Bansilal Ramnath Agarwal Charitable Trust's

Vishwakarma Institute of Information Technology, Pune-48

(An Autonomous Institute affiliated to Savitribai Phule Pune University)

Syllabus for
F.Y.M.Tech.
(Computer Engineering)

Department of
Computer Engineering

F.Y.M.Tech.

Pattern 2018

Syllabus Structure

Department of Computer Engineering

First Year M.Tech. Computer Engineering (FYMT) - Semester I (Pattern 2018)

Course Code	Course	Course Type	Teaching Scheme		Examination Scheme					Total	Credits
					Formative Assessment			Summative Assessment			
			L	P	ISE T1	ISE T2	CE	ESE	OR		
CSPA11181	Mathematical Foundation of Computer Science	TH	3	-	20	10	20	50	-	100	3
CSPA11182	Operating System Design	TH	3	-	20	10	20	50	-	100	3
CSPA11183	Program Elective I	TH	3	-	20	10	20	50	-	100	3
CSPA11184	Program Elective II	TH	3	-	20	10	20	50	-	100	3
CSPA11185	Laboratory I	CE-OR	-	4	-	-	50	-	50	100	2
CSPA11186	Laboratory II	CE-OR	-	4	-	-	50	-	50	100	2
CSPA11187	Research Methodology & IPR	CE	2	-	-		50	-	--	50	2
AP1	Audit Course I		-	-	-	-	-	-	-	-	-
	Total		**14**	**8**	**80**	**40**	**230**	**200**	**100**	**650**	**18**

Course Code	Program Elective I	Course Code	Program Elective II
CSPA11183A	Machine Learning	CSPA11184A	Information Retrieval and Web Mining
CSPA11183B	Data Preparation and Analysis	CSPA11184B	Advanced Wireless and Mobile Network
CSPA11183C	System Security	CSPA11184C	Web Analytics and Development

Audit courses

1. English for Research Paper Writing
2. Disaster Management
3. Sanskrit for Technical Knowledge
4. Value Education
5. Constitution of India
6. Pedagogy Studies
7. Stress Management by Yoga
8. Personality Development through Life Enlightenment Skills.

BoS Chairman **Dean Academics** **Director**

Department of Computer Engineering

First Year M.Tech. Computer Engineering (FYMT) - Semester II (Pattern 2018)

Course Code	Course	Course Type	Teaching Scheme		Examination Scheme					Total	Credits
					Formative Assessment			Summative Assessment			
					ISE						
			L	P	T1	T2	CE	ESE	OR		
CSPA12181	Data Sciences	TH	3	-	20	10	20	50	-	100	3
CSPA12182	Cyber Physical System	TH	3	-	20	10	20	50	-	100	3
CSPA12183	Program Elective III	TH	3	-	20	10	20	50	-	100	3
CSPA12184	Program Elective IV	TH	3	-	20	10	20	50	-	100	3
CSPA12185	Laboratory III	CE-OR	-	4	-	-	50	-	50	100	2
CSPA12186	Laboratory IV	CE-OR	-	4	-	-	50	-	50	100	2
CSPA12187	Mini Project	CE-OR	-	4	-	-	50	-	50	100	2
AP2	Audit Course II	-	-	-	-	-	-	-	-	-	-
	Total		**12**	**12**	**80**	**40**	**230**	**200**	**150**	**700**	**18**

Course Code	Program Elective III	Course Code	Program Elective IV
CSPA12183A	Soft Computing	CSPA12184A	Social Media Analysis
CSPA12183B	Big Data Analytics	CSPA12184B	Wireless Access Technologies
CSPA12183C	Usability Engineering	CSPA12184C	Optimization Techniques

Audit courses

1. English for Research Paper Writing
2. Disaster Management
3. Sanskrit for Technical Knowledge
4. Value Education
5. Constitution of India
6. Pedagogy Studies
7. Stress Management by Yoga
8. Personality Development through Life Enlightenment Skills

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F.Y.M.Tech.

Pattern 2018

Syllabus

Department of Computer Engineering

Mathematical Foundation of Computer Science (CSPA11181)

Teaching Scheme
Credits : 3
Lectures : 3 Hrs/week

Examination Scheme
Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Prerequisites

- Discrete Mathematics

Course Objectives

- To understand the mathematical fundamentals that is prerequisites for a variety 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 develop the understanding of the 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

Course Outcomes

After completion of the course, student will be able to

1. Apply graph-theoretic models of data structures and state machines to solve problems of connectivity and constraint satisfaction (e.g. scheduling)
2. Understand the basic notions of discrete and continuous probability
3. Understand the methods of statistical inference
4. Understand the role that sampling distributions play in statistical inference methods
5. Perform correct and meaningful statistical analyses of simple to moderate complexity
6. Understand discrete time Markov chains and their role into computer science problems

Unit I	**Graph Theory**

Simple Graphs: Isomorphism, Bipartite Graphs & Matchings , Coloring , Connectivity , Forests & Trees

Directed Graphs and Partial Orders : Scheduling, Partial Orders, Linear Orders, Product Orders, Equivalence Relations

Communication Networks: Routing Problems, Network Diameter, Switch Count, Network Latency, Congestion, 2-D Array, Butterfly, Benes ˇ Network

Planar Graphs: Euler's Formula, Bounding the Number of Edges in a Planar Graph, Coloring Planar Graphs, Classifying Polyhedra

Unit II	**Random Variables**

Discrete Random Variables: The Probability Mass Function, Distribution Functions, Special Discrete Distributions , The Probability Generating Function ,Discrete Random Vectors, Independent Random Variables.

Continuous Random Variables : The Exponential Distribution , The Reliability and Failure Rate, Some Important Distributions, Functions of a Random Variable, Jointly Distributed Random Variables, Order Statistics, Distribution of Sums, Functions of Normal Random Variables

Unit III	**Statistical Inference Expectations**

Sampling: Probabilistic and non-probabilistic**,** Parameter Estimation

Expectation : Moments, Expectation Based on Multiple Random Variables, Transform Methods ,Moments and Transforms of Some Distributions , Computation of Mean Time to Failure, Inequalities and Limit Theorems Distributions: Mixture Distributions , Conditional Expectation, Imperfect Fault Coverage and Reliability , Random Sums Hypothesis Testing: one-sided and two-sided tests, z-test, t-test	
Unit IV	**Regression Analysis**
Regression and Analysis of Variance: Least-squares Curve Fitting , The Coefficients of Determination , Confidence Intervals in Linear Regression, Trend Detection and Slope Estimation , Correlation Analysis, Simple Nonlinear Regression , Higher-dimensional Least-squares Fit ,Analysis of Variance	
Unit V	**Stochastic Processes and Discrete-Time Markov Chains**
Classification of Stochastic Processes, The Bernoulli Process, The Poisson Process Renewal Processes, Availability Analysis, Random Incidence, Renewal Model of Program Behavior Computation of n-step Transition Probabilities, State Classification and Limiting Probabilities, Distribution of Times Between State Changes, Markov Modulated Bernoulli Process, Irreducible Finite Chains with Aperiodic States	
Unit VI	**Continuous-Time Markov Chains**
The Birth–Death Process , Other Special Cases of the Birth–Death Model, Non-Birth–Death Processes Markov Chains with Absorbing States, Solution Techniques, Automated Generation	

Reference Books

1. K. Trivedi, "Probability and Statistics with Reliability, Queuing, and Computer Science Applications". Wiley.
2. Kenneth H. Rosen, "Discrete Mathematics and its Applications", 6th edition, McGraw-Hill, 2007. ISBN 978-0-07-288008-3.
3. U Dinesh Kumar, "Business Analytics", Wiley
4. John Vince, "Foundation Mathematics for Computer Science", Springer.
5. M. Mitzenmacher and E. Upfal, "Probability and Computing: Randomized Algorithms and Probabilistic Analysis"
6. Alan Tucker, "Applied Combinatorics", Wiley

Department of Computer Engineering

Operating System Design (CSPA11182)

Teaching Scheme
Credits : 3
Lectures : 3 Hrs/week

Examination Scheme
Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Prerequisites

- Basic knowledge of Operating System

Course Objectives

- To Introduce the basic concepts of operating system
- To learn about various design techniques
- To learn process management
- To learn memory management and its relevant design techniques
- To learn virtualization concept

Course Outcomes

After completion of the course, student will be able to

1 Explain the functions, structures and history of operating systems design
2 Give details about the design issues associated with operating systems
3 Master various process management concepts including scheduling, synchronization, deadlocks
4 Apply the concepts of memory management including virtual memory
5 Master issues related to file system interface and implementation, disk management
6 Be familiar with protection security mechanisms, and various types of operating systems design including Unix

Unit I	**Introduction**

System levels, Hardware Resources, Resource management, Virtual Computers, The Hardware Interface, The CPU, Memory and Addressing, Interrupts, I/O Devices, The Operating System Interface, Information and Meta-Information, Naming Operating System Objects, Device as Files, The process Concept, Communication between Processes, UNIX-Style Process Creation, Standard Input and Standard Output, The User Interface to an Operating Design Techniques: Operating Systems and Design, Design Problems, Design Techniques, Two Level Implementation, Interface Design, Connection in Protocols, Interactive and Programming Interfaces, Decomposition Patterns.

