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	Machine Learning	3-0-2	4	DCC
2.	MAS- 101	Mathematics for AI	3-1-0	4	DCC
3.	MCS- 103	Intelligent Data and Information Retrieval	3-0-2	4	DCC
4.	MCS- 105	Advanced Data Structures and Algorithms	3-0-2	4	DCC
5	GEC-101	Generic Open Elective-I	2-0-0/ 1-1-0/ 0-0-2	2	GEC
6.	DEC1 xx	Departmental Elective Course – 1	3-0-2/ 3-1-0	4	DEC
		Total credits		22	

Second Semester

S. No.	Code	Subject	L-T-P	Credits	Category
1.	MCS- 102	Deep Learning	3-0-2	4	DCC
2.	MCS -104	Natural Language Processing	3-0-2	4	DCC
3.	DEC 1xx	Departmental Elective Course – 2	3-0-2	4	DEC
4.	DEC1 xx	Departmental Elective Course – 3	3-0-2/ 3-1-0	4	DEC

5.	DEC1 xx	Departmental Elective Course - 4	3-0-2/ 3-1-0	4	DEC
6	ROC-102	Research Methodology and publication ethics	4-0-0	4	ROC
		Total credits		24	

Third Semester

Track-1 Course work

S. No.	Code	Subject	L-T-P	Credits	Category
1	DEC- 2xx	Departmental Elective-5	2-1-0/ 2-0-2	3	DEC
2	DEC- 2xx	Departmental Elective-6	2-1-0/ 2-0-2	3	DEC
3	GEC- 201	General Open Elective-II	2-0-0/ 1-1-0/ 0-0-4	2	GEC
1. 4	MCS- 251	Dissertation-I	-	6	ROC
5	MCS- 257	Summer Industrial Training/ Internship		1	ROC
		Total credits		15	

Track-2 Research Project

S.N.	Code	Subject	L-T-P	Credits	Category
1	GEC- 201	Generic Open Elective-II	2-0-0/ 1-1-0/ 0-0-4	2	GEC
2	MCS- 253	Research Project Work-I		12	ROC
3	MCS- 257	Summer Industrial Training/Internship		1	ROC
		Total Credits		**15**	

Track -3 Industry Project

S.N.	Code	Subject	L-T-P	Credits	Category
1	GEC- 201	Generic Open Elective-II	2-0-0/ 1-1-0/ 0-0-4	2	GEC
2	MCS- 255	Industry Project Work-I		12	ROC
3	MCS- 257	Summer Industrial Training/Internship		1	ROC
		Total Credits		**15**	

Fourth Semester

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

List of Departmental Elective Courses

Category	Course Code	Subject	Credits
Departmental Elective Course-1	MCS-107	Agent Based Intelligent Systems	3-0-2
	MCS- 109	AI based Programming Tools	3-0-2
	MCS- 111	Knowledge Engineering	3-0-2
Departmental Elective Course-2, Departmental Elective Course-3 and Departmental Elective	MCS-106	Cloud Computing	3-0-2
	MCS- 108	IoT and its Applications in AI	3-0-2
	MCS-110	Big Data Analytics	3-0-2
	MCS-112	Digital Image Processing	3-0-2
	MCS-114	Reinforcement Learning	3-0-2
	MCS-116	Computer Vision	3-0-2

Course-4	MCS-118	Speech Processing and Speech Recognition	3-0-2
	MCS-120	Probabilistic Graphical Models	3-0-2
	MCS-122	Video Analytics	3-0-2
	MCS-124	Parallel Algorithms	3-0-2
	MIS-118	Machine Learning in Cyber Security	3-0-2
Departmental Elective Course-5 and Departmental Elective Course-6	MCS-201	Conversational AI	3-0-0
	MCS-203	Human Computer Interaction	3-0-0
	MCS-205	Ethics in AI	3-0-0
	MCS-207	Cognitive Computing	3-0-0
	MCS-209	Robotics and Applications	3-0-0
	MCS-211	Mobile Application Development	2-0-2
	MCS-213	Wireless Sensor Networks	3-0-0
	MIS-203	Blockchain Fundamentals	2-0-2

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

Introduction:

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

Course Objectives:

- To provide an introduction to the basic principles, techniques, and applications of ML.
- To explain the strengths and weaknesses of different machine learning algorithms (relative to 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, basic probability theory and statistics

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

- 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:

