Course Structure for Master of Technology in Computer Science and Engineering w.e.f. July 2020

M.TechSem-I

Paper Code	Paper Title	Scheme of Studies Per Week			Credits
		L	T	P	
CSEC 411	Mathematical Foundations of Computer Science	3	1	0	4
CSEC 412	Advanced Data Structures	3	0	1	4
CSEE 413X	Elective – I	3	1	1	5
CSEE 414X	Elective – II	3	1	1	5
CSEA 415	Research Methodology and IPR (MOOC if available)	2	0	0	2+
				Total Credits:	20+

M.TechSem-II

Paper Code	Paper Title	Scheme of Studies Per Week			Credits
		L	T	P	
CSEC 421	Advanced Algorithms	3	1	1	5
CSEC 422	Soft Computing	3	1	1	5
CSEE 423X	Elective – III	3	1	1	5
CSEE 424X	Elective – IV (MOOC if available)	3	1	0	4+
				Total Credits:	20+

M.TechSem-III

Paper Code	Paper Title	Scheme of Studies Per Week			Credits
		L	T	P	
CSEE 511X	Elective – V (MOOC if available)	3	1	0	4+
CSEO 512X	Open Elective (MOOC if available)	3	1	0	4+
CSEP 514	Dissertation-I	0	0	12	12
				Total Credits:	20+

M.TechSem-IV

Paper Code	Paper Title	Scheme of Studies Per Week			Credits
		L	T	P	
CSEP 521	Dissertation-II	0	0	20	20
				Total Credits:	20

Program Outcomes of CSE (M.Tech.) program:

The main outcomes of the CSE (M.Tech.) program are given here. At the end of the program a student is expected to have:

1. An understanding of the theoretical foundations and the limits of computing.

2. An ability to adapt existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.
3. An ability to design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
4. Understanding and ability to use advanced computing techniques and tools.
5. An ability to undertake original research at the cutting edge of computer science & its related areas.
6. An ability to function effectively individually or as a part of a team to accomplish a stated goal.
7. An understanding of professional and ethical responsibility.
8. An ability to communicate effectively with a wide range of audience.
9. An ability to learn independently and engage in life-long learning.
10. An understanding of the impact of IT related solutions in an economic, social and environment context.

Elective – I

CSEE-4131: Data Science

CSEE-4132: Distributed System

CSEE-4133: Data Preparation and Analysis

CSEE-4134: Digital Forensics

CSEE-4135: Ethical Hacking

CSEE-4136: Intrusion Detection

CSEE-4137: Wireless Access Technologies

CSEE-4138: Mobile Application and Services

Elective – II

CSEE-4141: Recommender System

CSEE-4142: Machine Learning

CSEE-4143: Data Storage Techniques and Networks

CSEE-4144: Malware Analysis and Reverse Engineering

CSEE-4145: Secure Software Design and Enterprise Computing

CSEE-4146: Smart Sensors and Internet of Things

CSEE-4147: Logic and Functional Programming

Elective – III

CSEE 4231: Data Visualization

CSEE 4232 Big Data Analytics

CSEE 4233 Data Warehouse and Data Mining

CSEE 4234 Data Encryption and compression

CSEE 4235 Steganography and Digital Watermarking

CSEE 4236 Information Theory and Coding

CSEE 4237 Sensor Networks and Internet of Things

CSEE 4238 IoT Application and Communication Protocol

Elective – IV

CSEE-4241: Data Security and Access Control

CSEE-4242: Web Analysis and Development

CSEE-4243: Knowledge Discovery

CSEE-4244: Security Assessment and Risk Analysis

CSEE-4245: Secure Coding

CSEE-4246: Biometrics

CSEE-4247: Network Security

CSEE-4248: Advanced Machine Learning

Elective – V

CSEE-5111: GPU Computing

CSEE-5112: Cloud Computing

CSEE-5113: Distributed Databases

CSEE-5114: Data Warehouse and Mining

CSEE-5115: Web Search and Information Retrieval

CSEE-5116: Database Security and Access Control

CSEE-5117: IoT and Smart Cities

CSEE-5118: Emulation and Simulation Methodology

MASTER OF TECHNOLOGY IN COMPUTER SCIENCE AND ENGINEERING

[M.Tech. (CSE)]

FIRST SEMESTER

Core Subjects:

Course Code	CSEC 411
Course Name	Mathematical Foundation of Computer Science
Credits	3
Pre-Requisites	Discrete Mathematics

Total Number of Lectures:48

COURSE OBJECTIVE
•To understand the mathematical fundamentals that is prerequisites for avariety of courses like Data mining, Network protocols, analysis of Web traffic, Computer security, Software engineering, Computer architecture, operating systems, distributed systems, Bioinformatics, Machine learning.
•To developthe understanding ofthe mathematical and logical basis to many modern techniques in information technology like machine learning, programming language design, and concurrency.
•To study various sampling and classification problems.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1 Probability mass, density, and cumulative distribution functions, Parametric families of distributions, Expected value, variance, conditional expectation, Applications of the univariate and multivariate Central Limit Theorem, Probabilistic inequalities, Markov chains	7
Unit 2 Random samples, sampling distributions of estimators**,** Methods of Moments and Maximum Likelihood**,**	7
Unit 3 Statistical inference**,** Introduction to multivariate statistical models: regression and classification problems, principal components analysis**,** The problem of overfitting model assessment.	8
Unit 4 Graph Theory: Isomorphism, Planar graphs, graph colouring, hamilton circuits and euler cycles. Permutations and Combinations with and without repetition.	11

Specialized techniques to solve combinatorial enumeration problems	
Unit 5 **Computer science and engineering applications**	10
Data mining, Network protocols, analysis of Web traffic, Computer security, Software engineering, Computer architecture, operating systems, distributed systems, Bioinformatics, Machine learning.	
Unit 6 Recent Trands in various distribution functions in mathmatical field of computer science for varying fields like bioinformatic, soft computing, and computer vision.	5
COURSE OUTCOMES	
After completion of course, students would be able to:	
•To understand the basic notions of discrete and continuous probability.	
•To understand the methods of statistical inference, and the role that sampling distributions play in those methods.	
•To be able to perform correct and meaningful statistical analyses of simple to moderate complexity.	

References

1. John Vince, Foundation Mathematics for Computer Science, Springer.

2. K. Trivedi.Probability and Statistics with Reliability, Queuing, and Computer Science Applications. Wiley.

3. M. Mitzenmacher and E. Upfal.Probability and Computing: Randomized Algorithms and Probabilistic Analysis.

4. Alan Tucker, Applied Combinatorics, Wiley

Course Code	CSEC 412
Course Name	Advanced Data Structures
Credits	3
Pre-Requisites	UG level course in Data Structures

Total Number of Lectures:48

COURSE OBJECTIVE
•The student should be able to choose appropriate data structures, understand the ADT/libraries, and use it to design algorithms for a specific problem.
•Students should be able to understand the necessary mathematical abstraction to solve problems.
•To familiarize students with advanced paradigms and data structure used to solve algorithmic problems.
•Student should be able to come up with analysis of efficiency and proofs of correctness.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1 **Dictionaries:** Definition, Dictionary Abstract Data Type, Implementation of Dictionaries. **Hashing:** Review of Hashing, Hash Function, Collision Resolution Techniques in Hashing, Separate Chaining, Open Addressing, Linear Probing, Quadratic Probing, Double Hashing, Rehashing, Extendible Hashing.	7
Unit 2 **Skip Lists:** Need for Randomizing Data Structures and Algorithms, Search and Update Operations on Skip Lists, Probabilistic Analysis of Skip Lists, Deterministic Skip Lists	5
Unit 3 **Trees:** Binary Search Trees, AVL Trees, Red Black Trees, 2-3 Trees, B-Trees, Splay Trees	9
Unit 4	12
Text Processing: Sting Operations, Brute-Force Pattern Matching, The Boyer Moore Algorithm, The Knuth-Morris-Pratt Algorithm, Standard Tries, Compressed Tries, Suffix Tries, The Huffman Coding Algorithm, The Longest Common Subsequence Problem (LCS), Applying Dynamic Programming to the LCS Problem.	
Unit 5 **Computational Geometry:** One Dimensional Range Searching, Two Dimensional Range Searching, Constructing a Priority Search Tree, Searching a Priority Search Tree, Priority Range Trees, Quadtrees, k-D Trees.	10
Unit 6 Recent Trands in Hashing, Trees, and various computational geometry methods foreffeciently solving the new evolving problem	5

COURSE OUTCOMES
After completion of course, students would be able to:
•Understand the implementation of symbol table using hashing techniques.
•Develop and analyze algorithms for red-black trees, B-trees and Splay trees.
•Develop algorithms for text processing applications.
•Identify suitable data structures and develop algorithms for computational

geometry problems.

References:

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, 2nd Edition, Pearson, 2004.

2. M T Goodrich, Roberto Tamassia, Algorithm Design, John Wiley, 2002.

Elective – I

Course Code	CSEE-4131
Course Name	Data Science
Credits	3
Pre-Requisites	

Total Number of Lectures:48

COURSE OBJECTIVE
•Provide you with the knowledge and expertise to become a proficient data scientist.
•Demonstrate an understanding of statistics and machine learning concepts that are vital for data science;
•Produce Python code to statistically analyse a dataset;
•Critically evaluate data visualisations based on their design and use for communicating stories from data;

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction to core concepts and technologies: Introduction, Terminology, data science process, data science toolkit, Types of data, Example applications.	6
Unit 2: Data collection and management: Introduction, Sources of data, Data collection and APIs, Exploring and fixing data, Data storage and management, Using multiple data sources	7
Unit 3: Data analysis: Introduction, Terminology and concepts, Introduction to statistics, Central tendencies and distributions, Variance,Distribution properties and arithmetic, Samples/CLT, Basic machine learning algorithms, Linear regression, SVM, Naive Bayes.	10
Unit 4: Data visualisation:Introduction, Types of data visualisation,Data for visualisation:Data types, Data encodings, Retinal variables, Mapping variables to encodings, Visual encodings.	11
Unit 5: Applications of Data Science,Technologies for visualisation, Bokeh (Python)	7
Unit 6: Recent trends in various data collection and analysis techniques, various visualization techniques, application development methods of used in data science.	7

COURSE OUTCOMES
On completion of the course the student should be able to
•Explain how data is collected, managed and stored for data science;
•Understand the key concepts in data science, including their real-world applications and the toolkit used by data scientists;
•Implement data collection and management scripts using MongoDB

References:

1. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline. O'Reilly.

