . Plan and use the primary tools associated with cognitive computing.
- . Plan and execute a project that leverages Cognitive Computing.

Pedagogy: Classroom teaching which focuses upon relating the textbook concepts with real world phenomena, along with periodic tutorial classes in case studies to enhance the problem-solving ability.

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 – Cognitive Architectures	
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, Indianapolis, IN, 2005, ISBN: 978-1-118-89662-4.
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

AI BASED PROGRAMMING TOOLS	
Course Code: MCS 110 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 2

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 programming languages 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:

- Learn and analyze the programming skill useful for developing AI based applications.
- Develop programs in Python Programming.
- Developing program using R language.
- Understand the methodology of developing big application in AI.

Pedagogy: The course will be taught with lectures, lab exercises and mini project with case studies.

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 **11 Hours**

Advance Features of Python: File Handling Using Python File 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	**11 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, PHI Publisher, 2014
3	Dalgaard, Peter, "Introductory statistics with R", Springer Science & Business Media, 2013

KNOWLEDGE ENGINEERING	
Course Code: MCS 112 Contact Hours: L-3 T-1 P-0 Course Category: DEC	Credits: 4 Semester: 2

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:

- Identify basic components and types of knowledge .
- Understand various knowledge representation methods.
- Devise computer structures to store knowledge.
- Understand development of knowledge intensive systems.

Pedagogy: The course will be taught with lectures, demonstrations, and mini project with case studies.

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. 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 world problems. Acquisition of static and dynamic knowledge .	

UNIT III	**11 Hours**
Knowledge Manipulation: 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 IV	**10 Hours**
Knowledge Management: Use and Reuse of Knowledge, Knowledge Management Overview, Knowledge Conversion, Knowledge Management Roles, Implications of Knowledge Management.	
Text Books:	
1	James Martin, Problem Solving using Knowledge Engineering, PHI Publication, edition 4th 2017.
2	Ela Kumar, Knowledge Engineering, IK International Publication First Edition, 2017
3	Elias M.Awad, Hassan M.Ghaziri " Knowledge Management, PHI publication, Second Edition, 2011
Reference Books:	
1	Skyrme David " Knowledge Centric Problem Solving, Mc Graw Hill, publication 1st edition 2015.
2	Reich and Turing , " Artificial Intelligence", Mc Graw Hill, 3rd edition, 2016
3	M.Gahziri, Expert Systems Design, PHI publication , 1st edition , 2012,

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

Introduction: This course gives an insight into Cloud Computing and other related emerging Computing Technologies. It teaches various Cloud Computing Models and services and their current uses from industry perspective.

Course Objective: To familiarize with the evolution, concept and deployment models of cloud computing, and to familiarize different services of cloud computing.

Pre-requisite: There is no pre-requisite for this course.

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

- Develop ability to understand Cloud Computing Architecture and Services
- Develop ability to understand the use cases of Cloud Computing Applications
- Understand concept of Virtualization and Containership
- Integrate the Cloud Services in different aspects of a project

Pedagogy: The course will be taught with lectures, and lab exercises.

UNIT I	10 Hours
Introduction: Trends in Computing, Concept and Evolution of Cloud Computing Paradigm. Introduction to Cloud Computing, Benefits and challenges of cloud computing. **Cloud Deployment Models:** Public clouds, Private clouds, Community clouds, Hybrid clouds, Advantages of Cloud computing.	
UNIT II	**11 Hours**
Architecture and Services: Cloud delivery model, SPI framework, SPI evolution, SPI vs. traditional IT Model, IaaS service providers, SaaS service providers, PaaS service providers. Case studies on cloud service providers – Amazon EC2, Google App Engine, Microsoft Azure	
UNIT III	**11 Hours**
Virtualization: Virtualization Concept, Need of virtualization, Types of Virtualization. Storage virtualization, Compute/Processor virtualization, Network virtualization. Software Defined Networks, Network Function Virtualization.	

UNIT IV	10 Hours
Best Practices and Similar Upcoming Technologies: Analysis of Case Studies when deciding to adopt cloud computing architecture, Cloud Security, Block chain, Containerization and Docker. Recent research in computing.	
Text Books:	
1	Barrie Sosinky, "Cloud Computing". Wiley Publishing House, 2011.
2	Michael J. Kavis, "Architecting the Cloud: Design Decision for Cloud Computing". John Wiley & Sons, 2014.
3	Rajkumar Buyya &James Broberg ,"Cloud Computing: Principles and Paradigms (Wiley Series on Parallel and Distributed Computing)", Wiley-Blackwell, 2011.
Reference Books:	
1	Anthony T.Velte, Toby J. Velte Robert Elsenpeter, "Cloud computing a practical approach", McGraw-Hill Osborne, 2009.
2	Thomas Erl, Ricardo Puttini, "Cloud Computing: Concepts, Technology & Architecture", Prentice Hall, Pearson Publications, 2013.
3	G. Coulouris, J. Dollimore, T. and Kindberg, Distributed Systems: Concepts and Design Edition 3. Pearson Education

BIG DATA ANALYTICS

Course Code: MCS 105 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 familiarize the students with most important information technologies used in manipulating, storing, and analyzing big data.

