M.Tech. Degree

PROGRAMME

in

COMPUTER ENGINEERING

CURRICULUM

(w. e. f. Session 2019-2020)

DEPARTMENT OF COMPUTER ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY
KURUKSHETRA - 136119

VISION AND MISSION OF THE INSTITUTE

VISION

To be a role-model in technical education and research, responsive to global challenges.

MISSION

To impart technical education that develops innovative professionals and entrepreneurs and to undertake research that generates cutting-edge technologies and futuristic knowledge, focusing on the socio-economic needs.

VISION AND MISSION OF THE DEPARTMENT

VISION

To address societal needs and global industry challenges in the field of Computer & IT with state-of-art education & research.

MISSION

M-1: To create a platform for education, research and development by providing sound theoretical knowledge and practical skills in Computer Engineering and Information Technology.

M-2: To produce motivated professional technocrats capable of generating solutions for industry and society.

M-3: To develop the ability to work ethically at individual and team level and be responsive towards socio-economic needs.

VISION AND MISSION OF THE PROGRAM

VISION

To disseminate state-of-the-art education to develop competent professionals in Computer Engineering with capability to serve the global society**.**

MISSION

To educate and train manpower engaged in cutting-edge research by offering latest in the field of Computer Engineering for sustainable development of society.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The PG programme in Computer Engineering will produce post graduates that, within a few years of graduation:

PEOs	Description
PEO 1	Graduates of the institute will have adequate knowledge of computer science and engineering to excel in professional career and/or higher education.
PEO 2	Graduates of the institute will be skilled enough to analyze real life problems, design computing systems that delivers appropriate solutions that are technically sound, economically feasible and socially acceptable.
PEO 3	Graduates of the institute will have attitude towards continuous learning and will exhibit professional ethics, communication skills, team work in all walks of life.

PROGRAM OUTCOMES (POs)

Graduates of the Programme:

PO	Description
PO 1	An ability to independently carry out research /investigation and development work to solve practical problems
PO 2	An ability to write and present a substantial technical report/document
PO 3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
PO 4	Students should be able to analyse, design and develop solutions or models with understanding of their limitations for complex engineering problems through appropriate literature, techniques, resources and tools.

Department of Computer Engineering,
NIT, Kurukshetra
Proposed Scheme for Master of Technology in Computer Engineering

Curriculum w.e.f July 2019

Sr. No.	Code	Course Title	Teaching Schedule				Credit
			L	T	P	Total	
First Semester							
1.	MCO1C01	Advanced Data Structures and Algorithms	3	0	0	3	3
2.	MCO1C03	Machine Learning	3	0	0	3	3
3.	MCO1C05	Advanced Computer Networks	3	0	0	3	3
4.		Elective-1	3	0	0	3	3
5.		Elective -2	3	0	0	3	3
6.	MCO1L01	Algorithms Lab	0	0	2	2	1
7.	MCO1L11	Machine Learning with Python Lab	0	0	2	2	1
8.	MCO1S01	Seminar	0	2	0	2	1
Total						**21**	**18**
Second Semester							
1.	MCO1C02	Big Data and Analytics	3	0	0	3	3
2.	MCO1C04	Cloud and IoT Security	3	0	0	3	3
3.		Elective-3	3	0	0	3	3
4.		Elective-4	3	0	0	3	3
5.		Elective-5	3	0	0	3	3
6.	MCO1L02	Big Data and Analytics Lab	0	0	2	2	1
7.	MCO1L34	Along with Elective 3	0	0	2	2	1
8.	MCO1P02	Project	0	2	0	2	1
Total						**21**	**18**
Third Semester							
1.	MCO1D03	Dissertation Part-I	**14**				
Fourth Semester							
1.	MCO1D04	Dissertation Part-II	**14**				

Note:

- Elective can be opted from the list of electives/ core subjects of various specializations of Computer Engineering Department.
- Electives-V can be opted from the list of electives of other departments as well.
- List of Electives, being offered by the Department along with the number of slots and pre-requisites, if any, will be notified by the concerned department well before the registration.

Annexure

List of Elective Courses

Odd Semester (Electives 1 &2)		Even Semester (Elective3 with Lab)		Even Semester (Electives 4 &5)	
Code	**Course Title**	**Code**	**Course Title**	**Code**	**Course Title**
MCO1E31	Data Warehousing and Data Mining	MCO1E32	Nature Inspired Computing	MCO1E42	Information Retrieval and Web Search
MCO1E33	Software Architecture and Design Patterns	MCO1E34	Image Processing	MCO1E44	Number Theory and Cryptography
MCO1E35	Distributed Computing	MCO1E36	Wireless Sensor Networks	MCO1E46	Computer Vision
MCO1E37	Advanced Computer Architecture	MCO1E38	Deep Learning	MCO1E48	Selected Topics in Logics and Automata
MCO1E39	Pattern and Speech Recognition			MCO1E52	Graph Theory and Combinatorics
MCO1E41	High Performance Computing			MCO1E54	Advances in Cloud and Mobile Computing

MCO1C01**Advanced Data Structures and Algorithms**

L	T	P/D	Total	Credit		Max. Marks:	100
3	-	-	3	3	Theory:	50 Marks	
						Mid-Sem:	50 Marks

Course Objectives:

To develop the understanding of advanced algorithms.

1. To study complexity of advanced algorithms.
2. Design new algorithms or modify existing ones for new applications and able to analyze the space & time efficiency of most algorithms.

Syllabus:

Data Structures:AVL trees**,** Red black trees, Balanced Multi-way trees, Splay trees, tries, Segment trees, Binomial heap and Fibonacci heap.

Approximation Algorithms: Coping with NP-Hardness, Greedy Approximation Algorithms, Dynamic Programming and Weakly Polynomial-Time Algorithms, Linear Programming Relaxations, Randomized Rounding, Vertex Cover, set cover, TSP, knapsack, bin packing, subset-sum problem, Load balancing, Analysis of the expected time complexity of the algorithms.

Randomized and Probabilistic Algorithms:Game-theoretic techniques, Moments and Deviations, Numerical Probabilistic algorithms, Lovasz local lemma, Markov Chains and Random Walks, Algebraic Techniques, Geometric Algorithms, Randomized Quick sort, Las Vegas and Monte Carlo algorithms, Applications problems like load balancing, packet routing etc.

References:

1. *Introduction to Algorithms* by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein. Third Edition. MIT Press and PHI, 2010.
2. *Algorithm Design and Applications* by Michael T. Goodrich and Roberto Tamassia, John wiley publication.
3. *Randomized Algorithms* by Rajeev Motwani, Prabhakar Raghavan, published by Cambridge University Press, 2014.
4. *Probability and Computing: Randomized Algorithms and Probabilistic Analysis*, by Mitzenmacher and Upfal, Cambridge University Press, 2nd edition, 2017
5. *The Design of Approximation Algorithms* by David P. Williamson and David B. Shmoys, Cambridge University Press.
6. *Algorithm Design* by Jon Kleinberg, Eva Tardos by Pearson publications.

Course Outcomes:

At the end of the course, the students should be able to:

1. Apply basic concepts of approximation, randomization and distributed computing in algorithmic context.
2. Designs randomized parallel algorithms, approximation and distributed algorithms that run fast or that return the correct output with high probability
3. Derives good upper bounds for the expected running time of advanced algorithms.

4. Can apply the probabilistic method to show the existence of certain combinatorial objects design and analyze

MCO1C03**Machine Learning**

L T P/D Total Credit		Max. Marks: 100
3- - 33	Theory:	50 Marks
		Mid-Sem: 50 Marks

Course Objectives: This course will serve as a comprehensive introduction to various topics in machine learning. At the end of the course, the students should be able to design and implement machine learning solutions to classification, regression, and clustering problems; and be able to evaluate and interpret the results of the algorithms.

Syllabus:

Introduction and Basic Concepts: Definition of ML, Taxonomy of ML, Supervised Learning, Housing Price Prediction, Regression Vs Classification, Unsupervised Learning, Clustering, Clustering Genes, Latent Semantic Analysis (LSA), Reinforcement Learning.
Supervised Learning, Linear Regression, Classification and Logistic Regression, Generalized Linear Models (GLM), Constructing GLM, Discriminative Algorithms, Dataset Loading and Visualization, Gradient Descent Visualization

Weighted Least Squares, Netwon's Method, Perceptron, Maximum Entropy and Exponential Families, Generative Learning algorithms, Gaussian discriminant analysis, Naive Bayes, Laplace Smoothing, Kernel Methods, Support Vector Machines.
Learning End-Sem: Bias-Variance and Error Analysis, Bias/variance tradeoff, Error Analysis, Normal Equations, Variance, Gradient Descent.

k-means clustering algorithm, Mixtures of Gaussians, Expectation Maximization algorithm, Variational inference and Variational Autoencoders, Principal Component Analysis. Independent Component Analysis.
Markov Decision Process (MDP): Bellman Equations, Value iteration and policy iteration, Value function approximation.

