PONDICHERRY UNIVERSITY
DEPARTMENT OF COMPUTER SCIENCE
REGULATIONS AND SYLLABUS

Master of Technology
(Computer Science and Engineering)

(For CBCS System in Pondicherry University)
(Effective from the academic year 2018-2019)

Eligibility for Admission

Candidates who have secured 55% of marks or above in B.Tech./ B.E. in Computer Science and Engineering/ Information Technology or M.Sc. in Computer Science/Information Technology/ Software Engineering or equivalent or MCA with Bachelor's in Computer Science/ Computer Applications/ Information Technology /Mathematics /Statistics/ Physics/ Electronics/ Applied Sciences are eligible for admission.

Duration of the Course

The course shall be of two years' duration spread over four consecutive semesters. The maximum duration to acquire prescribed number of credits in order to complete the Programme of Study shall be four years.

Medium

The medium of instruction shall be English.

Passing & Classification

Passing & Classification for the award of the M. Tech (Computer Science & Engineering) Degree shall be as per the norms of CBCS System of Pondicherry University.

COURSE STRUCTURE

Category	Course Nomenclature	Number of courses	Credits per course	Total Credits	Remarks
SH	Supportive Hard Core	4	3	12	From CSE programme
H	Hard core- Theory Hard core- Lab	5 5	3 2	15 10	From CSE programme
RS	Restricted Soft core	2	3	6	From other departments like Electronics/BT/Maths/Stat or CS dept.
SS	Specialisation Soft core	3	3	9	Any research stream offered in the CSE/NIS programmes
OS	Open Soft Core	1	3	3	CS Department / Any University Department
	Directed Study	1	3	3	Relevant to research stream chosen
	Project Study Phase	1	4	4	
	Project Work	1	6	6	
	Project Report and Viva Voce	1	4	4	
			Total	**72**	

PONDICHERRY UNIVERSITY
DEPARTMENT OF COMPUTER SCIENCE

Master of Technology
(Computer Science and Engineering)

CURRICULUM
(Effective from the academic year 2018-2019)

Note: All Course Codes are to be preceded with 'CSCE'.
H – Hard Core subject
SH – Supportive Hard Core subject
RS- Restricted Soft core subject
SS- Specialisation Soft core subject
OS-Open Soft core subject

FIRST SEMESTER

S.No	Course Code	Course Title	H/S	L	T	P	S	Credits
1.	CSCE 611	Discrete Mathematics	SH	3	2	0	0	3
2.	CSCE 612	Probability and Statistics	SH	3	2	0	0	3
3.	CSCE 613	Network Configuration and Management	H	3	0	0	2	3
4.	CSCE 614	Advanced Data Structures and Algorithms	H	3	0	0	2	3
5.	CSCE 615	Internet and Web Technologies	H	3	0	0	2	3
6.	CSCE 616	Network Management lab	H	0	0	4	0	2
7.	CSCE 617	Web Technology lab	H	0	0	4	0	2

SECOND SEMESTER

S.No.	Course Code	Course Title	H/S	L	T	P	S	Credits
1.	CSCE 621	Graph theory and its applications	SH	3	2	0	0	3
2.	CSCE 622	Research Methodology	SH	3	2	0	0	3
3.	CSCE 623	Data Mining and Big Data	H	3	0	2	2	3
4.	CSCE 624	Mobile & Pervasive Computing	H	3	0	2	2	3
5.		Elective-1	RS	3	0	0	2	3
6.		Elective-2	SS	3	0	0	2	3
7.	CSCE 627	Data mining lab	H	0	0	4	0	2

8.	CSCE 628	Pervasive computing lab	H	0	0	4	0	2

THIRD SEMESTER

S.No.	Course Code	Course Title	H/S	L	T	P	S	Credits
1.	CSCE 711	Directed Study	H	-	-	-	-	3
2.	CSCE 712	Project Work Phase 1*	H	-	-	-	-	4
3.		Elective-3	RS	3	0	0	2	3
4.		Elective-4	OS	3	0	0	2	3
5.		Elective-5	SS	3	0	0	2	3

FOURTH SEMESTER

S.No.	Course Code	Course Title	H/S	L	T	P	S	Credits
1.		Elective-6	SS	3	0	0	2	3
2.	CSCE 721	Project work Phase 2	H	-	-	-	-	6
3.	CSCE 722	Project report and Viva voce	H	-	-	-	-	6

* In case of failure due to lack of attendance or minimum internal marks, the course has to be repeated in the subsequent semester and only after successful completion, CSCE 721 and CSCE 722could be credited. If failure is due to external marks only, the course can be credited along with CSCE 721 and CSCE 722 .

LIST OF ELECTIVES

Sl.No.	Code	Course Title
Research Stream-1 Data Science		
1	CSCE 811	Big Data Technologies
2	CSCE 812	Statistics for Data Analytics
3	CSCE 813	Multivariate Techniques for Data
4	CSCE 814	Data Mining and Data Analysis
5	CSCE 815	Machine Learning
6	CSCE 816	Deep Learning
Research Stream-2 Software Engineering		
7	CSCE 821	Software Testing
8	CSCE 822	Agile Software Process
9	CSCE 823	Software Risk Management and Maintenance
10	CSCE 824	Software Project Management
11	CSCE 825	Software Architecture
12	CSCE 826	Software Quality Assurance
Research Stream-3 Artificial Intelligence		
13	CSCE 831	Cognitive Science
14	CSCE 832	Knowledge representation and reasoning
15	CSCE 833	Computational Intelligence
16	CSCE 834	Artificial Intelligence for Automation
17	CSCE 835	Natural Language Processing
18	CSCE 836	Introduction to Robotics
Research Stream-4 Human Computer Interface		
19	CSCE 841	Introduction to human computer interaction
20	CSCE 842	Principles of interaction design
21	CSCE 843	Web accessibility
22	CSCE 844	Context aware computing
23	CSCE 845	Data Visualization
24	CSCE 846	Social Computing systems
Research Stream-5 Theoretical Computer Science		
25	CSCE 851	Automata Computability and complexity
26	CSCE 852	Mathematical logic for computer science
27	CSCE 853	Complexity Theory
28	CSCE 854	Computability Theory
29	CSCE 855	Advanced Compiler Design
Research Stream-6 Evolutionary Computing		
30	CSCE 861	Design of modern heuristics
31	CSCE 862	Evolutionary Algorithms
32	CSCE 863	Linear optimization
33	CSCE 864	Nature inspired algorithms
Research Stream-7 Image Processing		
34	CSCE 871	Advances In Computer Graphics
35	CSCE 872	Digital Image Processing
36	CSCE 873	Pattern Recognition
37	CSCE 874	Steganography and Digital Watermarking
38	CSCE 875	Biometric Security
39	CSCE 876	Content Based Information Retrieval

CSCE 611 DISCRETE MATHEMATICS

L	T	P	C
3	2	0	3

Pre-requisite:

- *Knowledge of functions and basic algebra*

Objectives:

- *Introduce the mathematical concepts fundamental to computer science.*
- *To illustrate the applications of mathematical concepts to computer science*

Module-I: Basic Structures: Sets, Functions, Sequences, Sums, and Matrices 6 hrs

Sets – Set Operations – Functions – Sequences and summation – cardinality – Matrices .

Module-II: Number theory 8 hrs

Divisibility and modular arithmetic – Integer representations and algorithms – Prime and GCD – Congruences and applications – cryptography.

Module-III: Induction and Recursion 8 hrs

Mathematical induction – strong induction and well ordering – recursive definition and structural induction – recursive algorithms – program correctness

Module-IV: Counting 8 hrs

Basics – Pigeon hole principle – Permutations and combinations – binomial coefficients - Generalized Permutations and combinations

Module-V: Advanced Counting Techniques 10 hrs

Recurrence relations – solving – applications – Divide and conquer – generating functions – inclusion – exclusion – applications

Text Book:

1. *Kenneth H.Rosen, Discrete Mathematics and its Applications, 2012, Seventh Edition, Jones & Bartlett Learning.*

Reference Books:

1. *Norman L Biggs, Discrete Mathematics, Oxford Press, 2nd Edition, 2002*
2. *Kenneth Bogart and Robert L Drysdale, Discrete Mathematics for Computer Science, Addison-Wesley; 1 edition2010*
3. *Thomas Koshy, Discrete Mathematics with Applications, Academic Press Inc, 2004.*

***Web* resources:**

*1. https://www.geeksforgeeks.org/engineering-mathematics-tutorials/*MOOC

2. NPTEL Course on Discrete Mathematics : https://nptel.ac.in/courses/111107058/#

CSCE 612 PROBABILITY AND STATISTICS

L	T	P	C
3	2	0	3

Pre-requisite:

- *Set Theory and Calculus*

Objectives:

- *To learn and understand random variables that describe randomness or an uncertainty in certain realistic situation.*
- *To understand the types of sampling distributions and transformations*
- *To understand the framing and testing of hypothesis*

Module-I: 10 hrs

Probability: Combinatorial methods- Classical, relative frequency and axiomatic definitions of probability, addition rule and conditional probability, multiplication rule, total probability, Bayes' Theorem and independence, problems.

Random Variables: Discrete, continuous random variables, probability mass function, probability density function and cumulative distribution functions - mathematical expectation, moments, moment generating function, Joint, marginal and conditional distributions, product moments, correlation and regression, independence of random variables, Chebyshev's inequality, problems.

Module-II: 8 hrs

Discrete and Continuous Distributions: Bernoulli, Binomial, Poisson, Geometric, Negative binomial, continuous Uniform, Normal, Exponential, Gamma, Pareto, Beta distributions

Reliability and hazard rate, reliability of series and parallel systems, problems. Function of a random variable, problems.

Module-III: 6 hrs

Sampling Distributions: The Central Limit Theorem, distributions of the sample mean and the sample variance for a normal population, Chi-Square, t and F distributions, problems.

Module-IV: 8 hrs

Estimation: Concepts of Unbiasedness, consistency and sufficiency, Methods of estimation - maximum likelihood estimation, Interval estimation, confidence intervals for mean and variance - problems.

Module-V: 8 hrs

Testing of Hypotheses: Null and alternative hypotheses, the critical regions, two types of error, level of significance, power of the test, tests for mean for one sample and two sample problems from normal populations, Tests for single mean, difference of means using t, paired t test- tests for proportions - Chi-square goodness of fit test and its applications, Test for independence of attributes, One way ANOVA, simple problems.

Reference Books:

1. *Irwin Miller and Marlyees Miller (2002): John E Freund's Mathematical Statistics, 6/e, PHI*
2. *Gupta, S.C. and Kapoor, V.K.(2000): Fundamentals of Mathematical Statistics, 10/e, Sultan Chand and Sons*
3. *S.M. Ross, Introduction to Probability and Statistics for Engineers and Scientists,2009, 4^{th} edition, Elsevier.*

CSCE 613 NETWORK CONFIGURATION AND MANAGEMENT

L	S	P	C
3	2	0	3

Pre-requisite:

- *Complete knowledge about Operating System and Computer Network*

Objectives:

- *Students learn how to implement and administer common operating systems environments. They gain experience in systems administration functions and issues as well as network services. Students develop a conceptual understanding of each operating system function and network service and learn how to plan, implement, and administer each. Topics include user access and privileges, DHCP, DNS, remote access, file and print, update and patch management, security and network management services*

Module-I: Introduction 8 Hrs

Network Management goals, organization, and functions - Network Management System Platform, Current Status and future of Network Management - Network monitoring - Network control - SNMPv1 Network management organization and communication function models - structure of SNMP management information – standards - SNMPv2 system architecture - protocol - protocol specification - SNMPv3 architecture.

Module-II: Network Configuration 10 Hrs

IPv4and IPv6 addressing, Network Interface Configuration, Diagnosing Network start-up issues, Linux and Windows Firewall configuration, Network troubleshooting commands, DNS principles and Operations, Basic Name Server and Client Configuration, Caching Only name server, Primary and Slave Name Server, DNS Zone Transfers, DNS Dynamic Updates, DNS Server Security.

Module-III: Web, Proxy, Mail Server Configuration and Management 10 Hrs

HTTP Server Configuration Basics, Virtual Hosting, HTTP Caching, Proxy Caching Server Configuration, Proxy Access Control List, Proxy-Authentication Mechanisms, Mail Domain Administration, Basic Mail Server Configuration (like Sendmail, qmail), SMTP, POP and IMAP principles, SMTP Relaying Principles, SPAM control and Filtering, Troubleshooting

Module-IV: Remote Administration and Management 5 Hrs

Remote Network monitoring-concepts - group management - RMON alarms and filters - packet capture group - practical issues - RMON2 protocol -practical issues - ATM network management- The ATM Network Reference Model, The Integrated Local Management Interface, The ATM Management Information Base - Telecommunication network management - TMN conceptual model - architecture - Network management applications.

Module-V: Techniques for Network Management 9 Hrs

Techniques for Network Management – Policy based management– Artificial Intelligence Techniques – Expert systems, Machine Learning - Graph-Theoretic techniques – Causality Graph, Dependency Graph, Decision Trees – Probabilistic Approaches – Fuzzy logic, Bayesian Networks – Web-based Network Management - NMS with Web Interface and Web-Based Management, Web Interface to SNMP Management, Embedded Web-Based Management –

Distributed Object Computing - Bio-inspired Approaches.

Text Book(s):

1. *Thomas A. Limoncelli, Christina J. Hogan , Strata R. Chalup.The Practice of System and Network Administration, Second Edition*
2. *Mani Subramanian, Network management: Principles and Practice, Addison Wesley, 2000.*
3. *Jianguo Ding, Advances in Network Management, Taylor and Francis Group, LLC, 2010.*

Reference Book(s):

1. *Advanced Linux Networking, Roderick W. Smith, Addison-Wesley Professional (Pearson Education), 2002.*
2. *Linux Network Administrator's Guide, Tony Bautts, Terry Dawson, Gregor N. Purdy, O'Reilly, Third Edition, 2005*
3. *William Stallings, Cryptography and Network Security: Principles and Standards, Prentice Hall India, 4th Edition, 2005.*

CSCE 614 ADVANCED DATA STRUCTURES AND ALGORITHMS

L	S	P	C
3	2	0	3

Pre-requisite:

Basic Knowledge in

- *Algorithm design and analysis techniques*
- *Data Structures*
- *Mathematical techniques*

Objectives:

Understanding of

- *Randomized algorithms*
- *Graph algorithms*
- *Parallel algorithms*

Module-I: Introduction 8 hrs

Introduction: Advanced data structures: B-Trees, Fibonacci heaps, data structures for disjoint sets, hash tables Role of Algorithms in Computing - Analyzing Algorithms - Designing Algorithms Growth Functions: Asymptotic Function - Standard Notations and common Functions

Module II: Divide and Conquer, Randomized Algorithms 8 hrs

Divide and Conquer: The maximum-subarray problem - Strassen's algorithm for matrix multiplication - The substitution method for solving recurrence - The recursion-tree method for solving recurrences - The master method for solving recurrences Randomized Algorithms: The Hiring Problem - Indicator Random Variables

Module III: **Advanced Design and Analysis Techniques 8 hrs**

Dynamic Programming: Rod Cutting - Matrix-Chain Multiplication - Elements of Dynamic Programming - Longest Common Subsequence - Optimal Binary Search Trees Greedy Algorithms: Elements of Greedy Strategy - Huffman Codes - Matroids and Greedy Methods Amortized Analysis: Aggregate Analysis - The Accounting Method - The Potential Method - Dynamic Tables Advanced graph algorithms: Johnsons Algorithm for Sparse Graphs Maximum Flow: Flow Networks - The Ford-Fulkerson Method - Maximum Bipartite Matching

Module IV: **Probabilistic and parallel Algorithms 8 hrs**

Probabilistic Algorithms – Numerical probabilistic algorithms – Monte Carlo Method – Las Vegas Algorithm.