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

Pre-requisite: To study this course , students should have studied course on , one Programming Language, like SQL, and should have exposure to Linux Environment.

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

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

Pedagogy: The course will be taught with lectures, demonstrations, lab exercises.

UNIT I	**10 Hours**
Introduction to Big Data and Hadoop : Types of Digital Data, Introduction to Big Data, Big Data Analytics, History of Hadoop, Apache Hadoop, Analyzing Data with Hadoop, Hadoop Streaming, Hadoop Echo System.	
UNIT II	**10 Hours**
HDFS (Hadoop Distributed File System) : The Design of HDFS, HDFS Concepts, Command Line Interface, Hadoop file system interfaces, Data flow, Data Ingest with Flume and Scoop and Hadoop archives, Hadoop I/O: Compression, Serialization, Avro and File-Based Data structures.	
UNIT III	**10 Hours**

Map Reduce :

Anatomy of a Map Reduce Job Run, Failures, Job Scheduling, Shuffle and Sort, Task Execution, Map Reduce Types and Formats, Map Reduce Features.

UNIT IV **12 Hours**

Hadoop Eco System :

Pig : Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators.

Hive : Hive Shell, Hive Services, Hive Metastore, Comparison with Traditional Databases, HiveQL, Tables, Querying Data and User Defined Functions.

Hbase : HBasics, Concepts, Clients, Example, Hbase Versus RDBMS.

Text Books

1	Seema Acharya, Subhasini Chellappan, "Big Data Analytics" Wiley 2015.
2	Tom White " Hadoop: The Definitive Guide" Third Edit on, O'reily Media, 2012.
3	Tom Plunkett, Mark Hornick, "Using R to Unlock the Value of Big Data: Big Data Analytics with Oracle R Enterprise and Oracle R Connector for Hadoop", McGraw-Hill / Osborne Media (2013),

Reference Books

1	Jay Liebowitz, "Big Data and Business Analytics" Auerbach Publications, CRC press (2013)
2	Michael Mineli, Michele Chambers, Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley Publications, 2013.

PARALLEL ALGORITHMS

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

Introduction: A conventional algorithm uses a single processing element. A parallel algorithm assumes that there are multiple processors. These processors may communicate with each other using a shared memory or an interconnection network. An algorithm designed for large number processors can be simulated on a machine with a small number of processor for a trade off on time, and therefore is of practical value, while at the same time allowing us to test the limits of parallelism. Many algorithmic design techniques in the parallel setting will be explored. Parallel complexity theory will also be briefly studied.

Course Objective: To introduce techniques for the design of parallel algorithms.

Pre-requisite: As a prerequisite of this course , Students Should have done courses in Data Structures, Algorithms and Discrete Mathematics.

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

- Develop efficient Parallel Algorithms related to Application areas of Computer Science
- Understand with the basic issues of implementing Parallel Algorithms.
- Learn the Techniques for writing programs for Big Applications
- Develop programs using Graph Algorithms

Pedagogy: The course will be taught with lectures, and lab exercises.

UNIT I	**10 Hours**
Introduction: Theoretical models of parallel computation: variants of the PRAM model, interconnection networks, synchronous and asynchronous models. Performance of parallel algorithms. Basic techniques: balanced trees, recursive doubling, divide and conquer, partitioning, pipelining, accelerated cascading, symmetry breaking.	
UNIT II	**11 Hours**
Comparator Networks: Odd even Merge sort, Biotonic-Sort-Merge-Sort, Optimal List colouring, Optimal List ranking algorithm- description, analysis & applications, fast optimal merge algorithm, Cole's Merge sort, Lower bound for sorting.	
UNIT III	**11 Hours**
Graph Algorithms: Connected components, Vertex Colouring, Sorting on 2D mesh, offline routing on a 2D mesh, Sorting on 3D mesh, mesh of trees .	