Deep Learning: Neural Networks, Vectorization, Backpropagation, Forward propagation
Regularization and model selection: Cross validation, Feature Selection, Bayesian statistics and regularization,
Reinforcement Learning and Control: Markov decision processes, Learning a model for an MDP, Continuous state MDPs.

References:

1. Bishop, C. M. (2006). *Pattern Recognition and Machine Learning*, Springer.
2. Understanding Machine Learning: From Theory to Algorithms by Shai Ben-David and Shai Shalev-Shwart.
3. Machine Learning: A Probabilistic Perspective by Kevin P. Murphy
4. An Introduction to Machine Learning by Miroslav Kubat.

Course Outcomes:
1. Gain knowledge about basic concepts of Machine Learning
2. Identify machine learning techniques suitable for a given problem
3. Solve the problems using various machine learning techniques
4. Apply Dimensionality reduction techniques.
5. Design application using machine learning techniques.

MCO1C05 **Advanced Computer Networks**

L	T	P/D	Total	Credit		
3	-	-	3	3	Max. Marks:	100
					End-Sem:	50 Marks
					Mid-Sem:	50 Marks

Course Objectives: To give the students an understanding of the principles behind the latest advances in computer network technology from opportunistic and social networks to IoT and SDN based networks.

Syllabus:
Opportunistic and Social Networks:Handling Spectrum Scarcity and Disruption, Architecture of Cognitive Radio Network (CRN) and Delay Tolerant Networks (DTN), Routing in Opportunistic Mobile and Social Networks, Multicasting, Single-node, Multiple-copy, and Single-copy model, Interest-based Data Dissemination, User Interest Profile, Multi-party data transmission, System Implementation, Quality-of-Service (QoS), QoS parameters, Metrics and classification, Network QoS parameters (bandwidth, delay, etc.), System QoS parameters (reliability, capacity, etc.), Task QoS parameters (memory, CPU usage, response time, etc.), Extension QoS parameters (reputation, security, etc.).

IoT Networks:Convergence of domains, Key technologies for IoT and its components, Multi-homing, Sensing, Actuation, Data Aggregation, IoT communication patterns, IoT data and its impact on communication, Characteristics of IoT networks, Protocols for IoT, NFC (Near field communication), Tactile Internet, Caching, Edge computing, Inter-dependencies, SoA, Gateways, Comparison between IoT and Web, Complexity of IoT networks, Scalability, Protocol classification, MQTT, SMQTT, CoAP, XMPP, AMQP, Wireless HART protocol and layered architecture, HART network manager, HART vs ZigBee, Cross layer QoS parameters.

Software Defined Networks (SDN):Network Function Virtualization (NFV), Unicast and multicast routing, Fundamental graph algorithms, Modern protocols for content delivery, Video delivery using HTTP, HTTP Live Streaming, DASH, Content Delivery Networks (CDN), TVOD and SVOD, Architecting a content distribution system over IP-based networks, CDN topologies, Edge-Caching, Streaming-Splitting, Pure-Play, Operator, Satellite, Hybrid, Computer hosting and orchestration for dedicated appliances and virtualization, Robust synchronization of absolute and difference clocks, Precision time protocol, Clock synchronization in SDN, ReversePTP scheme.

References:
1. Jie Wu and Yunsheng Wang, Opportunistic Mobile Social Networks, CRC Press, 2015.

2. James F. Kurose and Keith W. Ross, Computer Networking: A Top-down Approach Featuring the Internet, Addison-Wesley, 2001.
3. Huitema, C., Routing in the Internet, 2nded., Prentice-Hall, 2000.
4. Peterson and Davie, Computer Networks: A Systems Approach, 5th ed., Morgan Kaufmann, 2011.
5. Rajiv Ramaswami, Kumar N. Sivarajan, Galen H. Sasaki, Optical Networks: A Practical Perspective, Morgan Kaufmann.
6. Vijay Madisetti and Arshdeep Bahga, Internet of Things: A Hands-On- Approach, 2014, ISBN: 978 0996025515.
7. Francis daCosta, Rethinking the Internet of Things: A Scalable Approach to Connecting Everything, 1 st Edition, Apress Publications, 2013.

Course Outcomes:

1. To understand the concepts behind Opportunistic, IoT and Software Defined Networking.
2. To identify different issues in Opportunistic, Social,IoT and SDN Networks.
3. To analyze various protocols proposed to handle issues related to Opportunistic, Social,IoT and SDN Networks.

MCO1E31 **Data Warehousing and Data Mining**

L T P/D Total Credit Max. Marks: 100
3- - 33 End-Sem: 50 Marks
Mid-Sem: 50 Marks

Course Objectives:

1. Understand the principles and application of data mining and warehousing andalso able to identify the scope and necessity of system.
2. Describe the theoretical constructs and processes of data mining and warehousing.
3. Investigate the various data mining and warehousing models and techniques, in solving the real world problems.
4. Design and analyze a lightweight prototype or simulation that supports the concept of data mining and warehousing.

Syllabus:

Data Warehousing and Business Analysis: Data warehousing Components –Building a Data warehouse –Data Warehouse Architecture – DBMS Schemas for Decision Support – Data Extraction, Cleanup, and Transformation Tools –Metadata – reporting – Query tools and Applications – Online Analytical Processing (OLAP) – OLAP and Multidimensional Data Analysis.

Data Mining: - Data Mining Functionalities – Data Preprocessing – Data Cleaning – Data Integration and Transformation – Data Reduction – Data Discretization and Concept Hierarchy Generation- Architecture of A Typical Data Mining Systems: Classification of Data Mining Systems. Association Rule Mining: - Efficient and Scalable Frequent Item set Mining Methods – Mining Various Kinds of Association Rules – Association Mining to Correlation Analysis – Constraint-Based Association Mining.

Classification and Prediction: - Issues Regarding Classification and Prediction – Classification by Decision Tree Introduction – Bayesian Classification – Rule Based Classification – Classification by Back propagation – Support Vector Machines – Associative Classification – Lazy Learners – Other Classification Methods – Prediction – Accuracy and Error Measures – Evaluating the Accuracy of a Classifier or Predictor – Ensemble Methods – Model Section.

Cluster Analysis: - Types of Data in Cluster Analysis – A Categorization of Major Clustering Methods – Partitioning Methods – Hierarchical methods – Density-Based Methods – Grid-Based Methods – Model-Based Clustering Methods – Clustering High-Dimensional Data – Constraint-Based Cluster Analysis – Outlier Analysis.

Mining Object, Spatial, Multimedia, Text and Web Data: Multidimensional Analysis and Descriptive Mining of Complex Data Objects – Spatial Data Mining – Multimedia Data Mining – Text Mining – Mining the World Wide Web.

References: -

1. Han J, Pei J, Kamber M. Data Mining: concepts and techniques. 2011.
2. Berson A, Smith SJ. Data warehousing, data mining, and OLAP. McGraw-Hill. 1997.
3. Chen Z. Intelligent Data Warehousing: From data preparation to data mining. 2001.

Course Outcomes:

1. To analyze the different issues in data mining and data warehousing.
2. To identify and understand various applications of data mining in real world.
3. To learn the various classification algorithms and analyze their performance.

MCO1E33**Software Architecture and Design Patterns**

L T P/D Total Credit			Max. Marks:	100
3- - 33		End-Sem:	50 Marks	
			Mid-Sem:	50 Marks

Course Objectives:

1. To understand the fundamentals of software architecture.
2. To learn the various software architecture design components.
3. To understand the concept of patterns and catalog.
4. To learn about specific design patterns.

Syllabus:

Introduction to software architecture: Nature of software, defining software, software application domain. Architecture business cycle, Defining software architecture, Importance of software architecture, Architectural patterns, Reference models, Reference architectures, Architectural structures and views. Creating architecture quality attributes, achieving qualities, Architectural design and patterns, designing the architecture, Reconstructing software architecture.

Analysis of architectures: Architecture evaluation, Architecture design decision making, ATAM, CBAM. Moving from one system to many software product lines, Building systems from off the shelf components, Software architecture in future.