Multithreaded Algorithms: Basics of Dynamic Multithreading - Multithreaded Matrix Multiplication - Multithreaded Merge Sort Parallel Algorithms:simple examples – parallel sorting

Module V: String matching and approximation algorithms 8 hrs

String Matching Algorithms: Naïve approach - Rabin-Karp Algorithm - String Matching with Finite Automata -The Knutt-Morris-Pratt Algorithm-NP Completeness-Approximation algorithms

Text Book(s):

1. *Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, Introduction to Algorithms, MIT Press, 2009.*

Reference Book(s):

1. *S. Dasgupta, C. H. Papadimitriou, and U. V. Vazirani, Algorithms, McGrawHill, 2008.*
2. *G. Brassard and P. Bratley, Algorithmics: Theory and Practice, Prentice -Hall, 1988.*
3. *J. Kleinberg and E. Tardos, Algorithm Design, Pearson Education, 2006*
4. *Rajeev Motwani and Prabhakar Raghavan, Randomized Algorithms, Cambridge University Press, 1995.*

CSCE 615 INTERNET AND WEB TECHNOLOGIES

L	S	P	C
3	2	0	3

Pre-requisites:

- *Basic Understanding of Computer Programming*.

Course Objectives:

- *Getting familiar with Full Stack of Web development.*
- *Understanding the components of Web Design and Development.*
- *Acquiring skills on developing effective web applications.*

Module I :
The Internet Evolution – Protocols for the Internet – IP Subnetting and addressing - Name resolution – Web Browsers: Features – Comparative analysis; Markup languages – HTML5: Features – Multimedia handling – Canvas; Styling web pages : CSS3 – Types – Benefits – Design considerations.

Module II:
Client Side Scripting languages : Features – Comparative analysis; Dynamic pages using client side scripting – Client side storage through Cookies - Client side scripting frameworks : Case study with Jquery – Optimizing web pages for speed.

Module III:
Web servers : Features – Comparative analysis; Service side scripting languages: Features – Factors to consider in selecting Web Servers – Server Side Scripting case study with PHP : Introduction - Functions – Object Orientation – Error and Exception Handling – Internationalization and Localization – File Systems and the Server.

Module IV:
Databases for web applications : Features – Comparative analysis; Creating the web databases – Accessing databases from server side scripting – Database Administration – Non RDBMS Data Sources for Web applications.

Module V: Web Application Security
Web application security risks – Building secure web applications. Rich Internet Applications: Design and Security issues – Mobile Web : Components and Security considerations.

Ref Books:

1. *Laura Thomson & Luke Welling :PHP and MySQL Web Development, Pearson Education; Fifth edition (2016)*
2. *Thomas A. Powell:HTML& CSS: The Complete Reference, Fifth Edition, McGraw Hill Education; 5th edition (2017)*

Web Resources:

1. *https://github.com/MilanAryal/web-development-resources*
2. *https://github.com/bmorelli25/Become-A-Full-Stack-Web-Developer*
3. *https://github.com/JacobWylie/Web-Dev-Learning-Resources*
4. https://www.w3schools.com/ **MOOC** *NPTEL Course on Internet Technology : http://nptel.ac.in/courses/106105084/*

CSCE 616 NETWORK MANAGEMENT LAB

L	S	P	C
0	0	4	2

Skills to be acquired:

- *Administration of web server, proxy server, e-mail server, remote monitoring of server, etc.*

Lab Software Requirements:

- *Open source network management tools*

List of Exercises:

1. Server/Client Installation over VMware Environment
2. Packet Analysis by using TCPDUMP and WIRESHARK
3. Network Practice with Packet Tracer
4. System Administration: User/Group management, File System Management ….
5. Network Configuration: Start/Stop network Service, network interface configuration
6. Firewall Configuration
7. DNS and DHCP Configuration and Troubleshooting
8. Web and Proxy Server Configuration and Troubleshooting
9. Basic Mail Server Configuration and Troubleshooting
10. SAMBA, NFS, CUPS and FTP configuration and Troubleshooting
11. Webmin/SSH configurations

CSCE 618 WEB TECHNOLOGY LAB

L	S	P	C
0	0	4	2

Skills to be acquired:

- *Designing and developing web pages / applications.*

Lab Software Requirements:

- *Open Source Web Development tools.*

List of Exercises:

1. Exercises to make the student acquire client side development skills.
2. Exercises to make the student acquire server side development skills.
3. Exercises to make the student acquire Rich Internet Application development skills.
4. Exercises to make the student acquire skills related with making the applications secure.

CSCE 621 GRAPH THEORY AND ITS APPLICATIONS

L	T	P	C
3	2	0	3

Pre-requisite:

- *Nil*

Objectives:

- *To introduce graphs as a powerful modelling tool that can be used to solve practical problems in various fields*

Module-I: 8 hrs

Graph Theory Introduction: Introduction Of Graph and sub graphs - Graph Isomorphism – Representation – Degree- Paths and Connection, Cycles, Trees – Cut Edges – Cut vertices – Gayley's Formula- Connector Problem – Euler's and Hamiltonian Cycles.

Module-II: 8 hrs

Matching and Connectivity: Matching – Covering in Bipartite graphs – Perfect Matching – Personal Assignment Problem – Optimal Assignment Problem. Connectivity- Blocks – Construction of Reliable communication Networks.

Module-III: 8 hrs

Planar Graphs and Colouring: Planar Graphs – Dual Graphs - Euler's Formula – Kurotowski's Theorem - Applications. Edge Colouring- Chromatic Number, Vizing's Theorem- Timetabling Problem – Vertex Colouring – Chromatic Number- Brook's Theorem

Module-IV: 8 hrs

Directed graphs: Concepts-Directed walks-paths-cycles-orientation of graph-Job Sequencing problem-tournaments- Applications

Module-V: 8 hrs

Network: Flows – Cuts- Max-Flow Min Cut Theorem – Menger's Theorem – Feasible Flows.

Textbooks:

1. *R J Wilson, Introduction to Graph Theory, 2003, 4th Edition, Pearson Education.*
2. *J.A Bondy and U.S.R Murthy, Graph Theory with Applications, Macmillan, 1976.*

Reference Books:

1. *Reinhard Diestel, Graph Theory ,2000, 2nd Edition, Springer- Verlag.*
2. *Jay Yellen, Jonathan L.Gross, Graph Theory and Its Applications ,1998, 2nd edition, CRC Press LLC.*
3. *NarsinghDeo, Graph Theory: With Application to Engineering and Computer Science,2003, Prentice Hall of India.*

CSCE 622 RESEARCH METHODOLOGY

L	T	P	C
3	2	0	3

Pre-requisite:

- *Nil*

Objectives:

- *Learn to focus on a research problem using scientific methods*
- *Learn research design methods*
- *Learn the art of report and thesis writing*

Module-I: Objectives and types of research

Motivation and objectives – Research methods vs Methodology. Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical

Module-II: Research Formulation

Defining and formulating the research problem - Selecting the problem - Necessity of defining the problem - Importance of literature review in defining a problem – Literature review – Primary and secondary sources – reviews, treatise, monographs-patents – web as a source – searching the web - Critical literature review – Identifying gap areas from literature review - Development of working hypothesis.

Module-III: Research design and methods

Research design – Basic Principles- Need of research design — Features of good design – Important concepts relating to research design – Observation and Facts, Laws and Theories, Prediction and explanation, Induction, Deduction, Development of Models. Developing a research plan - Exploration, Description, Diagnosis, and Experimentation. Determining experimental and sample designs.

Module-IV: Reporting and thesis writing

Structure and components of scientific reports -Types of report – Technical reports and thesis – Significance – Different steps in the preparation – Layout, structure and Language of typical reports – Illustrations and tables- Bibliography, referencing and footnotes - Oral presentation – Planning – Preparation – Practice – Making presentation – Use of visual aids - Importance of effective communication-Software tools for research

Module-V: Application of results and ethics

Environmental impacts - Ethical issues - ethical committees - Commercialisation – Copy right – royalty - Intellectual property rights and patent law – Trade Related aspects of Intellectual Property Rights – Reproduction of published material – Plagiarism - Citation and acknowledgement - Reproducibility and accountability.

Text Book(s):

1. *Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., An introduction to Research Methodology, 2002. RBSA Publishers.*
2. *Kothari, C.R., Research Methodology: Methods and Techniques. New Age International. 418p. 1990.*
3. *Sinha, S.C. and Dhiman, A.K., Research Methodology, 2002.Ess Ess Publications. 2 volumes.*
4. *Trochim, W.M.K., Research Methods: the concise knowledge base, 2005., Atomic Dog Publishing. 270p.*
5. *Wadehra, B.L. Law relating to patents, trade marks, copyright designs and geographical indications. 2000. Universal Law Publishing.*

Reference Book(s):

1. *Anthony, M., Graziano, A.M. and Raulin, M.L., Research Methods: A Process of Inquiry, Allyn and Bacon. 2009.*
2. *Carlos, C.M., Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. 2000. Zed Books, New York.*
3. *Coley, S.M. and Scheinberg, C. A., "Proposal Writing", 1990, Sage Publications.*
4. *Day, R.A.,.How to Write and Publish a Scientific Paper, 1992, Cambridge University Press.*
5. *Fink, A.,Conducting Research Literature Reviews: From the Internet to Paper. 2009, Sage Publications*

CSCE123 DATA MINING AND BIG DATA

L	T	P	C
3	1	2	

Pre-requisite:

- *Knowledge in Artificial Intelligence*

Objectives:

- *To understand the computational approaches to Mining*
- *To understand the need and application of Map Reduce*
- *To understand the various search algorithms applicable to Big Data*
- *To analyse and interpret streaming data*

Module-I: Introduction to data mining 8 hrs

Why Data mining-KDD versus data mining, Stages of the Data Mining Process—Issues-Getting to know your data- Data Preprocessing -Data Warehousing and OLAP.

Module-II: Mining Associations, Classification and Clustering 8 hrs

Apriori algorithm-Decision Tree Induction - Bayesian Classification – Rule Based Classification – Classification by Back propagation – Support Vector Machines – Associative Classification – Lazy Learners – Other Classification Methods – Clustering techniques – , Partitioning methods- k-means- Hierarchical Methods – distance based agglomerative and divisible clustering, Density-Based Methods -Grid Based Methods – Model-Based Clustering Methods-Clustering high dimensional data– Outlier Analysis.

Module-III: Data mining and large scale files 8 hrs

Introduction to Statistical modeling – Machine Learning – Computational approaches to modeling – Summarization – Feature Extraction – Statistical Limits on Data Mining - Distributed File Systems – Map-reduce – Algorithms using Map Reduce

Module-IV: Mining Data Streams 8 hrs

Stream Data Model – Sampling Data in the Stream – Filtering Streams – Counting Distance Elements in a Stream – Estimating Moments – Counting Ones in Window – Decaying Windows

Module-V: Applications 8 hrs

Mining complex data objects – Spatial databases – Temporal databases – Multimedia databases — Case study Recommendation systems – Mining social networks

Laboratory Components:

Skills to be acquired:

- *Implementation of data mining algorithms*
- *Implementation of big data mining concepts*

List of S/W requirements

- *Weka, R language,Python*
- *Hadoop, spark*

Text Book(s):

1. *Jure Leskovec, AnandRajaraman, Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, Second Edition, 2014.*
2. *Jiawei Han, MichelineKamber, Jian Pei, "Data Mining Concepts and Techniques", Morgan Kaufman Publications, Third Edition, 2011.*
3. *Ian H.Witten, Eibe Frank "Data Mining – Practical Machine Learning Tools and Techniques", Morgan Kaufman Publications, Third Edition, 2011.*
4. *David Hand, HeikkiMannila and Padhraic Smyth, "Principles of Data Mining", MIT PRESS, 2001*

CSCE 624 MOBILE AND PERVASIVE COMPUTING

L	S	P	C
3	2	0	3

Pre-requisite:

- *Knowledge of Computer Networks*

Objectives:

- *Learn the underlying engineering principles that make pervasive computing work.*
- *To get an in-depth understanding about the most dynamic technologies like mobile computing, service discovery, context aware computing and security issues in mobile & pervasive computing.*

Module-I: Introduction to Mobile Computing **7 hrs**

Theory of Mobile Computing: Mobile Adaptive Computing – Adaptability – Mechanics of Adaptation – Mobility Management- Data Dissemination and Management – Challenges – Mobile Data Caching – Mobile Cache maintenance schemes – Mobile Web caching

Module-II: Context Aware Computing **10 hrs**

Context aware Computing – Ubiquitous Vs. pervasive Computing – Context aware computing and applications – Middleware support – Mobile middleware – Adaptation – Mobile Agents – Service discovery middleware.

Module-III: Adhoc& Sensor networks **6 hrs**

Introduction to Adhoc& Sensor networks- Properties of adhoc networks – Features of sensor networks – proposed application and challenges.

Module-IV: Protocols **8 hrs**

Protocols – Autoconfiguration – Energy efficient communications – Mobility requirements – Deployment and configuration - Routing – Fault Tolerance and Reliability- Energy efficiency.

Module-V: Wireless Security **8 hrs**

Mobile and Wireless security issues – problems in adhoc networks – additional issues : commerce , Types of attacks - Approaches to security – Limit the signal – encryption – integrity codes – IPSec - Authentication Protocols

Text Book(s):

1. *Frank Adelstein, Sandeep K.S. Gupta , Golden G Richard , Loren schwiebert, , Fundamentals of Mobile and Pervasive Computing , Tata McGraw Hill edition , 2005.*

Reference Book(s):

1. *Asoke K. Talukar, Mobile Computing, Second Edition, Tata McGraw-Hill Publication, 2010*

CSCE 627 DATA MINING LAB

L	S	P	C
0	0	4	2

Skills to be acquired:

- *Implementation of data mining algorithms*
- *Implementation of big data mining concepts*

List of S/W requirements

- *Hadoop, spark*
- *Weka, R language, Python*

List of exercise

- *Implementing classification and clustering algorithms*
- *Analysis of the algorithms*
- *Implementing mining algorithms on data streams*

CSCE 628 PERVASIVE COMPUTING LAB

L	S	P	C
0	0	4	2

Skills to be acquired:

- *To understand and use the fundamentals of programming for mobile devices.*
- *To apply event-driven programming and graphical user interfaces for mobile device*

Lab Software Requirements:

- *Open SourceDevelopment tools.*
- *J2ME*
- *NS3*

List of Exercises:

- *Study of mobile application development platform and tools.*
- *Design and develop pervasive applications*

CSCE 811 BIG DATA TECHNOLOGIES

L	S	P	C
3	2	0	3

Prerequisite:

- *Nil*

Objectives:

- *This course provides practical foundation level training that enables immediate and effective participation in big data projects. The course provides grounding in basic and advanced methods to big data technology and tools, including MapReduce and Hadoop and its ecosystem.*

Module I: Introduction to Big Data (8 hours)

Introduction – distributed file system – Big Data and its importance, Four Vs, Drivers for Big data, Big data analytics, Big data applications. Algorithms using map reduce, Matrix-Vector Multiplication by Map Reduce.

Module II Introduction to Hadoop (8 hours)

Big Data – Apache Hadoop&HadoopEcoSystem – Moving Data in and out of Hadoop – Understanding inputs and outputs of MapReduce - Data Serialization.

Module III Hadoop Architecture (8 hours)

Hadoop Architecture, Hadoop Storage: HDFS, Common Hadoop Shell commands , Anatomy of File Write and Read., NameNode, Secondary NameNode, and DataNode, Hadoop MapReduce paradigm, Map and Reduce tasks, Job, Task trackers - Cluster Setup – SSH & Hadoop Configuration – HDFS Administering –Monitoring & Maintenance.

Module IV Hadoop Ecosystem and Yarn (8 hours)

Hadoop ecosystem components - Schedulers - Fair and Capacity, Hadoop 2.0 New Features Name Node- High Availability, HDFS Federation, MRv2, YARN, Running MRv1 in YARN.