UNIT IV	10 Hours
Hypercube Algorithms: Butterfly Network, CCC, Benes network, Shuffle exchange graphs, de Brunjin Graph, Limits to parallelizability.	
Text Books:	
1	J. Jaja, An Introduction to Parallel Algorithms, Addison Wesley publication, first edition, 1992.
2	Selim G. Akl, The Design and Analysis of Parallel Algorithms, Prentice Hall publication, Third edition, 2010.
Reference Books:	
1	John Reif (editor): Synthesis of Parallel Algorithms. Morgan Kaufmann, 1993.
2	Vipin Kumar, Ananth Grama, Anshul Gupta, and George Karypis, Introduction to Parallel Computing: Design and Analysis of Algorithms, , Benjamin Cummings 2nd ed. – 2003
3	A.Gibbons, W.Rytter, Efficient Parallel Algorithms, Cambridge University Press, first edition, 1988

KNOWLEDGE BASED SYSTEM DESIGN	
Course Code: MCS 120 Contact Hours: L-3 T-0 P- 2 Course Category: DEC	Credits: 4 Semester: 2

Introduction: This course completely deals with design aspects of Knowledge Based System . There are systems that are Knowledge Intensive and Rule Intensive. The Knowledge Intensive Systems are for the applications that require extensive knowledge and Rule Intensive Systems are basically expert systems, which are extensive in procedure. The course deals with the design aspects of Knowledge Based Sytems.

Course Objective: **T**his course aims at telling the students the design features of knowledgebase d systems and concepts and methodologies of such systems

Pre-requisite: Basic knowledge of programming language fundamental concepts of mathematics and automation.

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

- Differentiate between knowledge intensive and rule intensive systems
- Understand details of expert systems and its design procedure
- Understand application domain of knowledge intensive systems
- Design knowledge based systems for small real world applicaitons

Pedagogy: Classroom teaching which focuses on developing understanding of students to digest the concepts of subject with large number of examples.

UNIT 1	Hrs 10
Introduction to Knowledge Based Systems: Basic Component of Knowledge Based Systems, Different types of Knowledge Bases, Difference between Knowledge Intensive and Rule Intensive Systems., Challenging issues in Development of Knowledge Based Systems .	
UNIT II	**Hrs 10**
Representation of Domain Knowledge, Identification of Knowledge specific to application domain, components and different modules of knowledge based system. Knowledge management , creation of knowledge , capture, assimilation,	

UNIT- III	Hrs 11
Design Criterion of Knowledge Based Systems: Salient features of design of Input / output interface, Design methodologies of Knowledge bases, Designing of inferencing module.	
UNIT – IV	**Hrs 11**
Expert System: Concept of Expert System, Application Domain of Expert System, Basic components of an Expert Systems, inference module, Input / output module, knowledge base. Design Methodologies of Expert Systems.	
Text Books	
1	Stuart j. Russell and peter Norvig, Artificial Intelligence,- A Modern Approach , Pearson 2nd Edition 2009.
2	E. Rich and K. Knight, "Artificial Intelligence", TMH, 2nd ED.,1992.
3	Ela Kumar," Artificial Intelligence ", I.K. International Publishing House, second Edition, 2011.
Reference Books	
1	P.H. Winston, " Artificial Intelligence," Pearson Education, 3rd Edition,2002
2	D.W. Patterson, "Introduction to Al and Expert Systems ", PHI, first edition, 1992
3	Lugar, Artificial intelligence, PHI publication, second edition, 2015 ,

COMPUTER VISION	
Course Code: MCS 122 Contact Hours: L-3 T-1 P- 0 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 ,vedio 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 scene understanding 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 learning the course the students should be able to:

- Implement fundamental image processing techniques required for computer vision
- .Understand Image formation process and perform shape analysis
- Extract features from Images and do analysis of Images and generate 3D model from images
- Develop applications using computer vision techniques and understand video processing, motion computation and 3D vision and geometry

Pedagogy: Classroom teaching which focuses upon relating the textbook concepts with real world phenomena, along with periodic tutorial classes in case studies to enhance the problem-solving ability.

UNIT I	11 Hrs
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 Hrs**

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 Hrs**

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 Hrs**

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 , 2010
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. Addison Wesley Longman, Inc., 1992.

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

RESEARCH ETHICS

Course Code: ROC 102	Credits: 3
Contact Hours: L-3 T-0 P- 0	Semester: 2
Course Category: ROC	

Introduction: The course introduces students to the key concepts, principles, debates and legal regulations of research ethics and professional conduct.

Course Objectives:

- The purpose is to enable students to correctly identify ethical risks in research and to apply ethical constructs to individual research projects, as well as to professional conduct.
- In addition, the students will gain empowering tools and skills that will increase their ability to contribute to the ongoing debate and development of research ethics and professional conduct.