Unit II	**Process Management and IPC**

Introduction process, System Initialization, System Call Interrupt Handling, Program Error Interrupts, Disk Driver Subsystem, Implementation of Waiting, Flow of Control Through the Operating System, Signaling in an Operating System, Interrupts in the Operating System, Operating Systems as Event and Table Managers, Process Implementation, Examples of Process Implementation, Patterns of Inter process communication, New message-passing system calls, IPC Patterns, Failure of Processes, Processes: Everyday Scheduling, Preemptive Scheduling Methods, Policy versus Mechanism in Scheduling, Scheduling in Real Operating Systems, Deadlock, Two Phase Locking, Starvation, Synchronization, Semaphores, Programming Language Based Synchronization Primitives, Message Passing Design Issues Design Techniques: Indirection, Using State Machines, Win Big Then Give Some Back, Reentrant Programs, Using Models for Inspiration, Adding a New Facility To a System

Unit III	**Memory Management**

Levels of Memory Management, Linking and Loading a Process, Variations in Program Loading, The Memory Management Design Problem, Dynamic Memory Allocation, Keeping Track of the Blocks, Multiprogramming Issues, Memory Protection, Memory Management System Calls, Virtual Memory, Virtual Memory Systems.
Design Techniques: Multiplexing, Late binding, Static Versus Dynamic, Space-Time Tradeoffs, Simple Analytic Models

Unit IV	**Virtualization and Virtual Machine**

Introduction, Storage virtualization, NAS, SAN, Virtual CPU, Process virtual Machine, Virtual Machine, Hosted versus native virtual machines, Intel ugliness

Unit V	**File systems**

The File Abstraction, File Naming, File System Objects and Operations, File System Implementation, File Systems Organization, Remote File systems Design Techniques: Caching, Optimization and Hints, Hierarchical Names, Naming of Objects, Unification of Concepts.

Unit VI	**I/O and Resource Management**

I/O Devices, I/O Systems ,Issues, Types of Resources, Integrated Scheduling, Queuing Models of Scheduling, Real- time Operating Systems, Protection of Resources, User Authentication, Mechanisms for Protecting Hardware Resources, Representation of Protection Information, Mechanisms For Software Protection, The Use of Cryptography in Computer Security, The Client Server Model

Reference Books

1. Charles Crowley, " Operating System: A Design-Oriented Approach", Tata McGraw-Hill
2. Understanding Full Virtualization, Para virtualization, and Hardware Assist, VMware white paper, © 2007 VMware.
3. Understanding Virtualization, IBM Systems Magazine, November 2004.
4. The NFS Distributed File Service: NFS White Paper, Sun Microsystems, March 1995
5. Introduction to Xen Virtualization, OpenSuse documentation.
6. Live Migration of Virtual Machines, Christopher Clark, Keir Fraser, Steven Hand, Jacob Gorm Hansen†, Eric Jul†, Christian Limpach, Ian Pratt, Andrew Warfield. University of Cambridge Computer Laboratory.
7. Johan De Gelas, "Hardware Virtualization: the Nuts and Bolts", Anand Tech, March 17, 2008.

Department of Computer Engineering

Program Elective I
Machine Learning (CSPA11183A)

Teaching Scheme
Credits : 3
Lectures : 3 Hrs/week

Examination Scheme
Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Prerequisites
- Data Structure
- Discrete Mathematics

Course Objectives
- To understand the basic building blocks and general principles that allow one to design machine learning algorithms
- To become familiar with specific, widely used machine learning algorithms
- To learn methodology and tools to apply machine learning algorithms to real data and evaluate their performance

Course Outcomes
After completion of the course, students will be able to
1. Formulate machine learning problems corresponding to different applications
2. Understand a range of machine learning algorithms along with their strengths and weaknesses
3. Develop an appreciation for what is involved in learning from data.
4. Understand a wide variety of learning algorithms.
5. Understand how to apply a variety of learning algorithms to data.
6. Understand how to perform evaluation of learning algorithms and model selection.

Unit I	**Introduction to Machine Learning**

Basic definitions, Introduction to Statistical Learning Methods, History of Machine Learning, Machine-Learning Problem, Learning Paradigms, Machine-Learning Techniques and Paradigms, Need of Learning, Machine Intelligence, types of learning, hypothesis space and inductive bias, evaluation, cross-validation, Linear regression, Decision trees, overfitting, Instance based learning, Feature reduction

Unit II	**Machine Learning Models**

Neural Network: Perceptron, Multilayer Network, Backpropagation, Introduction To Deep Neural Network, Computational Learning Theory, PAC Learning Model, Sample Complexity, VC Dimension, Ensemble Learning, Clustering: K-Means, Adaptive Hierarchical Clustering, Gaussian Mixture Model

Unit III	**Supervised learning and Unsupervised learning**

Mining Frequent Patterns, Association and Correlations: Basic Concepts, Frequent itemset Mining methods: Apriori Algorithm, Generate Association rules from Frequent itemsets, Mining closed and max. patterns.
Classification: Basic Concepts, Decision Tree induction, Bayes Classification Method, Rule based Classification, Model evaluation & selection, techniques to improve classification accuracy. Classification Advanced Methods: Bayesian Belief networks, Classification by Back Propagation, Support Vector Method, Classification using frequent Patterns, lazy learners, other classification methods.
Cluster Analysis: Basic Concepts & Methods, Cluster Analysis, partitioning methods, Hierarchical

Methods, Density based Methods, Grid based Methods, Evaluation of Clustering. Advanced Cluster Analysis: Probabilistic Model based Clustering, Clustering High Dimensional Data, Clustering Graph & Network data, Clustering & Constraints.	
Unit IV	**Fundamentals of Reinforcement Learning and Systematic machine learning**
Introduction, Reinforcement Machine Learning (RFML) basics, functions, Need of RF learning, Systematic machine learning (SML), SML models, challenges of SML, Learning Agents, Returns and Reward Calculations, Reinforcement Learning and Adaptive Control, Dynamic Systems, Reinforcement Learning and Control, Markov Property and Markov Decision Process, Value Functions, Action and Value, Dynamic Programming, case study of SML and RFML.(Reinforcement Learning for Boxing Trainer)	
Unit V	**Multi Perspective Machine Learning**
Multi Perspective decision making and Multi Perspective learning ,Dynamic and Interactive decision Making Adaptive Dynamic Programming, Example: Traffic controller based on Multi perspective approach and Emotion detection	
Unit VI	**Adaptive and Incremental Machine Learning**
Adaptive Learning and Adaptive Systems, Adaptive Machine Learning, Adaptation and Learning Method Selection Based on Scenario, Applications of Adaptive Learning, Competitive Learning and Adaptive Learning, Incremental Learning, Learning from What Is Already Learned, Supervised Incremental Learning, Incremental Unsupervised Learning and Incremental Clustering, Semi-supervised Incremental Learning, Incremental and Systemic Learning, Incremental Closeness Value and Learning Method, Learning and Decision-Making Model, Incremental Classification Techniques	

Reference Books

1. Parag Kulkarni, "Reinforcement and Systemic Machine Learning for Decision Making", July 2012, Wiley-IEEE Press, ISBN: 978-0-470-91999-6
2. Tom Mitchell, "Machine Learning". First Edition, McGraw- Hill, 1997
3. Ethem Alpaydin, "Introduction to Machine Learning", The MIT Press, October 2004, ISBN 0-262-01211-1
4. Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning: Data Mining", Inference, and Prediction, Second Edition, February 2009
5. Montgomery, Douglas C., and George C. Runger. "Applied statistics and probability for engineers". John Wiley & Sons, 2010
6. Jawai Han, Michelline Kamber, Jiran Pie, "Data mining concepts and techniques", Morgan Kaufmann Publishers, 3rd Edition.