Module VHIVE AND HIVEQL, HBASE (8 hours)

Hive Architecture and Installation, Comparison with Traditional Database, HiveQL – Querying- Data - Sorting And Aggregating, Map Reduce Scripts, Joins &Subqueries, HBase concepts Advanced-Usage, Schema Design, Advance Indexing - PIG, Zookeeper - how it helps in monitoring a cluster, HBase uses Zookeeper and how to Build Applications with Zookeeper.

References:

1. *Boris lublinsky, Kevin t. Smith, Alexey Yakubovich, "Professional Hadoop Solutions",Wiley, ISBN: 9788126551071, 2015.*
2. *Chris Eaton, Dirk derooset al. , "Understanding Big data ", McGraw Hill, 2012.*
3. *Tom White, "HADOOP: The definitive Guide" , O Reilly 2012.*
4. *VigneshPrajapati, "Big Data Analytics with R and Haoop", Packet Publishing 2013.*
5. *Tom Plunkett, Brian Macdonald et al, "Oracle Big Data Handbook", Oracle Press, 2014.*
6. *http://www.bigdatauniversity.com/*
7. *JyLiebowitz, "Big Data and Business analytics",CRC press, 2013.*

CSCE 812 STATISTICS FOR DATA ANALYTICS

L	*S*	*P*	*C*
3	2	0	3

Prerequisite:

- *Nil*

Objectives:

- *This course teaches fundamental concepts and tools needed to understand the emerging role of business analytics in organizations.*

MODULE I Data Analytics Life Cycle (9 Hours)

Introduction to Big data Business Analytics - State of the practice in analytics role of data scientists- Key roles for successful analytic project - Main phases of life cycle - Developing core deliverables for stakeholders.

MODULE II Statistics (9 Hours)

Sampling Techniques - Data classification, Tabulation, Frequency and Graphic representation -Measures of central value - Arithmetic mean, Geometric mean, Harmonic mean, Mode, Median,Quartiles, Deciles, Percentile - Measures of variation – Range, IQR, Quartile deviation, Mean deviation, standard deviation, coefficient variance, skewness, Moments & Kurtosis.

MODULE III Probability and Hypothesis Testing (9 hours)

Random variable, distributions, two dimensional R.V, joint probability function, marginal density function. Random vectors - Some special probability distribution - Binomial, Poison, Geometric, uniform, exponential, normal, gamma and Erlang. Multivariate normal distribution – Sampling distribuition – Estimation - point, confidence - Test of significance, 1& 2 tailed test, uses of t distribution, F-distribution, $\chi 2$ distribution.

MODULE IV Predictive Analytics (9 hours)

Predictive modeling and Analyisis - Regression Analyisis, Multicollinearity , Correlation analysis, Rank Correlation coefficient, Multiple correlation, Least square, Curve fitting and good ness of fit.

MODULE V Time Series Forecasting and Design Of Experiments (9 Hours)

Forecasting Models for Time series : MA, SES, TS with trend, season - Design of Experiments, one way Classification, two way classification, ANOVA, Latin square, Factorial Design.

Reference books:

1. *Chris Eaton, Dirk Deroos, Tom Deutsch et al., "Understanding Big Data", McGrawHIll,2012.*
2. *Alberto Cordoba, "Understanding the Predictive Analytics Lifecycle", Wiley, 2014.*
3. *Eric Siegel, Thomas H. Davenport, "Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die", Wiley, 2013.*
4. *James R Evans, "Business Analytics – Methods, Models and Decisions", Pearson 2013.*

5. *R. N. Prasad, Seema Acharya, "Fundamentals of Business Analytics", Wiley, 2015.*
6. *S M Ross, "Introduction to Probability and Statistics for Engineers and Scientists", Academic Foundation, 2011.*
7. *David Hand, HeikiMannila, Padhria Smyth, "Principles of Data Mining", PHI 2013.*
8. *Spyros Makridakis, Steven C Wheelwright, Rob J Hyndman, "Forecasting methods and applications", Wiley 2013(Reprint).*
9. *David Hand, HeikkiMannila, Padhraic Smyth, "Principles of Data mining", PHI 2013.*

CSCE 813 MULTIVARIATE TECHNIQUES FOR DATA ANALYSIS

L	*S*	*P*	*C*
3	2	0	3

Prerequisite:

- *Nil*

Objectives:

- *The purpose of this course is to introduce the students into the field of Multivariate Techniques for analyzing large volumes of data and to take decisions based on inference drawn.*

MODULE I :Introduction to Multivariate Analysis (9 Hours)

Meaning of Multivariate Analysis, Measurements Scales - Metric measurement scales and Nonmetric measurement scales, Classification of multivariate techniques (Dependence Techniques and Inter-dependence Techniques), Applications of Multivariate Techniques in different disciplines.

MODULE II : Factor Analysis (9 hours)

Factor Analysis: Meanings, Objectives and Assumptions, Designing a factor analysis, Deriving factors and assessing overall factors, Interpreting the factors and validation of factor analysis.

MODULE III : Cluster Analysis (9 hours)

Cluster Analysis: Objectives and Assumptions, Research design in cluster analysis, Deriving clusters and assessing overall fit (Hierarchical methods, Non Hierarchical Methods and

Combinations), Interpretation of clusters and validation of profiling of the clusters.

MODULE IV :Discriminant Analysis (9 hours)

Discriminant Analysis- concept, objective and applications. Procedure for conducting discriminant analysis. Stepwise discriminate analysis and Mahalanobis procedure. Logit model.

MODULE V :Linear Programming (9 hours)

Linear Programming problem - Formulation, graphical method, simplex method. Integer Programming. Transportation and Assignment problem.

References:

1. Joseph F Hair, William C Black etal , "Multivariate Data Analysis" , Pearson Education, 7th edition, 2013.
2. T. W. Anderson , "An Introduction to Multivariate Statistical Analysis, 3rd Edition", Wiley, 2003.
3. William r Dillon, John Wiley & sons, "Multivariate Analysis methods and applications", Wiley, 1984.
4. Naresh K Malhotra, Satyabhusan Dash, "Marketing Research Anapplied Orientation", Pearson, 2011.
5. Hamdy A Taha, "Operations Research", Pearson, 2012.
6. S R Yaday, A K Malik, "Operations Research", Oxford, 2014.

CSCE 814 DATA MINING AND DATA ANALYSIS

L	S	P	C
3	2	0	3

Prerequisite:

- *Basic knowledge in statistics*

Objectives:

- *To learn data analysis techniques.*
- *To understand Data mining techniques and algorithms.*
- *Comprehend the data mining environments and application.*

MODULE I INTRODUCTION TO DATA MINING 7 hrs

Data mining-KDD versus data mining, Stages of the Data Mining Process Task primitives, Data Mining Techniques -Data mining knowledge representation – Data mining query languages- Integration of a Data Mining System with a Data Warehouse – Issues, Data pre-processing – Data cleaning – Data transformation - Feature selection – Dimensionality reduction – Discretization and generating concept hierarchies-Mining frequent pattern association - correlation.

MODULE II CLASSIFICATION AND CLUSTERING 7 hrs

Decision Tree Induction - Bayesian Classification – Rule Based Classification – Classification by Back propagation – Support Vector Machines – Associative Classification – Lazy Learners – Other Classification Methods – Clustering techniques – Partitioning methods- k-means-Hierarchical Methods – Distance based agglomerative and divisible clustering - Density-Based Methods – Expectation maximization -Grid Based Methods – Model-Based Clustering Methods – Constraint – Based Cluster Analysis – Outlier Analysis.

MODULE III DATA MINING SOFTWARE AND APPLICATIONS 7 hrs

Mining complex data objects - Spatial databases, temporal databases, Multimedia databases-Time series and Sequence data - Text Mining –Graph mining-Web mining-Application and trends in data mining.

MODULE IV PREDICTION OF QUANTITATIVE VARIABLES 7 hrs

Prediction of quantitative variables – Non Parametric estimation – Logical regression – Projection pursuit – Inferential aspects – Regression trees – Neural networks – Case studies.

MODULE V METHODS OF INTERNAL ANALYSIS 8 hrs

Methods of Internal analysis – Cluster analysis – Association among variables – Web mining analysis. Data Analytics – Simulated data – Mathematical statistic analysis – Applications of probability theory – Linear models – Case study.

Reference Book(s):

1. *AdelchiAzzalini, Bruno Scapa, "Data Analysis and Data mining", 2nd Edition, Oxford University Press Inc., 2012.*

2. *Jiawei Han and MichelineKamber, "Data Mining: Concepts and Techniques", 3rd Edition, Morgan Kaufmann Publishers, 2011.*
3. *Alex Berson and Stephen J. Smith, "Data Warehousing, Data Mining & OLAP", 10th Edition, TataMcGraw Hill Edition, 2007.*
4. *G. K. Gupta, "Introduction to Data Mining with Case Studies", 1st Edition, Easter Economy Edition, PHI, 2006.*

CSCE 815 MACHINE LEARNING

L	S	P	C
3	2	0	3

Prerequisite:

- *Basic knowledge in AI*

Objectives:

- *To understand the machine learning theory*
- *To implement linear and non-linear learning models*
- *To implement distance-based clustering techniques*
- *To build tree and rule based models*
- *To apply reinforcement learning techniques*

MODULE I

Introduction – machine learning applications – learning associations, classification, regression, unsupervised learning – Reinforcement Learning – Supervised Learning – Learning a class from examples – VC Dimension – PAC learning – noise – learning multiple classes – regression – model selection and generalization – Bayesian Decision Theory – Classification – losses and risks – Discriminant Functions – Utility Theory – Association Rules

MODULE II

Parametric Methods – Maximum Likelihood Estimation – Bernoulli Density – Multinomial Density – Gaussian Density – Bias – Variance – Parametric classification – regression – Multivariate Methods – Multivariate Data – Parameter Estimation – Estimation of Missing Values – Multivariate Normal Distribution – Multivariate Classification – Multivariate Regression - Dimensionality Reduction – Subset Selection – Principal Component Analysis – Factor Analysis – Dimensionality Scaling – Linear Discriminant Analysis – Isomap – Locally Linear Embedding

MODULE III

Clustering – Mixture Densities – K Means Clustering – Expectation Maximization – Mixtures of Latent Variable Models – Supervised Learning after clustering – Hierarchical Clustering – Non Parametric Methods – Histogram Estimator – Kernel Estimator – K-Nearest Neighbor Estimator – Non Parametric Classification – Non Parametric Regression –Decision Trees – Classification Trees – Regression Trees

MODULE IV

Linear Discrimination – Linear Model – Geometry of the Linear Discriminant – Pairwise Separation – Gradient Descent – Logistic Discrimination – Discrimination by Regression – Multilayer Perceptrons – Introduction – Perceptron – Training a Perceptron – Learning Boolean Functions – Multilayer Perceptrons – Backpropagation Algorithm

MODULE V

Kernel Machines – Optimal Separating Hyperplane – kernel trick – vectorialkernals – multiple kernel learning – multiclass kernel machines – Hidden Markov Models – Discrete Markov

Processes – Hidden Markov Models – Three Basic Problems of HMMs – Evaluation Problem Finding the State Sequence – Learning Model Parameters – Generating Diverse Learners – Model Combination schemes – Voting – Error Correcting Output Codes – Bagging – Boosting

Reference Book(s):

1. *EthemAlpaydin, Introduction to Machine Learning, Second Edition, PHI,2010.*
2. *Machine Learning, An Algorithmic Perspective, Stephen Marsland, Chapman & Hall Machine Learning and Pattern Recognition Series, Second Edition, CRC Press,2009.*
3. *Machine Learning, The Art and Science of Algorithms that Make Sense of Data, Peter Flasch, Cambridge University Press.*
4. *Machine Learning, Tom M. Mitchell, Mc Graw Hill,2003*

CSCE 816 DEEP LEARNING

L	S	P	C
3	2	0	3

Prerequisite:

- *Basic knowledge in machine learning*

Objectives:

- *To understand the machine learning theory*
- *To implement linear and non-linear learning models*
- *To implement distance-based clustering techniques*
- *To build tree and rule based models*
- *To apply reinforcement learning techniques*

MODULE I

Building Intelligent Machines - Limitations - Mechanics of Machine Learning - Neuron - Feed-Forward Neural Networks - Linear Neurons and Their Limitations - Sigmoid, Tanh, and ReLU Neurons – Softmax Output Layers

Training Feed-Forward Neural Networks - The Fast-Food Problem - Gradient Descent - Delta Rule and Learning Rates - Gradient Descent with Sigmoidal Neurons - Backpropagation Algorithm - Stochastic and Minibatch Gradient Descent - Test Sets, Validation Sets, and Overfitting - Preventing Overfitting in Deep Neural Networks

MODULE II

Implementing Neural Networks in TensorFlow – Introduction – installation- creation and manipulation – operations – placeholder tensor – Sessions – Variables – Logistic Regression Model - Visualization – multilayer model

Beyond Gradient Descent. Challenges - Local Minima in the Error Surfaces of Deep Networks - Model Identifiability - Flat Regions in the Error Surface- Momentum-Based Optimization - Second-Order Methods - Learning Rate Adaptation – AdaGrad – RMSProp – Adam - Optimizer Selection

MODULE III

Convolutional Neural Networks - Neurons in Human Vision - The Shortcomings of Feature Selection - Vanilla Deep Neural Networks Don't Scale - Filters and Feature Maps - Convolutional Layer- Max Pooling - Architectural Description - MNIST with Convolutional Networks - Image Preprocessing Pipelines - Building a Convolutional Network for CIFAR-10 - Visualizing Learning - Leveraging and learning Convolutional Filters

Embedding and Representation Learning - Learning Lower-Dimensional Representations - Principal Component Analysis - Motivating the Autoencoder Architecture - Implementing an Autoencoder in TensorFlow - Denoising to Force Robust Representations - Sparsity in Autoencoders - The Word2Vec Framework - Implementing the Skip-Gram Architecture

MODULE IV

Models for Sequence Analysis - Analyzing Variable-Length Inputs - Tackling seq2seq with Neural N-Grams - Implementing a Part-of-Speech Tagger - Dependency Parsing and SyntaxNet - Beam Search and Global Normalization - A Case for Stateful Deep Learning Models - Recurrent Neural Networks - The Challenges with Vanishing Gradients - Long Short-Term Memory (LSTM) Modules - TensorFlow Primitives for RNN Models - Implementing a Sentiment Analysis Model - Solving seq2seq Tasks with Recurrent Neural Networks - Augmenting Recurrent Networks with Attention - Dissecting a Neural Translation Network

Memory Augmented Neural Networks - Neural Turing Machines - Attention-Based Memory Access - NTM Memory Addressing Mechanisms- Differentiable Neural Computers - Interference-Free Writing in DNCs - DNC Memory Reuse - Temporal Linking of DNC Writes - Understanding the DNC Read Head - The DNC Controller Network - Visualizing - Implementing, Teaching DNC

MODULE V

Deep Reinforcement Learning - Deep Reinforcement Learning - MDP - Future Return – Discounted - Explore Versus Exploit - Policy Versus Value Learning - Policy Learning via Policy Gradients - Pole-Cart with Policy Gradients - OpenAI Gym - Creating an Agent - Building the Model and Optimizer - Sampling Actions - Policy Gradient Main Function - Q-Learning and Deep Q-Networks - The Bellman Equation - Issues with Value Iteration - Approximating the Q-Function - Deep Q-Network (DQN) concepts- Deep Recurrent Q-Networks (DRQN) - Asynchronous Advantage Actor-Critic Agent

Reference Book(s):

1. *Nikhil Buduma,Fundamentals of Deep Learning, Designing Next Generation Machine Intelligence Algorithms, O'Reilly publications, June 2017*
2. *EthemAlpaydi,n Introduction to Machine Learning,, Second Edition, PHI.*
3. *Bishop, C. M. Neural Networks for Pattern Recognition. Oxford University Press. 1995*
4. *Ian Goodfellow, YoshuaBengio, Aaron Courville, Deep learning, MIT Press, 2016*

Web Resources

1. *https://github.com/joanbruna/stat212b*

CSCE 821 SOFTWARE TESTING

L	S	P	C
3	2	0	3

Pre-requisite:

- *Knowledge in Software Engineering*

Objectives:

- *To know the behaviour of the testing techniques to detect the errors in the software.*
- *To understand standard principles to check the occurrence of defects and its removal.*
- *To learn the functionality of automated testing tools.*
- *To understand the models of software reliability.*

Module-I: Testing Environment And Test Processes 9 hours

Testing Environment and Test Processes: World-Class Software Testing Model – Building a Software Testing Environment – **The Seven Step Testing process**: Overview of Software Testing Process – Organizing for Testing – Developing the Test Plan – Verification Testing – Analysing and Reporting Test Results – Acceptance Testing – Operational Testing – Post Implementation Analysis.

