DR B R AMBEDKAR NATIONAL INSTITUTE OF TECHNOLOGY
JALANDHAR

COURSE SCHEME AND DETAILED SYLLABI FOR
M.TECH. IN COMPUTER SCIENCE AND ENGINEERING
AND
COMPUTER SCIENCE AND ENGINEERING (INFORMATION SECURITY)

Effective from 2019 Batch onwards

DR B R AMBEDKAR NATIONAL INSTITUTE OF TECHNOLOGY

JALANDHAR

INSTITUTE VISION AND MISSION STATEMENTS

VISION

To build a rich intellectual potential embedded with interdisciplinary knowledge, human values and professional ethics among the youth, aspirant of becoming engineers and technologists, so that they contribute to society and create a niche for a successful career.

MISSION

To become a leading and unique institution of higher learning, offering state-of-the art education, research and training in engineering and technology to students who are able and eager to become change agents for the industrial and economic progress of the nation. To nurture and sustain an academic ambience conducive to the development and growth of committed professionals for sustained development of the nation and to accomplish its integration into the global economy.

ANNEXURE-IV

SCHEME FOR M. TECH (FULL-TIME) IN COMPUTER SCIENCE & ENGINEERING

SEMESTER – I

S. No.	Course no.	Subjects	L	T	P	Credit
1.	CS - 5xx	Core Subject - I	3	0	0	3
2.	CS - 5xx	Core Subject - II	3	0	0	3
3.	CS - 5xx	Core Subject - III	3	0	0	3
4.	CS - 5xx	Core Subject - IV	3	0	0	3
5.	CS -5xx	Elective-I	3	0	0	3
6.	CS – 5xx	Lab - I	0	0	3	2
7.	CS – 5xx	Lab - II	0	0	3	2
		Total	**15**	**0**	**6**	**19**

SEMESTER – II

S. No.	Course no.	Subjects	L	T	P	Credit
1.	CS - 5xx	Core Subject - V	3	0	0	3
2.	CS - 5xx	Core Subject - VI	3	0	0	3
3.	CS - 5xx	Core Subject - VII	3	0	0	3
4.	CS - 5xx	Core Subject - VIII	3	0	0	3
5.	CS -5xx	Elective-II	3	0	0	3
6.	CS – 5xx	Lab - III	0	0	3	2
7.	CS – 5xx	Lab - IV	0	0	3	2
		Total	**15**	**0**	**6**	**19**

SEMESTER – III

S. No.	Course no.	Subjects	L	T	P	Credit
1.	CS - 600	M Tech Dissertation Phase-I	0	0	12	6
2.	CS - 601	Project Seminar/ Independent study	0	0	6	3
3.	CS - 5xx	Elective-III	3	0	0	3
4.	CS - 5xx	Elective-IV	3	0	0	3
		Total	**6**	**0**	**18**	**15**

SEMESTER – IV

S. No.	Course no.	Subjects	L	T	P	Credit
1.	CS-600	M Tech Dissertation Phase – II	0	0	24	12
		Total	**0**	**0**	**24**	**12**

GRAND TOTALS OF CREDITS = 65

LIST OF DEPARTMENTAL CORES FOR M.TECH PROGRAMME IN COMPUTER SCIENCE AND ENGINEERING

Course Code	Course Title	Hrs/week			Credits
		L	T	P	
CS-501	Cryptography	3	0	0	3
CS-502	Advanced Computer Networks	3	0	0	3
CS-503	Advanced Databases and Data Mining	3	0	0	3
CS-504	Advanced Data Structures and Algorithms	3	0	0	3
CS-505	Digital Image Processing	3	0	0	3
CS-506	Machine Learning	3	0	0	3
CS-507	Software Project Management	3	0	0	3
CS-554	Network Security	3	0	0	3
CS-511	Cryptography Laboratory	0	0	3	2
CS-512	Advanced Computer Networks Laboratory	0	0	3	2
CS-513	Advanced Databases and Data Mining Laboratory	0	0	3	2
CS-514	Advanced Data Structures and Algorithms Laboratory	0	0	3	2
	Total	**24**	**0**	**12**	**32**

LIST OF DEPARTMENTAL ELECTIVES FOR M.TECH. PROGRAMME IN COMPUTER SCIENCE AND ENGINEERING

Core courses from M.Tech in Information security as Elective courses in M.Tech in Computer Science

Course Code	Course Title	Hrs/week			Credits
		L	T	P	
CS-551	Security Engineering	3	0	0	3
CS-552	Cyber Forenics	3	0	0	3
CS-553	Distributed Computing Systems	3	0	0	3