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

CONTENTS

UNIT-I	12 Hours

Introduction to Machine Learning, Well Posed Problems, Machine Learning Process, Designing a Learning System, Types of Machine Learning, Application of Machine Learning, Features, Feature Vectors, Feature Selection and Visualization, Testing ML Algorithms (Overfitting, Training, Testing, And Validation Sets, Confusion Matrix, Accuracy Metrics, ROC Curve, Unbalanced Datasets, Measurement Precision), Discriminative Models: Least Square Regression, Gradient Descent Algorithm, Univariate and Multivariate Linear Regression, Prediction Model, probabilistic interpretation, Regularization, Logistic regression, multi class classification, Support Vector Machines	
UNIT-II	**10 Hours**
The Brain and The Neuron, Neural Networks, The Perceptron, Linear Separability, The Multi-Layer Perceptron, Forward and Back-error propagation, The Curse of Dimensionality, Dimensionality Reduction, Principal Component Analysis, LDA, ICA. Learning With Decision Tree, ID3, CART, Ensemble Learning, Boosting, Bagging, Random Forest.	
UNIT-III	**10 Hours**
Generative models: k-Nearest Neighbor Classification, Bayesian concept learning, Likelihood, Posterior predictive distribution, beta-binomial model, Naive Bayes classifiers, classifying documents using bag of words. Bayesian Statistics and Frequentist statistics. Directed graphical models (Bayes nets), Conditional independence, Inference.	
UNIT-IV	**10 Hours**
Unsupervised Learning, Clustering, K-Means Clustering, Hierarchical Clustering, Evaluation Parameters for Unsupervised Learning. Self-Organizing Maps. Reinforcement Learning: State and Action Spaces, Action, Policy, Markov Decision Processes, The Difference Between SARSA and Q-Learning, Uses of Reinforcement Learning. Active Learning, Inductive Learning	
Text Books	
1	Stephen Marsland, “Machine Learning: An Algorithmic Perspective”, Chapman and Hall/CRC; 2nd or latest Edition, 2014
2	Bishop, C.M., “ Pattern recognition and machine learning”, Springer,2nd or latest edition,2010
3	Tom Mitchell, “ Machine Learning,” , McGraw Hill, 2017
Reference Books	
1	T. Hastie, R. Tibshirani, J. Friedman. “The Elements of Statistical Learning”, 2nd or latest, 2008.
2	Han, Jiawei, Jian Pei, and Micheline Kamber. “Data mining: concepts and techniques.”, Elsevier, 2011.

MATHEMATICS FOR AI	
Course Code: MAS 101 Contact Hours: L-3 T-1 P-0Course Category: DCC	Credits: 4 Semester: 1

Introduction: The Mathematics for AI course introduces basic mathematical concepts related to the AI and Machine learning

Course Objective:

- To understand basic concepts of Linear Algebra
- To introduce some fundamental concepts about Matrices and Matrix decomposition.
- To provide the concepts of Probability and Distributions
- To understand concepts of Vector Calculus and Gradients

Pre-requisite: Nil

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

- Develop new algorithms for Machine learning.
- Solve Classification Problems using Matrix Decomposition and Optimization concepts
- Understand Vector calculus and Linear Algebra for solving Regression problems
- Solve Dimensionality reduction and Density estimation problems using Probability and Distributions

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

CONTENTS

UNIT 1	12 Hours
Introduction and Motivation - Linear Algebra Basics: Vector Spaces- Groups and Vector Subspaces; Basis - Generating Set and Basis; Linear Mappings- Matrix Representation of Linear Mappings **Matrix Decompositions:** Eigenvalues and Eigenvectors; Singular Value Decomposition (SVD)- Geometric Intuitions for SVD, Construction of SVD	
UNIT 2	**10 Hours**

Calculus: Partial Differentiation - Basic Rules of Partial Differentiation, Chain Rule; Gradients- Gradients of Vector-Valued Functions, Jacobian; Backpropagation- Gradients in a Deep Network, Automatic Differentiation	
UNIT 3	**10 Hours**
Probability and Distributions: Probability Space; Conditional Probability, Bayes theorem, Independence, Theorem of total probability, Mean and variance, Few Discrete and Continuous distributions, Joint distributions and Covariance	
UNIT 4	**10 Hours**
Optimization: Optimization using Gradient Descent - Learning rate, Gradient Descent with Momentum, Stochastic Gradient Descent; Constrained Optimization; Convex Optimization- Linear programming, Quadratic Programming	
Text Books	
1. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine learning, Cambridge University Press, 2020.	
2. Charu C. Aggarwal, Linear Algebra and Optimization for Machine Learning A Textbook, Springer International Publishing, 2020.	
Reference Books	
1. Vaisman, Radislav, et al. Data Science and Machine Learning: Mathematical and Statistical Methods. United States, CRC Press, 2019.	