Module-II: Testing Techniques And Levels Oftesting 9 hours

Testing Techniques and Levels of testing: Using White Box Approach to Test design - Static Testing Vs. Structural Testing – Code Functional Testing – Coverage and Control Flow Graphs –Using Black Box Approaches to Test Case Design – Random Testing – Requirements based testing –Decision tables –State-based testing – Cause-effect graphing – Error guessing – Compatibility testing – Levels of Testing - Unit Testing - Integration Testing - Defect Bash Elimination. System Testing - Usability and Accessibility Testing – Configuration Testing - Compatibility Testing - Case study for White box testing and Black box testing techniques.

Module-III: Incorporating Specialized Testing Responsibilities 9 hours

Incorporating Specialized Testing Responsibilities: Testing Client/Server Systems – Rapid Application Development Testing – Testing in a Multiplatform Environment – Testing Software System Security - Testing Object-Oriented Software – Object Oriented Testing – Testing Web based systems – Web based system – Web Technology Evolution – Traditional Software and Web based Software – Challenges in Testing for Web-based Software –Testing a Data Warehouse - Case Study for Web Application Testing.

Module-IV: Test Automation 9 hours

Test Automation: Selecting and Installing Software Testing Tools - Software Test Automation – Skills needed for Automation – Scope of Automation – Design and Architecture for Automation – Requirements for a Test Tool – Challenges in Automation – Tracking the Bug – Debugging – Case study using Bug Tracking Tool.

Module-V: Software Testing And Quality Metrics 9 hours

Software Testing And Quality Metrics: Testing Software System Security - Six-Sigma – TQM - Complexity Metrics and Models – Quality Management Metrics - Availability Metrics

- Defect Removal Effectiveness - FMEA - Quality Function Deployment – Taguchi Quality Loss Function – Cost of Quality. Case Study for Complexity and Object Oriented Metrics

Laboratory Components:

Skills to be acquired:

- *Test generation from requirement*
- *Test generation from models.*
- *Test process and continuous quality improvement*

List of Exercises:

1. *Cause Effect Graph Testing for a Triangle Program.*
2. *Boundary Value Analysis for a Software Unit*
3. *Cyclomatic Complexity for Binary Search*
4. *Data Flow Testing for Gregorian Calendar*
5. *State based Testing for an Assembler*
6. *Stress Testing of a Map-Aided Vehicle Tracking and Scheduling System*
7. *Model Based Testing*
8. *Web Application Testing for Student Grade System*

Text Book(s):

1. *William Perry, "Effective Methods of Software Testing", Third Edition, Wiley Publishing 2007*
2. *Srinivasan Desikan and Gopalaswamy Ramesh, "Software Testing – Principles and Practices", Pearson Education, 2007.*

Reference Book(s):

1. *NareshChauhan, "Software Testing Principles and Practices" Oxford University Press, New Delhi, 2010.*
2. *Dale H. Besterfiled et al., "Total Quality Management", Pearson Education Asia, Third Edition, Indian Reprint (2006).*
3. *Stephen Kan, "Metrics and Models in Software Quality", Addison – Wesley, Second Edition, 2004*
4. *LleneBurnstein, " Practical Software Testing", Springer International Edition, Chennai, 2003*
5. *RenuRajani,Pradeep Oak, "Software Testing – Effective Methods, Tools and Techniques", Tata McGraw Hill,2004*
6. *Edward Kit, "Software Testing in the Real World – Improving the Process", Pearson Education, 1995.*
7. *Boris Beizer, " Software Testing Techniques" – 2 nd Edition, Van Nostrand Reinhold, New York, 1990*
8. *Adithya P. Mathur, "Foundations of Software Testing – Fundamentals algorithms and techniques", Dorling Kindersley (India) Pvt. Ltd., Pearson Education, 2008.*

CSCE 822 AGILE SOFTWARE PROCESS

3 2 0 3

Pre-requisite:

- *Knowledge in Software Engineering*

Objectives:

- *To understand the basic concepts of Agile Software Process*
- *To gain knowledge in the area of various Agile Methodologies.*
- *To develop Agile Software Process*
- *To know the principles of Agile Testing*

Module-I:INTRODUCTION 8 hours

Iterative development: Risk-Driven and Client-Driven iterative planning – Time boxed iterative development – During the iteration, No changes from external stakeholders – Evolutionary and adaptive development - Evolutionary requirements analysis – Early "Top Ten" high-level requirements and skillful analysis – Evolutionary and adaptive planning – Incremental delivery – Evolutionary delivery – The most common mistake –Specific iterative and Evolutionary methods.

Module-II: AGILE AND ITS SIGNIFICANCE 8 hours

Agile development: Classification of methods – The agile manifesto and principles – Agile project management – Embrace communication and feedback –Simple practices and project tools – Empirical Vs defined and prescriptive process – Principle-based versus Rule-Based – Sustainable discipline: The human touch – Team as a complex adaptive system – Agile hype – Specific agile methods.

Motivation: The facts of change on software projects – Key motivations for iterative development – Meeting the requirements challenge iteratively – Problems with the waterfall.

Evidence: Research evidence – Early historical project evidence – Standards-Body evidence – Expert and thought leader evidence – A Business case for iterative development – The historical accident of waterfall validity.

Module-III: AGILE METHODOLOGY 8 hours

Scrum Method overview – Lifecycle – Work products, Roles and Practices values –Common mistakes and misunderstandings – Sample projects – Process mixtures– Adoption strategies – Fact versus fantasy –Strengths versus "Other" history.

Module-IV: CASE STUDY 8 hours

Agile – Motivation – Evidence – Scrum – Extreme Programming – Unified Process –Evo– Practice Tips.

Module-V: AGILE PRACTICING AND TESTING 8 hours

Practice: Project management – Environment – Requirements – Test – The agile alliances – The manifesto – Supporting the values

Agile testing : Nine principles and sixconcrete practices for testing on agile teams.

Text Book(s):

1. *Craig Larman"Agile and Iterative Development – A Manager's Guide"Pearson Education – 2004.*
2. *Elisabeth Hendrickson, "Agile Testing" Quality Tree Software Inc 2008.*

Reference *Book(s):*

1. *Alistair "Agile Software Development series" Cockburn - 2001.*
2. *Robert C. Martin, Agile Software Development, Principles, Patterns, and Practices, Prentice Hall (2002).*

Web *Resources:*

1. ***www.****agileintro.wordpress.com/2008:Agile Introduction For Dummies*
2. *www.serena.com/docs/repository/solutions/intro-to-agile-devel.pdf:An Introduction to Agile Software Development*

CSCE 823 SOFTWARE RISK MANAGEMENT AND MAINTENANCE

L	S	P	C
3	2	0	3

Pre-requisite:

- *Knowledge in Software Engineering*

Objectives:

- *To understand the various risk levels in software development.*
- *To gain expertise in discovering risk and usage of risk assessment tools*
- *To understand the risk plan , implementation and tracking risks*
- *To realize the software maintenance process, measurement and benchmarking*
- *To expertise in the SQA maintenance tools*

Module-I: 9 hours

Risk Culture And Management Process: Risk- Basic Terms- Risk Vocabulary – Risk-Driven Project Management- Controlling the Process, Environment and Risk- Maturity in Risk Culture – Risk Scale – Preparing for Risk – Risk Management- Paradigms- Five Models of Risk Management – Thinking about Less Risky alternatives – Risk Management at Different Levels – Risk Escalation – Risk Models- Risk Intelligence - Software Risk Management steps.

Module-II: 9 hours

Discovering Risk And Assessment: Identifying software risk - Classification of Risks – Risk Taxonomy – Risk Mapping – Statements – Risk Reviews – Risk Ownership and stakeholder management – Risk Assessment Approach – Risk Assessment tools and techniques – Risk Probability, impact, exposure, matrix and Application Problem - Self - assessment checklist.

Module-III: 9 hours

Responding To Risks And Tracking: Special Treatment for Catastrophic risks- Constraint Risks – Risk Mitigation Plan Case Study – Contingency Plans- Implementing Risk Response- Tracking Risk Response and Hazards – Trigger Levels- Tracking Project Risks and Operational Risks- Learning by Tracking and Risk Tracker Tool.

Module-IV: 9 hours

Maintenance Process: Software Maintenance- Customer's Viewpoint- Economics of Maintenance- Issues in Maintenance- Software Maintenance Standard, Process, Activities and Categories – Maintenance Measurement – Service Measurement and Benchmarking – Problem Resolution – Reporting – Fix Distribution.

Module-V: 9 hours

Activities for Maintenance: Role of SQA for Support and Maintenance – SQA tools for Maintenance- Configuration Management and Maintenance – Maintenance of Mission Critical Systems – Global Maintenance Teams – Foundation of S3m Process Model- Exemplary Practices.

Text Book(s):

1. *C. RavindranathPandian, "Applied Software Risk Management: A guide for Software Project Managers", Auerbach Publications, 2007.*
2. *John Mcmanus, "Risk Management in Software Development Projects", Elsevier Butterworth- Heinemann, First Edition, 2004.*

Reference Book(s):

1. *Alian April and Alain Abran, "Software Maintenance Management: Evaluation and Continuous Improvement", John Wiley & Sons Inc, 2008*
2. *Gopalaswamy Ramesh and Ramesh Bhattiprolu, "Software Maintenance: Effective Practices for Geographically Distributed Environments", Second Reprint, Tata McGrawHill, 2009.*

CSCE 824SOFTWARE PROJECT MANAGEMENT

L	S	P	C
3	2	0	3

Pre-requisite:

- *Knowledge in Software Engineering*

Objectives:

- *This course is intended to provide the students with an overall view over Software Engineering Discipline and with insight into the processes of software development.*
- *To understand the various methods of Cost Estimation.*
- *To Study about Software Quality Management.*
- *To Study about Software Metrics*

Module-I: 9 hours

Project Concepts And Its Management: Project life cycle models-ISO 9001 model - Capability Maturity Model - Project, Planning-Project tracking-Project closure - Evolution of Software Economics –Software **Management Process Framework:** Phases, Artifacts, Workflows, Checkpoints – Software Management Disciplines: Planning / Project Organization and Responsibilities / Automation / Project Control – Modern Project.

Module-II: 9 hours

Cost Estimation: Problems in Software Estimation – Algorithmic Cost Estimation Process, Function, Points, SLIM (Software Life cycle Management), COCOMO II (Constructive Cost Model) – Estimating Web Application Development – Concepts of Finance, Activity Based Costing and Economic Value Added (EVA) – Balanced Score Card.

Module-III: 12 hours

Software Quality Management: Software Quality Factors – Software Quality Components – Software Quality Plan– Software Quality Metrics – Software Quality Costs – Software Quality Assurance-Standard – Certification – Assessment.

Module-IV: 12 hours

Software Management And Metrics: Software Configuration Management – Risk Management: Risk Assessment: Identification / Analysis / Prioritization – Risk Control: Planning / Resolution /Monitoring – Failure Mode and Effects Analysis (FMEA) –Defect Management-Cost Management. Software Metrics – Classification of Software Metrics: Product-Metrics: Size Metrics, Complexity Metrics, Halstead's Product Metrics, Quality, Metrics, and Process metrics.

Module-V: 12 hours

Project Evaluation And Emerging Trends: Strategic Assessment–Technical Assessment–Cost Benefit Analysis–Cash Flow Forecasting–Cost Benefit Evaluation Technique–Risk Evaluation–Software Effort Estimation. Emerging Trends: Import of the internet on project Management –people Focused Process Models.

Text Book(s):

1. *Ramesh Gopalaswamy ,"Managing and global Software Projects", TataMcGraw Hill Tenth Reprint, 2011.*

Reference *Book(s):*

1. *Demarco, T. and Lister, T. "Peopleware: Productive Projects and Teams, 2ndEd.", Dorset House,1999.*
2. *Royce, W. "Software Project Management: A Unified Framework", Addison-Wesley, 1998. Demarco, T. and Lister, T. "Peopleware: Productive Projects and Teams, 2ndEd.", Dorset House,1999.*
3. *Fenton, N.E., and Pfleeger, S.L.."Software Metrics: A Rigorous and PracticalApproach, Revised" Brooks Cole, 1998.*
4. *Kaplan, R.S., Norton, D.P. "The Balanced Scorecard: Translating Strategyinto Action", Harvard Business School Press, 1996.*
5. *Boehm, B. W. "Software Risk Management: Principles and Practices" in IEEE Software, January 1991, pp32-41.*
6. *Grant, J.L. "Foundations of Economic Value Added", John Wiley & Sons, 1997.*
7. *Cooper, R., "The Rise of Activity-Based Costing- PartOne: What is an Activity-Based Cost System" Journal of Cost Management, Vol.2, No.2*

CSCE 825 SOFTWARE ARCHITECTURE

L	S	P	C
3	2	0	3

Pre-requisite:

- *Knowledge in Software Engineering.*

Objectives:

- *Understand software architectural requirements and drivers.*
- *Be exposed to architectural styles and views.*
- *Be familiar with architectures for emerging technologies*

Module-I: 9 hours

Introduction And Architectural Drivers: Introduction – What is software architecture? – Standard Definitions – Architectural structures – Influence of software architecture on organization-both business and technical – Architecture Business Cycle- Introduction – Functional requirements – Technical constraints – Quality Attributes.

Module-II: 9 hours

Quality Attribute Workshop: Quality Attribute Workshop – Documenting Quality Attributes – Six part scenarios – Case studies.

Module-III: 9 hours

Architectural Views: Introduction – Standard Definitions for views – Structures and views – Representing views-available notations – Standard views – 4+1 view of RUP, Siemens 4 views, SEI's perspectives and views – Case studies.

Module-IV: 9 hours

Architectural Styles: Introduction – Data flow styles – Call-return styles – Shared Information styles – Event styles – Case studies for each style.

Module-V: 9 hours

Documenting The Architecture: Good practices – Documenting the Views using UML – Merits and Demerits of using visual languages – Need for formal languages – Architectural Description Languages – ACME – Case studies. Special topics: SOA and Web services – Cloud Computing – Adaptive structures.

Text Book(s):

1. *Len Bass, Paul Clements, and Rick Kazman, "Software Architectures Principles and Practices", 2nd Edition, Addison-Wesley, 2003..*
2. *Anthony J Lattanze, "Architecting Software Intensive System. A Practitioner's Guide", Auerbach Publications, 2010.*

Reference Book(s):

1. *Paul Clements, Felix Bachmann, Len Bass, David Garlan, James Ivers, Reed Little, Paulo Merson, Robert Nord, and Judith Stafford, "Documenting Software Architectures. Views and Beyond", 2nd Edition, Addison-Wesley, 2010.*
2. *Paul Clements, Rick Kazman, and Mark Klein, "Evaluating software architectures: Methods and case studies. Addison-Wesley, 2001.*
3. *RajkumarBuyya, James Broberg, and Andrzej Goscinski, "Cloud Computing. Principles and Paradigms", John Wiley & Sons, 2011.*

CSCE 826 SOFTWARE QUALITY ASSURANCE

L	S	P	C
3	2	0	3

Pre-requisite:

- *Knowledge in Software Engineering*

Objectives:

- *To understand the basic tenets of software quality and quality factors.*
- *Be exposed to the Software Quality Assurance (SQA) architecture and the details of SQA components*
- *Understand of how the SQA components can be integrated into the project life cycle.*
- *Be familiar with the software quality infrastructure.*
- *Be exposed to the management components of software quality.*

Module-I:9 hours

Introduction to Software Quality & Architecture: Need for Software quality – Quality challenges – Software quality assurance (SQA) – Definition and objectives – Software quality factors- McCall‟s quality model – SQA system and architecture – Software Project life cycle Components – Pre project quality components – Development and quality plans.