Introduction to design patterns: Describing a design pattern, design patterns in Smalltalk MVC. Catalog of design patterns, Organizing the catalog, role in solving design patterns, Specifying object interfaces and implementations. Selection of design pattern, Usage of design pattern.

Discussing various design patterns: Creational patterns: Abstract factory, Builder, Factory method, Prototype, Singleton. Structural patterns: Bridge, Composite, Decorator, Façade, Flyweight, Proxy. Behavioral patterns: Chain of responsibility, Command, Interpreter, Iterator, Mediator, Memento, Observer, State, Strategy, Template method, Visitor.

A Case study: Design problems, Document structure, Formatting, Embellishing the user interface, Supporting the multiple window systems and multiple look-and-feel standards, User operations, Spelling checking and hyphenation. Case studies: A-7E – A case study in utilizing architectural structures, The World Wide Web – a case study in interoperability, Air traffic control – a case study in designing for high availability.

References:
1. Richard N. Taylor, Nenad Medvidovic, and Eric M. Dashofy. Software architecture: foundations, theory, and practice. John Wiley & Sons, 2007.
2. Erich Gamma, John Vlissides, Ralph Johnson, Richard Helm. Design Patterns : Elements of Reusable Object-Oriented Software. Pearson, 2015
3. Bass L, Clements P, Kazman R. Software architecture in practice. Addison-Wesley Professional; 2003.

Course Outcomes:
1. Learn and evaluate existing software architectures.
2. Develop software applications starting from software architecture and design.
3. Architect and design using architectural styles and design patterns.

MCO1E35**Distributed Computing**

L T P/D Total Credit Max. Marks: 100
3- - 33 End-Sem: 50 Marks
Mid-Sem: 50 Marks

Course Objectives: To understand fundamental concepts of distributed computing and to acquire knowledge about development of fault tolerant protocols for middleware design.

Syllabus:
Unit 1:Design issues and challenges, Models and Architectures, Synchronous Vs Asynchronous, Classification of Failures in Distributed Systems, Basic Techniques for Handling Time in Distributed Systems, Physical Clocks, Physical Clock Synchronization, NTP, Inter-process Communication, Logical Clocks, Scalar, Vector, and Matrix Clock, Global State, Consistent Snapshot Algorithms for FIFO, Non-FIFO and Causal Delivery Systems,, Monitoring,

Consistency, Necessary and Sufficient Condition for Consistent Snapshot, Z-path and Z-cycles, Synchronous Vs. Asynchronous Checkpointing and Recovery.

Unit 2:Message Ordering and Group Communication Protocols, Naming in Distributed Systems, Quiescence Detection, Termination and Deadlock, Weight-throwing, MST-based, and Message-optimal Protocols, Mutual Exclusion, Shared Memory Vs. Message Passing Model, 2-P and n-P Algorithms, Contention-based and Token-based algorithms, Leader Election, Election in Ring Networks, Distributed Graph Algorithms for MST, MIS, CDS, and other Virtual Structures.

Unit 3:Agreement Protocols, Coordinated Attack, Distributed Consensus with Process Failures, Synchronous Systems with Crash and Byzantine Failures, Lower Bound, EIG, Phase-king Algorithm, Concept of Valance, FLP impossibility, Wait-free and 1-failure Termination, BGP, Weak Byzantine Agreement, k-agreement, Approximate Agreement, Distributed Commit, 2-PC and 3-PC protocols, Distributed Scheduling and Load Balancing. Distributed File Systems, and Distributed Shared Memory,Security.

References:

1. Distributed Systems: Concepts and Design; G Colouris, J Dollimore, T Kindberg 3/e Pearson Ed. 2002.
2. Distributed Systems: Principles and Paradigm; Andrew S Tanenbaum, Maarten van Steen 3/e Pearson Ed.2002.
3. Principles of Distributed Systems, VK Garg, Kluwer Academic Publishers,1996.
4. Distributed Systems and Algorithmic Approach by Su Kumar Boss, Chamal &Hall.
5. Principles of Distributed Computing by V K Garg, IEEEPress.
6. Distributed Computing by A D Kshem Kalyani & MukeshSingha.
7. Distributed Algorithms by Nancy Lynch, Morgan KaufmannPress.
8. Introduction to Distributed Algorithms by G Tel, CambridgeUniversity.

Course Outcomes:

1. Study software components of distributed computing systems. Know about the communication and interconnection architecture of multiple computer systems.
2. Recognize the inherent difficulties that arise due to distributed-ness of computing sources.
3. Understanding of networks & protocols, mobile & wireless computing and their applications to real world problems.
4. At the end, students will be familiar with the design, implementation and issues of distributed system.

MCO1E37**Advanced Computer Architecture**

L	T	P/D	Total	Credit		Max. Marks:	100
3-	-		33		End-Sem:	50 Marks	
						Mid-Sem:	50 Marks

Course Objectives:

1. To understand the fundamentals and design issues in the architectures of computer system.
2. To learn the fundamentals and design issues in the memory technology.
3. Ability to understand the requirements of uniprocessor and multiprocessor systems in the real

world.

4. To familiarize the students with efficient implementations of the large scale high performance systems

Syllabus:

Introduction: Overview of von Neumann architecture, comparison of CISC and RISC processors.

Pipelining:Basic concepts of pipelining, data hazards, control hazards, and structural hazards; Techniques for overcoming or reducing the effects of various hazards.

Hierarchical Memory Technology: Inclusion, Coherence and locality properties; Cache memory organizations, Techniques for reducing cache misses; Virtual memory organization, mapping and management techniques, memory replacement policies.

Instruction-level parallelism: Concepts of instruction-level parallelism (ILP), Techniques for increasing ILP; Superscalar, super-pipelined and VLIW processor architectures; Vector and symbolic processors; Case studies of contemporary microprocessors

Multiprocessor Architecture: Taxonomy of parallel architectures; Centralized shared-memory architecture, synchronization, memory consistency, interconnection networks; Distributed shared-memory architecture, Cluster computers.

References:

1. J. L. Hennessy and D. A. Patterson, "Computer architecture: a quantitative approach", Harcourt Asia, Singapore 1996
2. John L. Hennessy and David A. Patterson, Computer Architecture: A Quantitative Approach, Morgan Kaufmann.
3. John Paul Shen and Mikko H. Lipasti, Modern Processor Design: Fundamentals of Superscalar Processors, Tata McGraw-Hill.
4. M. J. Flynn, Computer Architecture: Pipelined and Parallel Processor Design, Narosa Publishing House.
5. Kai Hwang, Advanced Computer Architecture: Parallelism, Scalability, Programmability, McGraw-Hill.

Course Outcomes:

1. Understand fundamental issues in architecture design and their impact on performance.
2. Analyze existing architectures and design improved architectures.
3. Apply knowledge of uniprocessor systems to introduce parallelism.
4. Develop applications to solve computationally intensive problems.

MCO1E39 **Pattern and Speech Recognition**

L	T	P/D	Total	Credit		
					Max. Marks:	100
3-	-		3	3	End-Sem:	50 Marks
					Mid-Sem:	50 Marks

Course Objectives: The objective of the course is to understand the algorithms for Pattern Recognition and then to cover the major approaches of pattern recognition to speech recognition.

Syllabus:

Foundations of pattern recognition: Algorithms and machines, including statistical and structural methods. Data structures for pattern representation, feature discovery and selection, classification vs. description, parametric and non-parametric classification, supervised and unsupervised learning, use of contextual evidence, clustering, recognition with strings, and small sample-size problems.

Feature Extraction and Feature Selection: Feature extraction – discrete cosine and sine transform, Discrete Fourier transform, Principal Component analysis, Kernel Principal Component Analysis. Feature selection – class separability measures, Feature Selection Algorithms -Branch and bound algorithm, sequential forward / backward selection algorithms.

Parameter Estimation and Classification: Distance/similarity measures, Clustering Techniques K-means clustering, single linkage and complete linkage clustering, MST, medoids, DBSCAN. Recent advances in Pattern Recognition : Structural PR, SVMs, FCM, Soft-computing and Neuro-fuzzy techniques, and real-life examples

Speech Production and characteristics: Speech Production; Mechanism of speech production; Categories of sounds; Sound units in Indian languages. Nature of Speech Signal; Source-system characteristics; Segmental and supra segmental features; Temporal and spectral parameters for sound units in Indian languages.