2. Jure Leskovek, AnandRajaraman and Jeffrey Ullman. Mining of Massive Datasets. v2.1, Cambridge University Press.

Course Code	CSEE-4132
Course Name	Distributed Database
Credits	3
Pre-Requisites	

Total Number of Lectures: 48

COURSE OBJECTIVE
•The objective of course is to provide insight to distributed database, normalization techniques and integrity rules. It also includes parallel database systems along with object oriented models.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction: Distributed Data processing, Distributed database system (DDBMS), Promises of DDBMSs, Complicating factors and Problem areas in DDBMSs, Overview Of Relational DBMS Relational Database concepts, Normalization, Integrity rules, Relational Data Languages, Relational DBMS.	11
Unit 2: Distributed DBMS Architecture: DBMS Standardization, Architectural models for Distributed DBMS, Distributed DBMS Architecture. Distributed Database Design: Alternative design Strategies, Distribution design issues, Fragmentation, Allocation. Semantic Data Control: View Management, Data security, Semantic	8
Integrity Control.	
Unit 3: Overview of Query Processing: Query processing problem, Objectives of Query Processing, Complexity of Relational Algebra operations, characterization of Query processors, Layers of Query Processing. Introduction to Transaction Management: Definition of Transaction, Properties of transaction, types of transaction. Distributed Concurrency Control: Serializability theory, Taxonomy of concurrency control mechanisms, locking bases concurrency control algorithms.	9
Unit 4: Parallel Database Systems: Database servers, Parallel architecture, Parallel DBMS techniques, Parallel execution problems, Parallel execution for hierarchical architecture.	7
Unit 5: Distributed Object Database Management systems: Fundamental Object concepts and Object models, Object distribution design. Architectural issues, Object management, Distributed object storage, Object query processing. Transaction management. Database Interoperability: Database Integration, Query processing.	8
Unit 6: Recent approaches, models and current trends in improving the performance of Distributed Database.	5

COURSE OUTCOMES
After completion of course, students would be:
•Abe to understand relational database management systems, normalization to make efficient retrieval from database and query.

References:

1. Principles of Distributed Database Systems, Second Edition, M. Tamer Ozsu Patrick Valduriez
2. Distributed Databases principles and systems, Stefano Ceri, Giuseppe Pelagatti, Tata McGraw Hill.

Course Code	CSEE-4133
Course Name	Data Preparation and Analysis
Credits	3
Pre-Requisites	

Total Number of Lectures: 48

COURSE OBJECTIVE
•To prepare the data for analysis and develop meaningful Data Visualizations

LECTURE WITH BREAKUP	NO. OF LECTURES
Unit1: **Data Gathering and Preparation:** Data formats, parsing and transformation, Scalability and real-time issues	9
Unit2: **Data Cleaning:** Consistency checking, Heterogeneous and missing data, Data Transformation and segmentation	11
Unit3: **Exploratory Analysis:** Descriptive and comparative statistics, Clustering and association, Hypothesis generation	13
Unit4: **Visualization:** Designing visualizations, Time series, Geolocated data, Correlations and connections, Hierarchies and networks, interactivity	15

COURSE OUTCOMES
After completion of course, students would be:
•Able to extract the data for performing the Analysis.

References:

1. Making sense of Data : A practical Guide to Exploratory Data Analysis and Data Mining, by Glenn J. Myatt

Course Code	CSEE-4134
Course Name	Digital Forensics
Credits	3
Pre-Requisites	Cybercrime and Information Warfare, Computer Networks

Total Number of Lectures: 48

COURSE OBJECTIVE
•Provides an in-depth study of the rapidly changing and fascinating field of

computer forensics.
•Combines both the technical expertise and the knowledge required to investigate, detect and prevent digital crimes.
•Knowledge on digital forensics legislations, digital crime, forensics processes and procedures, data acquisition and validation, e-discovery tools
•E-evidence collection and preservation, investigating operating systems and file systems, network forensics, art of steganography and mobile device forensics

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: **Digital Forensics Science:** Forensics science, computer forensics, and digital forensics. **Computer Crime:** Criminalistics as it relates to the investigative process, analysis of cyber-criminalistics area, holistic approach to cyber-forensics	9
Unit 2: **Cyber Crime Scene Analysis:** Discuss the various court orders etc., methods to search and seizure electronic evidence, retrieved and un-retrieved communications, Discuss the importance of understanding what court documents would be required for a criminal investigation.	8
Unit 3: **Evidence Management & Presentation:** Create and manage shared folders using operating system, importance of the forensic mindset, define the workload of law enforcement, Explain what the normal case would look like, Define who should be notified of a crime, parts of gathering evidence, Define and apply probable cause.	9
Unit 4: **Computer Forensics:** Prepare a case, Begin an investigation, Understand computer forensics workstations and software, Conduct an investigation, Complete a case, Critique a case, **Network Forensics:** open-source security tools for network forensic analysis, requirements for preservation of network data.	10
Unit 5: **Mobile Forensics:** mobile forensics techniques, mobile forensics tools. **Legal Aspects of Digital Forensics:** IT Act 2000, amendment of IT Act 2008.	8
Unit 6: Recent trends in mobile forensic technique and methods to search and seizure electronic evidence	4

COURSE OUTCOMES
After completion of course, students would be able to:
•Understand relevant legislation and codes of ethics
•Computer forensics and digital detective and various processes, policies and procedures
•E-discovery, guidelines and standards, E-evidence, tools and environment.
•Email and web forensics and network forensics

References:

1. John Sammons, The Basics of Digital Forensics, Elsevier

2. John Vacca, Computer Forensics: Computer Crime Scene Investigation, Laxmi Publications

Course Code	CSEE-4135
Course Name	Ethical Hacking
Credits	3
Pre-Requisites	Computer Programming, Web Programming, Computer Networks

Total Number of Lectures: 48

COURSE OBJECTIVE
•Introduces the concepts of Ethical Hacking and gives the students the opportunity to learn about different tools and techniques in Ethical hacking and security and practically apply some of the tools.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction to Ethical Disclosure: Ethics of Ethical Hacking, Ethical Hacking and the legal system, Proper and Ethical Disclosure	9
Unit 2: Penetration Testing and Tools: Using Metasploit, Using BackTrackLiveCD Linux Distribution	8
Unit 3: Vulnerability Analysis: Passive Analysis, Advanced Static Analysis with IDA Pro, Advanced Reverse Engineering	9
Unit 4: Client-side browser exploits, Exploiting Windows Access Control Model for Local Elevation Privilege, Intelligent Fuzzing with Sulley, From Vulnerability to Exploit	10
Unit 5: Malware Analysis: Collecting Malware and Initial Analysis, Hacking Malware	8
Unit 6: Case study of vulnerability of cloud platforms and mobile platforms & devices.	4

COURSE OUTCOMES
After completion of course, students would be able to:
•Understand the core concepts related to malware, hardware and software vulnerabilities and their causes
•Understand ethics behind hacking and vulnerability disclosure
•Appreciate the Cyber Laws and impact of hacking
•Exploit the vulnerabilities related to computer system and networks using state of the art tools and technologies

References:

1. Shon Harris, Allen Harper, Chris Eagle and Jonathan Ness, Gray Hat Hacking: The Ethical Hackers' Handbook, TMH Edition

2. Jon Erickson, Hacking: The Art of Exploitation, SPD

Course Code	CSEE-4136
Course Name	Intrusion Detection
Credits	3
Pre-Requisites	Computer Networks, Computer Programming

Total Number of Lectures: 48

COURSE OBJECTIVE
•Compare alternative tools and approaches for Intrusion Detection through quantitative analysis to determine the best tool or approach to reduce risk from intrusion
•Identify and describe the parts of all intrusion detection systems and characterize new and emerging IDS technologies according to the basic capabilities all intrusion detection systems share.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: The state of threats against computers, and networked systems-Overview of computer security solutions and why they fail-Vulnerability assessment, firewalls, VPN's -Overview of Intrusion Detection and Intrusion Prevention Network and Host-based IDS	10
Unit 2: Classes of attacks - Network layer: scans, denial of service, penetration Application layer: software exploits, code injection-Human layer: identity theft, root access-Classes of attackers-Kids/hackers/sop Hesitated groups-Automated: Drones, Worms, Viruses	8
Unit 3: A General IDS model and taxonomy, Signature-based Solutions, Snort, Snort rules, Evaluation of IDS, Cost sensitive IDS	8
Unit 4: Anomaly Detection Systems and Algorithms-Network Behavior Based Anomaly Detectors (rate based)-Host-based Anomaly Detectors-Software Vulnerabilities State transition, Immunology, Payload Anomaly Detection	10
Unit 5: Attack trees and Correlation of alerts-Autopsy of Worms and Botnets-Malware detection-Obfuscation, polymorphism-Document vectors	8
Unit 6: Email/IM security issues-Viruses/Spam-From signatures to thumbprints to zero day detection-Insider Threat issues-Taxonomy-Masquerade and Impersonation Traitors, Decoys and Deception-Future: Collaborative Security	4

COURSE OUTCOMES
After completion of course, students would be able to:
•Apply knowledge of the fundamentals and history of Intrusion Detection in order to avoid common pitfalls in the creation and evaluation of new Intrusion Detection Systems. Evaluate the security an enterprise and appropriately apply Intrusion Detection tools and techniques in order to improve their security posture

References:

1. The Art of Computer Virus Research and Defense, Peter Szor, Symantec Press ISBN 0-321-30545-3

2. Crimeware, Understanding New Attacks and Defenses, Markus Jakobsson and ZulfikarRamzan, Symantec Press, ISBN: 978-0-321-50195-0 2008

Course Code	CSEE-4137
Course Name	Wireless Access Technologies
Credits	3
Pre-Requisites	Wireless Networks

Total Number of Lectures:48

COURSE OBJECTIVE
•Overview of wireless access technologies, Fixed wireless access networks. Terminal mobility issues regarding wireless access to Internet
•Introduction to various Network topologies, hotspot networks, Communication links: point-to-point, point-to-multipoint, multipoint-to-multipoint.
•To provide an overview of Standards for most frequently used wireless access networks: WPAN, UWB, WLAN, WMAN, WWAN. Network services. Wireless access networks planning, design and installation.
•To get and insight of Wireless networking security issues, Wireless access network exploitation and management, software requirements, link quality control.