Department of Computer Engineering

Program Elective I
Data Preparation and Analysis (CSPA11183B)

Teaching Scheme
Credits : 3
Lectures : 3 Hrs/week

Examination Scheme
Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Prerequisites

- UG level course in Data Structures

Course Objectives

- To prepare the data for analysis
- To develop meaningful Data for Visualizations

Course Outcomes

After completion of the course, students will be able to

1. Extract the data for performing the Analysis
2. Work in a business environment in which data preparation occurs.
3. Prepare data marts for statistical analysis
4. Summarize concepts of data quality
5. Read data from databases and clean the data for statistical analysis
6. Develop strategies for dealing with imperfect real world data

Unit I	**Data Gathering and Preparation**
Data formats, Data Sources, Data parsing and transformation, Scalability and real-time issues, Data Preparation, The Challenges of Sharing Lots of Files	
Unit II	**Data Cleaning**
Understanding Data Problem, Consistency checking, Heterogeneous and missing data, Data Transformation and segmentation	
Unit III	**Describing Data**
Preparing Data Tables, understanding relationships, Building Data Transformation Workflows	
Unit IV	**Understanding Data**
Identifying and understanding groups, Building models from Data, Strategies for Dealing with Large Datasets	
Unit V	**Exploratory Analysis**
Descriptive and comparative statistics, , Machine Learning for Large Datasets , Clustering and association, Hypothesis generation, Building a Data Classification System	
Unit VI	**Visualization**
Designing Visualizations, time series, Geo located data, Correlations and connections, Hierarchies and networks, interactivity, Study of various tools for Data Visualization	

Reference Books

1. Glenn J. Myatt , "Making sense of Data : A practical Guide to Exploratory Data Analysis and Data Mining", Willey publication, First Edition
2. Michael Manoochehri, "Data Just Right: Introduction to Large-Scale Data & Analytics", Addison-Wesley Data and Analytics

Department of Computer Engineering

Program Elective I
System Security (CSPA11183C)

Teaching Scheme
Credits : 3
Lectures : 3 Hrs/week

Examination Scheme
Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Prerequisites

- Buffer Overflow
- Unix Access Control and File System Permissions
- Basic Ideas about Discretionary and Mandatory Access control
- Securing Web Browser and Servers
- http vs https and IPsec

Course Objectives .

- To study Operating system security and malwares
- To study security issues in internet protocols.
- To study network defense tools
- To understand computer, network and information security

Course Outcomes

After completion of the course, student will be able to

1. Take leading roles in planning, organizing, managing, designing and configuring security solutions in public and private organizations
2. Be familiar with state-of-the-art security technologies and best practices
3. Understand Operating system security and malwares
4. Study security issues in internet protocols.
5. Study network defense tools
6. Understand computer, network and information security

Unit I	**Introduction**
Control hijacking attacks: exploits and defenses, Buffer Overflows: Attacks and Defenses for the Vulnerability of the Decade, Basic Integer Overflows, Bypassing Browser Memory Protections	
Unit II	**Access Control**
Principle of least privilege, access control, and operating systems security, Set UID Demystified, Operating Systems Security, Malwares: viruses, Worms, Trojans, Rootkits.	
Unit III	**Dealing with Legacy Codes**
Dealing with legacy code: sandboxing and isolation, Traps and Pitfalls: Practical Problems in System Call Interposition Based Security Tools, Efficient Software-Based Fault Isolation	
Unit IV	**TCP/IP security issues**
Security issues in Internet protocols: TCP, DNS, and routing, A look back at Security Problems in the TCP/IP Protocol Suite, DNS cache poisoning,	
Unit V	**Network Defense Tools**
Network defense tools: Firewalls, VPNs, Intrusion Detection, and filters, A Security Evaluation of DNSSEC with NSEC3, Distributed Firewalls, Bro: A System for Detecting Network Intruders in Real-Time, Unwanted traffic: denial of service attacks: Details of a recent large-scale DDoS event, Practical	

network support for IP Traceback, A DoS-Limiting Network Architecture	
Unit VI	**Case Studies**
Case Study, real world malware attacks, vulnerabilities	

Reference Books

1. Crispin Cowan, et al , "Buffer Overflows: Attacks and Defences for the Vulnerability of the Decade", http://crypto.stanford.edu/cs155/papers/cowan-vulnerability.pdf
2. Bypassing Browser Memory Protections, http://www.blackhat.com/presentations/bh-usa-08/Sotirov_Dowd/bh08-sotirov-dowd.pdf
3. Set UID Demystified, Chen, Dean, and Wagner, 2002. https://crypto.stanford.edu/cs155/papers/setuid-usenix02.pdf
5. T. Jaegeri , "Operating Systems Security" , 2008. Chapter 4, Security in Ordinary Operating Systems. https://crypto.stanford.edu/cs155/papers/ossecurity.pdf
6. T. Garfinkel, "Traps and Pitfalls: Practical Problems in System Call Interposition Based Security Tools", https://crypto.stanford.edu/cs155/papers/traps.pdf

Department of Computer Engineering

Program Elective II
Information Retrieval and Web Mining (CSPA11184A)

Teaching Scheme
Credits : 3
Lectures : 3 Hrs/week

Examination Scheme
Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Prerequisites

- Probability Theory
- Database Management
- Web Programming

Course Objectives

- To provide students an understanding of the fundamental techniques for IR, design and usability, document management and searching the web
- To cover the important concepts, principles , algorithms, and data/file structures that are necessary to design, and implement Information Retrieval
- To equip with sound skills to solve computational search problems
- To appreciate how to evaluate search engines
- To appreciate the different applications of IR techniques in the Internet or Web environment
- To give clear relevance and significance of IR and Web Mining to modern society

Course Outcomes

After completion of the course, student will be able to

1. Understand the difficulty of representing and retrieving documents
2. Understand the latest technologies for linking, describing and searching the web.
3. Understand and analyze the relationship between ir, hypermedia, and semantic models.
4. Be familiar with techniques for conveying the meaning of documents or hypermedia content,
5. Be familiar with classical techniques of information retrieval, and the additional techniques employed by web search engines sufficient to understand how web search engines work and how they could be improved.
6. Be familiar with the fundamentals of hypermedia systems sufficient to know how to develop a good web hypermedia and why a web site is good or bad

Unit I	**Information Retrieval Basics**
Goals and history of IR. The impact of the web on IR. Components of an IR system, Boolean and vector-space retrieval models; ranked retrieval; text-similarity metrics; TF-IDF (term frequency/inverse frequency) weighting; cosine similarity. Simple tokenizing, stop-word removal, and stemming; inverted indices, Index Construction and compression.	
Unit II	**Information Retrieval Models**
Probabilistic Information Retrieval, Language Modeling for Information Retrieval, Adhoc Retrieval, Latent Semantic Indexing, Relevance feedback, Pseudo relevance feedback, Query expansion, Query languages, POS tagging,	
Unit III	**Specific topics in IR**
Focused Retrieval, Transfer Learning, Learning to Rank, Personalization, Cross Language IR, Digital Libraries, Bibliographic systems, Patent Search, E-learning, Security Issues, Parallel and distributed	

IR	
Unit IV	**Web Mining**
Web Structure, content and usage mining, Web Crawling, Indexes, Search engines; spidering; meta crawlers; directed spidering; link analysis (e.g. hubs and authorities, Google PageRank), Information Extraction, spam filtering, XML retrieval, Recent trends in Web search	
Unit V	**Performance metrics**
Recall, precision, and F-measure; Social Networks : Social Web, Blogs, Wikis, Forums, Social Network analysis, Recommender systems, Information Filtering, Collaborative filtering and content-based recommendation of documents and products.	
Unit VI	**Semantic web**
Web 3.0, Ontology, OWL, RDF Schema, Knowledge representation, Multimedia Retrieval, Content based Image retrieval, Pattern Matching and classification for IR. Structured Data Extraction: Wrapper Generation, Information Integration, Opinion Mining and Sentiment Analysis,	

Reference Books

1. Yates & Neto, "Modern Information Retrieval", Pearson Education, ISBN 81-297-0274-6 (2011). Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze , "Introduction to Information Retrieval" (available online at http://nlp.stanford.edu/IR-book/)
2. Chakrabarti, S., "Mining the Web", Morgan Kaufmann (An Imprint of Elsevier) 2005.
3. B. Liu , "Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data ", Springer, Second Edition, 2011
4. C.J. Rijsbergen, "Information Retrieval", (http://www.dcs.gla.ac.uk/Keith/Preface.html)

Department of Computer Engineering

Program Elective II
Advanced Wireless and Mobile Network (CSPA11184B)

Teaching Scheme
Credits : 3
Lectures : 3 Hrs/week

Examination Scheme
Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Prerequisites
- Computer Networks

Course Objectives
- To be familiar with the wireless/mobile market and the future needs and challenges.
- To be familiar with key concepts of wireless networks, standards, technologies and their basic operations
- To learn how to design and analyze various medium access
- To learn how to evaluate MAC and network protocols using network simulation software tools.
- To be familiar with the wireless/mobile market and the future needs and challenges.