INTELLIGENT DATA AND INFORMATION RETRIEVAL	
Course Code: MCS 103 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: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

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

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

Introduction: This course is about teaching of various data structure designs & its implementations, analyzing the various algorithm strategies and designing of new 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 : The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT I	10 Hours
Algorithm Analysis - Methodologies for Analyzing Algorithms, Asymptotic growth rates, Amortized Analysis. **Linear Data Structures:** Arrays, Stacks, Queues,Linked lists. **Non-linear Data Structure:** Trees, Traversals, Binary Search Trees, AVL tree	

UNIT II	10 Hours
Graph Algorithms: DFS, BFS, Minimum Spanning Tree Algorithms, Topological sort, Strongly connected Components, Bi-connected Components, Bridges, Articulation points, All Pairs Shortest Paths, Single Source Shortest Paths. **Computational Geometry:** Convex Hull, Closest pair of points.	
UNIT III	**12 Hours**
Applications of Divide-and-Conquer, Greedy and Dynamic programming techniques - Knapsack, Median finding, Scheduling algorithms, Party planning, bitonic TSP. String matching algorithms: Z Algorithm, KMP algorithm, Rabin-Karp, Aho-Corasick, 2D queries, efficient algorithms for longest palindrome, longest common substring/ subsequence.	
UNIT IV	**10 Hours**
B-trees, Suffix trees, Segment trees, Flow Networks: Ford-Fulkerson algorithm, Edmonds Karp algorithm, Applications of maximum flows - Maximum bipartite matching, minimum cost matching. NP-Completeness: Important NP-Complete Problems, Polynomial time reductions, Approximation algorithms, online algorithms	

Text Books:

1	T. H. Cormen, C. E. Leiserson, R. L. Rivest, Clifford Stein, “Introduction to Algorithms”, 3rd Ed., PHI, 2011.
2	Michael T Goodrich and Roberto Tamassia, "Algorithm Design and Applications", Wiley, 2014.
3	Ellis Horowitz and Sartaz Sahani, “Fundamental of Computer Algorithms”, Galgotia Publications, 2009.

Reference Books:

1	Vijay V. Vazirani, "Approximation Algorithm", Springer Science and Business Media, 2003.
2	Ellis Horowitz and Sartaz Sahani, “Fundamental of Computer Algorithms”, Galgotia Publications, 2009.
3	Michael Goodrich , Roberto Tamassia and Michael Goldwasser , “Data Structures and Algorithms in Python” ,Wiley, 2013
4	Michael T Goodrich and Roberto Tamassia, "Algorithm Design and Applications", Wiley, 2014.

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

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

Course Objectives:

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

CONTENTS

UNIT-I	10 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.	

UNIT-II	10 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 Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parametersharing and tying. Greedy Layer wise Pre-training, Better activation functions, Better weight initialization methods, Batch Normalization. Case studies	
UNIT-III	**12 Hours**
Convolutional Neural Networks, State of art CNN models, Learning Vectorial Representations of Words. Recurrent Neural Networks,Backpropagation through time. Encoder Decoder Models, Attention Mechanism, Attention over images. Case studies	
UNIT-IV	**10 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, Trasformers - state of the art models, Case Studies	
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	Charu C. Aggarwal, Neural Networks and Deep Learning (1st Edition), Springer International Publishing AG, part of Springer Nature, 2018
2	Francois Chollet, Deep Learning with Python (1st Edition), Manning Publications Company, 2017

NATURAL LANGUAGE PROCESSING	
Course Code: MCS 104 Contact Hours: L-3 T-0 P- 2Course Category: DCC	Credits: 4 Semester: 2

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

Course Objectives:

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

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

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

- 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. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT I	12 hrs
Introduction: 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.

RESEARCH METHODOLOGY AND PUBLICATION ETHICS	
Course Code: ROC 102 Contact Hours: L-4 T-0 P-0Course Category: ROC	Credits: 4 Semester: 2

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

Course Objectives:

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

Pre-requisites: None

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

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

Pedagogy:

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

CONTENTS

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

Books

1	C R Kothari and Gaurav Garg, Research Methodology: Methods and Techniques, New Age International Publishers (2019)
2	Machedo, Research Methodology in Management and Industrial Engineering, Springer, 2020
3	Gatrell, Research design and proposal writing in spatial science, , Springer, 2020
4	Deb, Engineering Research Methodology A Practical Insight for Researchers, Springer, 2019

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

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

Course Objectives:

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

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

Course Outcomes:

- 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. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT I	**12 hrs**

Introduction: The Foundation of Artificial Intelligence, The history of Artificial Intelligence. Intelligent Agents: Agents and Environments, Good Behavior: The concept of Rationality, Thenature 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, HeuristicFunctions

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, PlanningUncertain Movements, Moving, Robotic Software Architectures, Application Domain;

AI: Present and Future; Agent Components, Agent Architecture

Mathematical Background: Complexity Analysis and 0() Notation, Vectors, Matrices andLinear 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.