Other elective courses

Course Code	Course Title	Hrs/week			Credits
		L	T	P	
CS-516	Formal Techniques for Software Reliability	3	0	0	3
CS-517	Decision Support Systems and Methods	3	0	0	3
CS-518	Natural Language Processing and Information Retrieval	3	0	0	3
CS-519	Object-Oriented Analysis and Design	3	0	0	3
CS-520	Quantitative Techniques	3	0	0	3
CS-521	Embedded System	3	0	0	3
CS-522	Mobile and Wireless Communication	3	0	0	3
CS-523	System and Network Administration	3	0	0	3
CS-524	Mobile Computing Technologies	3	0	0	3
CS-525	Optical Networks	3	0	0	3
CS-526	Biometric Security	3	0	0	3
CS-527	Numerical Methods	3	0	0	3
CS-528	Image Understanding and Pattern Recognition	3	0	0	3
CS-529	Search Techniques	3	0	0	3
CS-530	Game Theory and Its Application	3	0	0	3
CS-531	Secure M-Commerce	3	0	0	3
CS-532	Cloud Computing & Communication	3	0	0	3
CS-533	Mathematical Model for Internet	3	0	0	3
CS-534	Information Warfare	3	0	0	3
CS-535	Information Storage and Management	3	0	0	3

CS-536	Optical IP Networks	3	0	0	3
CS-537	Software Metrics and Quality Engineering	3	0	0	3
CS-538	Applications of Artificial Intelligence and Neural Networks	3	0	0	3
CS-539	Advanced Computer Architecture	3	0	0	3
CS-540	Statistical Methods for Research	3	0	0	3
CS-541	Agile Software Engineering	3	0	0	3
CS-542	Big Data Analytics	3	0	0	3
CS-543	Information Theory and Coding	3	0	0	3
CS-544	Wireless Data Networks	3	0	0	3
CS-545	Adhoc and Wireless Sensor Networks	3	0	0	3

ANNEXURE-V

SCHEME FOR M. TECH

COMPUTER SCIENCE AND ENGINEERING (INFORMATION SECURITY)

SEMESTER – I

S. No.	Course no.	Subjects	L	T	P	Credit
1.	CS - 5xx	Core Subject - I	3	0	0	3
2.	CS - 5xx	Core Subject - II	3	0	0	3
3.	CS - 5xx	Core Subject - III	3	0	0	3
4.	CS - 5xx	Core Subject - IV	3	0	0	3
5.	CS -5xx	Elective-I	3	0	0	3
6.	CS – 5xx	Lab - I	0	0	3	2
7.	CS – 5xx	Lab - II	0	0	3	2
		Total	**15**	**0**	**6**	**19**

SEMESTER – II

S. No.	Course no.	Subjects	L	T	P	Credit
1.	CS - 5xx	Core Subject - V	3	0	0	3
2.	CS - 5xx	Core Subject - VI	3	0	0	3
3.	CS - 5xx	Core Subject - VII	3	0	0	3
4.	CS - 5xx	Core Subject - VIII	3	0	0	3
5.	CS -5xx	Elective-II	3	0	0	3
6.	CS – 5xx	Lab - III	0	0	3	2
7.	CS – 5xx	Lab - IV	0	0	3	2
		Total	**15**	**0**	**6**	**19**

SEMESTER – III

S. No.	Course no.	Subjects	L	T	P	Credit
1.	CS - 600	M Tech Dissertation Phase-I	0	0	12	6
2.	CS - 601	Project Seminar/ Independent study	0	0	6	3
3.	CS - 5xx	Elective-III	3	0	0	3
4.	CS - 5xx	Elective-IV	3	0	0	3
		Total	**6**	**0**	**18**	**15**

SEMESTER – IV

S. No.	Course no.	Subjects	L	T	P	Credit
1.	CS-600	M Tech Dissertation Phase – II	0	0	24	12
		Total	**0**	**0**	**24**	**12**