Pre-requisites: None

Course Outcomes: Having successfully completed this course

- The students will have general knowledge and systematic understanding of research ethics and responsible conduct in theory and practice.
- They will also have familiarity with key concepts, topics, and developments in research ethics and responsible conduct familiarity with the legal regulation of research ethics in India and internationally.
- They will also acquire skills and capabilities to correctly apply ethical constructs to individual research projects, as well as critically reflect on their application ,intellectual independence and scientific integrity, as well as insight into the, responsibility for his/her research and for its publication and dissemination.

Pedagogy: Classroom teaching which focuses upon relating the textbook concepts with real world phenomena, along with regular tutorial classes to enhance the problem-solving ability.

UNIT I	**10 Hrs**
Moral Theory: Natural Law Theory, Utilitarianism, Kant and Moral Theory Ethical Egoism, Pluralism , Categorical Imperatives, Ross's Intuitionism, Stewardship Theory, Research involving - Human Subjects, Animals, Responsibilities to Society, Science and Self.	
UNIT II	**10 Hrs**
Copy Rights: Data sharing Plans, Indian Copyright Act 1957 and its Amendments, Intellectual Copyright Acts, Indian Patent Act 1970 and its Amendments, USPTO, Creative Common License, Plagiarism.	
UNIT III	**10 Hrs**
Conflict of Interest : Conflict of Interest, Candor Theory, Sarbans Oxley Act of 2002, Scientific Misconduct, Institutional Responsibility, Informed Consent, , Confidentiality, Non-Disclosure Agreement,Regulatory Compliance	

UNIT IV	12 Hrs
Case Studies: Immortal life of Henrietta Lacks, Stanford Prison Experiment, Tuskegee Syphilis Experiment. SCIGEN-An automatic CS paper generator, Chernobyl Disaster and more can be added by the instructor	
Text Books	
1	On Being a Scientist: A Guide to Responsible Conduct in Research: 3rd Edition, 3rd Revised Edition, Committee on Science Engineering and Public Policy, National Academies Press, 2009.
2	Penslar, Robin L., Research Ethics: Cases and Materials, , Ed., Indiana University Press, 1995.
3	D Elliot, and J E Stern, Research Ethics: A Reader, 1st Edition, University Press of New England, 1997.
4	The student's guide to research ethics, Paul Oliver, 2 Edition, Open University Press, 2010.

NEURAL NETWORKS AND DEEP LEARNING	
Course Code: MIS-203 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 3

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.
- Introduce major deep learning algorithms, the problem settings, and their applications to solve real world problems

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

Course Outcomes:
On successful completion of the course, students will be able to:
- Identify and describe Artificial Neural Network techniques in building intelligent machines
- Apply Artificial Neural Network to handle uncertainty and solve engineering problems.
- Identify the deep learning algorithms which are more appropriate for various types of learning tasks in various domains.
- Implement deep learning algorithms and solve real-world problems.

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 be adopted.

UNIT-I	8 Hours
History of Deep Learning, Deep Learning Success Stories, McCulloch Pitts Neuron, Thresholding Logic, Perceptrons, Perceptron Learning Algorithm, Multilayer Perceptrons (MLPs), Representation Power of MLPs, Sigmoid Neurons, Feedforward Neural Network, Backpropagation, Gradient Descent (GD), Momentum Based GD, Nesterov Accelerated GD, Stochastic and Minibatch GD, AdaGrad, RMSProp. Adaptive Learning Rate, Case study: Malware Classification	

UNIT-II	12 Hours
Principal Component Analysis and its interpretations, Singular Value Decomposition . Autoencoders and relation to PCA, SVD, Regularization in autoencoders, Denoising autoencoders, Sparse autoencoders, Contractive autoencoders. Regularization: Bias Variance Tradeo, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying. Greedy Layerwise Pre-training, Better activation functions, Better weight initialization methods, Batch Normalization. Case study: Malware Detection	
UNIT-III	12 Hours
Convolutional Neural Networks, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet. Learning Vectorial Representations of Words. Recurrent Neural Networks, Backpropagation through time. Encoder Decoder Models, Attention Mechanism, Attention over images. Case study: MNIST dataset	
UNIT-IV	8 Hours
Long Short Term Memory (LSTM), Restricted Boltzmann Machines, Unsupervised Learning, Motivation for Sampling, Markov Chains, Gibbs Sampling for training RBMs, Contrastive Divergence for training RBMs. Case Study: Natural Language Processing/Speech Processing	
Text Books	
1	Deep Learning, An MIT Press book, Ian Goodfellow and Yoshua Bengio and Aaron Courville http://www.deeplearningbook.org, 2016
2	Goodfellow, Yoshua Bengio, Aaron Courville, Francis Bach, Deep Learning (Adaptive Computation and Machine Learning series), MIT Press, 2017
Reference Books	
1	A. Ravindran, K. M. Ragsdell , and G. V. Reklaitis, Engineering Optimization: Methods and Applications, John Wiley & Sons, Inc. , 2016