Basic Speech Signal Processing Concepts: Signals and systems; Discrete Fourier transform; Digital filtering; Stochastic processes. Speech Signal Processing Methods: Short-time spectrum analysis; Spectrograms; Linear prediction analysis; Cepstrum analysis. Mel frequency cepstral co-efficients (MFCC), Linear prediction cepstral coefficients (LPCC), Perceptual LPCC.

Speech Recognition: Feature extraction for speech recognition, Static and dynamic features for speech recognition, robustness issues, discrimination in the feature space, feature selection. Isolated word recognition; Hidden markov models. Other Applications: Word spotting; Speaker recognition; Speech enhancement; Speech synthesis; Practical issues in speech Recognition.

References:

1. Pattern Classification R. O. Duda, P. E. Hart, D. G. Stork 1224.
2. Pattern Recognition. S. Theodoridis, K. Koutroumbas, Academic Press Edition 4th Edition, 2008
3. Pattern Recognition: Statistical, Structural and Neural Approaches AuthorR. SchalkoffPublisherWileyEdition2012
4. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer,2006
5. Digital Processing of Speech Signals, Rabiner and Schafer, Prentice Hall, 1978.
6. Fundamentals of Speech Recognition, Rabiner and Juang, Prentice Hall, 1994.
7. Speech and Audio Signal Processing: Processing and Perception of Speech and Music by Nelson Morgan and Ben Gold, July 1999, John Wiley & Sons, ISBN: 0471351547

Course Outcomes: At the end of this course, students will be able to:
1. Design systems and algorithms for pattern recognition
2. Analyze a given pattern recognition problem, and determine which algorithm to use
3. Implement algorithms to speech recognition
4. Evaluate and select the best pattern recognition approach for speech recognition.

MCO1E41**High Performance Computing**

L	T	P/D	Total	Credit		Max. Marks:	100
3-	-		3	3	End-Sem:	50 Marks	
						Mid-Sem:	50 Marks

Course Objectives:
Understanding of shared-memory and distributed-memory machines.

Syllabus:
Distributed Memory and Clusters: Introduction, Advantages, N-wide superscalar architectures, multi-core, multi-threaded, Hardware and Software requirements, Design issues.
Distributed Systems: Review of networks, Network operating system, Distributed Operating System, Resource sharing, Message passing, example system, Synchronization aspects, clocks, algorithms, Mutual exclusion, coroutines, CSP, DP, Distributed deadlock detection, Modelling – Petri Nets, Message passing programming.
Clusters – Hardware and Software for Cluster Computing, Cluster Configuration and Cluster Monitoring.
Application Accelerators: FPGAs, GPUs, Cell BE.

Power Aware Computing and Computing: Power-aware Processing Techniques, Power-aware Memory Design, Power-aware Interconnect Design, and Software Power Management.
Supercomputing, Grid Computing, Petascale Computing, Exascale Computing, Cloud Computing and Peer-to-Peer Computing, high-performance computing, high-throughput computing and many-task computing.

Parallel Algorithms: PRAM model of computation, PRAM algorithms for Prefix Sum, Reduction, Parallel computing frameworks.
Elementary parallel algorithms – Broadcast, Prefix sums, Odd-even Transposition Sort, Bitonic Merge, Dictionary Operations-Ellis Algorithm.

Parallel Programming: Fundamentals of Parallel Computers, Introduction to Parallel Programming, Parallel Programming Languages, Large Cache Design, Graphics Processing Unit, Shared Memory Programming with Pthreads, Introduction to parallel software, MPI and OpenMP programming, GPU/Parallel Programming with CUDA.

Books:
1. Highly Parallel Computing, George S. Almasi, and Allan Gottlieb, Benjamin-Cummings, Second Edition, 1993.

2. Parallel Computer Architecture: A Hardware/Software Approach, David Culler Jaswinder Pal Singh, and Morgan Kaufmann, Morgan Kaufmann, First Edition, 1998.
3. Scalable Parallel Computing: Technology, Architecture, Programming, Kai Hwang and Zhiwei Xu, McGraw-Hill Education, 1997.
4. An Introduction to Parallel Computing: Design and Analysis of Algorithms, Grama, Pearson Education India, Second Edition, 2004.
5. An Introduction to Parallel Programming, Peter Pacheco, Morgan Kaufmann, First Edition, 2011.
6. Computer Architecture: A Quantitative Approach, Hennessy, Elsevier, Fifth Edition, 2012.

References:

1. CUDA by Example: An Introduction to General-Purpose GPU Programming, Jason Sanders and Edward Kandrot, Addison-Wesley Professional, First Edition, 2010.
2. Parallel Computing: Theory and Practice, Michael Quinn, McGraw Hill, Second Edition, 2017.
3. Parallel Scientific Computing in C++ and MPI: A Seamless Approach to Parallel Algorithms and their Implementation, George Em Karniadakis and Robert M. Kirby II, Cambridge University Press, 2003.

Course Outcomes:

1. Understand the modern parallel/distributed systems.
2. Design and describe various methods used the general parallel program and shared-memory machines.
3. Designing distributed-memory machines using the MPI module.
4. Designing CUDA programs that make efficient use of the GPU processing power.
5. Build various modern parallel architecture.

MCO1E32**Nature Inspired Optimization**

L	T	P/D	Total Credit		Max. Marks:	100
3-	-		33	End-Sem:	50 Marks	
					Mid-Sem:	50 Marks

Prerequisites:

1. Students must be very comfortable programming in at least one modern programming language such as Matlab/Python
2. Familiarity with basic optimization methods (e.g., linear programming).
3. Perform basic statistical analyses/hypothesis tests and create plots using a programming language such as SAS/R/Minitab will be required.

Course Objectives: To review the concepts of traditional optimization approaches for solving computer related applications. To understand concepts and applications of Nature Inspired Optimization for computing.

Syllabus:

Introduction to Traditional Approaches: Genetic Algorithm, Genetic Programming, Particle Swarm Optimization, Ant Colony Optimization, Line Search, Golden Section Search, Fibonacci Search Classical Newton's Method, Modified Newton's Method, Quasi-Newton Method, Local Search Methods (Scatter Search, Tabu Search, Tandom Search, Downhill Simplex Method), Physics-Based Algorithms, Chemistry-Based Algorithms, Biology-Based Algorithms.

Gravitational Search Algorithm: Introduction, Physics of Gravity, Gravitational Search Algorithm, Parameters of GSA, Fitness Function, Variants of GSA (Binary, Chaotic, Piece-Wise Linear Chaotic Map, Chaotic Local Search, Discrete GSA, Mass-Dispersed GSA, Opposition-Based GSA), Application to Engineering Problems (Clustering Problem, Classification Problem).

Harmony Search: Introduction, Harmony in Music, Musical Improvisation, Harmony Memory, Harmony Search Algorithm, Improvising Harmony from HM, Characteristic Features of Parameters in the HAS, Application of HAS to Engineering Problems (Job Shop Scheduling, Clustering Problem).

Water Drop Algorithm: Introduction, River Systems, Natural WDs, WDs Algorithm, Parameters of WDA, Convergence Analysis, Applications of Engineering Problem (Travelling Salesman Problem, The n-Queen Problem, Multidimensional Knapsack Problem, Vehicle Routing Problem, Economic Load Dispatch Problem)

Simulated Annealing: Introduction, Principles of Statistical Thermodynamics, Annealing Process, SA Algorithm, Cooling (Annealing) Schedule, Neighborhoods, Variants of SA (Boltzmann Annealing, Fast Annealing), Hybrid SA, Applications to Engineering Problems (Travelling Salesman Problem, Job-Shop Scheduling Problem).

Miscellaneous Algorithms: Introduction, Big Bang- Big Crunch (BB-BC) Algorithm, Black Hole Algorithm, Galaxy-Based Search

References:

1. Nature-Inspired Computing: Physics and Chemistry-Based Algorithms, Nazmul H. Siddique, Hojjat Adeli, 1st Edition.ISBN 9781482244823, Chapman and Hall/CRC, 2017.
2. Nature-Inspired Computing and Optimization, Theory and Applications, Editors: Patnaik, Srikanta, Yang, Xin-She, Nakamatsu, Kazumi (Eds.), ISBN 978-3-319-50920-4, Springer, 2017.
3. Clever Algorithms: Nature-Inspired Programming Recipes, Jason Brownlee, ISBN-13: 978-1446785065, Publisher: Lulu.com (2012)
4. Advances in Nature-Inspired Computing and Applications, Shandilya, Shishir Kumar, Shandilya, Smita, Nagar, Atulya K (Eds.), ISBN 978-3-319-96451-5, Springer, 2019.