LECTURE WITH BREAKUP	NO. OF LECTURES
Unit 1: Necessity for wireless terminals connectivity and networking. Wireless networking advantages and disadvantages, Overview of wireless access	8

technologies. Narrowband and broadband networks, fixed and nomadic networks. Wireless local loop (WLL), Public Switched Telephone Network (PSTN) interfaces.	
Unit 2: Fixed wireless access (FWA) networks, frequency bands for different networks. Criterions for frequency bands allocation, Network topologies, hotspot networks. Communication links: point-to-point (PTP), point to-multipoint (PMP), multipoint-to-multipoint (MTM).	8
Unit 3: Standards for most frequently used wireless access networks: WPAN (802.15, Bluetooth, DECT, IrDA), UWB (Ultra-Wideband), WLAN (802.11, Wi-Fi, HIPERLAN, IrDA), WMAN (802.16, WiMAX, HIPERMAN, HIPERACCESS), WWAN (802.20), Other technologies for broadband wireless access, Local Multipoint Distribution Service (LMDS), Multichannel Multipoint Distribution Service (MMDS). Ad Hoc networks, Network services. Services types based on carrier frequency and bandwidth.	10
Unit 4: Wireless access networks planning, design and installation. Services provision, legislative and technical aspects, Technical and economical factors for network planning: expenses, coverage, link capacity, network complexity and carrier-to-interference ratio (C/I). Base station or access point allocation. Base station and access point equipment. Terminal mobility issues regarding wireless access to Internet. Wireless networking security issues.	9
Unit 5: Example of laptop or handheld PC wireless connection in real	8
environment. PC wireless interface equipment. Wireless access network exploitation and management, software requirements, link quality control. Business model, wireless network services market, market research and marketing, service providers, wireless data application service providers (WDASP) and their role on public telecommunication services market, billing systems.	
Unit 6: Recent trends in wireless networking and various access mechanism, new standards of wirelss communication.	5

COURSE OUTCOMES
On completion of the course the student should be able to
•interpret basic terms and characteristics of wireless access networks
•compare various wireless access technologies
•analyze measurements of wireless access network parameter
•assess security issues in wireless networks
•choose modulation technique for wireless transmission

References:

1. M. P. Clark, Wireless Access Networks: Fixed Wireless Access and WLL networks -- Design and Operation, John Wiley & Sons, Chichester
2. D. H. Morais, Fixed Broadband Wireless Communications: Principles and Practical Applications, Prentice Hall, Upper Saddle River
3. R. Pandya, Introduction to WLLs: Application and Deployment for Fixed and Broadband Services, IEEE Press, Piscataway

Course Code	CSEE-4138
Course Name	Mobile Applications and Services
Credits	3
Pre-Requisites	Wireless Communication and Mobile Computing

Total Number of Lectures:48

COURSE OBJECTIVE
•This course presents the three main mobile platforms and their ecosystems, namely Android, iOS, and PhoneGap/WebOS.
•.It explores emerging technologies and tools used to design and implement feature-rich mobile applications for smartphones and tablets
•It also take into account both the technical constraints relative to storage capacity, processing capacity, display screen, communication interfaces, and the user interface, context and profile

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction:Introduction to Mobile Computing, Introduction to Android Development Environment, Factors in Developing Mobile Applications, Mobile Software Engineering, Frameworks and Tools, Generic UI Development Android User	8
Unit 2: More on Uis: VUIs and Mobile Apps, Text-to-Speech Techniques, Designing the Right UI, Multichannel and Multimodal Uis, . Storing and Retrieving Data, Synchronization and Replication of Mobile Data, Getting the	8
Model Right, Android Storing and Retrieving Data, Working with a Content Provider	
Unit 3: Communications via Network and the Web:State Machine, Correct Communications Model, Android Networking and Web, Telephony Deciding Scope of an App, Wireless Connectivity and Mobile Apps, Android Telephony Notifications and Alarms:Performance, Performance and Memory Management, Android Notifications and Alarms, Graphics, Performance and Multithreading, Graphics and UI Performance, Android Graphics	10
Unit 4: Putting It All Together : Packaging and Deploying, Performance Best Practices, Android Field Service App, Location Mobility and Location Based Services Android Multimedia: Mobile Agents and Peer-to-Peer Architecture, Android Multimedia	9
Unit 5: Platforms and Additional Issues : Development Process, Architecture,	8

Design, Technology Selection, Mobile App Development Hurdles, Testing, Security and Hacking , Active Transactions, More on Security, Hacking Android	
Unit 6: Recent trends inCommunication protocols for IOT nodes, mobile computimng techniques in IOT, agents based communications in IOT	5

COURSE OUTCOMES
On completion of the course the student should be able to
•identify the target platform and users and be able to define and sketch a mobile application
•understand the fundamentals, frameworks, and development lifecycle of mobile application platforms including iOS, Android, and PhoneGap
•Design and develop a mobile application prototype in one of the platform (challenge project)

References:

1. Wei-Meng Lee, Beginning Android™ 4 Application Development, 2012 by John Wiley & Sons

Elective -II

Course Code	CSEE-4141
Course Name	Recommender System
Credits **Prerequisites**	3

Total Number of Lectures: 48

COURSE OBJECTIVE
•To learn techniques for making recommendations, including non-personalized, content-based, and collaborative filtering •To automate a variety of choice-making strategies with the goal of providing affordable, personal, and high-quality recommendations

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: **Introduction:** Overview of Information Retrieval, Retrieval Models, Search and Filtering Techniques: Relevance Feedback, User Profiles, Recommender system functions, Matrix operations, covariance matrices, Understanding ratings, Applications of recommendation systems, Issues with recommender system.	9
Unit 2: **Content-based Filtering:** High level architecture of content-based systems, Advantages and drawbacks of content based filtering, Item profiles, Discovering features of documents, pre-processing and feature extraction, Obtaining item features from tags, Methods for learning user profiles, Similarity based retrieval, Classification algorithms.	8
Unit 3: **Collaborative Filtering:** User-based recommendation, Item-based recommendation, Model based approaches, Matrix factorization, Attacks on collaborative recommender systems.	9
Unit 4: **Hybrid approaches:** Opportunities for hybridization, Monolithic hybridization design: Feature combination, Feature augmentation, Parallelized hybridization design: Weighted, Switching, Mixed, Pipelined hybridization design: Cascade Meta-level, Limitations of hybridization strategies	8
Unit 5: **Evaluating Recommender System:** Introduction, General properties of evaluation research, Evaluation designs: Accuracy, Coverage, confidence, novelty, diversity, scalability, serendipity, Evaluation on historical datasets, Offline evaluations.	6
Unit 6: **Types of Recommender Systems:** Recommender systems in personalized web search, knowledge-based recommender system, Social tagging recommender systems, Trust-centric recommendations, Group recommender systems.	8

COURSE OUTCOMES
After completion of course, students would be able to:
•Design recommendation system for a particular application domain. •Evaluate recommender systems on the basis of metrics such as accuracy, rank accuracy,

diversity, product coverage, and serendipity

References:

1. Jannach D., Zanker M. and FelFering A., Recommender Systems: An Introduction, Cambridge University Press (2011), 1st ed.
2. Charu C. Aggarwal, Recommender Systems: The Textbook, Springer (2016), 1st ed.
3. Ricci F., Rokach L., Shapira D., Kantor B.P., Recommender Systems Handbook, Springer(2011), 1st ed.
4. Manouselis N., Drachsler H., Verbert K., Duval E., Recommender Systems For Learning, Springer(2013), 1st ed.

Course Code	CSEE-4142
Course Name	Machine learning
Credits	3
Pre-Requisites	

Total Number of Lectures:48

COURSE OBJECTIVE
•To learn the concept of how to learn patterns and concepts from data without being explicitly programmed in various IOT nodes.
•To design and analyse various machine learning algorithms and techniques with a modern outlook focusing on recent advances.
•Explore supervised and unsupervised learning paradigms of machine learning.
•To explore Deep learning technique and various feature extraction strategies.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: **Supervised Learning (Regression/Classification)** •Basic methods: Distance-based methods, Nearest-Neighbours, Decision Trees, Na ve Bayes •Linear models: Linear Regression, Logistic Regression, Generalized	10
Linear Models •Support Vector Machines, Nonlinearity and Kernel Methods •Beyond Binary Classification: Multi-class/Structured Outputs, Ranking	
Unit 2: **Unsupervised Learning** •Clustering: K-means/Kernel K-means •Dimensionality Reduction: PCA and kernel PCA •Matrix Factorization and Matrix Completion •Generative Models (mixture models and latent factor models)	7
Unit 3 Evaluating Machine Learning algorithms and Model Selection, Introduction to Statistical Learning Theory, Ensemble Methods (Boosting, Bagging, Random Forests)	6
Unit 4 Sparse Modeling and Estimation, Modeling Sequence/Time-Series Data, Deep Learning and Feature Representation Learning	9
Unit 5	9

Scalable Machine Learning (Online and Distributed Learning) A selection from some other advanced topics, e.g., Semi-supervised Learning, Active Learning, Reinforcement Learning, Inference in Graphical Models, Introduction to Bayesian Learning and Inference	
Unit 6: Recent trends in various learning techniques of machine learning and classification methods for IOT applications. Various models for IOT applications.	5

COURSE OUTCOMES
After completion of course, students would be able to:
•Extract features that can be used for a particular machine learning approach in various IOT applications.
•To compare and contrast pros and cons of various machine learning techniques and to get an insight of when to apply a particular machine learning approach.
•To mathematically analyse various machine learning approaches and paradigms.

References:

1. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer 2009 (freely available online)
3. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007

Course Code	CSEE-4143
Course Name	Data Storage Technologies and Networks
Credits	3
Pre-Requisites	Basic knowledge of Computer Architecture, Operating Systems, and Computer Networking is required.

Total Number of Lectures: 48

COURSE OBJECTIVE
•to provide learners with a basic understanding of Enterprise Data Storage and Management Technologies

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: **Storage Media and Technologies** – Magnetic, Optical and Semiconductor Media, Techniques for read/write Operations, Issues and Limitations.	8
Unit 2: **Usage and Access** – Positioning in the Memory Hierarchy, Hardware and Software Design for Access, Performance issues.	9
Unit 3: **Large Storages** – Hard Disks, Networked Attached Storage, Scalability issues, Networking issues.	7
Unit 4: **Storage Architecture** - Storage Partitioning, Storage System Design, Caching, Legacy Systems.	9
Unit 5: **Storage Area Networks** – Hardware and Software Components, Storage Clusters/Grids. **Storage QoS**–Performance, Reliability, and Security issues.	10
Unit 6: Recent Trends related to Copy data management, Erasure coding, and Software defined storage appliances.	5
COURSE OUTCOMES	
After completion of course, students would be:	
•Learn Storage System Architecture	
•Overview of Virtualization Technologies, Storage Area Network	

References:

1. The Complete Guide to Data Storage Technologies for Network-centric ComputingPaperback–Import, Mar 1998 by Computer Technology Research Corporation

2. Data Storage Networking: Real World Skills for the CompTIA Storage by Nigel Poulton

Course Code	CSEE-4144
Course Name	Malware Analysis and Reverse Engineering
Credits	3
Pre-Requisites	Computer Programming, Compiler Design