DIGITAL IMAGE PROCESSING

Course Code: MCS 203 Contact Hours: L-3 T-0 P- 2 Course Category: DEC	Credits: 4 Semester: 3

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 Objective:

- 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:

- Understand the need for image transforms, different types of image transforms and their properties.
- Develop any image processing application.
- Learn different causes for image degradation and overview of image restoration techniques.
- Understand the need for image compression and to learn image compression techniques.
- 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. Use of ICT, web based sources as well as blackboard teaching will be adopted.

UNIT-I	**11 Hours**

Introduction: Fundamentals of Digital Image Processing, Components of digital image processing system, Brightness adaptation and discrimination, light, Image sensing and acquisition, Image formation model, definition and some properties of two dimensional system. Spatial and gray level resolution, Zooming and shrinking, some basic relationships between pixels.

Discrete 2D convolution, 2D discrete Fourier transform and its properties, Spectral density

function. Sampling and quantization of images. Gray level transformations, Smoothing and sharpening spatial filters, Smoothing and Sharpening frequency domain filters.

UNIT-II **10 Hrs**

Image Restoration: Model of image degradation/ Restoration process, Noise models, Noise reduction in spatial domain and frequency domain, Adaptive filtering, Inverse filtering, Wiener filtering.

Morphological Image processing: Basics, SE, Erosion, Dilation, Opening, Closing, Hit-or-Miss Transform, Boundary Detection, Hole filling, Connected components, convex hull, thinning, thickening, skeletons, pruning, Geodesic Dilation, Erosion, Reconstruction by dilation and erosion.

UNIT III **10 Hrs**

Image Compression: Error free compression: Variable length coding, LZW, Bit-plane coding, Lossless predictive coding Lossy compression: Lossy predictive coding, transform coding, wavelet coding. Image compression standards, CCITT, JPEG, JPEG 2000

Image Segmentation: Edge detection, Thresholding, Otsu's thresholding, Region growing, Fuzzy clustering, Watershed algorithm, Active contour methods, and Texture feature based segmentation, Wavelet based segmentation methods.

UNIT-IV **11 Hrs**

Feature Extraction from the Image: Boundary descriptors, Regional descriptors, Relational descriptors.

Image Processing applications: Study of various formats of medical images, Study of medical images in X-ray, MRI, CT imaging, Medical image enhancement and filtering. Medical image segmentation methods.

Text Books:

1.	R.C. Gonzalez and R.E. Woods: Digital Image Processing, Pearson; 4 edition, 2017
2.	Jayaraman S, Veerakumar T, Esakkirajan S, Digital Image Processing , TMH, 2009
3.	A.K. Jain: Fundamentals of Digital Image Processing, Pearson Education, 2nd edition, 1999

Reference Books:

1.	J.C. Russ," The Image Processing Handbook", (5/e), CRC, 2006
2.	J.R.Parker: Algorithms for Image Processing and Computer Vision , Wiley, 2nd edition 2010
3.	R.C.Gonzalez & R.E. Woods; "Digital Image Processing with MATLAB", 2nd edition, TMH, 2010
4	Geoff Dougherty,"Digital Image Processing for Medical Applications", Cambridge University Press; South Asian edition, 2010.

NATURAL LANGUAGE PROCESSING

Course Code: MCS 205 Contact Hours: L-3 T-0 P- 2 Course Category: DEC	Course Code: MCS 205 Contact Hours: L-3 T-0 P- 2 Course Category: DEC

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 on English Language and Hindi Language.

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

Course Outcomes:

- Understand the Various phases of Natural Language Processing.
- Understand deploying various applications of Text Processing.
- Process Text of different Languages to draw useful inferences
- Develop AI based Applications of NLP.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Use of ICT, web based sources as well as blackboard teaching will be adopted.

UNIT I	**12 hrs**
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 hrs**
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 POS Tagging using Wordnet.

UNIT III **10 hrs**

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 hrs**

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 NER in 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	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	Allen, James, Natural Language Understanding, Second Edition, Benjamin/Cumming, 1995.
3	Philipp Koehn, Statistical Machine Translation, Cambridge University Press.
4	U.S.Tiwari and Tanveer Siddiqui, Natural Language Processing and Information Retrieval, Oxford University Press,2008.