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

Introduction: Artificial intelligence is widely applied to solve real world problems. Different programming languages are used for implementing AI programs. Now, many reusable tools are also available for facilitating the programming. These reusable tools and 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 teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT I	10 Hours
Introduction: Concept of AI programming Tools. Concept of Logic Based Programming**,**Conventional AI Programming languages: Overview of LISP, Search Strategies in LISP, Pattern matching in LISP, Shell concept in LISP, Over view of Prolog, Production System UsingProlog. 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 111 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 1

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

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

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

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

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

CONTENTS

UNIT I	10 Hours
Introduction: Concept of Knowledge Engineering, Knowledge Economy, Knowledge Management vs Knowledge Engineering, Knowledge Engineering and Artificial Intelligence, Terminology related with Knowledge Engineering, Concept of Knowledge Reuse. Concept of Knowledgebase Intensive Systems and Development of elementary Knowledge Based System	

UNIT II		11 Hours
Knowledge Acquisition and Knowledge Manipulation. Basic features of Knowledge Acquisition. Challenges in identification of Tacit Knowledge, Acquisition of Domain Knowledge, and Contextual Knowledge, Process of identification of explicit knowledge related to specific real world problems. Acquisition of static and dynamic knowledge . Concept of Knowledge Manipulation, Basic principles of Inferencing, Methods of inferencing, Forward chaining, Backward chaining, bidirectional chaining, Factors that decides the direction of inferencing, Drawing Conclusion using Inferencing.		
UNIT III		10 hrs
Knowledge Management: Use and Reuse of Knowledge, Knowledge Management Overview, Knowledge Conversion, Knowledge Management Roles, Implications of Knowledge Management.		
UNIT IV		11 hrs
Expert System Design: Concept of Expert System, Application Domain of Expert System, Basic components of an Expert Systems, Design Methodologies of Expert Systems, Designing of inferencing module, and Input / output module. Design methodologies of Knowledge bases used in expert systems.		
Text Books:		
1	James Martin, Problem Solving using Knowledge Engineering, PHI Publication, edition 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 106 Contact Hours: L-3 T-0 P- 2Course 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 teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT I	10 Hours
Introduction: 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, Containerizationand 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 Concepts, Technology & Computing: Architecture", Prentice Hall, Pearson Publications, 2013.
3	G. Coulouris, J. Dollimore, T. and Kindberg, Distributed Systems: Concepts and Design Edition 3. Pearson Education

IOT AND ITS APPLICATION IN AI	
Course Code: MCS 108 Contact Hours: L-3 T-0 P-2Course Category: DEC	Credits: 4 Semester: 2

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

Course Objectives: This course aims at **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:

- Identify a real world problem and design a solution for solving the same using the concepts of IOT
- Develop Interface of various sensors, I/O devices and I/O peripherals with N /W Protocols
- Develop AI based/ IoT based Mobile Application Development
- Deploy and test the solution designed

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

CONTENTS

UNIT I	11 Hrs
Introduction to IoT: Architectural Overview of IoT: Components of IoT, Block Diagram, Design principles. Applications of IoT and its Infrastructure: AI Applications in IoT, Sensing, Actuation, Devices, Gateways. Introduction to IoT Programming Environments and Languages. Data Management, Business Processes in IoT.	

UNIT II	11 Hrs
IoT Interfacing: Component selection criterion for Implementing IoT application, Hardware Components- Computing (NodeMCU, Raspberry Pi), Communication, Sensing, Actuation, I/O interfaces. Software Components- Programming API's (using Python/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, authorization of devices, role of Cloud in IoT, Security aspects in IoT. **Case Study:** Smart Cities, Smart Homes, Automobiles, Industrial IoT, Agriculture etc.	

Text Books	
1	Adrian McEwen and Hakim Cassimally" Designing the Internet of Things, , Wiley Publication, 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.

BIG DATA ANALYTICS	
Course Code: MCS 110 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 2

Introduction: The explosion of social media and the computerization of every aspect of social and economic activity resulted in creation of large volumes of mostly unstructured data: web logs, videos, speech recordings, photographs, e-mails, Tweets, and similar. Today, we have the ability to reliably and cheaply store huge volumes of data, efficiently analyze them, and extract business and socially relevant information. The key objective of this course is to 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: Programming Language, like SQL, and 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 teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT I	10 Hours
Introduction to 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.

DIGITAL IMAGE PROCESSING	
Course Code: MCS 112 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 2

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

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

- 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. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT-I	11 Hours
Introduction: 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-MissTransform, 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 basedsegmentation, Wavelet based segmentation methods.	
UNIT-IV	**11 Hrs**
Feature Extraction from the Image: Boundary descriptors, Regional descriptors, Relationaldescriptors. **Image Processing applications:** Study of various formats of medical images, Study of medicalimages 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.

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

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

Course Objective

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

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

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

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

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

CONTENTS

UNIT I	10 Hours
Introduction to RL: Course logistics and overview, Introduction to Reinforcement Learning (RL), Origin and history of RL research, RL and its connections with other ML branches. Linear algebra overview, Probability overview, Sequential Decision Making, Modelling the world, Components of a reinforcement learning agent, Taxonomy of reinforcement learning agents. Introduction to Instance based learning	
UNIT II	**11 Hours**