Course Outcomes
After completion of the course, students will be able to
1. Demonstrate advanced knowledge of networking and wireless networking
2. Understand various types of wireless networks, standards, operations and use cases
3. Design WLAN, WPAN, WWAN, Cellular based upon underlying propagation and performance analysis
4. Demonstrate knowledge of protocols used in wireless networks and learn simulating wireless networks
5. Design wireless networks exploring trade-offs between wire line and wireless links
6. Develop mobile applications to solve some of the real world problems

Unit I	**Introduction**

Wireless Networking Trends, Key Wireless Physical Layer Concepts, Multiple Access Technologies - CDMA, FDMA, TDMA, Spread Spectrum technologies, Frequency reuse, Radio Propagation and Modelling, Challenges in Mobile Computing: Resource poorness, Bandwidth, energy etc.

Wireless Local Area Networks:

IEEE 802.11 Wireless LANs Physical & MAC layer, 802.11 MAC Modes (DCF& PCF) IEEE 802.11 standards, Architecture & protocols, Infrastructure vs. Adhoc Modes, Hidden Node & Exposed Terminal Problem, Problems, Fading Effects in Indoor and outdoor WLANs, WLAN Deployment issues

Unit II	**Wireless Cellular Networks**

1G and 2G, 2.5G, 3G, and 4G, Mobile IPv4, Mobile IPv6, TCP over Wireless Networks, Cellular architecture, Frequency reuse, Channel assignment strategies, Handoff strategies, Interference and system capacity, Improving coverage and capacity in cellular systems, Spread spectrum Technologies.

Unit III	**Wireless Sensor Networks**

WiMAX (Physical layer, Media access control, Mobility and Networking), IEEE802.22, Wireless Regional Area Networks, IEEE 802.21 Media Independent Handover, Overview

Wireless Sensor Networks : Introduction, Application, Physical, MAC layer and Network Layer,

Power Management, Tiny OS Overview.	
Unit IV	**Wireless PANs**
Bluetooth AND Zigbee, Introduction to Wireless Sensors,.	
Unit V	**Security**
Security in wireless Networks Vulnerabilities, Security techniques, Wi-FiSecurity, DoS in wireless communication.	
Unit VI	**Advanced Topics**
IEEE 802.11x and IEEE 802.11i standards, Introduction to Vehicular Adhoc Networks	

Reference Books

1. Schiller J., "Mobile Communications", Addison Wesley 2000
2. Stallings W., "Wireless Communications and Networks", Pearson Education 2005
3. Stojmenic Ivan, "Handbook of Wireless Networks and Mobile Computing", John Wiley and SonsInc 2002
4. Yi Bing Lin and Imrich Chlamtac," Wireless and Mobile Network Architectures", John Wiley and Sons Inc 2000
5. Pandya Raj, "Mobile and Personal Communications Systems and Services", PHI 200

Department of Computer Engineering

Program Elective II
Web Analytics and Development (CSPA11184C)

Teaching Scheme
Credits : 3
Lectures : 3 Hrs/week

Examination Scheme
Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Prerequisites
- Statistics
- Networking

Course Objectives
- To explore use of social network analysis
- To understand growing connectivity and complexity in the world ranging from small groups to WWW

Course Outcomes
After completion of the course, student will be able to
1. Become familiar with core research communities, publications, focused on web and social media analytics and research questions engaged in it
2. Recognize the role of web analytics within the digital marketing landscape
3. Identify, define and interpret commonly used web metrics
4. Understand and discuss clickstream data collection techniques, their impact on metrics, and their inherent limitations
5. Gain a practical understanding of common monitoring or analysis tasks and techniques used in web analytics
6. Effectively use the resulting insights to support website design decisions, campaign optimization, search analytics, etc

Unit I	**Introduction**
Social network and Web data and methods, Graph and Matrices, Basic measures for individuals and networks, Information Visualization, The Bold New World of Web Analytics	
Unit II	**Web Analytics Tools**
Click Stream Analysis, A/B testing, Online Surveys, Study of Google Analytics, Spring Metrics, Woopra, Clicky, Mint, Chartbeat, Kissmetrics, User Testing, Mouseflow, Crazy Egg	
Unit III	**Web Search and Retrieval**
Search Engine Optimization, Web Crawling and indexing, Ranking Algorithms, Web traffic models	
Unit IV	**Making Connection**
Link Analysis, Random Graphs and Network evolution, Social, Connects: Affiliation and identity, Connection Search, Collapse, Robustness Social involvements and diffusion of innovation, study of Web Analytics Connector	
Unit V	**Advanced Topics**
Understand advertising using analytics, Web-based Analytics and software product, Affiliate, Internet, and Referral marketing	
Unit VI	**Recent Trends**

Study of Artificial Intelligence, Virtual Reality, Internet of Things (IoT), Static Websites for Online Content, Cinemagraphs to Gain Popularity, Modular Designs for Web Development

Reference Books

1. Hansen, Derek, Ben Sheiderman, Marc Smith. "Analyzing Social Media Networks with NodeXL: Insights from a Connected World". Morgan Kaufmann, 304, 2011
2. Avinash Kaushik, "Web Analytics 2.0: The Art of Online Accountability", 2009.
3. Easley, D. & Kleinberg, J. Networks, "Crowds, and Markets: Reasoning About a Highly Connected World", New York: Cambridge University Press, 2010.
4. http://www.cs.cornell.edu/home/kleinber/networks-book/

Department of Computer Engineering

Laboratory I (CSPA11185)

Teaching Scheme
Credits : 2
Practical : 4 Hrs/week
Oral : 50 marks

Examination Scheme
Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Course Objectives

- To develop the understanding of the 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
- To Introduce the basic concepts of operating system
- To learn about various design techniques

Course Outcomes

After completion of the course, student will be able to

1. Understand the basic notions of discrete and continuous probability
2. Understand the methods of statistical inference, and the role that sampling distributions play in those methods.
3. Perform correct and meaningful statistical analyses of simple to moderate complexity
4. Explain the functions, structures and history of operating systems design
5. Give details about the design issues associated with operating systems
6. Master various process management concepts including scheduling, synchronization, deadlocks

General Instructions

- Design and implementation should be done using latest 64-bit C++/JAVA/ Python/QT 5.1 and above, Cuda C++ or such latest 64-bit programming tools.
- Development Tools such as MATLAB/OPENCV/OPENMP/NS3 or equivalent may be used if required to interface the developed classes to the simulators.
- Student can refer UCI datasets/Routers data sets or other benchmark datasets to implement the assignments, whenever is required.

List of Experiments

A. Mathematical Foundation of Computer Science

1. The data set is a data frame with three columns, time, duration and size, which give the duration in seconds and size in bytes of internet downloads at given times at a University. Compute
   a) the minimum, the maximum, and the quartiles for the duration and size of the downloads. Plot duration against size and log-duration against log-size
   b) Compute a 95% confidence interval for the mean of the log size of the down-loads.
   c) Break the data into two groups according to whether the time of observation is smaller or larger than 972500. Use the t-test to compare the means of the log size for the two groups. Does it make a difference in the comparison above whether we assume equal variances in the two groups or not.

2. Contrary to the popular expectation, try calculating the probability of getting 50 heads and 50 tails on 100 flips of fair coins? This expectation is known as the gambler's fallacy! An

approximate answer would suffice!

3. Generate 100 samples from Student's t distribution with 4 degrees of freedom and generate the qqplot for this sample. Generate another sample of same size, but now from at distribution with 30 degrees of freedom and generate the q-q plot. Do you see any difference ?

B. Operating System Design

1. Write a program to implement semaphore for IPC.
2. Write a program to implement sleeping-barber problem.
3. Write a program to implement page table management.
4. Write a program to implement Network operating system in lab.