Total Number of Lectures: 48

COURSE OBJECTIVE
•The objective of this course is to provide an insight to fundamentals of malware analysis which includes analysis of JIT compilers for malware detection in legitimate code. DNS filtering and reverse engineering is included.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Fundamentals of Malware Analysis (MA), Reverse Engineering Malware (REM) Methodology, Brief Overview of Malware analysis lab setup and configuration, Introduction to key MA tools and techniques, Behavioral Analysis vs. Code Analysis, Resources for Reverse-Engineering Malware (REM) Understanding Malware Threats, Malware indicators, Malware Classification, Examining ClamAVSignatures, Creating Custom ClamAV Databases, Using YARA to Detect Malware Capabilities, Creating a Controlled and Isolated Laboratory, Introduction to MA Sandboxes, Ubuntu, Zeltser'sREMnux, SANS SIFT, Sandbox Setup and Configuration New Course Form, Routing TCP/IP Connections, Capturing and Analyzing Network Traffic, Internet simulation using INetSim, Using Deep Freeze to Preserve Physical Systems, Using FOG for Cloning and Imaging Disks, Using MySQL Database to Automate FOG Tasks, Introduction to Python ,Introduction to x86 Intel assembly language, Scanners: Virus Total, Jotti, and NoVirus Thanks, Analyzers: Threat Expert, CWSandbox, Anubis, Joebox, Dynamic Analysis Tools: Process Monitor, Regshot, HandleDiff, Analysis Automation Tools: Virtual Box, VM Ware, Python , Other Analysis Tools	12
Unit 2:Malware Forensics Using TSK for Network and Host Discoveries, Using Microsoft Offline API to Registry Discoveries , Identifying Packers using PEiD, Registry Forensics with Reg Ripper Plu-gins:, Bypassing Poison Ivy's Locked Files, Bypassing Conficker's File System ACL Restrictions, Detecting Rogue PKI Certificates.	7
Unit 3:Malware and Kernel Debugging Opening and Attaching to Processes, Configuration of JIT Debugger for Shellcode Analysis, Controlling Program Execution, Setting and Catching Breakpoints, Debugging with Python Scripts and Py Commands**,** DLL Export Enumeration, Execution, and Debugging**,** Debugging a VMware Workstation Guest (on Windows)**,** Debugging a Parallels Guest (on Mac OS X). Introduction to WinDbg Commands and Controls, Detecting Rootkits with WinDbgScripts**,** Kernel Debugging with IDA Pro.	9
Unit 4:Memory Forensics and Volatility	8

Memory Dumping with MoonSols Windows Memory Toolkit**,** Accessing VM Memory Files Overview of Volatility, Investigating Processes in Memory Dumps**,** Code Injection and Extraction**,** Detecting and Capturing Suspicious Loaded DLLs**,** Finding Artifacts in Process Memory**,** Identifying Injected Code with Malfind and YARA.	
Unit 5:Researching and Mapping Source Domains/IPs Using WHOIS to Research Domains**,** DNS Hostname Resolution**,** Querying Passive DNS**,** Checking DNS Records**,** Reverse IP Search New Course Form**,** Creating Static Maps**,** Creating Interactive Maps.	7
Unit 6: Case study of Finding Artifacts in Process Memory, Identifying Injected Code with Malfind and YARA	5

COURSE OUTCOMES
On completion of the course the student should be able to
•To understand the concept of malware and reverse engineering.
•Implement tools and techniques of malware analysis.

References:

1. Michael Sikorski, Andrew Honig "Practical Malware Analysis: The Hands-On Guide to Dissecting Malicious Software" publisher Williampollock

Course Code	CSEE-4145
Course Name	Secure Software Design and Enterprise Computing
Credits	3
Pre-Requisites	Computer Programming, Software Engineering

Total Number of Lectures:48

COURSE OBJECTIVE
•To fix software flaws and bugs in various software.
•To make students aware of various issues like weak random number generation, information leakage, poor usability, and weak or no encryption on data traffic
•Techniques for successfully implementing and supporting network services on an enterprise scale and heterogeneous systems environment.
•Methodologies and tools to design and develop secure software containing minimum vulnerabilities and flaws.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: **Secure Software Design** Identify software vulnerabilities and perform software security analysis, Master security programming practices, Master fundamental software security design concepts, Perform security testing and quality assurance.	8
Unit 2: **Enterprise Application Development** Describe the nature and scope of enterprise software applications, Design distributed N-tier software application, Research technologies available for the presentation, business and data tiers of an enterprise software application, Design and build a database using an enterprise database system, Develop	11

components at the different tiers in an enterprise system, Design and develop a multi-tier solution to a problem using technologies used in enterprise system, Present software solution.	
Unit 3:	8
Enterprise Systems Administration Design, implement and maintain a directory-based server infrastructure in a heterogeneous systems environment, Monitor server resource utilization for system reliability and availability, Install and administer network services (DNS/DHCP/Terminal Services/Clustering/Web/Email).	
Unit 4: Obtain the ability to manage and troubleshoot a network running multiple services, Understand the requirements of an enterprise network and how to go about managing them.	8
Unit 5: Handle insecure exceptions and command/SQL injection, Defend web and mobile applications against attackers, software containing minimum vulnerabilities and flaws.	9
Unit 6: Case study of DNS server, DHCP configuration and SQL injection attack.	4

COURSE OUTCOMES
After completion of course, students would be able to:
•Differentiate between various software vulnerabilities.
•Software process vulnerabilities for an organization.
•Monitor resources consumption in a software.
•Interrelate security and software development process.

References:

1. Theodor Richardson, Charles N Thies, Secure Software Design, Jones & Bartlett
2. Kenneth R. van Wyk, Mark G. Graff, Dan S. Peters, Diana L. Burley, Enterprise Software Security, Addison Wesley.

Course Code	CSEE-4146
Course Name	Smart Sensors and Internet of Things
Credits	3
Pre-Requisites	Wireless Networks

Total Number of Lectures:48

COURSE OBJECTIVE
•Able to understand the application areas of IOT
•Able to realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks
•Able to understand building blocks of Internet of Things and characteristics

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Environmental Parameters Measurement and Monitoring: Why measurement and monitoring are important, effects of adverse parameters for the living being for IOT	7
Unit 2: Sensors: Working Principles: Different types; Selection of Sensors for	8

Practical Applications Introduction of Different Types of Sensors such as Capacitive, Resistive, Surface Acoustic Wave for Temperature, Pressure, Humidity, Toxic Gas etc	
Unit 3: Important Characteristics of Sensors: Determination of the Characteristics Fractional order element: Constant Phase Impedance for sensing applications such as humidity, water quality, milk quality Impedance Spectroscopy: Equivalent circuit of Sensors and Modelling of Sensors Importance and Adoption of Smart Sensors	11
Unit 4: Architecture of Smart Sensors: Important components, their features Fabrication of Sensor and Smart Sensor: Electrode fabrication: Screen printing, Photolithography, Electroplating Sensing film deposition: Physical and chemical Vapor, Anodization, Sol-gel	10
Unit 5: Interface Electronic Circuit for Smart Sensors and Challenges for Interfacing the Smart Sensor, Usefulness of Silicon Technology in Smart Sensor And Future scope of research in smart sensor	7
Unit 6: Recent trends in smart sensor for day to day life, evolving sensors and their architecture.	5

COURSE OUTCOMES
On completion of the course the student should be able to
•Understand the vision of IoT from a global context.
•Determine the Market perspective of IoT.
•Use of Devices, Gateways and Data Management in IoT.
•Application of IoT in Industrial and Commercial Building Automation and Real World Design Constraints.
•Building state of the art architecture in IoT.

References:

1. Yasuura, H., Kyung, C.-M., Liu, Y., Lin, Y.-L., Smart Sensors at the IoT Frontier, Springer International Publishing

2. Kyung, C.-M., Yasuura, H., Liu, Y., Lin, Y.-L., Smart Sensors and Systems, Springer International Publishing

Course Code	CSEE-4147
Course Name	Logic And Functional Programming
Credits	3
Pre-Requisites	Computer Programming, Mathematical Logic

Total Number of Lectures:48

COURSE OBJECTIVE
•To further the state of the art on the theoretical and practical aspects of developing declarative programming tools in logic programming for IOT data analysis .
•To introduce basics of functional programming and constraint logic programming for nodes in IOT.

•Introduction into formal concepts used as a theoretical basis for both paradigms, basic knowledge and practical experience.

LECTURE WITH BREAKUP	NO. OF LECTURES
Unit 1: Proposition Logic: Introduction of logic and Functional Paradigm, Propositional Concepts, Semantic Table , Problem Solving with Semantic Table.	5
Unit 2: **Natural Deduction and Axiomatic Propositional Logic:** Rules of Natural Deduction, Sequent Calculus, Axiomatic Systems, Meta theorems, Important Properties of AL, Resolution, Resolving Arguments	7
Unit 3: **Introduction to Predicate Logic** Objects, Predicates and Quantifiers, Functions, First Order Language, Quantifiers, Scopeand Binding, Substitution, An Axiomatic System for First Order Predicate Logic, Soundness and Completeness, Axiomatic Semantic and Programming	9
Unit 4: **Semantic Tableaux & Resolution in Predicate Logic:** Semantic Tableaux, Instantiation Rules, Problem-solving in Predicate Logic, Normal forms, Herbrand Universes and H-interpretation, Resolution, Unification, Resolution as a computing Tool, Nondeterministic Programming, Incomplete Data Structure, Second Order Programming in Prolog, Logic Grammars: Definite Clause Grammar, A Grammar Interpreter.	13
Unit 5: **Lazy and Eager Evaluation strategies:** Evaluation Strategies, Lazy Evaluation: Evaluation Order and strictness of function,Programming with lazy evaluation, Interactive functional program, Delay of unnecessary Computation, Infinite Data Structure, Eager Evaluation and Reasoning	9
Unit 6: Recent trends in logical and functional programming, predicate logics and various evaluation strategies.	5

COURSE OUTCOMES
On completion of the course the student should be able to
•Understanding of the theory and practice of functional and logic programming For IOT.
•The ability to write functional and logic programs for nodes in IOT.

•The ability to solve problems in and using functional and logic programming.

References:

1. John Kelly, “The Essence of Logic”, Prentice-Hall India.
2. Saroj Kaushik, “Logic and Prolog Programming”, New Age International ltd

Course Code: CSEA 415
Course Name: Research Methodology and IPR

Teaching Scheme
Lectures: 1hrs/week

Course Outcomes:
At the end of this course, students will be able to
•Understand research problem formulation.
•Analyze research related information
•Follow research ethics
•Understand that today's world is controlled by Computer, Information Technology,
but tomorrow world will be ruled by ideas, concept, and creativity.
•Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
•Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

Syllabus Contents:
Unit 1: Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope
and objectives of research problem.
Approaches of investigation of solutions for research problem, data collection, analysis,
interpretation, Necessary instrumentations
Unit 2: Effective literature studies approaches, analysis
Plagiarism, Research ethics,
Unit 3: Effective technical writing, how to write report, Paper
Developing a Research Proposal, Format of research proposal, a presentation and
assessment by a review committee
Unit 4: Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of
Patenting and Development: technological research, innovation, patenting, development.
International Scenario: International cooperation on Intellectual Property. Procedure for
grants of patents, Patenting under PCT.
Unit 5: Patent Rights: Scope of Patent Rights. Licensing and transfer of technology.
Patent information and databases. Geographical Indications.
Unit 6: New Developments in IPR: Administration of Patent System. New developments
in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case

Studies, IPR and IITs.