GRAND TOTALS OF CREDITS = 65

LIST OF DEPARTMENTAL CORES FOR M. TECH COMPUTER SCIENCE AND ENGINEERING WITH SPECIALIZATION IN INFORMATION SECURITY

Course Code	Course Title	Hrs/week			Credits
		L	T	P	
CS-551	Security Engineering	3	0	0	3
CS-552	Cyber Forensic	3	0	0	3
CS-553	Distributed Computing Systems	3	0	0	3
CS-554	Network Security	3	0	0	3
CS-501	Cryptography	3	0	0	3
CS-502	Advanced Computer Network	3	0	0	3
CS-503	Advanced Databases and Data Mining	3	0	0	3
CS-504	Advanced Data Structures and Algorithms	3	0	0	3
CS-511	Cryptography Laboratory	0	0	3	2
CS-513	Advanced Databases and Data Mining Laboratory	0	0	3	2
CS-514	Advanced Data Structures and Algorithms Laboratory	0	0	3	2
CS-564	Network Security Laboratory	0	0	3	2
	Total	**24**	**0**	**12**	**32**

LIST OF DEPARTMENTAL ELECTIVES FOR M. TECH COMPUTER SCIENCE AND ENGINEERING (INFORMATION SECURITY)

Core courses from M.Tech in Computer Science as Elective courses in M. Tech in Computer Science and Engineering (Information Security)

CS-505	Digital Image Processing	3	0	0	3
CS-506	Machine Learning	3	0	0	3
CS-507	Software Project Management	3	0	0	3

Other elective courses

Course Code	Course Title	Hrs/week			Credits
		L	T	P	
CS-518	Natural Language Processing and Information Retrieval	3	0	0	3
CS-521	Embedded System	3	0	0	3
CS-522	Mobile and Wireless Communication	3	0	0	3
CS-523	System and Network Administration	3	0	0	3
CS-525	Optical Networks	3	0	0	3
CS-526	Biometric Security	3	0	0	3
CS-527	Numerical Methods	3	0	0	3
CS-529	Search Techniques	3	0	0	3
CS-531	Secure M-Commerce	3	0	0	3
CS-532	Cloud Computing & Communication	3	0	0	3
CS-533	Mathematical Model for Internet	3	0	0	3
CS-536	Optical IP Networks	3	0	0	3
CS-540	Statistical Methods for Research	3	0	0	3
CS-542	Big Data Analytics	3	0	0	3
CS-544	Wireless Data Networks	3	0	0	3
CS-545	Adhoc and Wireless Sensor Networks	3	0	0	3
CS-566	Information Security Risk Management	3	0	0	3
CS-567	Computer Crime Investigation and Forensic	3	0	0	3
CS-568	Computer Security, Audit and Assurance	3	0	0	3
CS-569	Computer Intrusion Detection	3	0	0	3

DETAILED COURSE CONTENTS FOR M.TECH PROGRAMME IN COMPUTER SCIENCE & ENGINEERING

CORE COURSES

CS- 501 Cryptography **[3 0 0]**

Course Outcomes: At the completion of the course, students will be able to

CO1: Understand Mathematical foundations of Cryptography theory.

CO2: Analyze the robustness of Cryptosystems.

CO3: Design robust cryptosystem for real time applications.

CO4: Develop prototype Cryptosystems and demonstrate their performance.

Course Contents

Foundations of Cryptography and Security: Ciphers and Secret Messages, Security Attacks and Services.

Mathematical Tools for Cryptography: Substitutions and Permutations, Modular Arithmetic, Euclid's Algorithm, Finite Fields, Polynomial Arithmetic, Discrete Logarithms.

Conventional Symmetric Encryption Algorithms: Theory of Block Cipher Design, Feistel Cipher Network Structures, DES and Triple DES, Modes of Operation (ECB, CBC, OFB,CFB), Strength (or Not) of DES.

Modern Symmetric Encryption Algorithms: IDEA, CAST, Blowfish, Twofish, RC2, RC5, Rijndael (AES), Key Distribution.

Stream Ciphers and Pseudo Random Numbers: Pseudo random sequences, Linear Congruential Generators, Cryptographic Generators, Design of Stream Cipher, One Time Pad.

Public Key Cryptography: Prime Numbers and Testing for Primality, Factoring Large Numbers, RSA, Diffie-Hellman, ElGamal, Key Exchange Algorithms, Public-Key Cryptography Standards

Hashes and Message Digests: Message Authentication, MD5, SHA, RIPEMD, HMAC, Digital Signatures, Certificates, User Authentication: Digital Signature Standard (DSS and DSA), Security Handshake Pitfalls, Elliptic Curve Cryptosystems.

Authentication of Systems: Kerberos V4 and V5, X.509 Authentication Service.

Electronic Mail Security: Pretty Good Privacy (PGP), S/MIME, X.400, IP and Web Security, IPSec and Virtual Private Networks, Secure Sockets and Transport Layer (SSL and TLS).