Course Outcomes:

Upon completing this course student will be able to:

1. Describe the natural phenomena that motivate the discussed algorithms.
2. Understand the strengths, weaknesses and appropriateness of nature-inspired algorithms.
3. Apply nature-inspired algorithms to optimization, design and learning problems.
4. Prove algorithm convergence rates using probabilistic arguments.
5. Select and apply suitable nature-inspired algorithms to solve computational problems

MCO1E34**Image Processing**

L	T	P/D	Total	Credit		Max. Marks:	100
3-	-		3	3	End-Sem:	50 Marks	
						Mid-Sem:	50 Marks

Course Objectives: To introduce the concepts of image processing and basic analytical methods to be used in image processing. To familiarize students with image enhancement and restoration techniques, To explain different image compression techniques. To introduce segmentation and morphological processing techniques.

Syllabus:

Digital image fundamentals: elements of visual Perception, light and electromagnetic spectrum, image sensing and Acquisition, imaging sampling and quantization, intensity transformations and spatial filtering: basics, histogram processing, smoothing spatial filters

Image enhancement: Image enhancement in spatial and frequency domain. Design of Low pass, High pass, EDGE Enhancement, smoothening filters in Frequency Domain, Butter worth filter, Homomorphic filters in Frequency Domain Advantages of filters in frequency domain, comparative study of filters in frequency domain and spatial domain.

Image restoration and reconstruction: a model of image degradation/restoration process, noise models, restoration in presence of noise only-spatial filtering, estimating the degradation function, inverse filtering, Image Enhancement: Arithmetic and logical operations, pixel or point operations, size operations, Smoothing filters-Mean, Median, Mode filters – Comparative study, Edge enhancement filters – Directorial filters, Sobel, Laplacian, Robert, KIRSCH Homogeneity & DIFF Filters, prewitt filter, Contrast Based edge enhancement techniques. – Comparative study Low Pass filters, High Pass filters, sharpening filters. – Comparative Study, Comparative study of all filters.

Color image processing: fundamentals and models, pseudo color image processing, basics of full color image processing, color transformations, smoothing and sharpening, image segmentation based on color.

Image Segmentation: fundamentals, point, line and edge detection, region based segmentation
Morphology: - Dilation, Erosion, Opening, closing, some basic morphological algorithms, gray scale.

References:

1. R.Gonzalaz and R.Woods, "Digital Image Processing", Pearson edition, Inc3/ed,2008 or 4th ed, 2018.
2. Anil K.Jain, "Fundamentals of Digital Image Processing", PHI 1995.
3. William. K.Pratt, "Digital Image Processing", Wiley Interscience, 2nd Ed, 1991.
4. Milan Sonka vaclan Halavac Roger Boyle ,"Image processing, Analysis, and Machine vision", Vikas Publishing House.

Course Outcomes:

On successful completion of this course, students will be able to:

1. To acquire the fundamental concepts of a digital image processing system: digitization, enhancement and restoration, encoding, segmentation, feature detection
2. To identify and exploit analogies between the mathematical tools used for 1D and 2D signal analysis and processing.
3. To analyze 2D signals in the frequency domain through the Fourier transform.
4. To design and implement with Matlab algorithms for digital image processing operations such as histogram equalization, enhancement, restoration, filtering, and denoising.
5. Ability to apply image processing techniques in both the spatial and frequency (Fourier) domains.

MCO1E36**Wireless Sensor Networks**

L	T	P/D	Total	Credit			
						Max. Marks:	100
3-	-		33		End-Sem:	50 Marks	
						Mid-Sem:	50 Marks

Course Objectives: Objective of course is to:

1. To learn about the issues and challenges in the design of wireless sensor networks.
2. To understand the working of MAC and Routing Protocols for sensor networks.
3. To learn about the routing layer protocols and their QoS for sensor networks.
4. To understand various operating systems suggested for WSN.

Syllabus:

Introduction: Characteristic requirements for WSN - Challenges for WSNs – WSN vs Ad-hoc Networks, design principles for WSNs, Sensor node architecture, commercially available sensor nodes –Imote, IRIS, Mica Mote, EYES nodes, BTnodes, TelosB, Sunspot, physical layer and transceiver design considerations in WSNs, Energy usage profile, choice of modulation scheme, Dynamic modulation scaling, Antenna considerations, sensor node hardware and Network Architecture: Single-node architecture, hardware components & design constraints, Service interfaces of WSNs, Gateway concepts.

Medium Access Control Protocols: Issues in designing MAC protocol for WSNs, Fundamentals of MAC protocols - Low duty cycle protocols and wakeup concepts, Contention- based protocols, Schedule-based protocols, SMAC, BMAC, Traffic-adaptive medium access protocol (TRAMA), The IEEE 802.15.4 MAC protocol and Zig Bee.

Routing And Data Gathering Protocols: Routing challenges and design Issues in Wireless Sensor Networks, Flooding and gossiping, Data centric Routing, SPIN, Directed Diffusion, Energy aware routing, Gradient-based routing, Rumor Routing, COUGAR, ACQUIRE, Hierarchical Routing, LEACH, PEGASIS, Location Based Routing, GF, GAF, GEAR, GPSR, Real Time routing Protocols, TEEN, APTEEN, SPEED, RAP, Data aggregation, data aggregation operations, Aggregate Queries in Sensor Networks, Aggregation Techniques, TAG, Tiny DB.

Embedded Operating Systems: Operating System Design Issues, Examples of Operating

Systems: TinyOS, Mate, MagnetOS, MANTIS, OSPM, EYES OS, SenOS, EMERALDS, PicOS, NesC – Interfaces and Modules- Configurations and Wiring - Generic Components - Programming in Tiny OS using NesC, Emulator TOSSIM.

Applications & Case Study: WSN Applications: Home Control, Building Automation, Industrial Automation, Medical Applications, Highway Monitoring, Military Applications, Civil and Environmental Engineering Applications, Wildfire Instrumentation - Habitat Monitoring, Nanoscopic Sensor Applications, Case Study: Target detection and tracking - Contour/edge detection - Field sampling.

References:

1. Kazem Sohraby, Daniel Minoli and Taieb Znati, "Wireless Sensor Networks Technology, Protocols, and Applications", John Wiley & Sons, 2007.
2. Holger Karl and Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley & Sons, Ltd, 2005.
3. Feng Zhao, Leonidas Guibas, "Wireless Sensor Network", Elsevier, 1st Ed. 2004 (ISBN: 13-978-1-55860-914-3).
4. C. Siva Ram Murthy & B.S. Manoj, Mobile Ad hoc Networks - Architectures & Protocols, Pearson Education, New Delhi, 2004.
5. C. S. Raghvendra, Wireless Sensor Networks, Springer-Verlag, 2006 (Available as E-Book at NIT Kurukshetra Purchased in 2006).
6. K. Akkaya and M. Younis, "A survey of routing protocols in wirelesssensor networks", ElsevierAdHocNetworkJournal,Vol.3,no.3,pp.325—349.
7. Anna Ha´c, "Wireless Sensor Network Designs", John Wiley & SonsLtd.

Course outcomes:

1. Identify different issues in wireless sensor networks.
2. To analyze protocols developed for sensor networks.
3. To identify and understand various applications in sensor networks.

MCO1E38**Deep Learning**

L	T	P/D	Total	Credit		
					Max. Marks:	100
3	-	-	3	3	End-Sem:	50 Marks
					Mid-Sem:	50 Marks

Course Objectives:

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

Syllabus:

Introduction to Deep Learning: History of Deep Learning, Deep Learning revolution, Perspectives and Issues in deep learning framework, review of fundamental learning techniques. Difficulty of training deep neural networks, Greedy layerwise training. Limitations of deep learning

Artificial Neural Networks: Neural Network Representation, Activation functions, Thresholding, cost functions, hypotheses and tasks; training data; maximum likelihood based cost, cross entropy, MSE cost; sigmoid units; Backpropagation, Random Initialization, Multilayer Perceptrons (MLPs), Representation Power of MLPs, Gradient Descent, Feedforward Neural Networks, Backpropagation, Gradient Descent (GD).

Convolutional Neural Networks: Building blocks of CNNs, Architectures, convolution / pooling layers, Padding, Strided convolutions, Convolutions over volumes, Softmax regression, Deep Learning frameworks, Training and testing on different distributions, Bias and Variance with mismatched data distributions, Transfer learning, Multi-task learning, end-to-end deep learning, CNN models: LeNet – 5, AlexNet, VGG – 16, Residual Networks.