Module-II: 9 hours

Sqa Components and Project Life Cycle: Software Development methodologies – Quality assurance activities in the development process - Verification & Validation – Reviews – Software Testing – Software Testing implementations – Quality of software maintenance – Pre-Maintenance of software quality components – Quality assurance tools – CASE tools for software quality – Software maintenance quality – Project Management

Module-III: 9 hours

Software Quality Infrastructure: Procedures and work instructions - Templates - Checklists – 3S development team - Staff training and certification Corrective and preventive actions – Configuration management – Software change control – Configuration management audit - Documentation control – Storage and retrieval.

Module-IV: 9 hours

Software Quality Management & Metrics: Project process control – Computerized tools - Software quality metrics – Objectives of quality measurement – Process metrics – Product metrics – Implementation – Limitations of software metrics – Cost of software quality – Classical quality cost model – Extended model – Application of Cost model

Module-V: 9 hours

Standards, Certifications & Assessments: Quality management standards – ISO 9001 and ISO 9000-3 – capability Maturity Models – CMM and CMMI assessment methodologies - Bootstrap methodology – SPICE Project – SQA project process standards – IEEE st 1012 & 1028 – Organization of Quality Assurance – Department management responsibilities – Project management responsibilities – SQA units and other actors in SQA systems

Text Book(s):

1. *Daniel Galin, "Software Quality Assurance", Pearson Publication, 2009.*

Reference Book(s):

1. *Alan C. Gillies, "Software Quality: Theory and Management", International Thomson Computer Press, 1997.*
2. *Mordechai Ben-Menachem "Software Quality: Producing Practical Consistent Software", International Thompson Computer Press, 1997.*

CSCE 831 COGNITIVE SCIENCE

L	S	P	C
3	2	0	3

Pre-requisite:

- *Exposure to AI*

Objectives:

- *To learn the basics of Cognitive Science with focus on acquisition, representation, and use of knowledge by individual minds, brains, and machines*
- *To study the mind and intelligence, embracing psychology, artificial intelligence, neuroscience and linguistics*
- *To understand the role of neuro science in the cognitive field*

Module-I: Introduction to Cognitive Science 8hrs

The Cognitive view –Some Fundamental Concepts – Computers in Cognitive Science – Applied Cognitive Science – The Interdisciplinary Nature of Cognitive Science

Module-II: Cognitive Psychology 8hrs

Cognitive Psychology – The Architecture of the Mind - The Nature of Cognitive Psychology- A Global View of The Cognitive Architecture- Propositional Representation- Schematic Representation- Cognitive Processes, Working Memory, and Attention- The Acquisition of Skill- The Connectionist Approach to Cognitive Architecture

Module-III: Language Acquisition, Semantics and Processing Model 8hrs

Milestones in Acquisition – Theoretical Perspectives- Semantics and Cognitive Science – Meaning and Entailment – Reference – Sense – Cognitive and Computational Models of Semantic Processing – Information Processing Models of the Mind- Physical symbol systems and language of thought- Applying the Symbolic Paradigm- Neural networks and distributed information processing- Neural network models of Cognitive Processes

Module-IV: Integration Challenge 10hrs

Cognitive Science and Integration Challenge – Tackling the Integration Challenge.

Module-V: Tools 6hrs

Working with Concept Maps – Scribe Note making tools

Text Book(s):

1. *José Luis Bermúdez, "Cognitive Science: An Introduction to the Science of the Mind", 2014, Cambridge University Press, New York.*
2. *Neil Stillings, Steven E. Weisler, Christopher H. Chase and Mark H. Feinstein, "Cognitive Science: An Introduction", 1995, Second Edition, MIT press.*

CSCE 632 KNOWLEDGE REPRESENTATION AND REASONING

L	S	P	C
3	2	0	3

Pre-requisite:

- *Exposure to AI, formal languages, logic and programming*

Objectives:

- *Explore various representation formalisms and algorithms for reasoning*

Module-I: Logic and Inferences 8hrs

Formal Logic – Propositional Logic –Propositional Theorem Proving- Resolution method in propositional logic – FOL – Resolution – Forward Chaining – Backward Chaining - Refutation – Horn clauses and SLD resolution – Backward chaining – Second order logic

Module-II: Concepts and Language 8hrs

Conceptual Domain – Reification - RDF and Semantic web – Properties – Event Calculus – Conceptual Dependency Theory – Conceptual Analysis

Module-III: Structured Knowledge Representation 8hrs

Hierarchies in the Domain – Schema – Frames – Semantic Net – Scripts, Goals, Plans and MOP - Inheritance in Taxonomies – Description Logic – Formal Concept Analysis – Conceptual Graphs

Module-IV: Reasoning 8hrs

Knowledge Based Reasoning - Case Based reasoning – Default reasoning – Qualitative reasoning – Probabilistic reasoning – Stochastic Actions – Combining Evidences to form Beliefs

Module-V: Languages and Tools 8hrs

Working with LISP ,Prolog – RDF Tools – Ontology tools – SPARQL Implementation

Text Book:

1. *Deepak Khemani, A First Course in Artificial Intelligence, 2013, First Edition, McGrawHill.*
2. *Stuart J Russell and Peter Norvig, Artificial Intelligence – A Modern Approach, 2009, Third Edition, PHI*

CSCE 833 COMPUTATIONAL INTELLIGENCE

L	S	P	C
3	2	0	3

Pre-requisite:

- *Nil*

Objectives:
The subject aims to introduce students to

- *Fundamentals of key intelligent systems technologies including knowledge-based systems, neural networks, fuzzy systems, and evolutionary computation, and*
- *Practice in integration of intelligent systems technologies for engineering applications.*

Module-I: Introduction 5 hrs

Computational Intelligence: Intelligence machines -Computational intelligence paradigms – History- Expert Systems: Rule-based expert systems – Uncertainty management - Fuzzy expert systems:Fuzzy sets and operations of fuzzy sets - Fuzzy rules and fuzzy inference - Fuzzy expert systems

Module-II: Artificial Neural Networks 10 hrs

Fundamental neurocomputing concepts: artificial neurons, activation functions, neural network architectures, learning rules - Supervised learning neural networks: multi-layer feedforward neural networks, simple recurrent neural networks, time-delay neural networks, supervised learning algorithms - Unsupervised learning neural networks: self-organizing feature maps - Radial basis function networks - Deep neural networks and learning algorithms

Module-III: Evolutionary computation 10 hrs

Representation: Chromosomes-fitness functions- selection mechanisms -Genetic algorithms: crossover and mutation - Genetic programming -Evolution strategies

Module-IV: Hybrid Intelligent Systems 10 hrs

Neural expert systems -Neuro-fuzzy systems -Evolutionary neural networks

Module-V: Applications and case studies 5 hrs

Printed Character Recognition – Inverse Kinematics Problems – Automobile Fuel Efficiency Prediction – Soft Computing for Color Recipe Prediction-Case studies

Laboratory Components:

Skills to be acquired:

- Gain a working knowledge of knowledge-based systems, neural networks, fuzzy systems, and evolutionary computation;
- Apply intelligent systems technologies in a variety of engineering applications;

Lab Software Requirements:

- Implement typical computational intelligence algorithms in MATLAB

Text Book:

1. *A.P. Engelbrecht, Computational Intelligence: An Introduction, 2012,2nd Edition, John Wiley & Sons.*

Reference Books:

1. *Marsland S, Machine Learning: An Algorithmic Perspective, 2009, CRC Press.*
2. *S. Russell and P. Norvig, Artificial Intelligence – A Modern Approach,2010, Prentice Hall.*
3. *J.S.R.Jang, C.T.Sun and E.Mizutani, Neuro-Fuzzy and Soft Computing, 2004, PHI, Pearson Education.*
4. *Timothy J.Ross, Fuzzy Logic with Engineering Applications, 1997, McGraw-Hill.*

CSCE 834 ARTIFICIAL INTELLIGENCE FOR AUTOMATION

L	S	P	C
3	2	0	3

Pre-requisites:

- *Knowledge about data structures and algorithms*

Objective:

- *Understanding the various problem solving approaches*
- *Understanding the knowledge representation and reasoning techniques*
- *Understanding the handling of uncertain knowledge*

Module-I: INTRODUCTION TO PROBLEM SOLVING 8 hrs

Problem-Solving Agents, Example Problems, Searching for Solutions, Uninformed Search Strategies, Breadth-first search, Uniform-cost search, Depth-first search, Depth-limited search, Iterative deepening depth-first search, Bidirectional search. Informed (Heuristic) Search Strategies, Greedy best-first search, A* search, Heuristic Functions, The effect of heuristic accuracy on performance.

Module-II: Beyond Classical Search 8 hrs

Local Search Algorithms and Optimization Problems, Hillclimbing search, Simulated annealing, Local beam search, Genetic algorithms, Local Search in Continuous Spaces, Searching with Nondeterministic Actions, Searching with Partial Observations, Online Search Agents and Unknown Environments.

Module-III: Knowledge Representation 8 hrs

Ontological Engineering, Categories and Objects, Events, Mental Events and Mental Objects, Reasoning Systems for Categories, Semantic networks, Description logics, Reasoning with Default Information, Truth maintenance systems.

Module-IV: Uncertain knowledge and reasoning 8 hrs

Quantifying Uncertainty, Acting under Uncertainty, Basic Probability Notation, Inference Using Full Joint Distributions, Bayes' Rule and Its Use, Probabilistic Reasoning, R epresenting Knowledge in an Uncertain Domain, The Semantics of Bayesian Networks, Exact Inference in Bayesian Networks, Approximate Inference in Bayesian Networks, Inference by Markov chain simulation, Relational and First-Order Probability Models.

Module-V: Probabilistic Reasoning over Time 8 hrs

Time and Uncertainty, Inference in Temporal Models, Hidden Markov Models, Kalman Filters, Dynamic Bayesian Networks, Keeping Track of Many Objects, Combining Beliefs and Desires

under Uncertainty, The Basis of Utility Theory, Utility Functions, Multiattribute Utility Functions, Decision Networks, The Value of Information. Expert system architecture.

Text Book(s):

1. *Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", PEARSON 3rd ed,2009.*

Reference Book(s):

1. *DAN.W.Patterson, "Introduction to Artificial Intelligence and Expert Systems", PHI, 2nd edition, 2009.*
2. *George.F.Luger, "Artificial Intelligence", Pearson Education, Asia, 3rd Edition,2009.*

CSCE 835 NATURAL LANGUAGE PROCESSING

L	S	P	C
3	2	0	3

Pre-requisite:

- *Mathematical Methods for Computer Science,*
- *Logic and Proof,*
- *Knowledge of Programming*
- *Machine Learning*

Objectives:
At the end of the course, students should be

- *able to tag a given word with basic language processing features*
- *be able to discuss the current and likely future performance of several NLP applications;*
- *be able to describe briefly a fundamental technique for processing language for several subtasks, such as morphological processing, parsing, word sense disambiguation etc.;*
- *Understand how these techniques draw on and relate to other areas of computer science.*

Module-I: Introduction to NLP 8hrs

Knowledge in Speech and Language Processing -–Information Theory- Ambiguity Models and Algorithms, Language : N-gram Language Models - Evaluating Language Models, Thought and Understanding - The State of the Art and the Near term Future

Module-II: Speech Tagging and Transducers 8hrs

Part of Speech Tagging, Probability Basics: Hidden Markov - Maximum Entropy Models, Word Transducers: Finite State Transducers - Orthographic Rules - Finite-State Transducers Combining FST Lexicon Rules, Lexicon Free FSTs: The Porter Stemmer Human Morphological Processing.

Module-III: Syntax Parsing 8hrs

Syntax Parsing: Grammar Formalisms - Tree Banks - Parsing with Context Free Grammars - Features and Unification, Statistical parsing: probabilistic CFGs (PCFGs) - Lexicalized PCFG

Module-IV: Semantic Analysis 8hrs

Representing Meaning – Semantic Analysis - Lexical Semantics – Computational Lexical Semantics - Supervised – Dictionary based and Unsupervised Approaches - Compositional Semantics - Semantic Role Labelling - Semantic Parsing – Discourse Analysis.

Module-V: Case Studies and Applications 8hrs

Machine Translation Language Similarities and Differences - Named Entity Recognition and Relation Extraction- IE using sequence labelling-Machine Translation (MT) - Basic issues in MT-Statistical translation - Word Alignment - Phrase-based Translation – Question Answering

Laboratory Components:

Skills to be acquired:

- *Sentence Extraction*
- *Medical Language Extraction*
- *Semantic Tutorial for Languages*

Lab Software Requirements:

- *Any Programming Language*

List of Exercises:

1. *Build language models and generate text from them*
2. *Recognize sentences and separate the words*
3. *Speech tagging*
4. *Identify and find all mentions in unstructured text of named entities*
5. *making a simple supervised WSD classifier*
6. *determining topics from text (Lexical analysis)*

Text Book(s):

1. *Daniel Jurafsky and James H. Martin, Martin Speech and Language Processing, 2008, 2nd Edition, Prentice Hall.*
2. *Christopher D. Manning and HinrichSchuetze, Foundations of Statistical Natural Language Processing, 1999, MIT Press.*

Reference Book(s):

1. *James Allen, Natural Language Understanding, 1994, 2nd Edition, Addison Wesley.*
2. *Steven Bird, Ewan Klein and Edward Loper, Natural Language Processing with Python, O'Reilly Media, 2009, 1st Edition.*

Web Resources:

1. *http://www.nltk.org/*
2. *http://www.ucl.ac.uk/internet-grammar/home.htm*

CSEL 476 INTRODUCTION TO ROBOTICS

L	T	P	C
3	0	0	3

Pre-requisites:

- *Mathematical Foundation of Computer Science*
- *Basics of Machine Learning*

Objectives:

- *To understand agents, principles and applications*
- *Design, build and program simple autonomous robots.*

Module-I: Agents, Paradigms, Sensors (9 hrs)

Intelligent agents-Search overview-Adversarial search-Constraint satisfaction- Paradigms: Hierarchical, Reactive- Types of Sensors-Vision

Module-II: Knowledge representation, reasoning and planning (9 hrs)

Predicate logic-Fuzzy logic-Classical planning-Planning and acting in real world-Navigation

Module-III: Learning (9 hrs)

Decision making-Learning from examples-Knowledge in learning-Learning probabilistic models-Reinforcement learning-Deep learning

Module-IV: Robot Programming (9 hrs)

Features of various programming methods, Robot Task planning: concept, different methods, robot learning, Mobile Robot: Introduction, obstacle Representatives, Motion Planning in fixed and Changing structure - Simple Programs.

Module-V: Industrial Applications and Case Studies (9 hrs)

Application of robots: Material handling - Machine loading and unloading – Assembly – Inspection –Recent developments in Robotics- Safety Considerations.