Electronic Commerce Security: Electronic Payment Systems, Secure Electronic Transaction (SET), CyberCash, iKey Protocols, Ecash (DigiCash), Digital Watermarking and Steganography.

Text/References:

1. C.Y. Hsiung, "Elementary Theory of Numbers", World Scientific Pub Co Inc, 1992.
2. W. Stallings, "Cryptography and Network Security Principles and Practice", Prentice Hall, 5/e, 2010.
3. Charlie Kaufman, Radia Perlman, "Network Security: Private Communication in a Public World", Prentice Hall, 2/e, 2002.
4. Wenbo Mao, "Modern Cryptography: Theory and Practice", Prentice Hall, 2004.
5. Richard A. Mollin, "An Introduction to Cryptography", Chapman and Hall/CRC, 2/e, 2006.

CS- 502 Advanced Computer Networks

Course Outcomes: At the completion of the course, students will be able to

CO1: Understand packet switching networks and routing in packet switching networks with different routing algorithms.

CO2: Describe traffic management at packet level, flow level and flow aggregate levels of packet switching networks.

CO3: Explain the architecture of TCP/IP and protocols associated with TCP/IP and to analyze the network applications, network management and security issues

CO4: Apply the knowledge about QoS, VPNs, and tunneling and overlay networks and to understand mobile networking and wireless sensor networking

Course Contents

Reliable Protocol:

Transmission Control Protocol (TCP): Error Control, Flow Control, Congestion Control, Timers, And TCP Options: NOP, MSS, Window Scale Factor, Timestamp, SACK-Permitted And SACK Options

Stream Control Transmission Protocol (SCTP): Introduction, Services, Features, Packet Format, Association, State Transition Diagram, Flow Control, Error Control, Congestion Control

Congestion Control and Resource Allocation: Issues In Resource Allocation: Network Model, Taxonomy, Evaluation Criteria; Queuing Disciplines: FIFO, Fair Queuing; TCP Congestion Control: Additive Increase/Multiplicative Decrease, Slow Start, Fast Retransmit and Fast Recovery; Congestion-Avoidance Mechanisms: DECbit, Random Early Detection (RED), Source-Based Congestion Avoidance; Quality of Service: Application Requirements, Integrated Services (RSVP), Differentiated Services (EF 516, AF), Equation-Based Congestion Control

Next Generation Network: Unicast Routing Protocols: RIP, OSPF; Multicasting And Multicast Routing Protocols: Introduction, Multicast Addresses, IGMP, Multicast Routing, Routing Protocols, MBone

Internet Protocol Version 6: IPV6 Addressing: Introduction, Address Space Allocation, Global Unicast Addresses, Auto configuration, Renumbering; IPV6 Protocol: Packet Format, Transition from Ipv4 TO Ipv6; Generic Routing Encapsulation (GRE) For Tunnelling.

ICMPv6: Error Messages, Informational Messages, Neighbours-Discovery Messages, Group Membership Messages

Wireless LAN: Infrared vs. Radio Transmission, Infrastructure and Ad Hoc Networks. IEEE 802.11, System Architecture, Protocol Architecture, Physical Layer, Medium Access Control Layer, MAC Management, Future Development, HIPERLAN, Protocol Architecture, Physical Layer, Channel Access Control Sublayer, Medium Access Control Sublayer, Information Bases and Networking, Bluetooth, User Scenarios, Physical Layer, MAC Layer, Networking, Security, Link Management

Text/References:

1. Behrouz A. Forouzan , “TCP/IP Protocol Suite”, McGraw- Hill, 4/e, 2009.
2. Larry L. Peterson & Bruce S. Davie, “Computer Network: A System Approach”, Morgan Kaufmann, 5/e, 2012.
3. Jochen Schiller, “Mobile Communications”, Pearson Addison-Wesley, 2/e, 2003.
4. James F. Kurose, Keith W. Ross, “Computer Networking”, Pearson, 2012.
5. Charles M. Kozierok, “The TCP/IP Guide”, No starch press, 2005.

CS-503 Advanced Databases and Data Mining [3 0 0]

Course Outcomes: At the completion of the course, students will be able to

CO1: Understand the advanced concepts of Databases, security and privacy issues and the techniques to handle that.

CO2: To design and develop data warehouses and data marts models and their applications.

CO3: Learn and apply the data mining techniques to find out the hidden patterns and to turn into useful knowledge.

Course Contents

Database Management system: ER Model, Database models, Representation and Evaluation of Relationship Review of Relational Database Design, Normalization, Storage, Access Structures, Query Processing.