Recurrent Neural Networks: Recurrent Neural Network Model, Vanishing gradients with RNNs, Gated Recurrent Unit (GRU)¸ LSTM (long short term memory), Encoder Decoder architectures, Deep Unsupervised Learning: Autoencoders (standard, sparse, demising, contractive, etc), Variational Autoencoders, Adversarial Generative Networks, Autoencoder and Deep Boltzmann Machine.

Applications of Deep Learning: Image segmentation, object detection, automatic image captioning, Image generation with Generative adversarial networks, video to text with LSTM models. Attention models for computer vision tasks.

References:

1. Bengio, Yoshua, Ian J. Goodfellow, and Aaron Courville. "Deep Learning." An MIT Press book in preparation. (2015).
2. Fundamentals of Deep Learning: Designing Next-generation Machine Intelligence Algorithms by Nicholas Locascio and Nikhil Buduma O'Reilly Media; 1 edition (June 29, 2017)
3. Deep Learning: A Practitioner's Approach by Adam Gibson and Josh Patterson Shroff/O'Reilly; First edition (2017)
4. Python Deep Learning by Daniel Slater and Gianmario Spacagna, Packt Publishing; 2/e (January 16, 2019)
5. Hochreiter, Sepp, and Jargen Schmidhuber. "Long short-term memory." Neural computation 9.8 (1997): 17351780.
6. Bishop, C., M., Pattern Recognition and Machine Learning, Springer, 2006.
7. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.

Course Outcomes:

1. Identify the deep learning algorithms, which are more appropriate for various types of learning tasks in various domains.
2. Apply scaling up deep learning techniques and associated computing techniques and technologies.
3. Recognize various ways of selecting suitable model parameters for different applications.

MCO1C02**Big Data and Analytics**

L T P/D Total Credit Max. Marks: 100
-- 221 End-Sem: 50 Marks
Mid-Sem: 50 Marks

Course Objectives: The objectives of this subject are:

1. To know the fundamental concepts of big data and analytics.
2. To explore tools and practices for working with big data
3. To learn about stream computing.
4. To know about the research that requires the integration of large amounts of data and practice with C, python and R.

Syllabus:

Introduction to Big Data: Evolution of Big data – Best Practices for Big data Analytics, Big data characteristics, Validating, The Promotion of the Value of Big Data, Big Data Use Cases, Characteristics of Big Data Applications, Perception and Quantification of Value, Understanding Big Data Storage, A General Overview of High-Performance Architecture – HDFS – MapReduce and YARN – Map Reduce Programming Model. Feature engineering and visualization.

Clustering and Classification: Advanced Analytical Theory and Methods: Overview of Clustering, K-means, Use Cases, Overview of the Method – Determining the Number of Clusters, Diagnostics – Reasons to Choose and Cautions. Classification: Decision Trees, Overview of a Decision Tree, The General Algorithm – Decision Tree Algorithms, Evaluating a Decision Tree, Decision Trees in R, Naïve Bayes, Baye's Theorem, Naive Bayes Classifier.

Association and Recommendation System: Advanced Analytical Theory and Methods: Association Rules, Overview – Apriori Algorithm, Evaluation of Candidate Rules, Applications of Association Rules, Finding Association & finding similarity. Recommendation System: Collaborative Recommendation, Content Based Recommendation, Knowledge Based Recommendation, Hybrid Recommendation Approaches.

Stream Memory: Introduction to Streams Concepts – Stream Data Model and Architecture, Stream Computing, Sampling Data in a Stream, Filtering Streams, Counting Distinct Elements in a Stream, Estimating moments, Counting oneness in a Window, Decaying Window, Real time Analytics Platform (RTAP) applications, Case Studies – Real Time Sentiment Analysis, Stock Market Predictions. Using Graph Analytics for Big Data: Graph Analytics.

Nosql Data Management for Big Data and Virtualization:NoSQL Databases: Schema-less Models‖: Increasing Flexibility for Data Manipulation-Key Value Stores, Document Stores, Tabular Stores, Object Data Stores, Graph Databases Hive, Sharding, Hbase, Analyzing big data with twitter, Big data for E-Commerce Big data for blogs. Review of Basic Data Analytic Methods using R.

References:

1. Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 2012.
2. David Loshin, "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph", Morgan Kaufmann/El sevier Publishers, 2013.
3. EMC Education Services, "Data Science and Big Data Analytics: Discovering, Analyzing,

Visualizing and Presenting Data", Wiley publishers, 2015.
4. Bart Baesens, "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", Wiley Publishers, 2015.
5. Dietmar Jannach and Markus Zanker, "Recommender Systems: An Introduction", Cambridge University Press, 2010.

Course Outcomes:

1. Work with big data tools and its analysis techniques.
2. Analyze data by utilizing clustering and classification algorithms.
3. Learn and apply different mining algorithms and recommendation systems for large volumes of data.
4. Perform analytics on data streams.
5. Learn NoSQL databases and management.

MCO1C04**Cloud and IoT Security**

L	T	P/D	Total	Credit			
						Max. Marks:	100
3-	-		3	3	End-Sem:	50 Marks	
						Mid-Sem:	50 Marks

Course Objectives:

1. To understand the fundamentals of Internet of Things (IoT) and Cloud Computing.
2. Understand the cryptographic fundamentals for IoT.
3. Ability to understand the Security requirements in IoT.
4. To apply the concept of Internet of Things in the real world scenario.

Syllabus:

Fundamentals of IoT and Cloud Computing: Evolution of Internet of Things, Enabling Technologies, IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT models, Simplified IoT Architecture and Core IoT Functional Stack, Fog, Edge and Cloud in IoT, Functional blocks of an IoT ecosystem, Sensors, Actuators, Smart Objects and Connecting Smart Objects.

IoT Architectures and Protocols: M2M high-level ETSI architecture, IETF architecture for IoT, OGC architecture. IoT reference model: Domain model, information model, functional model, communication model. IoT reference architecture. Protocol Standardization for IoT: Efforts, M2M and WSN Protocols, SCADA and RFID Protocols. IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, LoRaWAN, Network Layer: IP versions, Constrained Nodes and Constrained Networks. Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks, Application Layer Protocols: CoAP and MQTT.

Securing the IoT: Security Requirements in IoT Architecture, Security in Enabling Technologies, Security Concerns in IoT Applications. Security Architecture in the Internet of Things, Security Requirements in IoT, Insufficient Authentication/Authorization, Insecure Access Control, Threats to Access Control, Privacy, and Availability, Attacks Specific to IoT. Vulnerabilities. Secrecy and Secret-Key Capacity, Authentication/Authorization for Smart Devices, Transport

Encryption, Attack & Fault trees.

Cloud Security for IoT: Cloud services and IoT: offerings related to IoT from cloud service providers, Cloud IoT security controls, and an enterprise IoT cloud security architecture. New directions in cloud enabled IoT computing.

Applications & Case Study: Real world design constraints, Applications, Asset management, Industrial automation, smart grid, Commercial building automation, Smart cities, participatory sensing. Data Analytics for IoT. Software & Management Tools for IoT Cloud Storage Models & Communication APIs. Cloud for IoT: Amazon Web Services for IoT.

References:

1. Xu, L. D., & Li, S. (2017). Securing the Internet of Things. Elsevier.
2. Weippl, E. (2018). Internet of Things Security: Fundamentals, Techniques and Applications. River Publishers.
3. Russell, B., & Van Duren, D. (2016). Practical internet of things security. Packt Publishing Ltd.
4. Hu, F. (2016). Security and privacy in Internet of things (IoTs): Models, Algorithms, and Implementations. CRC Press.
5. Zhou, H. (2012). The internet of things in the cloud: a middleware perspective. CRC press.
6. Hersent, O., Boswarthick, D., & Elloumi, O. (2011). The internet of things: Key applications and protocols. John Wiley & Sons.
7. Granjal, J., Monteiro, E., & Silva, J. S. (2015). Security for the internet of things: a survey of existing protocols and open research issues. IEEE Communications Surveys & Tutorials, 17(3), 1294-1312.

Course Outcomes:
1. Identify different issues in IoT security.
2. To analyze protocols and reference architectures developed for IoT.
3. To identify and understand various applications of IoT.

MCO1E42**Information Retrieval and Web Search**

L	T	P/D	Total	Credit			
						Max. Marks:	100
3-	-		3	3	End-Sem:	50 Marks	
						Mid-Sem:	50 Marks

Course Objectives:
1. Learn the information retrieval models.
2. Be familiar with Web Search Engine.
3. Be exposed to Link Analysis.
4. Understand Hadoop and Map Reduce.
5. Learn document text mining techniques.