Markov Decision Processes and Bandit Algorithms, Policy Gradient Methods & Introduction to Full RL, Reinforcement Learning Problems, MDP Formulation, Bellman Equations & Optimality Proofs, Markov Processes, Markov Reward Processes, Markov Decision Processes, Bellman Equation, Bandit Algorithms (UCB, PAC, Median Elimination, Policy Gradient), Contextual Bandits.	
UNIT III	**10Hours**
Dynamic Programming & Temporal Difference Methods, DQN, Fitted Q & Policy Gradient Approaches, Introduction to Dynamic Programming, Policy Evaluation (Prediction), Policy Improvement, Policy Iteration, Hierarchical Reinforcement Learning, Value Iteration, Generalized Policy Iteration, Hierarchical RL: MAXQ, Asynchronous Dynamic Programming, Efficiency of Dynamic Programming, Temporal Difference Prediction, Why TD Prediction Methods, On-Policy and Off-Policy Learning, Q-learning, Reinforcement Learning in Continuous Spaces, SARSA	
UNIT IV	**11 Hours**
Value Function, Bellman Equation, Value Iteration, and Policy Gradient Methods, Value Function, Bellman Equations, Optimal Value Functions, Bellman Optimality Equation, Optimality and Approximation, Value Iteration, Introduction to Policy-based Reinforcement Learning: Policy Gradient, Monte Carlo Policy Gradients, Generalized Advantage Estimation (GAE), Monte Carlo Prediction, Monte Carlo Estimation of Action Values, Monte Carlo Control, Monte Carlo Control without Exploring Starts, Incremental Implementation, Policy optimization methods (Trust Region Policy Optimization (TRPO) and Proximal Policy, Optimization (PPO))	
Text Books	
1	Richard S. Sutton and Andrew G. Barto, Reinforcement Learning: An Introduction, 2nd Edition, MIT Press. 2017.
2	Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012. ISBN: 9780262018029
Reference Books	
1	Mohit Sewak, Deep Reinforcement learning: Frontiers of Artificial Intelligence. Springer, 2019
2	Sugiyama, Masashi, Statistical reinforcement learning: modern machine learning approaches. Chapman and Hall/CRC, 2015
3	Csaba Szepesvari, "Algorithms for Reinforcement Learning", Morgan and Claypool, 2010.

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

Introduction : This course briefs about image processing techniques required for computer vision, Image formation process, Image analysis, generate 3D model from Images ,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 completion of the course, student will 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: :

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

CONTENTS

UNIT I	11 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, Motionestimation , 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

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

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

Course Objectives:

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

Pre-requisite: Fundamentals of Artificial Intelligence.

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

- Understand 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. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT I	12 hrs
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 – Alignment Paths.
Time

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 editionPearson, 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

PROBABILISTIC GRAPHICAL MODELS	
Course Code: MCS - 120 Contact Hours: L-3 T-0 P-2 20Course Category: DEC	Credits: 4 Semester: 2

Introduction: Probabilistic graphical models are an intuitive visual language for describing the structure of joint probability distributions using graphs. They enable the compact representation and manipulation of exponentially large probability distributions, which allows them to efficiently manage the uncertainty and partial observability that commonly occur in real-world problems. As a result, graphical models have become invaluable tools in a wide range of areas from computer vision and sensor networks to natural language processing and computational biology.

Course Objective

- To provide clear understanding of the foundations of probabilistic graphical models as a framework for representation, learning and inference in complex systems over many variables with high degrees of uncertainty,
- To provide the knowledge and skills necessary to effectively design, implement and apply probabilistic graphical models to solve real problems.

Pre-requisite: probability and statistics, course on machine learning. Computer programming proficiency.

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

- Use probabilistic graphical models as a framework for representation, learning and inference in complex systems
- Use probabilistic graphical modeling in their own research and/or have a strong enough foundation to pursue research on probabilistic graphical models themselves

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

CONTENTS

UNIT I	10 Hours
Introduction: Probability distributions, random variables, joint distributions, graphs, undirected and Directed Graphical Models. Representation: Bayesian Networks – Independence in graphs – d-separation, I-equivalence, minimal I-maps. Undirected Graphical models: Gibbs distribution and Markov Networks, Markov models and Hidden Markov Models. From Bayesian to Markov and Markov to Bayesian networks, Triangulation and Chordal Graphs. Directed Gaussian graphical models. Exponential Family Models.F actor Graph Representation. Conditional Random Fields. Other special Cases: Chains, Trees.	
UNIT II	**11 Hours**
Inference: Variable Elimination (Sum Product and Max-Product). Junction Tree Algorithm. Forward Backward Algorithm (for HMMs). Loopy Belief Propagation . Markov Chain Monte Carlo. Metropolis Hastings. Importance Sampling. Gibbs Sampling. Variational Inference.	
UNIT III	**11 Hours**
Learning Graphical models: Discriminative vs. Generative Learning., Density estimation, learning as optimization, maximum likelihood estimation for Bayesian networks, structure learning in Bayesian networks, Parameter Estimation in Markov Networks. Structure Learning. Learning undirected models- EM: Handling Missing Data.	
UNIT IV	**10 Hours**
Applications in Vision, Web/IR, NLP and Biology. Case studies. Advanced Topics: Statistical Relational Learning, Markov Logic Networks. Bayesian Deep Learning	

Text Books	
1	Daphne Koller and Nir Friedman ,"Probabilistic Graphical Models: Principles and Techniques" , MIT Press, 2009.
2	Qiang Ji ,"Probabilistic Graphical Models for Computer Vision", Academic Press; 1st edition (2019)
3	Michael Jordan (ed.)," Learning in Graphical Models". MIT Press, 1998. Collection of Papers.
Reference Books	
1	K.P. Murphy,"Machine Learning:A Probabilistic Perspective", MIT Press, 2012.
2	Judea Pearl. Morgan Kaufmann," Probabilistic Reasoning in Intelligent Systems" 1988.