Data Warehousing: Overview of data warehousing, Data warehouse design, OLAP technologies, Data cubing. Dimension reduction techniques, Data summarization methods, Clustering, Dimensional Modeling, Metadata, Performance issues and indexing, VLDB issues, Development life cycle, Merits, Tools, Applications and Case Studies.

Data Mining: Overview of knowledge discovery and data mining, Data mining techniques, steps in data mining process, Classification, Decision tees, Patterns, Association rules algorithms, Review of Al-methods, Relation to statistics, databases, machine learning, Visualization, deterministic models, Clustering Regression analysis, Time series analysis, Bayesian learning.

Security and Privacy Protection: An authorization mechanism for a relational database system, Warfare Attacks on Databases, Watermarking Relational Databases, Recent Advances in Access Control Models, Trust Management, Secure Group Key Management, Hippocratic Databases.

Text/References:

1. U. M. Fayyad, G. P. Shapiro, P. Smyth and R. Uthurusamy, “Advances in Knowledge Discovery and Data Mining”, The M.IT. Press, 1996.
2. Jiawei Han and Micheline Kamber, “Data Mining Concepts and Techniques”, Morgan Kauffmann Publishers, 3/e, 2011.
3. Sean Kelly, “Data Warehousing in Action”, John Wiley & Sons Inc., 1997.
4. Michael J. A. Berry, Gordon S. Linoff, “Mastering Data Mining”, Wiley, 1999.

CS-504 Advanced Data Structures and Algorithms [3 0 0]

Course Outcomes: At the completion of the course, students will be able to

CO1: Enhance their expertise in algorithmic analysis and algorithm design techniques.
CO2: Analyze, design, apply and use data structures and algorithms to solve engineering problems and evaluate their solutions
CO3: Understand and apply amortized analysis on data structures, including binary search trees, merge able heaps and graphs.
CO4: Have an idea of applications of algorithms in a variety of areas including string matching, and databases etc

Course Contents

Elementary Data Structures and Complexity Analysis: Overview of Basic Data Structures: Arrays, Linked List, Stack, Queues. Implementation of Sparse Matrices, Algorithm Complexity: Average, Best and worst case analysis, asymptotic notations, Simple Recurrence Relations and use in algorithm analysis

Search Structures: Binary search trees, AVL trees, 2-3 trees, 2-3-4 trees, Red-black trees, Btrees.

Graph Algorithms: Representation of Graphs, Traversals, Single-source shortest path Algorithms, All-pairs shortest path algorithms, Sub graphs, Disjoint Graphs, Connected Components, Articulation Points, Spanning tree, Minimum Spanning Trees Algorithms, Topological sort

String Matching Algorithms: Introduction, The Brute-Force- Algorithm, Rabin-Karp Algorithm, String Matching

with Finite automata, Knuth-Marries-Pratt Algorithm

Heap Structures: Min-max heaps, Deaps, Leftist heaps, Binomial heaps, Fibonacci heaps, Skew heaps

Multimedia Structures: Segment trees, k-d trees, Point Quad trees, MX-Quad trees, R-trees.

Text / References:

1. E. Horowitz, S.Sahni and Dinesh Mehta, Fundamentals of Data structures in C++, Galgotia, 1999.
2. Adam Drozdex, Data Structures and algorithms in C++, Second Edition, Thomson learning – vikas publishing house, 2001.
3. G. Brassard and P. Bratley, Algorithmics: Theory and Practice, Printice –Hall, 1988.
4. Thomas H.Corman, Charles E.Leiserson, Ronald L. Rivest, "Introduction to Algorithms", PHI.

CS-505 Digital Image Processing **[3 0 0]**

Course Outcomes: At the completion of the course, students will be able to

CO1: Understand the fundamental concepts of a digital image processing system.
CO2: Evaluate the techniques for image enhancement and image restoration in spatial and frequency domain.
CO3: Categorize various compression techniques.
CO4: Interpret image segmentation and representation techniques.
CO5: Acquire an appreciation for the image processing issues and techniques and apply these techniques to real world problems

Course Contents

Digital Image Fundamentals: Why is Computer Vision Difficult?, Different stages of image processing and analysis, Components of image processing system, Sampling and Quantization, Some basic relationships like neighbor's connectivity, distance measure between pixels.