Text Books:

1. *Robin.R.Murphy, Introduction to AI Robotics, MIT press, 2000.*
2. *Stuart J Russell and Peter Norvig, Artificial Intelligence – A Modern Approach, Third Edition, PHI,2010.*

Reference Books:

1. *Kortenkamp, D., Bonasso, R. P., & Murphy, R. (Eds.). Artificial intelligence and mobile robots. Menlo Park, CA: AAAI Press,1998*
2. *Mikell P Groover & Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, Industrial Robotics, Technology programming and Applications, McGraw Hill, 2012.*
3. *M. P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas G. Odrey, Industrial Robotics Technology, Programming and Applications, McGraw Hill, Int. 2008.*

CSCE 841 INTRODUCTION TO HUMAN COMPUTER INTERACTION

L	S	P	C
3	2	0	3

Pre-requisites:

- *Basic Understanding of Graphical User Interface.*

Course Objectives:

- *Understanding the components of Human Computer Interaction*
- *Understanding the basics of interaction design*
- *Understanding the fundamentals of Universal design*

Module I : The Components

The Human : Human Memory – Thinking – Emotion – Individual Preferences – Psychology and Design of Interactive Systems. The Computer : Text Entry Devices – Pointing Devices – Display Devices – Devices for Virtual Reality and 3D interaction – Physical Controls, Sensors and Special Devices – Memory – Processing and Networks.

Module II: The Interaction

Models of Interaction – Frameworks and HCI- Ergonomics – Interaction Styles – Elements of WIMP interface – Interactivity – Context of interaction – User Experience; Interaction Design Basics : Design Definition – The process of Design – User Focus – Scenarios – Navigation Design – Screen design and Layout – Iteration and prototyping.

Module III:

HCI in the software process: The software life cycle – Iterative design and prototyping – Design rationale. Design Rules: Introduction – Principles to support usability – Standards – Guidelines – Golden rules and heuristics – HCI patterns

Module IV:

Dialog Notations and design – Dialog semantics – Modeling rich interaction – Cognitive models – Evaluation techniques.

Module V: Universal Design

Universal design principles – multimodal interaction – design for diversity; User Support: requirements of user support – approaches to user support – adaptive help systems – designing user support systems.

Text Book:

1. *Alax Dix, Janet Finaly, Gregory D. Abowd, Russell Beale. Human Computer Interaction-Third Edition – Pearson Prentice Hall Publishers.*

Reference Book:

1. *Jonathan Lazar. Research Methods in Human–Computer Interaction - John Wiley &Sons(2009)*

MOOC

1. *NPTEL Course on Human Computer Interaction (HCI) : http://nptel.ac.in/courses/106103115/*

CSCE 842 PRINCIPLES OF INTERACTION DESIGN

L	S	P	C
3	2	0	3

Pre-requisites:

- *Basic Understanding of Human-Computer Interaction methodology and GUI styles*

Course Objectives:

- *Focuses on creating interfaces, systems, and devices revolving around user behavior.*
- *Explores the interaction design process, explains how interaction designers work and the tools they use, and details the essential principles of interaction design*

Module - I

Introduction: Goals of System Engineering – Goals of User Interface Design – Motivations of Human factors in Design – High Level Theories –Object-Action Interface Design - Three Principles – Guidelines for Data Display and Data Entry

Module - II

Managing Design Process: Organizational Design to Support Usability – The Three Pillars of Design Development Methodologies- Ethnographic Observation – Participating Design- Scenario Development- Social Impact Statement for Early Design – Legal Issues- Reviews – Usability Testing and laboratories- Surveys- Acceptance tests – Evaluation during Active use- Specification Methods- Interface – Building Tools- Evaluation and Critiquing tools

Module - III

Manipulation and Virtual Environments: Introduction-Examples of Direct Manipulation Systems –Explanation of Direct Manipulation-Visual Thinking and Icons – Direct manipulation Programming – Home Automation- Remote Direct Manipulation- Virtual Environments- Task-Related Organization – Item Presentation Sequence- Response Time and Display Rate – Fast Movement Through Menus- Menu Layouts- Form Filling – Dialog Box – Functionality to Support User's Tasks – Command Organization Strategies – Benefits of Structure- Naming and Abbreviations – Command Menus- Natural Language in Computing.

Module- IV

Interaction Devices: Introduction – Keyboards and Functions – Pointing Devices- Speech recognition ,Digitization and Generation – Image and Video Displays – Printers –Theoretical Foundations –Expectations and Attitudes – User Productivity – Variability – Error messages – Non anthropomorphic Design –Display Design – color-Reading from Paper versus from Displays- Preparation of Printed Manuals- Preparation of Online Facilities.

Module-V

Windows Strategies and Information Search: Introduction- Individual Window Design- Multiple Window Design- Coordination by Tightly –Coupled Window- Image Browsing- Personal Role Management and Elastic Windows – Goals of Cooperation – Asynchronous Interaction – Synchronous Distributed – Face to Face- Applying Computer Supported Cooperative Work to Education – Database query and phrase search in Textual documents – Multimedia Documents Searches – Information Visualization – Advance Filtering Hypertext and Hypermedia – World Wide Web- Genres and Goals and Designers – Users and their tasks – Object Action Interface Model for Web site Design

Text book:

1. *Ben Shneiderman , " Designing the User Interface", 5th Edition, Addison-Wesley, 2010*

Reference books:

1. *Barfied , Lon , "The User Interface : Concepts and Design", Addison – Wesley.*
2. *Wilbert O. Galiz , "The Essential guide to User Interface Design", Wiley Dreamtech.*
3. *Jacob Nielsen, "Usability Engineering ", Academic Press.*
4. *Alan Dix et al, "Human - Computer Interaction ", Prentice Hall, 2012.*

CSCE 843 WEB ACCESSIBILITY

L	S	P	C
3	2	0	3

Pre-requisites:

- *Basic Understanding of Web Technologies.*

Course Objectives:

- *Understanding the components of web accessibility*
- *Understanding Accessibility standards and Evaluation Processes.*
- *Acquiring skills to evaluate and make the web contents accessible*.

Module I : Introduction

The need for Web accessibility – Universal Design – Types of Disabilities and Accessibility Requirements – Introduction to Guidelines and Standards – Accessibility Myths – Assistive Technologies - Benefits of Accessible Design.

Module II: Web Content Accessibility Guidelines

Web Contents Accessibility Guidelines – WCAG 1.0 vs WCAG 2.x – Principles : Perceivable – Operable – Understandable – Robust – Levels A, AA, AAA – WCAG standards evaluation tools and Comparative analysis.

Module III: Universal Design of Components

Component Specific Requirements : Images – Hyperlinks – Color contrast – Audio and Video components – Tables – Forms – Document Accessibility – Dynamic web contents Accessibility – Mobile Content Accessibility.

Module IV: WAI –ARIA and Other Standards

Web Accessibility Initiatives – Accessible Rich Internet Applications – Features. ATAG : Authoring tools accessibility guidelines – UAAG : User Agents Accessibility Guidelines – Accessibility Laws.

Module V:

Readability: Text Readability – Evaluation : Flesch-Kincaid - Gunning Fog - SMOG index – Dale Challe Score – Other Readability Scores – Web Content Readability. Security and Accessibility : Web Security Concerns for Persons with Disabilities – Making Security accessible.

Laboratory Components:
Skills to be acquired:

1. *Evaluating the Web Accessibility*
2. *Designing Accessible Pages*

Lab Software Requirements:

1. *Open Source Web Development tools.*

List of Exercises:

1. *Exercises to make the student to acquire web accessibility evaluation skills.*
2. *Exercises to make the student to acquire accessibility evaluation comparison skills.*
3. *Exercises to make the student to acquire skills related with accessible page design.*
4. *Exercises to make the student to acquire skills related with design accessible mobile web apps.*

Reference Book:

1. *Simon Harper, YelizYesilada (Editors) . Web Accessibility: A Foundation for Research – Springer Publications.*

Web Resources:

1. *W3C Resources on Web Accessibility https://www.w3.org/WAI/intro/accessibility.php*
2. *WebAIM(Web Accessibility in Mind) Resources : http://webaim.org*

Online Courses

1. *Introduction to Web Accessibility by Google : https://webaccessibility.withgoogle.com/course*

CSCE 844 CONTEXT AWARE COMPUTING

L	S	P	C
3	2	0	3

Pre-requisites:

- *Basic Knowledge of mobile computing and distributed systems*

Course Objectives:

- *Getting familiar with the components of Context aware computing*
- *Acquiring skills to build context aware applications*

Module I

Introduction: Context, Context awareness and Situations – Analogies – Elements of a Context aware System – Architecture – Infrastructure, Middleware and Toolkits.

Module II

Context aware mobile devices – Location bases serviced – ambient services – e-communities – Interaction in context aware systems.- Enhancing context-aware mobile services.

Module III

Context aware mobile software agents – Context-aware addressing and communication for people, things and Software agents.

Module IV

Context aware sensor networks – Context awareness and mirror-world models – Constructing context aware pervasive systems : Declarative approaches and design patterns.

Module V

Context Aware Security: Traditional Security issues – models – context aware security systems – context aware safety.

References:

1.Seng W. Loke, Context aware pervasive systems-Architecture for a new breed of applications, Auerbach publications, 2006.

2. Context-Aware Mobile and Ubiquitous Computing for Enhanced Usability: Adaptive Technologies and Applications: Dragan Stojanović, IGI Global Snippet, 2009.

3. Rocha, Ricardo CoutoAntunes da, Endler, Markus, Context Management for Distributed and Dynamic Context-Aware Computing, Springer,2012.

CSCE 845 DATA VISUALIZATION

L	S	P	C
3	2	0	3

Pre-requisites:

- *Basic Understanding of Interaction design.*
- *Basic Understanding of Programming*

Course Objectives:

- *Understanding the Objectives of Data Visualization*
- *Acquiring skills in professional data visualization techniques*
- *Understanding the fundamentals of Universal design*

Module *I :**Introduction*

Introduction to Data Visualization – History of Visualization – Need for Visualization - Interactive Visualization – Web Specific Components – Common Types of Data Visualization – Data Visualization and Infographics – Dashboards.

Module II:

Data Abstraction : Data Set types – Attribute Types – Semantics. Task Abstraction : Actions – Targets. Charts – Data Preprocessing - Choosing the optimal charts – Making charts effective – Context in Visualization - Analyzing Visual Patterns – Beautiful vs Useful Design - Cognitive Load Theory - Responsive Design principles.

Module III:

Perception and Visualization – Perceptual processing – Metrics - The Visualization Process – Visual Variables – Taxonomies.

Visualization validation : Threats to Validity – Validation approaches .

Module IV:

Spatial Data Visualization - Multivariate Data Visualization Techniques : Point-Based – Line based – Region based – Hybrid Techniques – Visualization techniques for trees, graphs and networks – Text and Document Visualization.

Module V: Universal Design

Interaction concepts – Interaction techniques: screen space – object space – data space – attribute space – Interaction Control – Web specific visualization with the case study of D3.

Laboratory Components:

Skills to be acquired:

1. *Building effective visualization*
2. *Design and development of interactive visualization*

Lab Software Requirements:

1. *Open Source Web Development and visualization tools.*

List of Exercises:

1. *Exercises to make the student to acquire chart building skills with code.*
2. *Exercises to make the student to acquire skills to build effective infographics.*
3. *Exercises to make the student to acquire skills related with web based visualization.*
4. *Exercises to make the student to acquire skills to handle various visualization libraries such as D3*
5. *Exercises to make the student to acquire advanced visuzliation mechanisms such as Dendrogram, Node-link tree etc.*

Text Book:

1. Matthew O.Ward Interactive Data Visualization: Foundations, Techniques, and Applications AK Peters / CRC Press.

2. Mico Yuk. Data Visualization For Dummies
3. Tamara Munzner. Visualization Analysis and Design AK Peters Publications.

Web Resources :

1. http://chimera.labs.oreilly.com/books/1230000000345/ch01.html#_why_write_code (Interactive Data Visualization for the web – Open Book)

CSCE 846 SOCIAL COMPUTING SYSTEMS

L	S	P	C
3	2	0	3

Pre-requisites:

- *Basic Understanding of HCI Concepts*

Course Objectives:

- *Understanding the components of Social computing systems.*
- *Acquiring skills to analyse the social network data.*

Module I :

Introduction to Social computing – Human centeredcomputing : Methods – benefits – incentives – computer supported cooperative work – collaboration platforms- Introduction to Crowd sourcing: Components – activities.

Module II:

Social Network methods : Social network data – Graphs to represent social relations – Matrices to represent social relations – working with network data – Connection: Networks and actors – basic demographics – density – reachability – connectivity – distance.

Module III:

Embedding: Introduction – density – reciprocity – transitivity – clustering – Group external and internal ties – Krackhardt's graph theoretical dimensions of hierarchy - Ego networks.

Module IV:

Opinion Formation Models – Cultural and language dynamics – crowd behavior patterns – Hierarchies formation – Propagation models in social networks ; Advertisements and social network systems.

Module V:

Statistical tools to analyze social network data – Sentiment analysis – Recommendation systems – Link prediction in social networks.

Ref Books:

1. *Cioffi-Revilla, Claudio. Introduction to Computational Social Science, Springer, 2014.*
2. *Robert Hanneman and Mark Riddle. Introduction to social network methods. Online Open Book.*
3. *Matthew A. Russell. Mining the Social Web: Data Mining Facebook, Twitter, Linkedin, Google+, Github, and More, 2nd Edition, O'Reilly Media, 2013.*
4. *Jennifer Golbeck, Analyzing the social web, Morgan Kaufmann, 2013.*

MOOC:

https://www.coursera.org/learn/social-computing

CSCE 851 AUTOMATA, COMPUTATBILITY AND COMPLEXITY

L	S	P	C
3	2	0	3

Pre-requisite:

- *Knowledge of discrete mathematics, proofs, data structures and algorithms*

Objectives:

- *Introduce concepts in automata theory, design recognizers for different formal languages, and determine decidability and complexity of computational problems.*

Module-I: Introduction to theory of computation and Finite Automata10hrs

Mathematical preliminaries – Basic concepts – Applications – DFA – NFA – Equivalence – Reduction of states.

Module-II: Regular Language (RL) , Regular Grammar, Properties of RL8hrs

Regular Expressions (RE) – Relation between RE and RL – Regular Grammars – Properties – Context Free Grammars (CFG)

Module-III: Simplification of Context Free Grammars & Normal Forms 8hrs

Methods for transforming Grammars – Chomsky and Greibach Normal Forms

Push Down Automata (PDA)

Non-deterministic PDA – PDA and Context Free Languages (CFL) – Deterministic PDA and CFL

Module-IV: Properties of CFL and Turing Machines6hrs

Pumping lemma –closure properties

Turing machines (TM) – the standard TM – Turings' thesis – Linear Bounded Automata

Module-V: Algorithmic computation8hrs

Problems that cannot be solved by TM – Undecidable problems for recursively enumerable and context-free languages- Post correspondence problem

Computational complexity

Efficiency of computation – TM and complexity – language families and complexity classes – complexity classes P and NP.

Text Book:

1. *Peter Linz, An introduction to Formal Languages and Automata, 2012, Fifth Edition, Jones & Bartlett Learning.*

Reference Books

1. *Automata, Computability and Complexity: Theory and Applications, Pearson Education India; 1 edition 2012.*
2. *Moore, Cristopher, and Stephan Mertens.* The Nature of Computation. *Oxford University Press, 2011.*
3. *Arora, Sanjeev, and Boaz Barak. Computational Complexity: A Modern Approach. Cambridge University Press, 2009.*

Web resources

1. www.Automatatutor.com

MOOC

1. NPTEL COURSE ON Formal languages and Automata Theory - https://nptel.ac.in/courses/111103016/

CSCE 852 MATHEMATICAL LOGIC FOR COMPUTER SCIENCE

L	S	P	C
3	2	0	3

Pre-requisite:

- *Exposure to Automata Theory*

Objectives:

- *To learn the basics of mathematical logic*
- *To apply those concepts in various computer science domain*

Module-I: Introduction 8 hrs

Objective – History – Terminology – Propositions, Beliefs and declarative sentences – Contradictions - Formalization – Formalizing the language – Extending the language

Module-II: Propositional Logic 8 hrs

Formulas, Models, Tableaux – Deductive systems – Resolution – Binary Decision Diagrams -

Module-III: First order Logic 8 hrs

Formulas, Models, Tableaux – Deductive systems - Gentzen system – Hilbert system – C-Rule - Formulas to Logic, Horn clauses in SLD resolution – Search Rules

Module-IV: Temporal Logic 8 hrs

Introduction – Syntax and semantics – Models of Time – Linear Temporal Logic – Binary temporal operators and its Axioms

Module-V: Tools 8 hrs

Working with Prolog programs – Standard ML programs

Text Books:

1. *Steve Reeves and Michael Clarke, "Logic for Computer Science", 2003, Addison – Wesley.*
2. *M Ben Ari," Mathematical Logic for computer science", 3rd Edition, 2015, Prentice Hall.*

CSCE 853 COMPLEXITY THEORY

L	S	P	C
3	2	0	3

Course Pre-requisite:
Prior knowledge of following materials is assumed. A brief overview of basics will be given in the first lecture. Other than this, the course should be self-contained.