References:

- Stuart Melville and Wayne Goddard, "Research methodology: an introduction for
science & engineering students'"
- Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
- Ranjit Kumar, 2 ndEdition, "Research Methodology: A Step by Step Guide for beginners"
- Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd,2007.
- Mayall, "Industrial Design", McGraw Hill, 1992.
- Niebel, "Product Design", McGraw Hill, 1974.
- Asimov, "Introduction to Design", Prentice Hall, 1962.
- Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
- T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

SECOND SEMESTER

Course Code	CSEC 421
Course Name	Advanced Algorithms
Credits	3
Pre-Requisites	UG level course in Algorithm Design and Analysis

Total Number of Lectures:48

COURSE OBJECTIVE
• Introduce students to the advanced methods of designing and analyzing algorithms.
• The student should be able to choose appropriate algorithms and use it for a specific problem.
• To familiarize students with basic paradigms and data structures used to solve advanced algorithmic problems.
• Students should be able to understand different classes of problems concerning their computation difficulties.
• To introduce the students to recent developments in the area of algorithmic design.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit1 **Sorting:** Review of various sorting algorithms, topological sorting **Graph:** Definitions and Elementary Algorithms: Shortest path by BFS, shortest path in edge-weighted case (Dijkasra's), depth-first search and computation of strongly connected components, emphasis on correctness proof of the algorithm and time/space analysis, example of amortized analysis.	6
Unit 2 **Matroids:** Introduction to greedy paradigm, algorithm to compute a maximum weight maximal independent set. Application to MST. **Graph Matching:** Algorithm to compute maximum matching. Characterization of maximum matching by augmenting paths, Edmond's Blossom algorithm to compute augmenting path.	8
Unit 3 **Flow-Networks:** Maxflow-mincut theorem, Ford-Fulkerson Method to compute maximum flow, Edmond-Karp maximum-flow algorithm. **Matrix Computations:** Strassen's algorithm and introduction to divide and conquer paradigm, inverse of a triangular matrix, relation between the time complexities of basic matrix operations, LUP-decomposition.	9
Unit 4 **Shortest Path in Graphs:** Floyd-Warshall algorithm and introduction to dynamic programming paradigm. More examples of dynamic programming. **Modulo Representation of integers/polynomials:** Chinese Remainder Theorem, Conversion between base-representation and modulo-representation. Extension to polynomials. Application: Interpolation problem.	10

Discrete Fourier Transform (DFT): In complex field, DFT in modulo ring. Fast Fourier Transform algorithm. Schonhage-Strassen Integer Multiplication algorithm	
Unit 5 **Linear Programming:** Geometry of the feasibility region and Simplex algorithm **NP-completeness:** Examples, proof of NP-hardness and NP-completeness. **One or more of the following topics based on time and interest** Approximation algorithms, Randomized Algorithms, Interior Point Method, Advanced Number Theoretic Algorithm	10
Unit 6 Recent Trands in problem solving paradigms using recent searching and sorting techniques by applying recently proposed data structures.	5

COURSE OUTCOMES
After completion of course, students would be able to:
•Analyze the complexity/performance of different algorithms.
• Determine the appropriate data structure for solving a particular set of problems.
• Categorize the different problems in various classes according to their complexity.
• Students should have an insight of recent activities in the

References:

1."Introduction to Algorithms" byCormen, Leiserson, Rivest, Stein.

2. "The Design and Analysis of Computer Algorithms" by Aho, Hopcroft, Ullman.

3. "Algorithm Design" by Kleinberg and Tardos

Course Code	**CSEC 422**
Course Name	Soft Computing
Credits	3
Pre-Requisites	Basic knowledge of mathematics

URSE OBJECTIVE

- To introduce soft computing concepts and techniques and foster their abilities in designing appropriate technique for a given scenario.
- To implement soft computing based solutions for real-world problems.
- To give students knowledge of non-traditional technologies and fundamentals of artificial neural networks, fuzzy sets, fuzzy logic, genetic algorithms.
- To provide studentan hand-on experience on MATLAB to implement various strategies.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1 **Introduction to Soft Computing and Neural Networks:** Evolution of Computing: Soft Computing Constituents, From Conventional AI to Computational Intelligence: Machine Learning Basics	7
Unit 2 **Fuzzy Logic:** Fuzzy Sets, Operations on Fuzzy Sets, Fuzzy Relations, Membership Functions: Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems, Fuzzy Expert Systems, Fuzzy Decision Making.	8
Unit 3 **Neural Networks:** Machine Learning Using Neural Network, Adaptive Networks, Feed forward Networks, Supervised Learning Neural Networks, Radial Basis Function Networks : Reinforcement Learning, Unsupervised Learning Neural Networks, Adaptive Resonance architectures, Advances in Neural networks	10
Unit 4 **Genetic Algorithms:** Introduction to Genetic Algorithms (GA), Applications of GA in Machine Learning : Machine Learning Approach to Knowledge Acquisition.	5
Unit 5 **Matlab/Python Lib:** Introduction to Matlab/Python, Arrays and array operations, Functions and Files, Study of neural network toolbox and fuzzy logic toolbox, Simple implementation of Artificial Neural Network and Fuzzy Logic	13
Unit 6 Recent Trands in deep learning, various classifiers, neural networks and genetic algorithm. Implementation of recently proposed soft computing techniques.	5

COURSE OUTCOMES

After completion of course, students would be able to:

- Identify and describe soft computing techniques and their roles in building intelligent machines

• Apply fuzzy logic and reasoning to handle uncertainty and solve various engineering problems.
• Apply genetic algorithms to combinatorial optimization problems.
• Evaluate and compare solutions by various soft computing approaches for a given problem.

References:

1. Jyh:Shing Roger Jang, Chuen:Tsai Sun, EijiMizutani, Neuro:Fuzzy and Soft Computing, Prentice:Hall of India, 2003.
2. George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic:Theory and Applications, Prentice Hall,
1995.
3. MATLAB Toolkit Manual

ELECTIVE III

CSEE 4231 : Data Visualisation

Unit 1: Introduction of visual perception, visual representation of data, Gestalt principles, information overloads.

Unit 2: Visual representations, visualization reference model, visual mapping, visual analytics, Design of visualization applications.

Unit 3: Classification of visualization systems, Interaction and visualization techniques Unit misleading, Visualization of one, two and multi-dimensional data, text and text documents.

Unit 4: Visualization of groups, trees, graphs, clusters, networks, software, Metaphorical visualization

Visualization of volumetric data, vector fields, processes and simulations,

Unit5: Visualization of maps, geographic information, GIS systems, collaborative visualizations, Evaluating visualizations. Recent trends in various perception techniques, various visualization techniques, data structures used in data visualization.

REFERENCES:

WARD, GRINSTEIN, KEIM,.Interactive Data Visualization: Foundations, Techniques, and Applications. Natick : A K Peters, Ltd.

E. Tufte, The Visual Display of Quantitative Information, Graphics Press.

CSEE: 4232 BIG DATA ANALYTICS

Unit 1:

What is big data, why big data, convergence of key trends, unstructured data, industry examples of big data, web analytics, big data and marketing, fraud and big data, risk and big data, credit risk management, big data and algorithmic trading, big data and healthcare, big data in medicine, advertising and big data, big data technologies, introduction to Hadoop, open source technologies, cloud and big data, mobile business intelligence, Crowd sourcing analytics, inter and transfirewall analytics.

Unit 2:

Introduction to NoSQL, aggregate data models, aggregates, key-value and document data models, relationships, graph databases, schemaless databases, materialized views, distribution models, sharding, master-slave replication, peer-peer replication, sharding and replication,

consistency, relaxing consistency,version stamps, map-reduce, partitioning and combining, composing map-reduce calculations.

Unit 3:

Data format, analyzing data with Hadoop, scaling out, Hadoop streaming, Hadoop pipes, design of Hadoop distributed file system (HDFS), HDFS concepts, Java interface, data flow, Hadoop I/O, data integrity, compression, serialization, Avro,file-based data structures

Unit 3:

Data format, analyzing data with Hadoop, scaling out, Hadoop streaming, Hadoop pipes, design of Hadoop distributed file system (HDFS), HDFS concepts, Java interface, data flow, Hadoop I/O, data integrity, compression, serialization, Avro, file-based data structures

Unit 4:

MapReduce workflows, unit tests with MRUnit, test data and local tests, anatomy of MapReduce job run, classic Map-reduce, YARN, failures in classic Map-reduce and YARN, job scheduling, shuffle and sort, task execution, MapReduce types, input formats, output formats

UNIT 5:

Hbase, data model and implementations,Hbase clients, Hbase examples, praxis.Cassandra, Cassandra data model, Cassandra examples, Cassandra clients, Hadoop integration.

REFERENCES:

Michael Minelli, Michelle Chambers, and AmbigaDhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013.

P. J. Sadalage and M. Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", Addison-Wesley Professional, 2012.

Tom White, "Hadoop: The Definitive Guide", Third Edition, O'Reilley, 2012.

Eric Sammer, "Hadoop Operations", O'Reilley, 2012.

E. Capriolo, D. Wampler, and J. Rutherglen, "Programming Hive", O'Reilley, 2012.

Lars George, "HBase: The Definitive Guide", O'Reilley, 2011.

Eben Hewitt, "Cassandra: The Definitive Guide", O'Reilley, 2010.

Alan Gates, "Programming Pig", O'Reilley, 2011.

CSEE 4233 DATA WAREHOUSING AND DATAMINING

Unit 1:

Introduction to Data Warehousing; Data Mining: Mining frequent patterns, association and correlations; Sequential Pattern Mining concepts, primitives, scalable methods;

Unit 2:

Classification and prediction; Cluster Analysis – Types of Data in Cluster Analysis, Partitioning methods, Hierarchical Methods; Transactional Patterns and other temporal based frequent patterns,

Unit 3:

Mining Time series Data, Periodicity Analysis for time related sequence data, Trend analysis, Similarity search in Time-series analysis;

Unit 4:

Mining Data Streams, Methodologies for stream data processing and stream data systems, Frequent pattern mining in stream data, Sequential Pattern Mining in Data Streams, Classification of dynamic data streams, Class Imbalance Problem; Graph Mining; Social Network Analysis;

Unit 5:

Web Mining, Mining the web page layout structure, mining web link structure, mining multimedia data on the web, Automatic classification of web documents and web usage mining; Distributed Data Mining.

REFERENCES:

Jiawei Han and M Kamber, Data Mining Concepts and Techniques,, Second Edition, Elsevier Publication, 2011.

Vipin Kumar, Introduction to Data Mining - Pang-Ning Tan, Michael Steinbach, Addison Wesley, 2006.

G Dong and J Pei, Sequence Data Mining, Springer, 2007.