Image Enhancement and Restoration: Basic Intensity Transformation Functions, Histogram processing, Spatial Domain methods: Fundamentals of spatial filtering, Smoothing Spatial Filters, Sharpening Spatial Filters, Frequency domain methods: low pass filtering, High pass filtering, Image Degradation/Restoration model

Image Compression: Fundamentals of image compression, error criterion, Coding Inter-pixel and Psycho visual redundancy, Image Compression models, Error free compression: Huffman, Arithmetic, Run length Coding, Lossy Compression: Block Transform Coding based on DCT and DWT, Image Compression standard: JPEG.

Morphological image processing: Basic Morphology concepts, Binary dilation and erosion, Opening and Closing operations, Basic Morphological Algorithms: Boundary extraction, Hole Filling, Extraction of Connected Components.

Image Segmentation and Edge Detection: Fundamentals, Point, Line and Edge Detection: Detection of isolated points, lines, Basic Edge Detection, Advanced Edge detection using Canny edge detector, Laplacian edge detector and Laplacian of Gaussian edge detector. Edge Linking and Boundary Detection, Thresholding: Basic Global Thresholding and Optimum Global Thresholding using Otsu's Method, Region Based Segmentation: Region Growing, Region Splitting and Merging

Representation and Description: Representation schemes like chain coding, Polygonal approximation using minimum perimeter polygon, Signatures, Boundary Descriptors: Shape Numbers, Fourier, and Statistical moments. Regional Descriptors: Topological Descriptors, Texture, Moment Invariants

Recognition and Interpretation: Pattern and pattern classes, Decision Theoretic methods: minimum distance classifier, matching by correlation, Structural Methods: Matching Shape Numbers

Text/References:

1. Rafael C. Gonzales and Richard E. Woods, "Digital Image Processing", Pearson Education, 3/e, 2007.
2. Milan Sonka, Vaclav Hlavac and Roger Boyle, "Digital Image Processing and Computer Vision", Cengage Learning, 2007.
3. Anil K. Jain, "Fundamentals of Digital Image Processing", Pearson Education, 1988.

4. B. Chanda, "Digital Image Processing and Analysis", PHI Learning Pvt. Ltd., 2011.
5. William K. Pratt, "Digital Image Processing", Wiley-Interscience, 4/e, 2007.

CS-507 Software Project Management **[3 0 0]**

Course Outcomes: At the completion of the course, students will be able to

CO1: Learn Conventional Software Management and Evolution of Software Economics

CO2: Understand Project Organizations and Responsibilities

CO3: Understand the evolution and applications of operations in various fields, mathematically formulate linear programming problems and solve them using different techniques

CO4: Construct a project network and apply program evaluation review technique and critical path method to find date of completion of project and other project related metrics

Course Contents

Introduction: Project Management (PM) Fundamentals, People, Process, and Product, Technology Classic mistakes, PMI Processes, Software project phases, Organizational structures, Project charter Statement of Work (SOW)

Planning Phase: Development lifecycle models, Matching lifecycles to projects, Project plans Work Breakdown Structures (WBS)

Estimation and Budgeting: Estimation, Budgeting, Project selection, NPV, ROI, Payback models

Scheduling: Project network diagram fundamentals, PERT techniques, Gantt charts, Critical chain scheduling

Risk and Change Management: Risk management, Change control, More MS-Project

Development Management: Team models, Requirements process, Configuration management, Software metrics, Programming languages & tools, Managing conflict and motivating, MS-Project: Assigning Resources

Status reporting: Project metrics, Earned value analysis, Communications Techniques, Process Improvement,

MS Project:

(a) Resource leveling (b) Other views

System Test Process: Test specifications, Black box and white box testing, Test scripts, Unit and integration testing, Acceptance test specifications, Test tools, MS Project: (a) Reporting

Final Phases & Other Issues: Project Recovery, Documentation, Cutover/Migration, Post Project Reviews, Closing, MS Project: (a) Advanced features

Project Success: Management support, Expectations, Success metrics

Text / References:

1. Kathy Schwalbe, "Information Technology Project Management", Cengage Learning, 7/e, 2013.
2. M. Cottrell and B. Hughes, "Software Project Management", McGraw-Hill, 5/e, 2009.
3. QuantumPM, "Microsoft Office Project Server 2003 Unleashed", Pearson Education India, 2005.
4. Robert T. Futrell, Donald F. Shafer and Linda Isabell Shafer , "Quality Software Project", Pearson India, 2002.
5. D. J. Henry, "Software Project Management – A Real-World Guide to Success", Addison-Wesley, 2003.

CS-506 Machine Learning **[3 0 0]**

Course Outcomes: At the completion of the course, students will be able

CO1: Understanding about the basic principles, techniques and applications of machine learning.