MOBILE APPLICATION DEVELOPMENT

Course Code: MCS 207 Contact Hours: L-3 T-0 P- 2 Course Category: DEC	Credits: 4 Semester: 3

Introduction: Mobile Application Development is process of creating software applications that runs on mobile devices. This course is highly essential and relevant as it has applicability to diverse domains like education, healthcare, e-commerce, entertainment by developing mobile apps for these fields. The mobile development process involves creating installable software bundles (code, binaries, assets, etc.), implementing backend services such as data access with an API, and testing the application on target devices.

Course Objectives:

- Understand mobile software architecture and building blocks for Android and iOS.
- Get familiar with the workflow and lifecycle of components for developing mobile applications,
- develop Model-View-Controller based app with simple user interface and work with platform API for persistence storage, database and cloud storage.

Pre-requisite: The student should have working knowledge of at least one object oriented programming language.

Course Outcomes:

- Understand the workflow of mobile application development
- Understand android and Swift programming.
- Process and Store application data
- Develop Android/iOS based Mobile Application

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Use of ICT, web based sources as well as blackboard teaching will be adopted.

UNIT I	**12 hrs**
Introduction: Overview of Mobile Application Development, Integrated Development Environment(IDE), Source Code Repository, Workflow, Native Apps vs Hybrid Apps, Introduction to Android and iOS Platforms, Application development fundamentals, SDKs Model-View Controller for user interface	

UNIT II	**10 hrs**
Android Programming: Android Basics, Android Architecture,Android Application Design Essentials: terminologies, application context, activities, services, intents. Android User Interface Design Essentials. Testing and Deploying Android Applications. Common Android APIs	
UNIT III	**10 hrs**
iOS Programming: Introduction to Xcode and InterfaceBuilder for iOS, Model Development with Swift, Swift Language Essentials, Swift programming , UI Kit Framework, Structure of iOS application, Xcode, Interface Editor, View Controller, emulator and other tools	
UNIT IV	**10 hrs**
Application Development: Data Storage, Cloud Storage for app development, course project mobile application development and deployment	
Text Books	
1	Griffiths, Dawn, and David Griffiths. Head First Android Development: a brain-friendly guide. " O'Reilly Media, Inc.", 2017.
2	Keur, Christian, and Aaron Hillegass. iOS programming: the Big Nerd Ranch guide. Pearson Technology Group, 2016.
Reference Books	
1	Hellman, Erik. Android programming: pushing the limits. John Wiley & Sons, 2013.
2	Pradhan, Anubhav, and Anil V. Deshpande. "Composing Mobile Apps Learn Explore Apply using Android." Wiley 2014.
3	Jemerov and S. Isakova, Kotlin in Action, 1st Ed. Manning Publications, 2016
4	Cornez, Trish, and Richard Cornez. Android Programming Concepts. Jones & Bartlett Publishers, 2015.

HUMAN COMPUTER INTERACTION	
Course Code: MCS 209 Contact Hours: L-3 T-0 P- 2 Course Category: DEC	Credits: 4 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 andguidelines for web user interface.
- Learn the ecosystem and tools of mobile Human Computer interaction.

Pre-requisite: Programming skill in some practical programming language

Course Outcomes:

- Design and Development processes and life cycle of Human Computer Interaction.
- Analyze product usability evaluations and testing methods.
- Apply the interface design standards/guidelines for cross cultural and disabled users.
- Categorize, Design and Develop Human Computer Interaction in proper architectural structures.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Use of ICT, web based sources as well as blackboard teaching will be adopted.

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, Frameworks and 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 ReillyMedia 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",2nd edition, Elsevier ., 2010.
4	Ben Shneiderman,Catherine Plaisant, Maxine Cohen, Steven Jacobs, "Designing the User Interface", 5th Edition, Pearson Education, 2013.

SPEECH PROCESSING AND SPEECH RECOGNITION	
Course Code: MCS 211 Contact Hours: L-3 T-0 P- 2 Course Category: DEC	Credits: 4 Semester: 3

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:

- Uunderstand 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: The student should have studied Fundamentals of Artificial Intelligence.

Course Outcomes:

- Clear understanding of Speech production system
- Understand various speech Analysis techniques
- Build speech Models using HMM
- 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. Use of ICT, web based sources as well as blackboard teaching will be adopted.