CSEE 4234 DATA ENCRYPTION & COMPRESSION

Unit 1:

Introduction to Security: Need for security, Security approaches, Principles of security, Types of attacks.Encryption Techniques: Plaintext, Cipher text, Substitution & Transposition techniques, Encryption & Decryption, Types of attacks, Key range & Size.

Unit 2:

Symmetric & Asymmetric Key Cryptography: Algorithm types & Modes, DES, IDEA, Differential & Linear Cryptanalysis, RSA, Symmetric &Asymmetric key together, Digital signature, Knapsack algorithm. User Authentication Mechanism: Authentication basics, Passwords, Authentication tokens, Certificate based & Biometric authentication, Firewall.

Unit 3:

Case Studies Of Cryptography: Denial of service attacks, IP spoofing attacks, Secure inter branch payment transactions, Conventional Encryption andMessage Confidentiality, Conventional Encryption Principles, Conventional Encryption Algorithms, Location of Encryption Devices, Key Distribution.Public Key Cryptography and Message Authentication: Approaches toMessage Authentication, SHA-1, MD5, Public-Key Cryptography Principles,RSA, Digital, Signatures, Key Management.

Unit 4:

Introduction: Need for data compression, Fundamental concept of datacompression & coding, Communication model, Compression ratio,Requirements of data compression, Classification. Methods of Data Compression: Data compression-- Loss less &Lossy

Unit 5:

Entropy encoding-- Repetitive character encoding, Run length encoding,Zero/Blank encoding; Statistical encoding-- Huffman, Arithmetic & Lempel-Zivcoding; Source encoding-- Vector quantization (Simple vector quantization &with error term); Differential encoding—Predictive coding, Differential pulsecode modulation, Delta modulation, Adaptive differential pulse codemodulation; Transform based coding : Discrete cosine transform & JPEGstandards; Fractal compression

REFERENCES:

Cryptography and Network Security by B. Forouzan, McGraw-Hill.

The Data Compression Book by Nelson, BPB.

Cryptography & Network Security by AtulKahate, TMH.

CSEE 4235 :STEGANOGRAPHY AND DIGITAL WATERMARKING

Unit 1:

Steganography: Overview, History, Methods for hiding (text, images, audio,video, speech etc.), Issues: Security, Capacity and Imperceptibility,

Steganalysis: Active and Malicious Attackers, Active and passive steganalysis,

Unit 2:

Frameworks for secret communication (pure Steganography, secret key, public key steganography), Steganography algorithms (adaptive and non-adaptive),

Unit 3:

Steganography techniques: Substitution systems, Spatial Domain, Transform domain techniques, Spread spectrum, Statistical steganography, Cover Generation and cover selection, Tools: EzStego, FFEncode, Hide 4 PGP, Hide and Seek, S Tools etc.)

Unit 4:

Detection, Distortion, Techniques: LSB Embedding, LSB Steganalysis using primary sets, Texture based

Unit 5:

Digital Watermarking: Introduction, Difference between Watermarking and Steganography, History, Classification (Characteristics and Applications), Types and techniques (Spatial-domain, Frequency-domain, and Vector quantization based watermarking), Attacks and Tools (Attacks by Filtering, Remodulation, Distortion, Geometric Compression, Linear Compression etc.), Watermark security & authentication.

REFERENCES:

Peter Wayner, "Disappearing Cryptography–Information Hiding: Steganography & Watermarking", Morgan Kaufmann Publishers, New York, 2002.

Ingemar J. Cox, Matthew L. Miller, Jeffrey A. Bloom, Jessica Fridrich, TonKalker, "Digital Watermarking and Steganography", Margan Kaufmann Publishers, New York, 2008.

Information Hiding: Steganography and Watermarking-Attacks and Countermeasures by Neil F. Johnson, ZoranDuric, SushilJajodia

CSEE 4236 : INFORMATION THEORY AND CODING

Unit 1:

Information and entropy information measures, Shannon's concept ofInformation. Channel coding, channel mutual information capacity (BW)

Unit 2:

Theorem for discrete memory less channel, information capacity theorem, Error detecting and error correcting codes,

Unit 3:

Types of codes: block codes, Hamming and Lee metrics, description of linear block codes, parity check Codes, cyclic code, Masking techniques,

Unit 4:

Compression: loss less and lossy, Huffman codes, LZW algorithm, Binary Image compression schemes, run length encoding, CCITT group 3 1- DCompression, CCITT group 32D compression, CCITT group 42DCompression.

Unit 5:

Convolutional codes, sequential decoding. Video image Compression: CITT H 261 Video coding algorithm, audio (speech) Compression. Cryptography and cipher.

REFERENCES:

Fundamentals in information theory and coding, Monica Borda,Springer.

Communication Systems: Analog and digital, Singh and Sapre, TataMcGraw Hill.

Model Curriculum of Engineering & Technology PG Courses [Volume-I]

Multimedia Communications Fred Halsall.

Information Theory, Coding and Cryptography R Bose.

Multimedia system Design Prabhat K Andleigh and Kiran Thakrar

CSEE 4237 : SENSOR NETWORKS AND INTERNET OF THINGS

Unit 1:

Introduction and Applications:smart transportation, smart cities, smart living, smart energy, smart health, and smart learning. Examples of research areas include for instance: Self-Adaptive Systems, Cyber Physical Systems, Systems of Systems, Software Architectures and Connectors, Software Interoperability, Big Data and Big Data Mining, Privacy and Security

Unit 2:

IoT Reference Architecture- Introduction, Functional View,Information View, Deployment and Operational View, Other Relevant architectural views. Real-World Design Constraints- Introduction, Technical Design constraints- hardware, Data representation and visualization, Interaction and remote control.

Unit 3:

Industrial Automation- Service-oriented architecture-based device integration, SOCRADES: realizing the enterprise integrated Web of Things, IMC-AESOP: from the Web of Things to the Cloud of Things, Commercial Building Automation- Introduction, Case study: phase one- commercial building automation today, Case study: phase two- commercial building automation in the future.

Unit 4:

Hardware Platforms and Energy Consumption, Operating Systems, Time Synchronization, Positioning and Localization, Medium Access Control, Topology and Coverage Control, Routing: Transport Protocols, Network Security, Middleware, Databases

Unit 5: IOT Physical Devices & Endpoints: What is an IOT Device, Exemplary Device Board, Linux on Raspberry , Interface and Programming & IOT Device Recent trends in sensor network and IOT architecture, Automation in Industrial aspect of IOT

References:

Mandler, B., Barja, J., Mitre Campista, M.E., Cagáová, D., Chaouchi, H., Zeadally, S., Badra, M., Giordano, S., Fazio, M., Somov, A., Vieriu, R.-L., Internet of Things. IoT Infrastructures, Springer International Publishing

CSEE 4238 : IOT APPLICATIONS AND COMMUNICATION PROTOCOLS

Unit 1:

Basic function and architecture of a sensor — sensor body, sensor mechanism, sensor calibration, sensor maintenance, cost and pricing structure, legacy and modern sensor network. Development of sensor electronics — IoT vs legacy, and open source vs traditional PCB design style Development of sensor communication protocols, Protocols: Modbus, relay, Zigbee,

Zwave, X10,Bluetooth, ANT, etc. Business driver for sensor deployment — FDA/EPA regulation, fraud/tempering detection, supervision, quality control and process managementDifferent kind of calibration Techniques: manual, automation, infield, primaryand secondary calibration — and their implication in IoTPowering options for sensors: battery, solar, Witricity, Mobile and PoE

Unit 2:

Zigbee and Zwave — advantage of low power mesh networking. Long distance Zigbee. Introduction to different Zigbee chips. Bluetooth/BLE: Low power vs high power, speed of detection, class of BLE. Introduction of Bluetooth vendors & their review. Wireless protocols such as Piconet and packet structure for BLE and ZigbeeOther long distance RF communication link. LOS vs NLOS links, Capacity and throughput calculation Application issues in wireless protocols:power consumption, reliability, PER, QoS, LOS

Unit 3:

PCB vs FPGA vs ASIC design Prototyping electronics vs Production electronicsQA certificate for IoT- CE/CSA/UL/IEC/RoHS/IP65 Basic introduction of multi-layer PCB design and its workflow Electronics reliability-basic concept of FIT and early mortality rate Environmental and reliability testing-basic concepts Basic Open source platforms: Arduino, Raspberry Pi, Beaglebone

Unit 4:

Introduction to Mobile app platform forIoT: Protocol stack of Mobile app for IoT, Mobile to server integration, Linkafy Mobile platform for IoT, Axeda,

Unit 5:

Database implementation for IoT : Cloud based IoT platforms, SQL vs NoSQL, Open sourced vs. Licensed Database, Available M2M cloud platform, AxedaXively, Omega NovoTech, Ayla Libellium, CISCO M2M platform, AT &T M2M platform, Google M2M platform

REFERENCES:

Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things: Key Applications and Protocols, Wiley-Blackwell.

ELECTIVE IV

CSEE- 4241: DATA SECURITY AND ACCESS CONTROL

Unit1:

Introduction to Access Control, Purpose and fundamentals of access control, briefhistory, Policies of Access Control, Models of Access Control, and Mechanisms, Discretionary Access Control (DAC), Non- Discretionary Access Control, Mandatory Access Control (MAC). Capabilities and Limitations of Access Control Mechanisms: Access Control List (ACL) and Limitations, Capability List and Limitations.

Unit 2:

Role-Based Access Control (RBAC) and Limitations, Core RBAC, Hierarchical RBAC, Statically Constrained RBAC, Dynamically Constrained RBAC, Limitations of RBAC. Comparing RBAC to DAC and MAC Access control policy.

Unit 3:

Biba'sintrigity model, Clark-Wilson model, Domain type enforcement model, mapping the enterprise view to the system view, Role hierarchies- inheritance schemes, hierarchy structures and inheritance forms, using SoD in real system Temporal Constraints in RBAC, MAC AND DAC. Integrating RBAC with enterprise IT infrastructures: RBAC for WFMSs, RBAC for UNIX and JAVA environments Case study: Multi line Insurance Company

Unit 4:

Smart Card based Information Security, Smart card operating system- fundamentals, design and implantation principles, memory organization, smartcard files, file management, atomic operation, smart card data transmission ATR, PPS Security techniques- user identification, smart card security, quality assurance and testing, smart card life cycle-5 phases, smart card terminals.

Unit 5:

Recent trends in Database security and access control mechanisms. Case study of Role-Based Access Control (RBAC) systems.

REFERENCES:

Role Based Access Control: David F. Ferraiolo, D. Richard Kuhn, RamaswamyChandramouli.

http://www.smartcard.co.uk/tutorials/sct-itsc.pdf : Smart Card Tutorial.