CO2: Broad understanding of machine learning algorithms and their use in data-driven knowledge discovery and program synthesis.

CO3: Knowledge of the strengths and weaknesses of different machine learning algorithms (relative to the characteristics of the application domain).

CO4: The ability to adapt or combine some of the key elements of existing machine learning algorithms to design new algorithms as needed.

Course Contents

Introduction: Well-Posed Learning Problems, Designing a Leaning System, Perspectives and Issues in Machine Learning.

Concept Learning and the General-to-Specific Ordering: Introduction, A Concept Learning Task, Concept Learning as Search, FIND-S: Finding a Maximally Specific Hypothesis, Version Spaces and the CANDIDATE-ELIMINATION Algorithm.

Decision Tree Learning: Introduction, Decision Tree Representation, Appropriate problem for Decision tree Learning, The Basic Decision Tree Learning Algorithm, Hypothesis Space Search in Decision Tree Leaning, Inductive Bias in Decision Tree Leaning, Issues in Decision Tree Leaning

Artificial Neural Networks: Introduction, Natural Network Representations, Appropriate Problems for Neural Network Learning, Perceptions, Multilayer Network and the BACKPROPAGATION Algorithm

Bayesian Learning: Introduction, Bayes Theorem, Bayes Theorem and Concept Learning, Bayes Optimal Classifier, Native Bayes Classifier, An Example: Learning to Classify Text.

Instance- Based Learning: Introduction, K-NEAREST NEIGHBOUR Learning, Distance-Weighted NEAREST NEIGHBOUR Algorithm.

Genetic Algorithms: Motivation, Genetic Algorithms, Hypothesis Space Search, Genetic Programming, Parallelizing Genetic Algorithms.

Learning Sets of Rules: Introduction, Sequential Covering Algorithms, Learning Rule Sets: Summary, Learning First-Order Rules, Learning Sets of First-Order Rules: FOIL, Induction as Inverted Deduction, Inverted Resolution.

Support Vector Machine: Maximum margin linear separators, Quadratic Programming Solution to finding maximum margin separators, Kernels for learning non-linear functions.

Text / References:

1. Tom Mitchell, “Machine Learning”, McGraw-Hill, 1997.
2. E. Alpaydin, “Machine Learning”, MIT Press, 2010.
3. K. Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012.
4. C. Bishop, “Pattern Recognition and Machine Learning, Springer”, 2006.

CS - 554 Network Security **[3 0 0]**

Course Outcomes: At the completion of the course, students will be able to
CO1: Learn and understand various factors driving the need for network security
CO2: Identify and learn about various types of attacks to network
CO3: Analyze various vulnerability, threat, and attacks to network
CO4: Compare and contrast symmetric and asymmetric encryption systems and their vulnerability to attack, and explain the characteristics of hybrid systems.

Course Contents

Introduction to information Security: Types of information security controls and purposes of Information Security Management, Allocation of information security responsibilities.

Telecommunications Security: Objectives, Threats and Countermeasures, Identification of Security threats and development of countermeasures, Technologies and Security policies,

Authentication: Overview of Authentication schemes: Password and address based Authentication, Cryptographic Authentication protocols, Trusted Intermediaries and session key establishment. Security handshake pitfalls: Mutual authentication, Integrity for data, Mediated Authentication and strong password protocols

Public key infrastructure (PKI): PKI trust models, Revocation and Authorization futures.

Security at the Network Layer (IPsec): IPsec Overview, History, and Standards: Overview of IPsec Services and Functions - IPsec Standards. IPsec General Operation, Components, and Protocols: IPsec Core Protocols - IPsec Support Components. IPsec Architectures and Implementation Methods: Integrated Architecture - Bump in the Stack (BITS) Architecture - Bump in the Wire (BITW) Architecture. IPsec Modes: Transport Mode - Tunnel Mode - Comparing Transport and Tunnel Modes. IPsec Security Constructs: Security Policies, Security Associations, and Associated Databases - Selectors - Security Association Triples and Security Parameter Index (SPI). IPsec Authentication Header (AH): AH Datagram Placement and Linking - AH Format. IPsec Encapsulating Security Payload (ESP): ESP Fields - ESP Operations and Field Use - ESP Format. Internet Key Exchange (IKE): Improved Diffie-Hellman Key Exchange – IKE Phases – Phases and Modes – Phase 1: Main Mode, Aggressive Mode – Phase II: Quick Mode – SA Algorithms. ISAKMP: General Header – Payloads.