Department of Computer Engineering

Laboratory II (CSPA11186)

Teaching Scheme
Credits : 2
Practical : 4 Hrs/week
Oral : 50 Marks

Examination Scheme
Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Course Objectives

- To identify research component in various fields of Program Elective I and II courses
- To study recent trends by implementing some task under various fields of Program Elective I and II courses

Course Outcomes

After Completion of the course, students will be able to

1. Formulate machine learning problems corresponding to different applications
2. Read data from databases and clean the data for statistical analysis
3. Study security issues in internet protocols
4. Understand the difficulty of representing and retrieving documents
5. Demonstrate advanced knowledge of networking and wireless networking
6. Become familiar with core research communities, publications, focused on web and social media analytics and research questions engaged in it

General Instructions

- Design and implementation should be done using latest 64-bit C++/JAVA/ Python/QT 5.1 and above, Cuda C++ or such latest 64-bit programming tools.
- Development Tools such as MATLAB/OPENCV/OPENMP/NS3 or equivalent may be used if required to interface the developed classes to the simulators.
- Student can refer UCI datasets/Routers data sets or other benchmark datasets to implement the assignments, whenever is required.

List of Experiments

Student Should Perform assignments based on Program Elective I and Program Elective II

1. Related to supervised learning methods implement Classification algorithm based on IEEE Transactions/ACM Elsevier/Springer or other reputed conference papers(IIT conferences etc) published in the recent 5 year. Compare and Analyze your result using standard Data mining tool like Weka/MOA/R etc.
2. Related to unsupervised learning methods implement clustering algorithm based on IEEE Transactions/ACM Elsevier/Springer or other reputed conference papers(IIT conferences etc) published in the recent year. Compare and Analyze your result using standard Data mining tool like Weka/MOA/R etc.
3. Design and implement system based on Adaptive and Incremental Machine Learning for sample application.
4. Implement Reinforcement learning for game play.
5. Estimate the precision, recall, accuracy, and F-measure on the text classification task using any classifier for each of the 10 categories using 10-fold cross-validation. Consider standard data set for text classification.
6. Study and implement two journal (IEEE Transactions/ACM /Elsevier/Springer) paper published in the current year based on Data Preprocessing and Analysis domain.

7. Study and implement two journal (IEEE Transactions/ACM /Elsevier/Springer) paper published in the current year based on System Security domain
8. Perform text preprocessing with creation of inverted index for unstructured text.
9. Implement Recommender system for online shopping
10. Study and implement opinion mining / sentiment analysis for sample application
11. Study and implement one journal (IEEE Transactions/ACM /Elsevier/Springer) paper published in the current year based on Information Retrieval and WEB Mining domain
12. Study and implement two journal (IEEE Transactions/ACM /Elsevier/Springer) paper published in the current year based on Advanced Wireless & Mobile Network domain
13. Study and implement two journal (IEEE Transactions/ACM /Elsevier/Springer) paper published in the current year based on Web Analytics and Development domain

Department of Computer Engineering

Research Methodology & IPR (CSPA11187)

Teaching Scheme
Credits : 2
Lectures : 2 Hrs/week

Examination Scheme
Formative Assessment : 50 Marks
Summative Assessment : NA

Prerequisites
- Basic Statistics

Course Objectives
- Develop understanding of the basic framework of research process.
- Formulate the problem statement and prepare research plan for the problem under investigation.
- Apply various numerical /quantitative techniques for data analysis.
- Get introduced to the concept of Intellectual property rights

Course Outcomes
After Completion of the course, students will be able to
1. Define research and formulate a research problem
2. Critically analyze published research
3. Discuss and apply preliminary data analysis techniques.
4. Write a research proposal to a suitable funding agency .
5. Define concept of Intellectual property rights.
6. Understand the issues of IPR

Unit I	**Introduction to Research and Research Problem**

Meaning of research, types of research, process of research, Objectives of research, Research and Scientific Method, Sources of research problem, Criteria / Characteristics of a good research problem, formulation of research hypotheses, Qualities of a good Hypothesis, Null Hypothesis & Alternative Hypothesis. Hypothesis Testing -Logic & Importance

Unit II	**Literature Review and Data Collection**

Literature survey- Definition of literature and literature survey, need of literature survey, elements and objectives of literature survey, sources of literature-monographs-patents – web as a source, Critical literature review – Identifying gap areas from literature review and strategies of literature survey, Errors in research

Classification of data, benefits and drawbacks of data, evaluation of data, qualitative methods of data collection, types of data analysis, statistics in research- measure of central tendency, measure of dispersion, measure of asymmetry, measure of relationship, Sampling, sample size, sample design-concept of probability sampling and non-probability sampling, attitude measurement and scaling, types of measurements

Unit III	**Data Analysis Techniques**

Testing of hypothesis and Goodness of Fit: Definition of null and alternative hypothesis, students 't' distribution, Chi-square distribution, F-test, analysis of variance techniques, introduction to non-parametric tests. Validity and reliability, Approaches to qualitative and quantitative data analysis.

Correlation and regression analysis, Introduction to factor analysis, discriminant analysis, cluster analysis, multidimensional scaling, Descriptive statistics, inferential statistics, Multidimensional

measurement and factor analysis.	
Unit IV	**Introduction to IPR and Intellectual Property Issues**
Nature of Intellectual Property: Patents, Designs, Trademarks and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development, patenting under PCT, patent license, patentable and non-patentable inventions Domain names and related issues, Copyright in digital media, Recent Developments in IPR	

Reference Books

1. Dr. C. R. Kothari, "Research Methodology: Methods and Trend", New Age International Publishers.
2. Deepak Chawla and Neena Sondhi, "Research Methodology**:** concepts and cases", Vikas Publishing House Pvt.Ltd. (ISBN 978-81-259-5205-3)
3. John Best and James Kahn, "Research in Education", Prentice Hall of India Pvt. Ltd
4. Prabuddha Ganguly, " Intellectual Property Rights",TataMc-Graw Hill.
5. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007

Department of Computer Engineering

Data Sciences (CSPA12181)

Teaching Scheme
Credits : 3
Lectures : 3 Hrs/week

Examination Scheme
Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Prerequisites
- Databases

Course Objectives
- To provide the knowledge and expertise to become a proficient data scientist
- To demonstrate an understanding of statistics and machine learning concepts that are vital for data science
- To critically evaluate data visualizations based on their design and use for communicating stories from data
- To produce code to statistically analyze a dataset using tools like Python and R

Course Outcomes
After Completion of the course, students will be able to
1. Describe the Data Science Process and how its components interact
2. Apply basic machine learning algorithms (Linear Regression, k-Nearest Neighbors (k-NN), k-means, Naive Bayes) for predictive modeling
3. Build their own recommendation system using existing components
4. Identify common approaches used for Feature Generation and Selection
5. Use the tools and technology like Hadoop, Python and R
6. Create effective visualization of given data

Unit I	**Introduction: What Is Data Science?**

Big Data: Overview, Data Structures, Analyst Perspective on Data Repositories, BI Versus Data Science , Current Analytical Architecture. Drivers of Big Data, Examples of Big Data Analytics
Data Analytics Lifecycle: Discovery, Data Preparation, Data Preparation, Model Planning, Model Building, Communicate Results, Operationalize
Statistical Inference: Populations and Samples, Populations and Samples of Big Data, Modeling, Exploratory Data Analysis, Philosophy of Exploratory Data Analysis, The Data Science Process, A Data Scientist's Role

Unit II	**Analytical Theory and Methods**

Linear Regression, k-Nearest Neighbors (k-NN), k-means, Apriori algorithm, Spam Filters, Naive Bayes, and Wrangling, Logistic Regression, Decision Trees.

Unit III	**Extracting meaning from Data**

The Kaggle model, feature selection for better data science (case study)
Recommendation Engine: Nearest Neighbor Algorithm Review, The Dimensionality Problem, Singular Value Decomposition (SVD), Principal Component Analysis (PCA), Alternating Least Squares
Time Stamps and Financial Modeling : Timestamps, Financial Modeling, In-Sample, Out-of-Sample, and Causality, Preparing Financial Data, Log Returns, Case study.