VIDEO ANALYTICS	
Course Code: MCS 122 Contact Hours: L-3 T-0 P- 2 Course Category: DEC	Credits: 4 Semester: 2

Introduction : This course is about video analytics enabling automated analysis of detection of interesting spatial and temporal events. Image and video analysis include techniques capable of extracting high-level information from the data. Starting from the foundations of image / video analysis this course covers algorithms applied in systems for video analytics so as to develop interesting applications including surveillance

Course Objective:

- To gain a working knowledge with image and video processing.
- To understand the analytics on video.
- To apply the knowledge to develop applications that use video analytics.

Pre-requisite: Basic Mathematics, Programming Concepts.

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

- Implement the algorithms available for performing analysis on video data and address the challenges.
- Implement approaches for identifying and tracking objects and person with motion based algorithms.
- Analyze approaches for action representation and recognition.
- Identify, Analyze and apply algorithms for developing solutions for real world problems.

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

UNIT 1	Hrs 10
Introduction and Fundamentals: Image feature extraction: Feature point detection, Scale Invariant Feature Transform, Edge Detection, Color features. Pattern recognition and Machine learning: SVM and AdaBoost. Background Modeling and Subtraction: Kernel Density Approximation, Background Modeling and Subtraction Algorithms.	
UNIT II	**Hrs 10**

Object Detection and Tracking: Pedestrian detection by boosting local shape features: Tree learning algorithms, Edgelet features. Occluded pedestrian detection by part combination. Pedestrian tracking by Associating Detection Responses. Vehicle Tracking and Recognition: Joint tracking and Recognition framework, Joint appearance-motion generative model, Inference algorithm for joint tracking and recognition

UNIT- III	**Hrs 12**
Human Motion Tracking: Image feature representation, Dimension reduction and Movement dynamics learning. Human action recognition: Discriminative Gaussian Process dynamic model. **Face Recognition and Gait Analysis:** Overview of Recognition algorithms – Human Recognition using Face, Face Recognition from still images, Face Recognition from video.	
UNIT – IV	**Hrs 10**
Video Segmentation and Key Frame Extraction: Introduction, Applications of Video Segmentation, Shot Boundary Detection, Pixel-based Approaches, Block-based Approaches, Histogram-based Approaches, Clustering-based Approaches, Performance Measures, Shot Boundary Detection, Key-frame Extraction.	
Text Books	
1	Francesco Camastra, Alessandro Vinciarelli, "Machine Learning for Audio, Image and Video Analysis", Springer Nature, Second Edition, 2015.
2	Yunqian Ma, Gang Qian, “Intelligent Video Surveillance: Systems and Technology”, CRC Press, First Edition, 2009.
3	Fredrik Nilsson, Communications Axis, “Intelligent Network Video: Understanding Modern Video Surveillance Systems”, CRC Press, Second Edition, 2017.
Reference Books	
1	Anthony C. Caputo, “Digital Video Surveillance and Security”, Butterworth-Heinemann, Second Edition, 2014.
2	Herman Kruegle, “CCTV Surveillance: Video Practices and Technology”,Butterworth-Heinemann, Second Edition, 2006.
3	Amit K.Roy-Chowdhury, Rama Chellappa, S. Kevin Zhou, Al Bovik, “Recognition of Humans and Their Activities Using Video (Synthesis Lectures on Image, Video, and Multimedia Processing)”, Taxmann Publications Private Limited, 2005.
4	Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, First Edition, 2010.
5	David A. Forsyth, Jean Ponce, "Computer Vision- A Modern Approach", Pearson Education, Second Edition, 2015.

PARALLEL ALGORITHMS	
Course Code: MCS 124 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: 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 teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT I	10 Hours
Introduction: 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

MACHINE LEARNING IN CYBER SECURITY	
Course Code: MIS 118 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 2

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

Course Objective:

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

Pre-requisite: Programming, Machine Learning.

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

- Understand the key features (aspects) to extract from cyber systems from a security perspective.
- Apply the concepts of machine learning to secure cyber systems.