CSEE-4242: WEB ANALYTICS AND DEVELOPMENT

Unit 1:

Introduction – Social network and Web data and methods, Graph and Matrices, Basic measures for individuals and networks, Information Visualization

Unit 2:

Web Analytics tools: Click Stream Analysis, A/B testing, Online Surveys

Unit 3:

Web Search and Retrieval: Search Engine Optimization, Web Crawling and

indexing, Ranking Algorithms, Web traffic models

Unit 4:

Making Connection: Link Analysis, Random Graphs and Network evolution, Social

Unit 5:

Connects: Affiliation and identity

Connection: Connection Search, Collapse, Robustness Social involvements and diffusion of innovation

REFERENCES:

Hansen, Derek, Ben Sheiderman, Marc Smith. 2011. Analyzing Social Media Networks with NodeXL: Insights from a Connected World. Morgan Kaufmann, 304.

Avinash Kaushik. 2009. Web Analytics 2.0: The Art of Online Accountability.

Easley, D. & Kleinberg, J. (2010). Networks, Crowds, and Markets: Reasoning About a Highly Connected World. New York: Cambridge University Press. http://www.cs.cornell.edu/home/kleinber/networks-book/

Wasserman, S. & Faust, K. (1994). Social network analysis: Methods and applications. New York: Cambridge University Press. Monge, P. R. & Contractor, N. S. (2003). Theories of communication networks. New York: Oxford University Press.

CSEE-4243 : KNOWLEDGE DISCOVERY

Unit 1:

Introduction KDD and Data Mining - Data Mining and Machine Learning, Machine Learning and Statistics, Generalization as Search,Data Mining and Ethics

Unit 2:

Knowledge Representation - Decision Tables, Decision Trees, Classification Rules, Association Rules, Rules involving Relations, Trees for Numeric Predictions, Neural Networks, Clusters

Unit 3:

Decision Trees Evaluation of Learned-DivideResultsandConquer, Calculating Information, Entropy, Pruning, Estimating Error Rates, The C4.5 Algorithm

Cross-Validation- Training and Testing, Predicting Performance,

Unit 4:

Classification Rules - Inferring Rudimentary Rules, Covering Algorithms for Rule Construction, Probability Measure for Rule Evaluation, Association Rules, Item Sets, Rule Efficiency

Unit 5:

Numeric Predictions - Linear Models for Classification and Numeric Predictions, Numeric Predictions with Regression Trees, Evaluating Numeric Predictions.

REFERENCES:

Data mining and knowledge discovery handbook by Maimon, oded(et al.)

Data Cleansing : A Prelude to knowledge Discovery

CSEE-4244 SECURITY ASSESSMENT AND RISK ANALYSIS

Unit 1:

SECURITY BASICS: Information Security (INFOSEC) Overview: critical information characteristics – availability information states – processing security countermeasures education, training and awareness, critical information characteristics – confidentiality critical information characteristics – integrity, information states – storage, information states – transmission, security countermeasures policy, procedures and practices, threats, vulnerabilities.

Unit 2:

Threats to and Vulnerabilities of Systems: definition of terms (e.g., threats,vulnerabilities, risk), major categories of threats (e.g., fraud, Hostile Intelligence Service (HOIS), malicious logic, hackers, environmental and technological hazards, disgruntled employees, careless employees, HUMINT, and monitoring), threat impact areas, Countermeasures: assessments (e.g., surveys, inspections), Concepts of Risk Management: consequences (e.g., corrective action, risk assessment), cost/benefit analysis of controls, implementation of cost effective controls,

monitoring the efficiency and effectiveness of controls (e.g., unauthorized or inadvertent disclosure of information), threat and vulnerability assessment

Unit 3:

Security Planning: directives and procedures for policy mechanism, Risk Management: acceptance of risk (accreditation), corrective actions information identification, risk analysis and/or vulnerability assessment components, risk analysis results evaluation, roles and responsibilities of all the players in the risk analysis process, Contingency Planning/Disaster Recovery: agency response procedures and continuity of operations, contingency plan components, determination of backup requirements, development of plans for recovery actions after a disruptive event, development of procedures for off siteprocessing, emergency destruction procedures, guidelines for determiningcritical and essential workload, team member responsibilities in responding to anemergency situation.

Unit 4:

POLICIES AND PROCEDURES

Physical Security Measures: alarms, building construction, cabling, communications centre, environmental controls (humidity and air conditioning), filtered power, physical access control systems (key cards, locks and alarms) Personnel Security Practices and Procedures: access authorization/verification (need to know), contractors, employee clearances, position sensitivity, security training and awareness, systems maintenance personnel, Administrative Security Procedural Controls: attribution, copyright protection and licensing ,Auditing and Monitoring: conducting security reviews, effectiveness of securityprograms, investigation of security breaches, privacy review of accountabilitycontrols, review of audit trails and logs

Unit 5:

Operations Security (OPSEC): OPSEC surveys/OPSEC planning INFOSEC: computer security – audit, cryptography encryption (e.g., point to point, network, link), cryptography key

management (to include electronic key), cryptography strength (e.g., complexity, secrecy, characteristics of the key)

REFERENCES:

Principles of Incident Response and Disaster Recovery, Whitman &Mattord, Course Technology ISBN: 141883663X

(Web Link) http://www.cnss.gov/Assets/pdf/nstissi_4011.pdf

CSEE-4245 SECURE CODING

Unit 1:

Introduction to software security, Managing software security risk, Selecting software development technologies, An open source and closed source, Guidingprinciples for software security, Auditing software, Buffet overflows, Access control, Race conditions, Input validation, Password authentication

Unit 2:

Anti-tampering, Protecting against denial of service attack, Copy protection schemes, Client-side security, Database security, Applied cryptography, Randomness and determinism

Unit 3:

Buffer Overrun, Format String Problems, Integer Overflow, and Software Security Fundamentals SQL Injection, Command Injection, Failure to Handle Errors, and Security Touchpoints

Unit 4:

Cross Site Scripting, Magic URLs, Weak Passwords, Failing to Protect Data, Weak random numbers, improper use of cryptography

Unit 5:

Information Leakage, Race Conditions, Poor usability, Failing to protect network traffic, improper use of PKI, trusting network name resolution.

REFERENCES:

J. Viega, M. Messier. Secure Programming Cookbook, O'Reilly.

M. Howard, D. LeBlanc. Writing Secure Code, Microsoft

J. Viega, G. McGraw. Building Secure Software, Addison Wesley

CSEE-4246: BIOMETRICS

Unit 1:

Introduction and Definitions of bio-metrics, Traditional authenticated methods and technologies.

Unit 2:

Bio-metric technologies: Fingerprint, Face, Iris, Hand Geometry, Gait Recognition, Ear, Voice, Palm print, On-Line Signature Verification, 3D FaceRecognition, Dental Identification and DNA.

Unit 3:

The Law and the use of multi bio-metrics systems.

Unit 4:

Statistical measurement of Bio-metric. Bio-metrics in Government Sector and Commercial Sector.

Unit 5:

Case Studies of bio-metric system, Bio-metric Transaction. Bio-metric System Vulnerabilities. Recent trends in Bio- metric technologies and applications in various domains. Case study of 3D face recognition and DNA matching.

REFERENCES:

Biometrics for network security, Paul Reid, Hand book of Pearson

D. Maltoni, D. Maio, A. K. Jain, and S. Prabhakar, Handbook of Fingerprint Recognition, Springer Verlag, 2003.

A. K. Jain, R. Bolle, S. Pankanti (Eds.), BIOMETRICS: Personal Identification in Networked Society, Kluwer Academic Publishers, 1999.

J. Wayman, A.K. Jain, D. Maltoni, and D. Maio (Eds.), Biometric Systems: Technology, Design and Performance Evaluation, Springer, 2004.

Anil Jain, Arun A. Ross, Karthik Nanda kumar, Introduction to biometric, Springer, 2011.

Biometric Systems: Technology, Design and Performance Evaluation, J. Wayman, A.K. Jain, D. Maltoni, and D. Maio

CSEE-4247: NETWORK SECURITY

Unit 1:

Data security: Review of cryptography. Examples RSA, DES, ECC.

Unit 2:

Authentication, non-repudiation and message integrity. Digital signatures and certificates. Protocols using cryptography (example Kerberos). Attacks on protocols

Unit 3

Network security: Firewalls, Proxy-Servers, Network intrusion detection. Transport security: Mechanisms of TLS, SSL, IPSec.

Unit 4

Web security – SQL injection, XSS, etc. Software security and buffer overflow.

Malware types and case studies.Access Control, firewalls and host/network intrusion detection.

Unit 5

Other topics: Biometric authentication, Secure E-Commerce (ex. SET), Smart Cards, Security in Wireless Communication.

REFERENCES:

W. R. Cheswick and S. M. Bellovin. Firewalls and Internet Security. Addison Wesley, 1994.

W. Stallings. Cryptography and Network Security. Prentice Hall, 1999.

B. Schneier. Applied Cryptography. Wiley, 1999

CSEE-4248 : ADVANCED MACHINE LEARNING

Unit 1:

Key concepts, Supervised/Unsupervised Learning, Loss functions and generalization, Probability Theory, Parametric vs Non-parametric methods, Elements of Computational Learning Theory Ensemble Learning, Bagging, Boosting, Random Forest

Unit 2:

Kernel Methods for non-linear data, Support Vector Machines, Kernel Ridge Regression, Structure Kernels, Kernel PCA, Latent Semantic Analysis

Unit 3:

Bayesian methods for using prior knowledge and data, Bayesian inference, Bayesian Belief Networks and Graphical models, Probabilistic Latent Semantic Analysis, The Expectation-Maximisation (EM) algorithm, Gaussian Processes

Unit 4:

Dimensionality Reduction - CCA, LDA, ICA, NMF – Canonical Variates - Feature Selection vs Feature Extraction

Unit 5:

Filter Methods - Sub-space approaches - Embedded methodsLow-Rank approaches - RecommenderSystems .Application areas - Security - Business – Scientific

REFERENCES:

Christopher M. Bishop, Pattern Recognition and Machine Learning.

John Shawe-Taylor and NelloCristianini, Kernel Methods for Pattern Analysis.

ELECTIVE V

CSEE-5111: GPU COMPUTING

Unit 1:

Introduction: History, Graphics Processors, Graphics Processing Units, GPGPUs. Clock speeds, CPU / GPU comparisons, Heterogeneity, Accelerators, Parallel programming, CUDA OpenCL / OpenACC, Hello World Computation Kernels, Launch parameters, Thread hierarchy, Warps Wavefronts, Thread blocks / Workgroups, Streaming multiprocessors, 1D / 2D / 3D thread mapping, Device properties, Simple Programs

Unit 2:

Memory: Memory hierarchy, DRAM / global, local / shared, private / local, textures, Constant Memory, Pointers, Parameter Passing, Arrays and dynamic Memory, Multi-dimensional Arrays, Memory Allocation, Memory copying across devices, Programs with matrices, Performance evaluation with different memories

Unit 3:

Synchronization: Memory Consistency, Barriers (local versus global), Atomics, Memory fence. Prefix sum, Reduction. Programs for concurrent Data Structures such as Worklists, Linked-lists. Synchronization across CPU and GPU Functions : Device functions, Host functions, Kernels functions, Using libraries (such as Thrust), and developing libraries.