UNIT I	12 hrs
Basic Concepts of Speech Fundamentals: Articulatory Phonetics ,Production and Classification of Speech Sounds; Acoustic Phonetics acoustics of speech production; Time Domain and Frequency Domain methods of Signal Processing, Short-Time Fourier Transform, Filter-Bank and LPC Methods.	
UNIT II	**10 hrs**
Speech Analysis: Features, Feature Extraction and Pattern Comparison Techniques: Speech distortion measures – mathematical and perceptual – Log Spectral Distance, Cepstral Distances, Weighted Cepstral Distances and Filtering, Likelihood Distortions, Spectral Distortion using a Warped Frequency Scale, LPC, PLP and MFCC Coefficients, Time Alignment and	

Normalization – Dynamic Time Warping, Multiple Time – Alignment Paths.

UNIT III **10 hrs**

Speech Modeling: Hidden Markov Models: Markov Processes, HMMs – Evaluation, Optimal State Sequence – Viterbi Search, Baum-Welch Parameter Re-estimation, Implementation of HMM

Speech Recognition : Large Vocabulary Continuous Speech Recognition: Architecture of a large vocabulary continuous speech recognition system – acoustics and language models

UNIT IV **10 hrs**

Speech Recognition using Deep Neural network: Introduction to Recurrent Neural Network, Convolution Neural Network and LSTM network. Building a speech Recognition system using Deep neural networks

Text Books

1	L.R.Rabiner ,B.W. Juang and Yagnanarayana, " Fundamentals of Speech Recognition" Pearson, 2009
2	Daniel Jurafsky and James H. Martin, "Speech and Language Processing", 3rd edition Pearson, 2009

Reference Books

1	Frederick Jelinek, "Statistical Methods of Speech Recognition", MIT Press.,1998
2	Thomas F Quatieri, "Discrete-Time Speech Signal Processing – Principles and Practice", first edition, Prentice Hall., 2001
3	Claudio Becchetti and Lucio Prina Ricotti, "Speech Recognition", John Wiley and Sons, 1999
4	Ben gold and Nelson Morgan, "Speech and audio signal processing: processing and perception of speech and music", Wiley- India Edition, 2006

REAL TIME SYSTEMS	
Course Code: MCS 213 Contact Hours: L-3 T-0 P- 2 Course Category: DEC	Credits: 4 Semester: 3

Introduction: Realtime Systems are being used across various applications such as transportation, smart home, smart city, smart agriculture, robotics etc. In this, we deal with the architecture of the Realtime systems, Realtime Operating Systems, Communication Systems and its design and development along with applications.

Course Objectives:

- Uunderstand Real time Systems, its architecture and applications development for solving real world problems
- Understand scheduling policies, Realtime OS, Realtime databases and its development.

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

Course Outcomes:

- Understanding the architecture and applications development for solving real world problems using Real time systems.
- Deploying smart applications on different RT OS platforms.
- Interface of various peripherals with n/w Protocols
- Application Development

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Use of ICT, web based sources as well as blackboard teaching will be adopted.

UNIT-I	11hrs
Introduction to Realtime Systems: Brief history of Real Time Systems, Its architecture, Challenges in design. System Resources, Resource Analysis, Real-Time Service Utility. Processing with Real Time Scheduling: Scheduler Classes, Preemptive Fixed Priority Scheduling Policies with timing diagrams, Rate Monotonic least upper bound, Necessary and Sufficient feasibility, Deadline – Monotonic Policy, Dynamic priority policies, Worst case execution time, Deadlock.	

UNIT-II	10hrs
Operating Systems: Operating System basics and its types, The Kernel and its subsystems, Kernel Space and User Space, Kernel Architecture etc. Task, process and Threads, Multi-Processing and Multitasking, Types of multitasking, Task Scheduling, Task states, Non-Preemptive scheduling, Preemptive Scheduling, Round Robin Scheduling, Idle Task, Task Communication, Task Synchronization, Thread Safe Reentrant Functions with reference to any RTOS.	
UNIT-III	**11hrs**
Firmware Design, development with Free RTOS: Embedded Firmware Design Approaches, Super-loop based approach, Programming in Embedded C, Integrated development environment (IDE), Overview of IDEs for Embedded System Development. Introduction to FreeRTOS, multitasking on xx Cortex-M0/M3 Microcontroller/ similar controller or SoC, Port of FreeRTOS, Resources Used by FreeRTOS, Task Management, Task Functions, Task Priorities, Idle task and task hook function, Creation and Deletion of tasks.	
UNIT-IV	**10hrs**
Realtime System design with Free RTOS: Queue Management, Characteristics of a Queue, Working with Large Data, Interrupt Management, Queues within an Interrupt Service Routine, Critical Sections and Suspending the Scheduler, Resource Management, Memory Management. Design and Development of Realtime Systems. Mini Project	
Text Books	
1	Rajib Mall, "Real-Time Systems: Theory and Practice," Pearson, 2008.
2	Jane W. Liu, "Real-Time Systems" Pearson Education, 2001.
3	Krishna and Shin, "Real-TIme Systems," Tata McGraw Hill. 1999
Reference Books	
1	Alan C. Shaw, Real-Time Systems and Software, Wiley, 2001.
2	Philip Laplante, Real-TIme Systems Design and Analysis, Fourth Edition, Wiley,2011
3	Dr K V K Prasad , “Embedded / Real-Time Systems: Concepts, Design and Programming, Dreamtech Press, 2003.