Syllabus:

Introduction: Introduction- History of IR, Components of IR, Issues, Open source Search Engine Frameworks, the impact of the web on IR, The role of artificial intelligence (AI) in IR, IR Versus Web Search, Components of a Search engine, Characterizing the web.

Information Retrieval: Boolean and vector-space retrieval models, Term weighting, TF-IDF weighting, cosine similarity, Preprocessing, Inverted indices, efficient processing with sparse vectors, Language Model based IR, Probabilistic IR, Latent Semantic Indexing, Relevance feedback and query expansion.

Web Search Engine – Introduction and Crawling: Web search overview, web structure, the user, paid placement, search engine optimization/ spam. Web size measurement, search engine optimization/spam, Web Search Architectures, crawling, meta-crawlers, Focused Crawling, web indexes, Near-duplicate detection, Index Compression, XML retrieval.

Web Search – Link Analysis and Specialized Search: Link Analysis –hubs and authorities – Page Rank and HITS algorithms -Searching and Ranking – Relevance Scoring and ranking for Web – Similarity.

Hadoop & Map Reduce – Evaluation – Personalized search – Collaborative filtering and content-based recommendation of documents and products – handling “invisible” Web – Snippet generation, Summarization, Question Answering, Cross- Lingual Retrieval.

Document Text Mining: Information filtering; organization and relevance feedback, Text Mining, Text classification and clustering. Categorization algorithms: naive Bayes; decision trees; and nearest neighbor – Clustering algorithms: agglomerative clustering; k-means; expectation maximization (EM).

References:

1. C. Manning, P. Raghavan, and H. Schütze, Introduction to Information Retrieval, Cambridge University Press, 2008.
2. Ricardo Baeza -Yates and Berthier Ribeiro – Neto, Modern Information Retrieval: The Concepts and Technology behind Search 2 nd Edition, ACM Press Books 2011.
3. Bruce Croft, Donald Metzler and Trevor Strohman, Search Engines: Information Retrieval in Practice, 1 st Edition Addison Wesley, 2009.
4. Mark Levene, An Introduction to Search Engines and Web Navigation, 2 nd Edition Wiley, 2010.

Course Outcomes:

1. To identify the different issues in informal retrieval and web searching.
2. To analyse and understand various applications of web search in real world.
3. To use the various techniques for text mining and analyse their performance.

MCO1E44**Number Theory and Cryptology**

L T P/D Total Credit Max. Marks: 100
3- - 33 End-Sem: 50 Marks
Mid-Sem: 50 Marks

Course Objectives:
1. To emphasize the application of the number theory in the design of cryptographic algorithms.
2. To understand the strength and weakness of cryptosystems.
3. To introduce the elliptic curve cryptography.

Syllabus:
Elementary Number Theory: Divisibility, Division Algorithm, Euclidean Algorithm; Congruences, Complete Residue systems, Reduced Residue systems; Fermat's little theorem, Euler's Generalization, Wilson's Theorem; Chinese Remainder Theorem, Generalized Chinese Remainder Theorem-Euler Phi-function, multiplicative property; Finite Fields, Primitive Roots; Quadratic Residues, Legendre Symbol, Jacobi Symbol; Gauss's lemma, Quadratic Reciprocity Law.

PrimalityTestingandFactorization:PrimalityTests; Pseudoprimes,CarmichaelNumbers; Fermat's pseudoprimes, Euler pseudoprimes; Factorization by Pollard’s Rho method; Simple ContinuedFraction, simple infinite continued fractions; Approximation to irrational numbers using continued fractions; Continued Fraction method forfactorization.

Public Key Cryptosystems: Traditional Cryptosystem, limitations; Public Key Cryptography; Diffie-Hellmann key exchange; Discrete Logarithm problem; One-way functions, Trapdoor functions; RSA cryptosystem; Digital signature schemes; Digital signature standards; RSA signature schemes; Knapsack problem; ElGamal Public Key Cryptosystem; Attacks on RSA cryptosystem: Common modulus attack; Homomorphism attack, timing attack; Forging of digital signatures; Strong primes, Safe primes, Gordon's algorithm for generating strong primes; Strong pseudoprimes to the base a.

Elliptic Curve Cryptography: Cubic Curves, Singular points, Discriminant; Introduction to Elliptic Curves, Geometry of elliptic curves over reals; Weierstrass normal form, point at infinity; Addition of two points; Bezout's theorem, associativity; Group structure, Points of finite order; Elliptic Curves over finite fields, Discrete Log problem for Elliptic curves; Elliptic Curve Cryptography; Factorization using Elliptic Curve; Lenstra's algorithm; ElGamal Public Key Cryptosystem for ellipticcurves.

Mini Project (Implementation of any Cryptographic Algorithm from above related topics, as an assignment)

References:
1. A Course in Number Theory and Cryptography, Neal Koblitz, (Springer2006)
2. An Introduction to Mathematical Cryptography, Jill Pipher, Jeffrey Hoffstein, Joseph H. Silverman (Springer,2008)

3. An Introduction to theory of numbers, Niven, Zuckerman and Montgomery, (Wiley2006)
4. Elliptic curves: Number theory and cryptography, Lawrence C. Washington, (Chapman & Hall/CRC2003)
5. An Introduction to Cryptography, R.A. Mollin (Chapman & Hall,2001)
6. Rational Points on Elliptic Curves, Silverman and Tate (Springer2005)
7. Guide to elliptic curve cryptography Hankerson, Menezes, Vanstone (Springer,2004)
8. Elementary Number Theory, Jones and Jones (Springer,1998)

Course Outcomes:

On successful completion of this course, students will be able to:

1. Understand the significance of cryptography to the modern world
2. Able to learn basic elements of number theory and its applications in cryptography
3. Understand the mathematical foundations of Cryptographic algorithms
4. Understand Public Key Cryptography, Discrete Logarithm problem, RSA Cryptosystem, ECC and various attacks
5. Solve elementary problems in number theory relating to cryptography.
6. Build on number theoretic basics to further their knowledge of advanced methods of cryptography.

MCO1E46**Computer Vision**

L T P/D Total Credit Max. Marks: 100
3- - 33 End-Sem: 50 Marks
Mid-Sem: 50 Marks

Course Objective:

1. Able to recognize and describe both the theoretical and practical aspects of computing with images.
2. Able to describe the foundation of image formation and image analysis.
3. Understand the geometric relationships between 2D images and the 3D world.
4. Have gained exposure to motion, matching, recognition, extraction, and categorization from images.

Syllabus:

Introduction And Digital Image Formation: Overview, Fundamentals of Image Formation, What is computer vision?, A brief history.

IMAGE FORMATION AND IMAGE MODELS: Geometric Camera Models, Geometric Camera Calibration, Radiometry, Measuring Light, Shadows and shading, Color.

Early Vision - Multiple Images: The Geometry of Multiple Views, Stereopsis, Affine Structure from Motion, Projective Structure from Motion.

Feature Detection and Matching: Points and patches, Edges, Lines

Mid Level Vision: Segmentation by Clustering, Segmentation by Fitting a Model, Segmentation and Fitting using Probabilistic Methods, Tracking with Linear Dynamic Models.
FEATURE-BASED ALIGNMENT: 2D and 3D feature-based alignment, Pose estimation, Geometric intrinsic calibration.

High Level Vision – Geometric Methods: Model-Based Vision, Smooth Surfaces and their Outlines, Aspect Graphs, Range Data.
STRUCTURE FROM MOTION: Triangulation, Two-frame structure from motion, Factorization, Bundle adjustment, Constrained structure and motion.

High Level Vision -Probabilistic and Inferential Methods: Recognition by Relations between Templates, Geometric Templates from Spatial Relations, Application, Image Based Rendering.
DENSE MOTION ESTIMATION: Translational alignment, Parametric motion, Spline-based motion, Optical flow, Layered motion.

3D Reconstruction: Shape from X, Active range finding, Surface representations, Point-based representations - Volumetric representations - Model-based reconstruction - Recovering texture maps.
Recognition: Object detection, Face recognition, Instance recognition, Category recognition, Context and scene understanding.