Unit IV:	**Mining and Analyzing Data**

Mining Social-Network Graphs: Social networks as graphs, Clustering of graphs, Direct discovery of communities in graphs, Partitioning of graphs, Neighborhood properties in graphs Case Study: Google's

Hybrid Approach to Social Research **Time Series Analysis**: Overview, Box-Jenkins Methodology, ARIMA Model. **Text Analysis:** Steps , Collecting Raw Text , Representing Text, Term Frequency—Inverse Document Frequency (TFIDF) , Categorizing Documents by Topics , Determining Sentiments , Gaining Insights	
Unit V	**Technology and Tools**
Analytics for Unstructured Data , MapReduce , Apache Hadoop **The Hadoop Ecosystem**: Pig, Hive, HBase, Mahout. **SQL Essentials:** Joins, Set Operations, Grouping Extensions, In-Database Text Analysis **Advanced SQL :** Window Functions, User-Defined Functions and Aggregates, Ordered Aggregates MADlib NoSQL , Data Lakes	
Unit VI	**Data Visualization and Representation**
Basic principles, ideas and tools for data visualization, Visualization of Numerical Data, Visualization of Non-Numerical Data, The Visualization Dashboard Data Science and Ethical Issues : Discussions on privacy, security, ethics	

Reference Books

1. Cathy O'Neil and Rachel Schutt. "Doing Data Science, Straight Talk From The Frontline", O'Reilly.
2. Author Edition, "Data Science & Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", EMC Education Services, Wiley, India
3. U Dinesh Kumar, "Business Analytics", Wiley
4. Kevin Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012

Department of Computer Engineering

Cyber Physical System (CSPA12182)

Teaching Scheme
Credits : 3
Lectures : 3 Hrs/week

Examination Scheme
Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Prerequisites

- Principles of Imperative Computation
- Integration, Differential Equations, and Approximation

Course Objectives

- To learn IoT concepts and technologies
- To Understand IoT Market perspective
- To Understand State of the Art – IoT Architecture
- To study IoT protocol stacks and Real World IoT Design Constraints

Course Outcomes

After completion of the course, students will be able to

1. Understand the core principles behind CPSs and develop models and controls
2. Identify safety specifications and critical properties of CPSs
3. Understand abstraction and system architectures and learn how to design by invariant
4. Reason rigorously about CPS models and verify CPS models of appropriate scale
5. Understand the semantics of a CPS model
6. Develop an intuition for operational effects

Unit I	**Introduction**

The IoT Paradigm, smart objects, bits and atoms, IoT value chains, An IoT architecture outline. What is the IoT and why is it important? Elements of an IoT ecosystem. Technology drivers. Business drivers, Typical IoT applications. Trends and implications.

Unit II	**IoT Technologies**

Technologies behind the IoT, RFID + NFC, Wireless networks + WSN, RTLS + GPS, Agents and multiagent systems. Wireless technologies for IoT. Edge connectivity and protocols. Zigbee

Unit III	**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 is popular again, Data representation and visualization, Interaction and remote control. 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

Unit IV	**Internet of Things Privacy, Security and Governance**

Introduction, Overview of Governance, Privacy and Security Issues, Contribution from FP7 Projects, Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smartie Approach. Data Aggregation for the IoT in Smart Cities, Security

Unit V	**Identity Management Models in IoT**

Introduction, Vulnerabilities of IoT, Security requirements, Challenges for a secure Internet of Things, identity management, Identity portrayal, Different identity management model: Local identity, Network identity, Federated identity, Global web identity, Identity management in Internet of Things, User-centric identity management, Device-centric identity management, Hybrid identity management.	
Unit VI	**Trust Management in IoT**
Introduction, Trust management life cycle, Identity and trust, Third party approach, Public key infrastructure, Attribute certificates, Web of trust models, Web services security, SAML approach, Fuzzy approach for Trust, Access control in IoT, Different access control schemes, Authentication and Access control policies modeling.	

Reference Books

1. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.
2. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT, 2014.
3. J. Biron and J. Follett, "Foundational Elements of an IoT Solution", O'Reilly Media, 2016.
4. Keysight Technologies, "The Internet of Things: Enabling Technologies and Solutions for Design and Test", Application Note, 2016.

Department of Computer Engineering

Program Elective – III
Soft Computing (CSPA12183A)

Teaching Scheme
Credits : 3
Lectures : 3 Hrs/week

Examination Scheme
Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Prerequisites

- None

Course Objectives

- To design and develop intelligent systems in the framework of soft computing.
- To acquire knowledge of scientific application-driven environments.
- To apply concepts of machine learning in the intelligent system in order get complete automated system.

Course Outcomes

After completion of the course, students will be able to

1. Understand importance of soft computing
2. Know about the basics of soft computing techniques and also their use in some real life situations.
3. Solve the problems using neural networks techniques.
4. Find the solution using different fuzzy logic techniques.
5. Use the genetic algorithms for different modelling.
6. Implement the algorithms of soft computing

Unit I	**Soft Computing Basics**

Introduction, soft computing vs. hard computing, various types of soft computing techniques, applications of soft computing. Introduction: Neural networks, application scope of neural networks, fuzzy logic, genetic algorithm, machine learning.

Unit II	**Neural Networks**

Neuron, Nerve structure and synapse, Artificial Neuron and its model, activation functions, Neural network architecture: single layer and multilayer feed forward networks, recurrent networks. Various learning techniques; perception and convergence rule, Auto associative and hetro-associative memory, perceptron model, single layer artificial neural network, multilayer perception model; back propagation learning methods, effect of learning rule co-efficient; back propagation algorithm, factors affecting back propagation training, applications.

Unit III	**Fuzzy Logic**

Basic concepts of fuzzy logic, Fuzzy sets and Crisp sets, Fuzzy set theory and operations, Properties of fuzzy sets, Fuzzy and Crisp relations, Fuzzy to Crisp conversion. Membership functions, interference in fuzzy logic, fuzzy if-then rules, Fuzzy implications and Fuzzy algorithms, Fuzzyfications & Defuzzifications, Fuzzy Controller, Fuzzy rule base and approximate reasoning: truth values and tables in fuzzy logic, fuzzy propositions formation of rules ,decomposition of compound rules, aggregation of fuzzy rules, fuzzy reasoning, fuzzy inference system, fuzzy expert systems

Unit IV	**Genetic Algorithm**

Basic concepts, working principle, procedures of GA, flow chart of GA, Genetic representations, (encoding) Initialization and selection, Genetic operators, Mutation, Generational Cycle, Traditional algorithm Vs genetic algorithm, simple GA, general genetic algorithm, schema theorem, Classification of genetic algorithm, Holland classifier systems, genetic programming, applications of genetic algorithm, Convergence of GA, Applications & advances in GA, Differences & similarities between GA & other traditional method, applications.	
Unit V	**Machine Learning**
Learning form Examples - Inductive Concept Learning - Sequence Prediction - Effect of Noise in Input. Learning by Analogy- Concept formation - Derivational Analogy. Learning by Observation and Discovery - Search for Regularity- Conceptual Clustering, Computational Learning Theory	
Unit VI	**Applications of Computational Intelligence**
Shortest Path Algorithm, Printed Character Recognition – Inverse Kinematics Problems – Automobile Fuel Efficiency Prediction – Soft Computing for Color Recipe Prediction, Stock Marker Forecasting	

Reference Books

1. S. Rajsekaran & G.A. Vijaya Lakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications", Prentice Hall of India.
2. N.P.Padhy,"Artificial Intelligence and Intelligent Systems", Oxford University Press.
3. J S R Jang, CT Sun and E. Mizutani , "Neuro-Fuzzy and Soft Computing", PHI PVT LTD.
4. Sivandudam and Deepa, "Principles of soft computing", John Mikey India.

Department of Computer Engineering

Program Elective III
Big Data Analytics (CSPA12183B)

Teaching Scheme
Credits : 3
Lectures : 3 Hrs/week

Examination Scheme
Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Prerequisites

- Knowledge of Probability Theory, Statistics and Programming

Course Objectives

- To understand big data for business intelligence.
- To learn business case studies for big data analytics.
- To understand NoSQL big data management.
- To perform map-reduce analytics using Hadoop and related tools

Course Outcomes

After completion of the course, students will be able to

1. Describe big data and use cases from selected business domains
2. Explain NoSQL big data management
3. Install, configure, and run Hadoop and HDFS
4. Perform map-reduce analytics using Hadoop
5. Use Hadoop related tools such as HBase, Cassandra, Pig, and Hive for big data analytics
6. Write case studies in Business Analytic and intelligence

Unit I	**Introduction**

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 trans firewall analytics.

Unit II	**NoSQL**

Introduction to NoSQL, aggregate data models, aggregates, key-value and document data models, relationships, graph databases, schema less 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 III	**Data Formats**

Data format, analysing 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 IV	**MapReduce Workflows**

MapReduce workflows, unit tests with MR Unit, 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 V	**Hbase**

Hbase, data model and implementations, Hbase clients, Hbase examples, praxis. Cassandra, Cassandra data model, Cassandra examples, Cassandra clients, Hadoop integration.	
Unit VI	**Advanced Topics**
Pig, Grunt, pig data model, Pig Latin, developing and testing Pig Latin scripts. Hive, data types and file formats, HiveQL data definition, HiveQL data manipulation, HiveQL queries.	

Reference Books

1. Michael Minelli, Michelle Chambers, and Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic", Wiley CIO Series
2. Michele Chambers, Ambiga Dhiraj Michael Minelli , "Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013
3. P. J. Sadalage and M. Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", Addison-Wesley Professional, 2012
4. Tom White, "Hadoop: The Definitive Guide", Third Edition, O'Reilley, 2012.