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

CONTENTS

UNIT I	10 hours
Introduction: Need for Machine Learning in Cyber Security. **Network Security:** NetFlows, BotNets, BotNet Detection. Deep Packet Inspection. Intrusion Detection. Anomaly Detection.	
UNIT II	**10 hours**
Behavioral Biometrics: Keyboard & Mouse Pattern Analysis, Active authentication. **Mobile Security:** Static & Dynamic Analysis, Malware Detection.	
UNIT III	**12 hours**

Web Security: Web Server Log Analysis, Email Spam Detection, Malicious URLs Detection, Phishing Attack Detection.	
UNIT IV	**10 hours**
Model Security: Data Poisoning Attacks, Generative Adversarial Networks. Deep Fakes - Creation and Detection. Dataset Inference. Model Reconstruction Attacks.	
Text Books	
1	Marcus A Maloof, "Machine Learning and Data Mining for Computer Security: Methods and Applications", Springer, 2006..
2	Sushil Jajodia & Daniel Barbara, "Applications of Data Mining in Computer Security", Springer, 2008.
Reference Books	
1	Dhruba Kumar Bhattacharyya & Jugal Kumar Kalita, "Network Anomaly Detection: A Machine Learning Perspective", Chapman and Hall/CRC; 1st Edition, 2013.

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

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

Course Objective

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

Pre-requisite: Machine Learning , Deep Learning

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

- Understand Basic Programming concepts to work with chat bots
- Build and deploy domain specific chatbots
- Integrate the Virtual Assistants with third party APIs

Pedagogy:

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

CONTENTS

UNIT I	11 Hours
Introduction to virtual assistants and their platforms, Chatbots, application of chat bots, motivations for chatbots, relevance of chatbot with industry. Introduction to Watson Assistant: Watson Assistant components, Intents, Entities, Dialog, Dos and Don'ts of dialog design. Building Our Chatbot: Intents and Entities Creating a workspace, Defining Chit Chat intents, Defining Domain-Specific intents, Defining entities	
UNIT II	**10 Hours**
Building Our Chatbot Dialog : The default Welcome and Anything else nodes, Creating Chit Chat dialog, Simple conditions and responses, handling complex dialog flow, trying out and exporting our chatbot.	
UNIT III	**10 Hours**

Deploying Our Chatbot: Deploying our chatbot on WordPress, Installing and configuring the Watson Assistant plugin, Finding and fixing problems, more advanced concepts, Analysing chatbot conversations	
UNIT IV **11 Hours**	
Introduction to Microsoft Bot, RASA and Google Dialogflow, Microsoft Bot Framework, Introduction to QnA Maker, Introduction to LUIS, Introduction to RASA, RASA Core, RASA NLU, Introduction to Dialog flow. Integration with Third party APIs, Connecting to an Enterprise Data Store, Deployment to Cloud.	
Text Books	
1	Andrew Freed, “Conversational AI: Chatbots that work, Manning Publications,2021
2	Galitsky, Boris. Developing Enterprise Chatbots. Springer International Publishing, 2019.
3	Janarthanam, Srini. Hands-on chatbots and conversational UI development: Build chatbots and voice user interfaces with Chatfuel, Dialogflow, Microsoft Bot Framework, Twilio, and Alexa Skills. Packt Publishing Ltd, 2017.
Reference Books	
1	Singh, Abhishek, Karthik Ramasubramanian, and Shrey Shivam. "Building an Enterprise Chatbot.", Springer, Apress, 2019
2	Michael McTear, Conversational Ai: Dialogue Systems, Conversational Agents, and chat bots (Synthesis Lectures on Human Language Technologies), Morgan & Claypool (2020)
3	Kelly III, John E., and Steve Hamm. Smart machines: IBM's Watson and the era of cognitive computing, Columbia University Press, 2013.

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

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

Course Objectives:

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

interaction.**Pre-requisite:** Programming skill in some programming language

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

- 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. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT I	12 hrs
HCI foundations- Input–output channels, Human memory, Thinking: reasoning and problem solving, Emotion, Individual differences, Psychology and the design of interactive systems, Text entry devices, Positioning, pointing and drawing, Display devices, Devices for virtual reality and 3D interaction, Physical controls, sensors and special devices, Paper: printing and scanning Designing- Programming Interactive systems- Models of interaction, 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, HCIpatterns 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 Min d – Simpl e 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.

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

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

Course Objective

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

Pre-requisite: Machine Learning

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

- Understand the ethical issues in artificial intelligence (AI)
- Analyze an AI/ML system for its explainability, robustness and fairness
- Understand the role of AI systems in the context of Human Society and Trusted decision making

Pedagogy:

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

UNIT I	10 Hours
AI and its ethical relevance, Machine Ethics, Autonomous systems, Trustworthy AI, Broad Principles of Trustworthinesss, Fairness, Accountability, Sustainability, and Transparency; Difference between each of these aspects	
UNIT II	**10 Hours**
Bias and Types of Bias in AI systems, Identifying and mitigating bias in an AI system ,Various bias mitigation methods and algorithms, Data fairness, Design fairness, Outcome fairness, Implementation fairness Fairness evaluation methods and algorithms - Algorithmic Fairness and other Fairness Methodologies	
UNIT III	**10 Hours**
Accountability; Answerability and Auditability; Sustainability; Safety;Accuracy, Robustness of AI systems - methods and techniques, Reliability of AI systems - methods and techniques, Verification of AI/ML systems, Ethics and Accountability in AI, Role of AI in Human Society and co-existence	
UNIT IV	**12Hours**
Explainable AI–Explanation in decision trees/Random Forests. Explanation of Linear classifiers by weights, Sparse models, Naive Bayes classifiers etc. Blackbox/whitebox/Greybox techniques – In the area of image/video classification, fine grained classification, vision and language, autonomous driving etc.,CAM, Grad-CAM, Grad-CAM++, LIME, Guided LIME, and their algorithms	

Text Books

1	Mark Coeckelbergh ,"AI Ethics" , MIT Press, 2020.
2	Paula Boddington," Towards a Code of Ethics for Artificial Intelligence (Artificial Intelligence: Foundations, Theory, and Algorithms)", springer, 2017
3	Dennis Rothman, "Hands-On Explainable AI (XAI) with Python: Interpret, visualize, explain, and integrate reliable AI for fair, secure, and trustworthy AI apps", Packt Publishing Ltd 2020

Reference Books

1	John Havens, "Heartificial Intelligence: Embracing Our Humanity to Maximize Machines", TarcherPerigee; Illustrated edition 2016
2	S.Matthew Liao, "Ethics of Artificial Intelligence", OUP USA, 2020
3	Silvie Spreeuwenberg. "AIX: Artificial Intelligence needs eXplanation: Why and how transparency increases the success of AI solutions", LibRT: the Lab for Intelligent Business Rules Technology, 2019
4	Wendell Wallach , Colin Allen , "Moral Machines: Teaching Robots Right from Wrong ",OUP USA, 2010

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

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

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

Pre-requisite: A course on AI

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

- 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: :

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

CONTENTS

UNIT I	10 Hours
Introduction: Cognitive science and cognitive Computing with AI, Cognitive Computing - Cognitive Psychology - The Architecture of the Mind - The Nature of Cognitive Psychology – Cognitive architecture – Cognitive processes – The Cognitive Modeling Paradigms - Declarative / Logic based Computational cognitive modeling – connectionist models – Bayesian models. Introduction to Knowledge-Based AI – Human Cognition on AI – 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, First edition, 2015
2	Masood, Adnan, Hashmi, Adnan ,Cognitive Computing Recipes-Artificial Intelligence Solutions Using Microsoft Cognitive Services and TensorFlow, 2015
Reference Books	
1	Peter Fingar, Cognitive Computing: A Brief Guide for Game Changers, PHI Publication, 2015
2	Gerardus Blokdyk ,Cognitive Computing Complete Self-Assessment Guide, 2018
3	Rob High, Tanmay Bakshi, Cognitive Computing with IBM Watson: Build smart applications using Artificial Intelligence as a service, IBM Book Series, 2019

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

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

Course Objectives:

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

Pre-requisite: Basic concepts of mathematics

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

- 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. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT I	10 hrs
Introduction to Robotics: Classification of Robots, Characteristics and performance, advantages and disadvantages of a Robot, Basic Control Systems Concepts and Models, Controllers, Control System Analysis, Robot Activation and Feedback Components, Power Transmission Systems.	
UNIT II	**11 hrs**

Robotics Kinematics: Position Analysis, Robots as Mechanism, Matrix Representation, Transformation Matrices, Forward and Inverse Kinematics. Actuators: Characteristics of Actuating Systems, Actuating Devices and Control. Robot End Effectors: Types, MechanicalGrippers, 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

MOBILE APPLICATION DEVELOPMENT	
Course Code: MCS 211 Contact Hours: L-2 T-0 P- 2 Course Category: DEC	Credits: 3 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: After completing this course , the students will be able to:

- 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. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT I	7 hrs

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	**7 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	**7 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	**7 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.

WIRELESS SENSOR NETWORKS	
Course Code: MCS 213 Contact Hours: L-3 T-0 P-0 Course Category: DEC	Credits: 3 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: After completing this course , the students will be able to:

- 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. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT I	12 hrs
Introduction: 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.

BLOCKCHAIN FUNDAMENTALS	
Course Code: MIS-203 Contact Hours: L-2 T-0 P-2 Course Category: DEC	Credits: 3 Semester: 3

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

Course Objectives:

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

Pre-requisite: Cryptography, distributed Computing, Basic knowledge of programming.

Course Outcome: The students will be able to

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

Pedagogy:

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

CONTENTS

UNIT I	7 hrs
Basics: Distributed Database, Two General Problem, Byzantine General problem And Fault Tolerance, Hadoop Distributed File System, Distributed Hash Table, ASIC resistance, Turing Complete. Cryptography: Hash function, Digital Signature - ECDSA, Memory Hard Algorithm, Zero Knowledge Proof.	
UNIT II	**7 hrs**

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