References:

1. Digital Image Processing, Rafael C. Gonza Lez and Richard E. Woods, Fourth Edition, Pearson, 2018.
2. Computer Vision: A Modern Approach, Forsyth and Ponce, Second Edition, Pearson, 2015.
3. Computer Vision: Algorithms and Applications, Richard Szeliski, Springer-Verlag, 2010.
4. Computer Vision: Models, Learning, and Inference, Dr Simon J. D. Prince, Cambridge University Press, 2012.
5. Multiple View Geometry in Computer Vision, Richard Hartley and Andrew Zisserman, Cambridge University Press, 2004.

Course Outcomes:

1. Understand the basics of 2D and 3D Computer Vision.
2. Design and describe various methods used for motion, registration, alignment, detection, recognition and matching in images.
3. Build computer vision applications.

MCO1E48**Selected Topics in Logics and Automata**

L T P/D Total Credit		Max. Marks: 100
3- - 33	End-Sem:	50 Marks
		Mid-Sem: 50 Marks

Course Objectives: The course aims at giving an introduction to the theory of automata working on infinite words and infinite trees and connections thereof to logics.

Syllabus:

Regular Languages and Logic; First-Order-and Monadic-Second-Order-Logic, Other Equivalent Representations, Two-way Finite Automata, First Order Logic with Transitive Closure, Two-Way Multihead Automata; k-ary Transitive Closure; Tree Walking Automata; Descriptive Complexity Automata on finite words - equivalence of MSO and automata; Automata on infinite words; different acceptance conditions; Closure properties and equivalence of different acceptance conditions and related translations Determinization and complementation results; Equivalence of automata and MSO and decidability of MSO; Automata on infinite trees - different acceptance conditions; Closure properties and comparison of expressive power of different acceptance conditions and related translations Complementation result for tree automata via parity games; Equivalence of MSO and tree automata; Decidability of MSO over tress; Parity games and determinacy; Ehrenfeucht-Frasse games in logics and applications.

References:

1. W. Thomas. Automata on infinite objects. In J. van Leeuwen, editor, Handbook of Theoretical Computer Science, volume B: Formal Models and Semantics, pages 133-192. Elsevier Science Publishers, Amsterdam, 1990.
2. W. Thomas. Languages, automata, and logic. In G. Rozenberg and A. Salomaa, editors, Handbook of Formal Languages, volume III, pages 389-455. Springer, New York, 1997.
3. H. Comon et al. Tree Automata Techniques and Applications. Online available at http://www.grappa.univ-lille3.fr/tata
4. F. Gecseg and M. Steinby. Tree Automata. Akademiai Kiado, Budapest, 1984.
5. T. Wilke. Alternating Tree Automata, Parity Games, and Modal μ-Calculus. Bull. Belg. Math. Soc., pages 359-391. 1993.

Course Outcome:

1. Able to understand the concept of several automata formalisms on finite objects.
2. Able to understand the concepts of automata and logic equivalence.
3. Analyse expressive power of Automata theory in comparison to extensions of First Order Logic.

MCO1E52 **Graph Theory and Combinatorics**

L	T	P/D	Total	Credit			
						Max. Marks:	100
3-	-		33		End-Sem:	50 Marks	
						Mid-Sem:	50 Marks

Course Objective: To study graph theory, fundamentals, trails, circuits, trees, matrices, directed graphs, graph coloring, labeling, graph decompositions, cycles, domination, symmetries counting, principle of exclusion and inclusion, generating functions, and recurrence relations.

Syllabus:

Graph fundamentals: Walks, paths, directed graphs, knots, cycles, neighborhood, clique, reachability, connectivity, spanning tree, knot detection algorithms. Graph coloring: Problem and model, greedy and random coloring algorithms, edge coloring, coloring trees, coloring planar and arbitrarygraph.

Graph traversal: Tarry‟s traversal algorithm, search algorithms, BFS algorithms and applications, classical and Awerbuch‟s DFS algorithm, DFS with neighbor knowledge, spanning tree construction using flooding and DFS, GHS, Awerbuch, Korach-Kutten-Moran MST algorithms and applications, synchronizers.

Routing: Shortest path algorithms, Dijkstra, Bellman-Ford, Floyd-Warshall, Chandi-Misra algorithms, Johnson‟s algorithm, link state, distance vector, and interval routing algorithms, maximum flow, Ford-Fulkerson method, maximum bipartite matching, push-relabel algorithm, relabel-to-frontalgorithm.

Maximal Independent Set (MIS): Rank-based MIS algorithms, Luby‟s MIS algorithm, MIS construction from vertex coloring.

Domination algorithms: Greedy MDS algorithms, Guha-Khuller algorithm, connected dominating sets, MIS-based and pruning-based algorithms, weakly connected dominating sets.

Matching: Unweighted and weighted matching algorithms, matching from edge coloring.

Vertex cover: Unweighted and weighted vertex cover algorithms, pricing algorithm, bipartite matching-based algorithms.

References:

1. Douglas B. West, Introduction to Graph Theory,PHI.
2. David Avis, Alain Hertz, Odile Marcotte (Eds.), Graph Theory and Combinatorial Optimization, Springer.
3. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, Introduction to Algorithms,PHI.
4. Sukumar Ghosh, Distributed Systems: An Algorithmic Approach, Chapman &Hall/CRC.
5. Kayhan Erciyes, Distributed Graph Algorithms for Computer Networks,Springer.
6. Yvonne-Anne Pignolet, ThomasLocher,Roger Wattenhofer,PrinciplesofDistributedComputing, Availableonline.
7. Herbert S. Wilf, Algorithms and Complexity, Availableonline.
8. Michel Raynal, Distributed Algorithms for Message-Passing Systems,Springer.
9. Nancy Lynch, Distributed Algorithms, MorganKaufmann.
10. Gerard Tel, Introduction to Distributed Algorithms, Cambridge Univ. Press

Course Outcomes:

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

1. Explain the basic concepts of graph theory.
2. Apply the basic concepts of mathematical logic describe and solve some real time problems using concepts of graph theory.

MCO1E54**Advances in Cloud and Mobile Computing**

L	T	P/D	Total	Credit		Max. Marks:	100
3-	-		3	3	End-Sem:	50 Marks	
						Mid-Sem:	50 Marks

Course Objectives: To understand issues and research challenges Cloud and Mobile Computing**.**

Syllabus:
Cloud Computing: Cloud Stability, and Scalability, Robustness of Data Centers, Dynamic Failure Detection and Recovery, Arbitrary and Non-arbitrary Failures, Membership Management, Group Communication, Gossip Protocols, Energy efficiency in Clouds, Mobile Cloud Computing, State of Art, Applications, Challenges, Cloud Gaming System, Correlation, Modelling, Architecture and Integration, Service Components, Routing, QoS, Cloud Computing for Mobile Services, Fusion, Event-driven Systems and Mobile Applications, Communication, Big Data, Value and Development, IoT and Big data, Generation and Acquisition, Storage, Analysis, Tools, Applications

Mobile Computing: Challenges in Mobile Computing, Coping with Uncertainty, Cooperative and Temporal Spectrum Sensing, Emerging Sensing Paradigms and Intelligence, Spectrum Management, Resource Scarcity, Bandwidth, Mobility, Localization, Synchronization, Handling Fundamental Challenges in Faulty Environments, Mitigating Coexistence and Interference, Reliable Message Delivery, Publish/Subscribe, Advanced Graph Theoretic Approaches in Mobile Computing Systems, Algorithms for Construction of Virtual Structures, Fault Tolerance, Blocking and Non-blocking Protocols

References:

1. Kenneth P. Birman, Guide to Reliable Distributed Systems, Springer, 2012.
2. Zaigham Mahmood, Ricardo Puttini, and Thomas Erl, Cloud Computing: Concepts, Technology & Architecture. Prentice Hall. ISBN: 9780133387568
3. S. Thamarai Selvi, Christian Vecchiola, and Rajkumar Buyya, Mastering Cloud Computing, Morgan Kaufmann, ISBN: 9780124114548
4. F. Richard Yu and Victor Leung, Advances in Mobile Cloud Computing Systems, CRC Press.
5. Advances on Cloud Computing and Context-Aware Systems, vol. 19, no. 2, April 2014, Mobile Networks and Applications, Springer.
6. Ivan Stojmenovic, Handbook of Wireless Networks and Mobile Computing, John Wiley & Sons.
7. Sudip Misra, Barun Kumar Saha, and Sujata Pal, Opportunistic Mobile Networks: Advances and Applications, Springer International Publishing, 2016.

Course Outcomes:
After completion of the course, the student will be able to:
1. Understand the basics of Cloud and Mobile computing paradigms.
2. Understand different architectures of Cloud Computing.
3. Design Cloud and Mobile Computing based applications.