Department of Computer Engineering

Program Elective III
Usability Engineering (CSPA12183C)

Teaching Scheme
Credits : 3
Lectures : 3 Hrs/week

Examination Scheme
Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Prerequisites

- Human Computer Interface

Course Objectives

- To describe the human centered design process and usability engineering process and their roles in system design and development.
- To discuss usability design guidelines, their foundations, assumptions, advantages, and weaknesses.
- To describe basics of human subjects research and complete a basic human subjects research certification form.
- To design a user interface based on analysis of human needs and prepare a prototype system.
- To assess user interfaces using different usability engineering techniques.

Course Outcomes

After completion of the course, students will be able to

1. Define and distinguish between the different types of user interface,
2. Exploit cognitive and social factors that make interactive software usable
3. Apply key design principles and guidelines that assist user interface designers
4. Understand the limitations of guidelines
5. Apply techniques of Usability Engineering across the development lifecycle
6. Develop a sound usability test and evaluation plan for a particular design project

Unit I	**Introduction to Human-Computer Interaction as an emerging field**
Disciplines contributing to HCI, Human Information Processing Psychology of everyday things, Importance of human factors in design – cultural , emotional , technological, business, Need Satisfaction curve of technology, Levels of human computer interaction	
Unit II	**Foundations of User Interface Design (U.I.D)**
Goals of UID, Goal directed Design, User Interface Models, Understanding and Conceptualizing Interface, Psychology of users designing for collaboration and communication, Process of Interaction Design, Standards & Guidelines, Usability Testing, GIU,	
Unit III	**Human Factors**
The importance of User Interface – UI and Software Designer – Goals of UI design – Motivations for human factors in Design – Understanding user needs and requirements	
Unit IV	**Models**
Theories – Different models - Object - Action Interface Model - Principles for Design – Data display and entry guidelines. Case Study to be taken with latest application	
Unit V	**Design Process**
User Interface Design Process – Classes of UI design – Principles of good design – Evaluating design using the principles – Choice of color – Task oriented approach for UI - Case study.	

GUI design process - Design of icons – Use of metaphors – GUI style guides and toolkits – Portability – GUI design and object oriented approach – Case study.	
Unit VI	**Usability**
The viewpoint of user, customer and designer –Usability specification – Description of stages in usability specification and evaluation. Case Study to be taken with latest application, Information Related: Information Search and Visualization – Hypermedia and WWW. HCI Standards: ECMA – ISO – BSI guide.	

Reference Books

1. Linda Mcaulay, "HCI for Software Designers", International Thompson Computer Press, USA,1998.
2. Ben Schneiderman, "Designing the User Interface", Pearson Education, New Delhi,2005.
3. Alan Cooper, "The Essentials of User Interface Design", IDG Books, New Delhi,1995.
4. Jacob Nielsen, "Usability Engineering", Academic Press, 1993.

Department of Computer Engineering

Program Elective IV
Social Media Analysis (CSPA12184A)

Teaching Scheme
Credits : 3
Lectures : 3 Hrs/week

Examination Scheme
Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Prerequisites
- Databases
- Statistics

Course Objectives
- To understand social network and its usage
- To model and visualize the social network
- To mine users interest in the social network

Course Outcomes
After completion of the course, students will be able to
1. Understand the interest of user based on his usage in social media
2. Understand the model and methods of Social networking
3. Predict the possible next outcome of the social network
4. Assess social networking opportunities for marketing
5. Understand the link between qualitative and quantitative methods of social network analysis
6. Understand how social technologies impact society and vice versa

Unit I	**Introduction**
Introduction to Web ,Emergence of the Social Web – Statistical Properties of Social Networks - Network analysis - Development of Social Network Analysis - Key concepts and measures in network analysis - Discussion networks - Blogs and online communities ,Web-based networks	
Unit II	**Graphs and Network relation**
Introduction to networks and relations. Introduction to graph .graph representations, analyzing relationships to understand people and groups, binary and valued relationships, symmetric and asymmetric relationships, multimode relationships, Using graph theory for social networks analysis adjacency matrices, edge lists, adjacency lists, graph traversals and distances, depth first traversal, breadth first traversal paths and walks, Dijkstra's algorithm, graph distance and graph diameter, social networks vs. link analysis, ego centric and socio centric density	
Unit III	**Methods and Models**
core methods: The Kernighan-Lin(KL) algorithm, Agglomerative/Divisive Algorithms, Spectral Algorithms, Emerging trends: Community Discovery in Dynamic Networks, Community Discovery in heterogeneous Network	
Unit IV	**Applications and emerging trends**
social media networking applications – Accessing applications hosted in a cloud computing, Case study of social networking sites (like Twitter, Facebook, Blog data) analysis ,Behavior Analytics Individual behavior, collective behavior	
Unit V	**Text and opinion mining**
Text Mining in Social Networks -Opinion extraction – Sentiment classification and clustering - Temporal sentiment analysis - Irony detection in opinion mining - Wish analysis - Product review mining – Review Classification – Tracking sentiments towards topics over time	

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Unit VI	**Emerging Fields and Problems**
Community Discovery in Dynamic Networks , Community Discovery in Heterogeneous Networks , Community Discovery in Directed Networks , Coupling Content and Relationship Information for Community Discovery, Content delivery network features and types	

Reference Books

1. Charu Agarwal, "Social Network Data Analytics",Springer, 11 edition
2. Reza Zafarani, Mohammad Ali Abbasi, and Huan Liu, "Social Media Mining: An Introduction", Cambridge University Press, 2014.
3. Maksim Tsvetovat Alexnder Kouznetsov, "Social Network Analysis for Startups Finding connections on the social web", O'Reilly Media, 2011.
4. John Scott . "Social Network Analysis", 3rd edition, SAGE Publications, 2012

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Program Elective IV
Wireless Access Technologies (CSPA12184B)

Teaching Scheme
Credits : 3
Lectures : 3 Hrs/week

Examination Scheme
Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Prerequisites
- Wireless Networks

Course Objectives
- To overview of wireless access technologies, Fixed wireless access networks. Terminal mobility issues regarding wireless access to Internet
- To introduce 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 network planning, design and installation.
- To get and insight of Wireless networking security issues, Wireless access network exploitation and management, software requirements, link quality control.

Course Outcomes
After completion of the course, students will be able to
1. Interpret basic terms and characteristics of wireless access networks
2. Compare various wireless access technologies
3. Analyse measurements of wireless access network parameter
4. Apply system thinking to understand the wireless network evolution, requirements, standardization, architecture, air-interface, protocols, procedures, performance and security
5. Assess security issues in wireless networks
6. Choose modulation technique for wireless transmission

Unit I	**Introduction**
Necessity for wireless terminals connectivity and networking. Wireless networking advantages and disadvantages, Overview of wireless access technologies. Narrowband and broadband networks, fixed and nomadic networks. Wireless local loop (WLL), Public Switched Telephone Network(PSTN) interfaces.	
Unit II	**Fixed Wireless Access (FWA) Networks**
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).	
Unit III	**Standards**
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.	
Unit IV	**Wireless Access Networks Planning**
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.	
Unit V	**Example**
Example of laptop or handheld PC wireless connection in real 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 VI	**Recent Trends**
Recent trends in wireless networking and various access mechanism, new standards of wireless communication.	

Reference Books

1. Martin P. Clark, "Wireless Access Networks: Fixed Wireless Access and WLL networks – Design and Operation", John Wiley & Sons
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 Broad band Services", IEEE Press, Piscataway

Department of Computer Engineering

Program Elective IV
Optimization Techniques (CSPA12184C)

Teaching Scheme
Credits : 3
Lectures : 3 Hrs/week

Examination Scheme
Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Prerequisites
- Linear Algebra and Numerical Methods

Course Objectives
- To provide insight to the mathematical formulation of real world problems.
- To optimize these mathematical problems using nature based algorithms. And the solution is useful specially for NP-Hard problems.