- *Computation Theory*
- *Automata Theory*
- *Linear Algebra, Algorithms*

Course Objectives:

At the end of the course the student will be able to

- *Understand the fundamental concepts of Complexity theory*
- *Provide the concepts of complexity classes and reduction problems*
- *Enumerate NP-complete and NP-equivalent problems*
- *Discuss complexity of approximation problems and black box problems*
- *Describe communication complexity*

Module-I : INTRODUCTION (8 hours)
Introduction: Complexity Theory – Algorithmic Problems and Their Complexity – Algorithmic Problems – Some Important Algorithmic Problems – Measuring Computation Time

Module- II : COMPLEXITY CLASSES & REDUCTIONS (8 hours)

Complexity classes: Randomized Algorithms – The Fundamental Complexity Classes for Algorithmic Problems – The Fundamental Complexity Classes for Decision Problems Reductions: Algorithmic Relationships Between Problems – Reductions Between Various Variants of a Problem.

Module-III : NP-COMPLETE AND NP-EQUIVALENT PROBLEMS (8 hours)
NP-Completeness: Theory of NP-Completeness – Fundamental Considerations Problems in NP – Alternative Characterizations of NP – NP-complete and NP-equivalent Problems – Traveling Salesperson Problems – Knapsack Problems – Scheduling Problems

Module- IV : COMPLEXITY OF APPROXIMATION PROBLEMS (8 hours)
Complexity of Approximation Problems: Complexity Classes – Approximation Algorithms – Approximation-Preserving Reductions. Complexity of Black Box Problems: Black Box Optimization

Module-V : COMMUNICATION COMPLEXITY (8 hours)
The Communication Game – Nondeterministic Communication Protocols – Communication Complexity and VLSI Circuits – Communication Complexity and Computation Time

Text Book(s):

1. *Ingo Wegener, "Complexity Theory: Exploring the limits of efficient algorithms", Springer-Verlag Berlin Heidelberg, 2005.*
2. *Sanjeev Arora, "Computational Complexity - A Modern Approach", Cambridge University Press, 2009.*

Reference Book(s):

1. *Neil F.Johnson, "Simply Complexity: A Clear Guide to Complexity Theory", Oneworld Publications, 2007.*

2. *OdedGoldreich, "Computational Complexity: A Conceptual Perspective", Cambridge University Press, 2008.*

CSCE 854 COMPUTABILITY THEORY

L	S	P	C
3	2	0	3

Pre-requisite:

- *Exposure to Automata Theory and basic logic*

Objectives:

- *To learn the basics of mathematical logic and computability*
- *To apply those concepts in various computer science domain*

Module-I: Computability Theory 8 hrs

Enumerability – Diagonalization – Turing Computability – Uncomputability – Abacus Computability – Recursive functions – Recursive sets and relations – Equivalent definitions of computability

Module-II: Logic8 hrs

First order Logic – Syntax and Semantics – Undecidability of First Order Logic – Monadic and Dyadic Logic – Second order Logic- Modal Logic and Provability

Module-III: Logic Proofs8 hrs

Models - The Existence of models – Proofs and completeness – Indefinitability, undecidability, Imcompleteness – Unprovability of consistencey

Module-IV: Logic Theorems 8 hrs

Normal Forms – Disjunctive and Prenex Normal forms – Skolem Normal Form - Herbrand's Theorem - Craig Interpolation Theorem – Ramsey's Theorem

Module-V: Tools 8 hrs

Working with Prolog – IDP – FLORID - MOLTAP

Text Book:

1. George S Boolos, John P Burgess and Richard C Jeffrey, "Computability and Logic", Fifth Edition, 2007, Cambridge University Press, New York.

Reference Book:

1. *Martin Davis, "Engines of Logic: Mathematicians and the origin of computers", 2001, Norton*

CSCE 855-ADVANCED COMPILER DESIGN

L	S	P	C
3	2	0	3

Pre-requisite:

- *Knowledge of data structures, algorithms, compilers, architecture, assembly language programming*

Objectives:

- *Discuss advanced issues in the design and implementation of compilers*

Module-I:

Compilers and Scanner - 10hrs

Overview of compilation –compiler structure – Translation - Introduction to Scanners – Regular expressions – Scanner – Implementing scanners

Module-II: Parser and Context sensitive analysis 10 hrs

Expressing syntax – top down parsing – Bottom Up Parsing – Practical issues

Type systems – attribute grammar framework – Adhoc SDT

Module-III: Intermediate Representation and Optimization 10 hrs

Graphical IR – Linear IR – Mapping values to names – Symbol Table

Scope of optimization – Local – Regional – global – Interprocedural optimization

Module-IV: Data flow analysis and Scalar optimization 8 hrs

Iterative data flow analysis – Single static assignment - Interprocedural analysis

Useless code elimination - code motion – specialization – redundancy elimination – other transformations

Module-V: Instruction selection, scheduling and register allocation 10 hrs

Code generation – tree pattern matching – peephole optimization

Instruction scheduling – local list – Regional scheduling

Register allocation – issues – local allocation – global allocation

Text Book:

1. *Keith D Cooper and Linda Torczon, Engineering a Compiler, Morgan Kaufmann, 2 edition, 2011*

Reference Book:

1. *Advanced Compiler Design and implementation, Steven Muchnick, .Morgan Kaufmann Publishers , 1997*

MOOC: *https://in.udacity.com/course/compilers-theory-and-practice--ud168*

CSCE 861 DESIGN OF MODERN HEURISTICS

L	S	P	C
3	2	0	3

- *Pre-requisite: Knowledge of fundamental concepts of Designing Strategies, Complexity analysis of Algorithms, followed by problems on Graph Theory and Sorting methods*

- *Objectives: To enable the students to understand and appreciate and to design application and to learn and practise the optimization techniques.*

Module-I: Optimization Problems9 hours

Introduction - Solution Process - RecognizingProblems, Defining Problems, Constructing Models, Solving Models Validating Solutions, Implementing Solutions - Problem Instances- Search Spaces - Metrics, Neighborhoods, Fitness Landscapes, Optimal Solutions - Properties of Optimization Problems - Problem Difficulty, Locality, Decomposability

Module-II: Optimization Methods 10 hours

Analytical and Numerical Optimization Methods- Optimization Methods for Linear, Continuous Problems - Linear Optimization Problems, Simplex Method - Optimization Methods for Linear, Discrete Problems -Heuristic Optimization Methods - Heuristics, Approximation Algorithms, Modern Heuristics

Module-III: Design elements and Principles9 hours

Analytical and Numerical Optimization Methods-Optimization Methods for Linear, Continuous Problems - Optimization Methods for Linear, Discrete Problems - Heuristic Optimization Methods

Module-IV: Search Strategies 9 hours

Local Search Methods - Recombination-Based Search - Genetic Algorithms, Estimation of Distribution Algorithms, Genetic Programming

Module-V: Case Study8 hours

The Optimal Communication Spanning Tree Problem - Biasing Modern Heuristics for OCST Problems - Search Operator - Representation - Initialization - Using an MST as Initial Solution

Text Book(s):

1. *Rothlauf, Franz, Design of Modern Heuristics - Principles and Application, Nature Computing Series, Springer 2011.*

Reference Books:

1. *Xiaopeng Fang, Engineering Design Using Genetic Algorithms, Iowa State University 2007.*
2. *David E. Goldberg, Genetic Algorithms in Search, Optimization, and Machine Learning, Addison -Wesley publishing company, Inc., 1st Edition, 1989.*

CSCE 862 EVOLUTIONARY ALGORITHMS

L	S	P	C
3	2	0	3

Pre-requisite:

- *Programming competence.*
- *An Algorithms course should suffice.*
- *A general course in artificial intelligence is desirable, but not necessary*

Objectives:

- *To master the basics of EA*
- *To learn the techniques for solving optimization problems through EA*

Module-I: Introduction to EA5 hours
EA Basics: Introduction to Evolutionary Computation: Biological evolution and genetics- artificial evolution, Basics of optimization and search space , evolutionary computation and AI, - The Historical Development of EC Classes of EA- Structure of EA - Advantages of Evolutionary Computation -.Hybridization with Other Methods - Parallelism - Applications of Evolutionary Computation - computational time complexity of the algorithms.

Module-II: Genetic Algorithm10 hours
A simple genetic algorithm- Biological background - Encoding- Fitness Evaluation techniques - Search Operators: Crossover, mutation- Selection Schemes: Fitness proportional selection and fitness scaling, ranking, tournament selection, Selection pressure and its impact on evolutionary search.
The Schema Theorem in GA- Building Block Hypothesis - Applications of GA in Engineering problems, job shop scheduling and routing problems

Module-III: Advanced operators and techniques in Genetic Algorithm 8 hours
Inversion and reordering operators – Micro operators- Population sizing - Advanced selection schemes- Types of GA- Parallel & Distributed GA- Hybrid GA- Adaptive GA – Genetic algorithm implementation using MATLAB.

Module-IV: Genetic Programming8 hours
Genetic programming and how it differs from GA., The creation and regeneration of populations: crossover, mating, and reproduction Classic GP problems and their solutions: Santa Fe Trail, Symbollic regression, boolean circuit design.

Module-V: Multi-objective Optimization8 hours
Linear and nonlinear multi-objective problems, convex and non – convex problems, dominance – concepts and properties, Pareto – optimality, Use of Evolutionary Computations to solve multi objective optimization. NSGA, SPEA ,etc. for multi-objective optimization.

Text Book(s):

1. *Sivanandam, S.N., Deepa, S. N ,Introduction to Genetic Algorithms, Springer, 2008*
2. *Deb, K.: Multi-Objective Optimization using Evolutionary Algorithms, John Wiley and Son, 2002.*

3. *John Koza, Genetic Programming, MIT Press, 1992*

Reference Book(s):

1. *D. E. Goldberg, Genetic Algorithm In Search, Optimization And Machine Learning, New York: Addison _ Wesley (1989)*

CSCS 863 LINEAR OPTIMIZATION

L	S	P	C
3	2	0	3

Pre-requisite:

- *Basic Mathematical Knowledge*

Objectives:

- *To enable the students to become a sophisticated practitioner of (linear) optimization, or a researcher.*

Module-I: Introduction to Linear Programming 9 hours
Introduction- The geometry of Linear programming - Polyhedra and convex sets – Extreme points, vertices and basic feasible solution –Polyhedra in standard form – Degeneracy – Existence and Optimality of extreme points–Representation of the polyhedral – Projection of polyhedral.

Module-II: Simplex Method 9 hours
Optimality conditions – Development of simplex method – Implementation of the simplex method–Anticyclying–Finding the initial basic feasible solution – Column geometry and the simplex method – Computational efficiency of the simplex method.

Module-III: Duality theory and Sensitivity analysis 11 hours
The dual problem–The duality theorem–Optimal dual variables as marginal costs, standard form problems and dual simplex method–Farkas` lemma and linear inequalities–Form separating hyper planes to duality–Cones and extreme rays–Representation of polyhedral – General linear programming duality–Local sensitivity analysis–Global dependence on right – hand side vector–The set of all dual optimal solutions–Global dependence on the cost vector– Parametric programming.

Module-IV: Large scale Optimization 8 hours
Delayed column generation–The cutting stock problem–Cutting plane methods – Dantzig-Wolfe decomposition– Stochastic programming and Benders decomposition

Module-V: Network flow problems 8 hours
Graphs–Formulation of the network flow problem–The network simplex algorithm–The negative cost cycle algorithm–The maximum flow problem–Duality in network flow problems–Dual ascent methods–Theassignment problem and the auction algorithm–The shortest path problem–The minimum spanning tree problem

Text Books:

1. *Dimitris Bertsimas, John N. Tsitsiklis, Introduction to Linear Optimization, Athena Scientific; 1997.*
2. *Dimitri P. Bertsekas, Dynamic Programming and Optimal Control, Athena Scientific; 4th edition (1 September 2005).*

Reference Books:

1. *Stanislaw H. Zak Edwin K.P. Chong, An Introduction to Optimization, Wiley, Second edition (2010)*
2. *R. Fletcher, Practical Methods of Optimization, Wiley, Second edition (2009)*
3. *Kalyanmoy Deb, Optimization for Engineering Design: Algorithms and Examples, Prentice Hall India Learning Private Limited; Second edition (2012)*

CSCE 864 NATURE INSPIRED ALGORITHMS

L	S	P	C
3	2	0	3

- *Pre-requisite:*
  Basic Knowledge of optimization theory
- *Objectives:*
  To enable the students to understand and appreciate the design of nature inspired algorithms and to explore the Meta-heuristic *techniques.*

Module-I: Single solution based Meta-heuristics 9 hours

Introduction-Newton's Method – Optimization: Gradient-Based Algorithms, Hill Climbing with Random Restart - Search for Optimality–No Free Lunch Theorems - Nature Inspired Meta heuristics - A Brief History of Metaheuristics

Module-II: Evolutionary Algorithms 7 hours

Analysis of Optimization Algorithms - Nature-Inspired Algorithms – Cultural Algorithm- Co Evolutionary Algorithm - Simulated Annealing

Module-III: Swarm Intelligence 10 hours

Swarm Intelligence – ACO Algorithm - PCO Algorithm – Bacterial Optimization – Ant and Bee Colony Optimization based Algorithm – Bio-Geography Based Optimization - Accelerated PSO - Convergence Analysis: Dynamical Systems, Markov Chain Approach - Binary PSO

Module-IV: Physics and Chemistry based Algorithms 9 hours

Quantum computational complexity and chemistry - Digital quantum simulation - Hybrid Algorithm – Krill Herd (KH) algorithm

Module-V: Case studies 10 hours

Simulated annealing – Particle swarm Optimization – Differential Evolution - Firefly algorithm - Cuckoo search – Bat algorithm – Flower pollination algorithm

Reference Books:

1. Xin-She Yang, Nature-Inspired Optimization Algorithms, 1st Edition, Elsevier, 2014.
2. Nazmul H. Siddique, HojjatAdeli, Nature-Inspired Computing: Physics and Chemistry-Based Algorithms, Taylor & Francis, 2016.
3. Omid Bozorg-Haddad, Advanced Optimization by Nature-Inspired Algorithms, Studies in Computational Intelligence, Springer, 2017.