Unit 4:

Support Streams: Debugging GPU Programs. Profiling, Profile tools, Performance aspects : Asynchronous processing, tasks, Task-dependence, Overlapped data transfers, Default Stream, Synchronization with streams. Events, Event-based Synchronization - Overlapping data transfer and kernel execution, pitfalls.

Unit 5:

Image Processing, Graph algorithms, Simulations, Deep Learning Case Studies

REFERENCES:

Programming Massively Parallel Processors: A Hands-on Approach; David Kirk, Wen-meiHwu; Morgan Kaufman; 2010 (ISBN: 978-0123814722)

CUDA Programming: A Developer's Guide to Parallel Computing with GPUs; Shane Cook; Morgan Kaufman; 2012 (ISBN: 978-0124159334)

CSEE-5112 : CLOUD COMPUTING

Unit 1:

Introduction to Cloud Computing

Unit2:

OnlineSocial Networks and Applications, Cloud introduction and overview, CloudDifferentComputingclouds,Risks,ArchitectureNovelapplications of cloud computing Requirements, Introduction Cloud computing architecture, On Demand Computing Virtualization at the infrastructure level, Security in Cloud computing environments, CPU Virtualization, A discussion on Hypervisors Storage Virtualization Cloud Computing Defined, The SPI Framework for Cloud Computing, The Traditional Software Model, The Cloud Services Delivery Model Cloud Deployment Models Key Drivers to Adopting the Cloud, The Impact of Cloud Computing on Users, Governance in the Cloud, Barriers to Cloud Computing Adoption in the Enterprise

Unit 3:

Security Issues in Cloud Computing Infrastructure Security, Infrastructure Security: The Network Level, The Host Level, The Application Level, Data Security and Storage, Aspects of Data Security, Data Security Mitigation Provider Data and Its Security

Identity and Access Management

Unit 4:

TrustBoundaries and IAM, IAM Challenges, Relevant IAM Standards and Protocols Security for Cloud ManagementServices,IAM PracticesintheCloudinthe Cloud, Cloud Authorization Management Security Management Standards, Security Management in the Cloud, Availability Management: SaaS, PaaS, IaaS Privacy Issues Privacy Issues, Data Life Cycle, Key Privacy Concerns in the Cloud, Protecting Privacy, Changes to Privacy Risk Management and Compliance in Relation to Cloud Computing, Legal and Regulatory Implications, U.S. Laws and Regulations, International Laws and Regulations

Unit 5:

Audit and Compliance Internal Policy Compliance, Governance, Risk, and Compliance (GRC),

Unit6:

Regulatory/ExternalCompliance, Cloud Security Alliance, Auditing the Cloud for Compliance, Security-as-a-Cloud

REFERENCES:

Cloud Computing Explained: Implementation Handbook for Enterprises, John Rhoton, Publication Date: November 2, 2009

Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance (Theory in Practice), Tim Mather, ISBN-10: 0596802765,O'Reilly Media, September 2009

CSEE-5113: Distributed Database

Unit 1:

Introduction: Distributed Data processing, Distributed database system (DDBMS), Promises of DDBMSs, Complicating factors and Problem areas in DDBMSs, Overview Of Relational DBMS Relational Database concepts, Normalization, Integrity rules, Relational Data Languages, Relational DBMS.

Unit 2:

Distributed DBMS Architecture: DBMS Standardization, Architectural models for Distributed DBMS, Distributed DBMS Architecture. Distributed Database Design: Alternative design Strategies, Distribution design issues, Fragmentation, Allocation. Semantic Data Control: View Management, Data security, SemanticIntegrity Control.

Unit 3:

Overview of Query Processing: Query processing problem, Objectives of Query Processing, Complexity of Relational Algebra operations, characterization of Query processors, Layers of Query Processing. Introduction to Transaction Management: Definition of Transaction, Properties of transaction, types of transaction. Distributed Concurrency Control: Serializabilitytheory, Taxonomy of concurrency control mechanisms, locking bases concurrency control algorithms.

Unit 4:

Parallel Database Systems: Database servers, Parallel architecture, Parallel DBMS techniques, Parallel execution problems, Parallel execution for hierarchical architecture.

Unit 5:

Distributed Object Database Management systems: Fundamental Object concepts and Object models, Object distribution design. Architectural issues, Object management, Distributed object storage, Object query processing. Transaction management. Database Interoperability: Database Integration, Query processing.

REFERENCES:

Principles of Distributed Database Systems, Second Edition, M. Tamer Ozsu Patrick Valduriez

Distributed Databases principles and systems, Stefano Ceri, Giuseppe Pelagatti, Tata McGraw Hill.

CSEE-5114 : DATA WAREHOUSING AND DATA MINING

Unit 1:

Introduction to Data Warehousing; Data Mining: Mining frequent patterns, association and correlations; Sequential Pattern Mining concepts, primitives, scalable methods;

Unit 2:

Classification and prediction; Cluster Analysis – Types of Data in Cluster Analysis, Partitioning methods, Hierarchical Methods; Transactional Patterns and other temporal based frequent patterns,

Unit 3:

Mining Time series Data, Periodicity Analysis for time related sequence data, Trend analysis, Similarity search in Time-series analysis;

Unit 4:

Mining Data Streams, Methodologies for stream data processing and stream data systems, Frequent pattern mining in stream data, Sequential Pattern Mining in Data Streams, Classification of dynamic data streams, Class Imbalance Problem; Graph Mining; Social Network Analysis;

Unit 5:

Web Mining, Mining the web page layout structure, mining web link structure, mining multimedia data on the web, Automatic classification of web documents and web usage mining; Distributed Data Mining.

REFERENCES:

Jiawei Han and M Kamber, Data Mining Concepts and Techniques,, Second Edition, Elsevier Publication, 2011.

Vipin Kumar, Introduction to Data Mining - Pang-Ning Tan, Michael Steinbach, Addison Wesley, 2006.G Dong and J Pei, Sequence Data Mining, Springer, 2007

CSEE-5115 : WEB SEARCH AND INFORMATION RETRIEVAL

Unit 1:

Information retrieval model, Information retrieval evaluation, Searching the Web

Unit 2:

Document Representation, Query languages and query operation, Meta-data search,

Unit 3:

Indexing and searching, Scoring and ranking feature vectors,

Unit 4:

Ontology, domain specific search, parallel and distributed information retrieval,

Unit 5:

Text and multimedia languages, Social networks.

Unit 6:

Recent trends in Web search and Information retrieval techniques.

REFERENCES:

C. D. Manning, P. Raghavan and H. Schütze, Introduction to Information Retrieval, Cambridge University Press, 2008 (available at http://nlp.stanford.edu/IR-book).

Chakrabarti, S. (2002). Mining the web: Mining the Web: Discovering knowledge from hypertext data. Morgan-kaufman.

B. Croft, D. Metzler, T. Strohman, Search Engines: Information Retrieval in Practice, Addison-Wesley, 2009 (available at http://ciir.cs.umass.edu/irbook/).

R. Baeza-Yates, B. Ribeiro-Neto, Modern Information Retrieval, Addison-Wesley, 2011 (2nd Edition).

CSEE-5116: DATA SECURITY AND ACCESS CONTROL

Unit1:

Introduction to Access Control, Purpose and fundamentals of access control, brief history, Policies of Access Control, Models of Access Control, and Mechanisms, Discretionary Access Control (DAC), Non- Discretionary Access Control, Mandatory Access Control (MAC). Capabilities and Limitations of Access Control Mechanisms: Access Control List (ACL) and Limitations, Capability List and Limitations.

Unit 2:

Role-Based Access Control (RBAC) and Limitations, Core RBAC, Hierarchical RBAC, Statically Constrained RBAC, Dynamically Constrained RBAC, Limitations of RBAC. Comparing RBAC to DAC and MAC Access control policy.

Unit 3:

Biba'sintrigity model, Clark-Wilson model, Domain type enforcement model, mapping the enterprise view to the system view, Role hierarchies- inheritance schemes, hierarchy structures and inheritance forms, using SoD in real system Temporal Constraints in RBAC, MAC AND DAC. Integrating RBAC with enterprise IT infrastructures: RBAC for WFMSs, RBAC for UNIX and JAVA environments Case study: Multi line Insurance Company

Unit 4:

Smart Card based Information Security, Smart card operating system- fundamentals, design and implantation principles, memory organization, smartcard files, file management, atomic operation, smart card data transmission ATR, PPS Security techniques- user identification, smart card security, quality assurance and testing, smart card life cycle-5 phases, smart card terminals.

Unit 5:

Recent trends in Database security and access control mechanisms. Case study of Role-Based Access Control (RBAC) systems.

REFERENCES:

Role Based Access Control: David F. Ferraiolo, D. Richard Kuhn, RamaswamyChandramouli.

http://www.smartcard.co.uk/tutorials/sct-itsc.pdf : Smart Card Tutorial

CSEE-5117: IOT and Smart Cities

Unit 1:

Introduction and Applications:smart transportation, smart cities, smart living, smart energy, smart health, and smart learning.

Unit 2:

IoT Reference Architecture- methods to assist local governments to develop international good e-practice

Unit 3:

Methods to redesign and redefine back and front offices in order to build smarter and transparent governments

Unit 4:

Methods to design public mobile services aimed at efficiency, cost- saving and participation with attention for e-inclusion

Unit 5:

Methodologies for user involvement, profiling customers and indentifying needs; test methodologies to transfer these needs in appropriate services; and test techniques to fit the right channel to the specific services and customers thereby setting a framework for a higher level of e-services in the NSR

Unit 6:

Pilot new service channels, bluetooth services for public transport, online forms in mobile phones and wireless city services

REFERENCES:

Smart City on Future Life - Scientific Planning and Construction by Xianyi Li

The Age of Intelligent Cities: Smart Environments and Innovation-for-all Strategies (Regions and Cities) by NicosKomninos

Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia by Anthony Townsend

CSEE-5118 : EMULATION AND SIMULATION METHODOLOGIES

Unit 1:

Fundamentals of Discrete Event Simulations (DES)

Unit 2:

Model-based representationfor DES, from communication and

networking, to mobility and data traffic.

Unit 3:

Application-based Granularity Requirements: from bit-level, packet- level, to system-level evaluation, and their appropriate selection as a function of the application requirements.

Unit 4:

Fundamentals on Random Numbers, Fundamentals on Statistical Tools for Performance Evaluation, Simulation vs. Emulations

Unit 5:

Case study for the evaluation of communications for ITS.

Recent trends in simulation and emulation for IOT, model based and= application based granularity presentation

REFERENCES:

Jack L. Burbank, An Introduction to Network Simulator 3, Wiley