AGENT BASED INTELLIGENT SYSTEM

Course Code: MCS 215 Contact Hours: L-3 T-1 P- 0 Course Category: DEC	Credits: 4 Semester: 3

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:

- Develop a computational agent with various searching techniques.
- Apply the reasoning mechanisms of proposition and predicate logic to agents.
- Use the learning mechanisms for an artificial agent.
- 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. Use of ICT, web based sources as well as blackboard teaching will be adopted.

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.

ROBOTICS AND APPLICATIONS	
Course Code: MCS 217 Contact Hours: L-3 T-1 P-0 Course Category: DEC	Credits: 4 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:

- Understand the basics of robotics and its fundamentals.
- Understand deploying robotics applications and sensor nodes.
- 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. Use of ICT, web based sources as well as blackboard teaching will be adopted.

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, ChriElewski, Michael Negin, "Robotics Engineering an Integrated Approach", PHI Learning, 1989

WIRELESS SENSOR NETWORKS

Course Code: MCS 219 Contact Hours: L-3 T-0 P- 2 Course Category: DEC	Credits: 4 Semester: 3

Introduction: This course will cover the latest topics in the area of Wireless Sensor Networks. It will cover all aspects of these important systems, from the hardware and radio architecture through protocols and software to applications. Topics will include sensor network architectures, hardware platforms, physical layer techniques, medium access control, routing, topology control, quality of service (QoS) management, localization, time synchronization, security, storage, and other advanced topics.

Course Objectives:

- Learn the basic principles behind a Wireless Sensor Network
- Learn challenges of designing network protocols, services, and applications for WSNs those are composed of large numbers of constrained devices.

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

Course Outcomes:

- Design and implement wireless sensor networks.
- Implement and evaluate new ideas for solving wireless sensor network design issues

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Use of ICT, web based sources as well as blackboard teaching will be adopted.

UNIT I	**12 hrs**
Introduction: Mobile Ad-hoc Networks (MANETs), Introduction to Sensor Networks, Constraints and Challenges, Advantage of Sensor Networks, Applications of Sensor Networks, **Architecture:** Single-Node Architecture - Hardware Components, Energy Consumption of Sensor Nodes, Operating Systems, Network Architecture -Sensor Network Scenarios, **Optimization Goals, Gateway Concepts.**	
UNIT II	**10 hrs**
Networking Sensors: Physical Layer and Transceiver Design Considerations, MAC Protocols for Wireless Sensor Networks, classification of MAC protocols, MAC protocols for sensor network, location discovery, S-MAC, IEEE 802.15.4. Routing Protocols- Energy-Efficient Routing, Geographic Routing.	

UNIT III	10 hrs
Infrastructure Establishment: Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control	
UNIT IV	**10 hrs**
Platform, Tool and Security: Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms, Node-level Simulators. Security issues in Sensor Networks. Future Research Direction.	
Text Books	
1	Holger Karl & Andreas Willig, " Protocols And Architectures for Wireless Sensor Networks" , John Wiley, 2005.
2	Feng Zhao & Leonidas J. Guibas, "Wireless Sensor Networks- An Information Processing Approach", Elsevier, 2007.
3	C.Siva Ram Murthy and B.S.Manoj, "Ad hoc Wireless Networks Architectures and Protocols" , first edition, Pearson Education, 2006
Reference Books	
1	Dr.Xerenium, Shen, Dr. Yi Pan , "Fundamentals of Wireless Sensor Networks, Theory and Practice", Wiley Series on wireless Communication and Mobile Computing, 1st Edition, 2010.
2	Kazem Sohraby, Daniel Minoli, &TaiebZnati, "Wireless Sensor Networks- Technology, Protocols, And Applications", John Wiley, 2007.
3	Bhaskar Krishnamachari , "Networking Wireless Sensors", Cambridge university press, 2005.
4	Anna Hac, "Wireless Sensor Network Designs", John Wiley, 2003.