Course Outcomes
After completion of the course, students will be able to
1. Formulate optimization problems.
2. Understand and apply the concept of optimality criteria for various types of optimization problems.
3. Solve various constrained and unconstrained problems in Single variable as well as multivariable.
4. Apply the methods of optimization in real life situation.
5. Feasibility study for solving an optimization problem
6. Investigate, study, develop, organize and promote innovative solutions for various applications

Unit I	**Engineering application of Optimization**
Engineering application of Optimization, Formulation of design problems as mathematical programming problems.	
Unit II	**General Structure**
General Structure of Optimization Algorithms, Constraints, The Feasible Region.	
Unit III	**Branches of Mathematical Programming: Optimization**
Branches of Mathematical Programming: Optimization using calculus, Graphical Optimization, Linear Programming, Quadratic Programming, Integer Programming, Semi Definite Programming.	
Unit IV	**Optimization Algorithms**
Optimization Algorithms like Genetic Optimization, Particle Swarm Optimization, Ant Colony Optimization etc.	
Unit V	**Real life Problems**
Real life Problems and their mathematical formulation as standard programming problems.	
Unit VI	**Recent trends**
Applications of ant colony optimization, genetics and linear and quadratic programming in real world applications.	

Reference Books

1. Laurence A. Wolsey (1998). "Integer programming", Wiley. ISBN 978-0-471-28366-9.
2. Andreas Antoniou , "Practical Optimization Algorithms and Engineering Applications".
3. An Introduction to Optimization Edwin K., P. Chong & Stanislaw h. Zak.
4. Dimitris Bertsimas; Robert Weismantel (2005), " Optimization Over Integers. Dynamic Ideas", ISBN 978-0-9759146-2-5.
5. John K. Karlof (2006), "Integer Programming: Theory And Practice", CRC Press. ISBN 978-0-8493-1914-3.

Department of Computer Engineering

Laboratory III (CSPA12185)

Teaching Scheme
Credits : 2
Practical : 4 Hrs/week
Oral : 50 Marks

Examination Scheme
Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Course Objectives

- To critically evaluate data visualizations based on their design and use for communicating stories from data
- To produce code to statistically analyze a dataset using tools like Python and R
- To learn IoT concepts and technologies
- To Understand State of the Art – IoT Architecture
- To study IoT protocol stacks and Real World IoT Design Constraints

Course Outcomes

After Completion of the course, students will be able to

1. Create effective visualization of given data
2. Use the tools and technology like Hadoop, Python and R.
3. Identify common approaches used for Feature Generation and Selection
4. Understand the core principles behind CPSs and develop models and controls
5. Identify safety specifications and critical properties of CPSs
6. Understand abstraction and system architectures and learn how to design by invariant

General Instructions

- Design and implementation should be done using latest 64-bit C++/JAVA/ Python/R/QT 5.1 and above, Cuda C++ or such latest 64-bit programming tools.
- Development Tools such as MATLAB/OPENCV/OPENMP/NS3 or equivalent may be used if required to interface the developed classes to the simulators.
- Student can refer UCI datasets/Routers data sets or other benchmark datasets to implement the assignments, whenever is required.

List of Experiments

A. Data Sciences

1. Design and implement the distributed architecture for the Hadoop or similar recent architecture Prepare architecture diagram and installation document to be used for distributed Application
2. Build a Database for a client server application using NoSQL . Perform various queries on it. (Build ERP/Digital Library/On line shopping /on line Examination or similar kind of system)
3. Using ETL tool (Pentaho or any other similar tool) design a multidimensional data ware house for a hypothetical system. Use Standard datasets to build the DWH system
4. Design and implement a Business Intelligent system based on Big data analytics. Compare and

Analyze your result using standard Data set.

5. Study and implement two journal (IEEE Transactions/ACM /Elsevier/Springer) papers published in the current year based on Data Science domain

B. Cyber Physical System

1. a. Study of Connectivity and configuration of Raspberry-Pi /Beagle board circuit with basic peripherals, LEDS. Understanding GPIO and its use in program.

   b. Understanding the connectivity of Raspberry-Pi /Beagle board circuit with temperature sensor. Write an application to read the environment temperature. If temperature crosses a threshold value, the application indicated user using LEDSs

2. Study of different CPU frequency governors. Write an application to change CPU frequency of Raspberry-Pi /Beagle board

3. Write an application using Raspberry-Pi /Beagle board to control the operation of stepper motor.

4. Write an application using Raspberry-Pi /Beagle board to control the operation of a hardware simulated traffic signal.

5. Write an application using Raspberry-Pi /Beagle board to control the operation of a hardware simulated lift elevator

6. Study and implement one journal (IEEE Transactions/ACM /Elsevier/Springer) papers published in the current year based on Cyber Physical Systemdomain

Department of Computer Engineering

Laboratory IV (CSPA12186)

Teaching Scheme
Credits : 2
Practical : 4 Hrs/week
Oral : 50 Marks

Examination Scheme
Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Course Objectives

- To identify research component in various fields of Program Elective III and IV courses
- To study recent trends by implementing some task under various fields of Program Elective III and IV courses

Course Outcomes

After completion of the course, students will be able to

1. Implement the algorithms of soft computing
2. Use Hadoop related tools such as HBase, Cassandra, Pig, and Hive for big data analytics.
3. Apply key design principles and guidelines that assist user interface designers
4. Understand the model and methods of Social networking
5. Compare various wireless access technologies
6. Understand and apply the concept of optimality criteria for various types of optimization problems

General Instructions

- Design and implementation should be done using latest 64-bit C++/JAVA/ Python/R/QT 5.1 and above, Cuda C++ or such latest 64-bit programming tools.
- Development Tools such as MATLAB/OPENCV/OPENMP/NS3 or equivalent may be used if required to interface the developed classes to the simulators.
- Student can refer UCI datasets/Routers data sets or other benchmark datasets to implement the assignments, whenever is required.

List of Experiments

Student Should Perform assignments based on Program Elective III and Program Elective IV from the following list

1. Create a Blog or website for any suitable application
2. Study Social media data discovery techniques using Netlytic (https://netlytic.org) analyze various generated graphs and reports
3. Use Publically available social media data from Twitter, Facebook, Instagram or Youtube. Extract , preprocess and apply Machine learning approach to identify various patterns of the data
4. Study and implement two journal (IEEE Transactions/ACM /Elsevier/Springer) papers published in the current year based on Soft Computingdomain
5. Study and implement two journal (IEEE Transactions/ACM /Elsevier/Springer) papers published in the current year based on Big Data Analyticsdomain
6. Study and implement two journal (IEEE Transactions/ACM /Elsevier/Springer) papers published in the current year based on Usability Engineeringdomain
7. Study and implement two journal (IEEE Transactions/ACM /Elsevier/Springer) papers published in the current year based on Social Media Analysis domain
8. Study and implement two journal (IEEE Transactions/ACM /Elsevier/Springer) papers published in the current year based on Wireless Access Technologies domain

9. Study and implement two journal (IEEE Transactions/ACM /Elsevier/Springer) papers published in the current year based on Optimization Techniquesdomain

Department of Computer Engineering

Mini Project (CSPA12187)

Teaching Scheme
Credits : 2
Practical : 4 Hrs/ week
Oral : 50 Marks

Examination Scheme
Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Course Objectives

- To enable the students to apply fundamental knowledge for understanding state of the art information about any topic relevant to curriculum
- To enhance communication skills of the students

Course Outcomes

After completion of the course, students will be able to

1. Demonstrate a solution to the problem selected.
2. Demonstrate an ability to present and defend their research work to a panel of experts

Mini Project shall be on any topic of student's own choice approved by the faculty. The continuous evaluation will be based on the continuous work of the student to achieve set objectives, technical contents of the topic to assess understanding of the student about the same. Students should prepare a power point presentation for its delivery in 15 minutes. The student should submit duly certified spiral bound report having the following contents.

- Introduction
- Literature Survey
- Theoretical contents/fundamental topics
- Relevance to the present national and global scenario (if relevant)
- Merits and Demerits
- Field Applications / case studies / Experimental work / software application / Benefit cost/ feasibility studies
- Conclusions
- References

A. Report shall be typed on A4 size paper with line spacing 1.5 on one side of paper.
Left Margin : - 25 mm
Right Margin : - 25 mm
Top Margin : - 25 mm
Bottom Margin : - 25 mm

B. Size of Letters
Chapter Number: - 12 font size in Capital Bold Letters- Times New Roman
Chapter Name: - 12 Font size in Capital Bold Letters- Times New Roman
Main Titles (1.1, 3.4 etc):- 12 Font size in Bold Letters- Sentence case. Times New Roman
Sub Titles (1.1.4, 2.5.3 etc):- 12 Font size in Bold Letters-Sentence case. Times New Roman
All other matter: - 12 Font size sentence case. Times New Roman

C. No blank sheet be left in the report
D. Figure name: - 12 Font size in sentence case-Below the figure.

E. Table title -12 Font size in sentence case-Above the table.

Continuous Evaluation: Will be monitored by the respective guides.
Summative Assessment: An oral presentation of the mini project will be held at the end of semester .