Web Resources:

1. http://www.academia.edu/7395054/Nature-Inspired_Optimization_Algorithms
2. http://www.cleveralgorithms.com/nature-inspired/index.html
3. http://onlinelibrary.wiley.com/doi/10.1002/adma.201002689/full

CSCE 871 ADVANCES IN COMPUTER GRAPHICS

L	S	P	C
3	2	0	3

Pre-requisite:

- *Nil*

Objectives:

- *Learn basic and fundamental computer graphics techniques.*
- *Learn image synthesis techniques;*
- *Examine applications of modeling, design and visualization.*
- *Learn different colormodeling and computer animation*
- *Learn hierarchical modeling and graphing file formats.*

Module-I: Introduction 10 hrs

Introduction to interactive computer graphics-2D-3D,Visible-Surface Detection Methods :Classification- Back-Face Method, Depth-Buffer Method, A-Buffer Method, Scan-Line Method, BSP-Tree Method, Area-Subdivision Method, Octree Methods, Ray-Casting Method, Comparison of Visibility –Detection Methods, Curved Surfaces, Wire-Frame Visibility – Detection Functions

Module-II: Illumination Models and Surface 10 hrs

Rendering Methods: Light Sources, Surface Lighting Effects, Basic Illumination Models, Transparent Surfaces, Atmospheric Effects, Shadows, Camera parameters, Displaying light intensities, Halftone patterns and dithering techniques, polygon rendering methods, ray-tracing methods, Radiosity lighting model, Environment mapping, Photon mapping, Adding surface details, Modeling surface details with polygons, Texture mapping, Bump mapping

Module-III: Color models 10 hrs

Properties of light, Color models, Standard primaries and the chromaticity diagram, The RGB color model, The YIQ and related color models, The CMY and CMYK color models, The HSV color model, The HLS color model, Color Selection and applications.

Module-IV: Animation ` 10 hrs

Raster methods, Design of animations sequences, Traditional techniques, General computer-animation functions, languages, Key-frame systems, Motion specification, Articulated figure animation, Periodic motions

.

Module-V: Hierarchical modeling and Graphics file formats 10 hrs

Basic modeling concepts, packages, General hierarchical modeling methods, Image-File configurations, Color-reduction methods, File-compression techniques, Composition of the major file formats.

Text Book(s):

1. *Hearn Baker, Computer Graphics with openGL, 4rd edition, Pearson publication.2010*
2. *James D Foley,Andries van dam,Steven K Feiner,John F Hughes, Computer graphics, Pearson Education 3rd edition, 2013*

Reference Book(s):

1. *Edward Angel: Interactive Computer graphics a top-down approach with openGL, Addison Wesley, 6th edition 2012*
2. *Advanced graphics programming using openGL: TomMcReynolds-David Blythe. Elesvier.MK, 2005*

CSCE 872 DIGITAL IMAGE PROCESSING

L	S	P	C
3	2	0	3

Pre-requisite:

- *Nil*

Objectives:

- *To understand the image fundamentals and mathematical transforms necessary for image processing and to study the image enhancement techniques.*
- *To understand the image segmentation and representation techniques.*
- *To understand how image are analyzed to extract features of interest.*
- *To introduce the concepts of image registration and image fusion.*
- *To analyze the constraints in image processing when dealing with 3D data sets.*

Module-I: Introduction to DIP 10 hrs
Origin- Applications, Steps, Components- Elements of Visual Perception, A Simple Image Formation Model, Basic Concepts in Sampling and Quantization, Representing Digital Images, Spatial and Gray-level Resolution, Zooming and Shrinking Digital Images, Some Basic Relationships Between Pixels, Linear and Nonlinear Operations.
Module-II: Image Enhancement in the Spatial Domain10 hrs
Basic Gray Level Transformations, Histogram Processing, Enhancement Using Arithmetic/Logic Operations, Spatial Filtering, Smoothing, Sharpening, Combining Spatial Enhancement Methods.
Image Enhancement in the Frequency Domain: Fourier Transform and the Frequency Domain, Smoothing, Sharpening, Homomorphic Filtering.
Module-III:Image Restoration 10hrs
A Model of the Image degradation/Restoration process, Noise Models, Restoration in the Presence of Noise–Spatial Filtering, Periodic Noise Reduction:Frequency Domain Filtering, Linear, Position-Invariant Degradations, Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering, Constrained Least Square Filtering, Geometric Mean Filter.
Module-IV: Color Fundamentals10hrs
Color Models, Pseudocolor Image Processing, Basics of Full-Color Image Processing, Color Transformations, Smoothing and Sharpening, Color Segmentation, Noise in Color Images, Color Image Compression.
Wavelets and Multiresolution Processing:Image Pyramids, Subband coding, The Haar Transform, Multiresolution Expansions, Wavelet Transforms in one Dimension, Fast Wavelet Transform, Wavelet Transforms in Two Dimensions, Wavelet Packets.
Image Compression:Fundamentals, Image Compression Models, Error-free (Lossless) compression, Lossy Compression.
Module-V:Image Segmentation 10 hrs
Morphological Image Processing:Preliminaries, Dilation and Erosion, Opening and Closing, The Hit-or-Miss Transformation, Some Basic Morphological Algorithms.
Image Segmentation:Detection of Discontinuities, Edge Linking and Boundary Detection, Thresholding, Region-Based Segmentation.
Text Book(s):

1. *Rafael C Gonzalez and Richard E. Woods: Digital Image Processing, PHI 2nd Edition 2005*

Reference Book(s):

1. *A. K. Jain: Fundamentals of Digital Image Processing, Pearson, 2004.*
2. *Scott.E.Umbaugh: Digital Image Processing and Analysis, CRC Press, 2014.*
3. *S.Jayaraman, S.Esakkirajan, T.Veerakumar: Digital Image Procesing, McGraw Hill Ed. (India) Pvt. Ltd., 2013*

CSCE 873 PATTERN RECOGNITION

L S P C

3 2 0 3

Pre-requisite:

- *Nil*

Objectives:

- *To study the mathematical morphology necessary for Pattern recognition.*
- *To introduce the student to various Pattern recognition techniques.*
- *To study the Representation and description and feature extraction.*
- *To study the principles of decision trees and clustering in pattern recognition.*

Module-I: Introduction10hrs
Definition of PR, Applications, Datasets for PR, Different paradigms for PR, Introduction to probability, events, random variables, Joint distributions and densities, moments. Estimation minimum risk estimators, problems.
Module-II: Representation10hrs
Data structures for PR, Representation of clusters, proximity measures, size of patterns, Abstraction of Data set, Feature extraction, Feature selection, Evaluation.
Module-III: Nearest Neighbor based classifiers & Bayes classifier10hrs
Nearest Neighbor based classifiers & Bayes classifier: Nearest neighbor algorithm, variants of NN algorithms, use of NN for transaction databases, efficient algorithms, Data reduction, prototype selection, Bayes theorem, minimum error rate classifier, estimation of probabilities, estimation of probabilities, comparison with NNC, Naive Bayes classifier, Basyessian belief network.
Module-IV: Decision Trees10hrs
Introduction, DT for PR, Construction of DT, Splitting at the nodes, Over-fitting & Pruning, Examples.
Module-V: Clustering10hrs
Hierarchical (Agglomerative, single/complete/average linkage, wards, Partitional (Forgy's, k-means, Isodata), clustering large data sets, examples.

Text Book(s):

1. V Susheela Devi, M Narsimha Murthy, Pattern Recognition (An Introduction), Universities Press, ISBN 978-81-7371-725-3,2011.

2. Earl Gose, Richard Johnsonbaugh, Steve Jost Pattern Recognition & Image Analysis,. PHI ISBN-81-203-1484-0, 1996.

Reference Book(s):

1. Duda R. O., P.E. Hart, D.G. Stork., Pattern Classification, John Wiley and sons, 2000.

CSCE 874 STEGANOGRAPHY AND DIGITAL WATERMARKING

L S P C

3 2 0 3

Pre-requisite:

- *Basic knowledge of security*

Objectives:
To make the student

- *understand the importance of information hiding*
- *analyse various steganographic techniques*
- *learn the various watermarking techiques*

Module-I: Introduction to Information hiding10hrs
Brief history and applications of information hiding – Principles of Steganography – Frameworks for secret communication – Security of Steganography systems –Information hiding in noisy data – Adaptive versus non adaptive algorithms – Laplace filtering – Using cover models – Active and malicious attackers – Information hiding in written text – Examples of invisible communications.

Module-II: Survey of steganographic techniques10hrs
Substitution system and bitplane tools – Transform domain techniques – Spread spectrum and information hiding – Statistical Steganography - Distortion and code generation techniques – Automated generation of English text.

Module-III: Steganalysis10hrs
Detecting hidden information – Extracting hidden information - Disabling hidden information – Watermarking techniques – History – Basic Principles – applications –Requirements of algorithmic design issues – Evaluation and benchmarking of watermarking system.

Module-IV: Watermarking techniques 10 hrs
Cryptographic and psycho visual aspects – Choice of a workspace – Formatting the watermark bets - Merging the watermark and the cover – Optimization of the watermark receiver – Extension from still images to video – Robustness of copyright making systems.

Module-V: Fingerprints10hrs
Applications – Classification – Research history – Schemes – Digital copyright and watermarking – Conflict of copyright laws on the internet.

Text Book(s):

1. *Stefan Katzenbelsser and Fabien A. P. Petitcolas, "Information hiding techniques for Steganography and Digital Watermarking", ARTECH House Publishers, January 2004.*

Reference Book(s):

1. *Jessica Fridrich, "Steganography in Digital Media: Principles, Algorithms, and Applications", Cambridge university press, 2010.*

2. *Ingemar Cox, Matthew Miller,JeffreyBloom,JessicaFridrich and TonKalker, "DigitalWatermarking And Steganography", Morgan Kaufmann Publishers, Nov 2007.*

CSCE 875 BIOMETRIC SECURITY

L	S	P	C
3	2	0	3

Pre-requisite:

- *Basic knowledge of security*

Objectives:

i) To review image processing techniques for biometric security

ii) To understand Face, Fingerprint, Palmprint, Iris biometric technologies

iii) To understand three-dimensional image analysis techniques

iv) To study some applications of biometric security algorithms

Module-I: Introduction To Biometrics10 hrs
Introduction and background – biometric technologies – passive biometrics – active biometrics – Biometric systems – Enrollment – templates – algorithm – verification – Biometric applications – biometric characteristics – Authentication technologies – Need for strong authentication – Protecting privacy and biometrics and policy – Biometric applications – biometric characteristics.
Module-II: Fingerprint Technology 10 hrs
History of fingerprint pattern recognition – General description of fingerprints – Finger print feature processing techniques – fingerprint sensors and RF imaging techniques – finger point quality assessment – computer enhancement and modeling of fingerprint images – finger print enhancement – Feature extraction – fingerprint classification – fingerprint matching.
Module-III: Face Recognition And Hand Geometry 10 hrs
Introduction to face recognition, Neural networks for face recognition – face recognition from correspondence maps – Hand geometry – scanning – Feature Extraction – Adaptive Classifiers – Visual-Based Feature Extraction and Pattern Classification – feature extraction – types of algorithm – Biometric fusion.
Module-IV: Multimodal Biometrics And Performance Evaluation 10 hrs
Introduction to multimodal biometric system – Integration strategies – Architecture – level of fusion – combination strategy – training and adaptability – examples of multimodal biometric systems – Performance evaluation – Statistical Measures of Biometrics – FAR – FRR – FTE – EER – Memory requirement and allocation.
Module-V: Biometric Authentication 10 hrs
Introduction –Methods –Systems – fingerprint –Face Recognition – hand geometry-Maximization theory – Support Vector Machines.–Securing and trusting a biometric transaction – matching location – local host – authentication server – match on card (MOC) – Multibiometrics and Two-Factor Authentication.

Text Book(s):

1. *Paul Reid, "Biometrics for Network Security", Pearson Education, 2004.*
2. *NaliniK.Ratha,RundBolle,"Automatic fingerprint recognition system, Springer", 2003.*

Reference Book(s):

1. *L C Jain, I Hayashi, S B Lee, U Haleci, "Intelligent Biometric Techniques in Fingerprint and Face Recognition".*

2. *S.Y.Kung,S.H.Lin,M.W.,"Mak Biometric Authentication: A Machine Learning Approach".*
3. *John Chirillo, Scott Blaul, "Implementing Biometric Security", John Wile, 2003.*
4. *IEEE – T- PAMI (IEEE transaction on Pattern Analysis and Machine Intelligence) International journal of computer vision, Springer.*

CSCE 876 CONTENT BASED INFORMATION RETRIEVAL

L	S	P	C
3	2	0	3

Pre-requisite:

- *Basic knowledge about information retrieval*

Objectives:
To make the student understand

- *the various techniques used in image enhancement*
- *the image retrieval techniques*

Module-I: Introduction10hrs
Introduction – Steps in Image Processing Systems – Image Acquisition – Sampling and Quantization – Pixel Relationships – Colour Fundamentals and Models, File Formats, Image operations – Arithmetic, Geometric and Morphological.
Module-II: Image Enhancement10hrs
Spatial Domain Gray level Transformations : Spatial Domain Gray level Transformations - Histogram Processing -- Spatial Filtering – Smoothing and Sharpening. Frequency Domain : Filtering in Frequency Domain – DFT, FFT, DCT – Smoothing and Sharpening filters – Homomorphic Filtering.
Module-III: Multimedia Databases10hrs
Multimedia Databases: Definition – Applications – Data Structures – Image Databases – Video and Audio Processing – Query Languages – SQL Extension – Colour Based Retrieval – Texture Based Retrieval – Shape Based Retrieval – Multimedia Retrieval Frameworks.
Module-IV: Image Retrieval10hrs
Classification of Images Based on features – Image Segmentation – Region and Object Extraction – Video Parsing for Information Retrieval – Intelligent Search Agents – Evaluation of Image and Video Retrieval – Metrics for evaluation and procedures.
Module-V: Content Based Image Retrieval10hrs
Multimedia Query Languages – Semantic Image Features – Image Queries-Classification and Indexing schemes – Video Retrieval – Image Data Management – Standards – Current trends and applications.
Text *Book(s):*

1. *J.K.Wu, M.S.Kankanhalli, J.H.Lim, D.Z.Hong "Perspectives on Content Based Multimedia Systems", Kluwer Academic publishers,Boston,2000.*
2. *Rafael C.Gonzalez and Richard E.Woods, "Digital Image Processing" Second Edition, Pearson Education, 2003.*
3. *Milan Sonka, Vaclav Hlavac and Roger Boyle, "Image Processing, Analysis and Machine Vision", Second Edition, Thomson Learning, 2001*

Reference Book(s):

1. *Anil K.Jain, "Fundamentals of Digital Image Processing", Person Education, 2003.*
2. *Michael S.Lew "Image and Video Retrieval", Springer – Verlag, 2002.*
3. *V.S.Subrahmanian and SusilJajodia (Eds), "Multimedia Database Systems Issues and Reaserchdirections",Springer –Verlag, 1996.*

4. *SetragKhosafian and A.Brad Baker, "Multimedia and Image Databases" Morgan Kaufmann, 1996.*

CSCE 711 DIRECTED STUDY

L	S	P	C
0	0	0	3

Pre-requisite:

- *Nil*

Objectives:

1. Ability to formulate an area of study and participate in defining a process for knowledge building in relation to the area of study.
2. Ability to orally discuss and critically analyze key issues of the subject matter studied in the course.
3. The ability to conceptualize key issues and research questions relative to the area of study.
4. Complete projects demonstrating a critical analysis of a specific dimension or aspect of the subject and its relationship to other dimensions or aspects of the subject.

Outcomes:

The subject matter of the course will relate to the student's research interests. The primary products of this course are an extensive literature review that could serve as the foundation for the student's subsequent project work.

The student has to submit a report containing the following

***Introduction and Statement of the Problem**. The first few pages should make it clear what the paper is about and how the subject will be approached and analyzed.*
***Literature Review**. A minimum of 30 research articles should be included as references in the review.*
The literature review must include

- *an in-depth, detailed and nuanced understanding of a specific issue, topic orquestion in the area of study;*
- *the theoretical issues and arguments raised and discussed in the literature of the research area;*
- *an analysis of the strengths and weaknesses of the extant research literature;*

***Discussion.** This section states and justifies the description, analysis and argument on the topic in a precise, readable and rigorous manner.*
***Conclusion.** The conclusion summarizes the main argument of the essay as shows how the work enhances our understanding of the subject.*