Security at the Transport Layer (SSL/TLS): SSL Architecture: Services – Key Exchange Algorithms – Encryption/Decryption Algorithms – Hash Algorithms – Cipher Suite – Compression Algorithms – Cryptographic Parameter Generation – Sessions and Connections. Four Protocols: Handshake Protocol – Change Cipher Spec Protocol – Alert Protocol – Record Protocol. SSL Message Formats: Change Cipher Spec Protocol – Alert Protocol – Handshake Protocol – Application Data. TLS: Version – Cipher Suite – Generation of Cryptographic Secrets – Alert Protocol – Handshake Protocol – Record Protocol. SSL versus SET.

Security at the Application Layer: PGP and S/MIME: EMAIL – Email Architecture – Email Security. PGP – Scenarios – Key Rings – PGP Certificates – Key Revocation – Extracting Information from Rings – PGP Packets – PGP Messages – Applications of PGP. S/MIME: MIME-S/MIME – Applications of S/MIME. Time Stamping Protocol. Secure Electronic Transaction (SET): - Introduction – SET Participants – SET Process – SET Internals.

System Security (Linux Firewall): Firewall Design Principles. IPTABLES: Packet filtering with Iptables. Network Layer Attacks and Defense: Logging the IP Header – IP Spoofing – IP Fragmentation – Low TTL values – The Smurf Attack – Route Table Modification – DDoS Attacks – Linux Kernel IGMP Attack – Network Layer Responses. Transport Layer Attacks and Defense: Logging the TCP and UDP Header with Iptables – Port Scans – Port Sweeps – TCP sequence Prediction Attacks – SYN floods – TCP session hijacking -Transport Layer Responses. DNS Attacks. Router Access controls Lists (ACL) - Inbound & outbound traffic – Service and System blocking.

Text / References:

1. Charles M. Kozierok , “The TCP/IP Guide: A Comprehensive, Illustrated Internet Protocols Reference”, No starch press, 2005
2. Behrouz A. Forouzan, “Cryptography and Network Security”, Tata McGraw-Hill, 2007
3. Michael Rash,” Linux Firewalls: Attack Detection and Response with IPTABLES, PSAD, and FWSNORT”, No Starch Press, 2007.
4. S. Cimato and C. Galdi, “Security in Communication Networks”, Springer, 2003.
5. Charlie Kaufman and Radia Perlman, “Network Security: Private Communication in a Public World”, Prentice Hall, 2/e, 2002.
6. Rajaraman, “Introduction to Information technology”, Prentice Hall of India, 2/e, 2013.
7. Thomas M. Thomas and Donald Stoddard, “Network Security First Step”, Cisco Press, 2/e, 2012.

CS-551 Security Engineering **[3 0 0]**

Course Outcomes: At the completion of the course, students will be able to followings

CO1: An ability to analyze security and privacy of systems.

CO2: An ability to conduct user-centered design for security engineering.

CO3: An ability to understand programming constraints with systems security.

CO4: An understanding of limitations and advantages of security protocols, biometric systems, Password authentication and various alternative systems.

Course Contents

Introduction: What is Security Engineering? How security engineering overlaps and is distinct from other fields of engineering.

Security Engineering, Protocols: Authentication, Manipulating the message, Chosen protocol attacks, managing.

Encryption keys, Passwords: System issues, Technical protection of passwords, Access Control: Operating system access controls.

Cryptography, Multilevel security, Banking and Bookkeeping: Introduction, How bank Computer works, ATM, **Biometrics:** Introduction, Handwritten signatures, Face Recognition, Voice Recognition, Finger prints, Vulnerabilities in Network Security.

Defense against Network attack: Firewalls, Encryption, Trojans ,Viruses and Worms, Intrusion Detection, Management issues.

Mobile Device Security: Mobile platform security. Mobile app distribution and security. Mobile OS security. Privacy issues with apps.

Evaluating Security: Assurance, Economic Incentives, Evaluation.

Text/References:

1. Ross J. Anderson , “Security Engineering”, 2/e, 2008.
2. Menezes, P. Oorshcot, and S. Vanstone, “Handbook of Applied Cryptography”, CRC Press, 1997.
3. Escamilla, “Intrusion Detection – Network Security Beyond the Firewall”, John Wiley & Sons, 1998.
4. W. Stallings, “Cryptography and Network Security Principles and Practice”, 5/e, 2010.

CS-552 Cyber Forensics **[3 0 0]**

Course Outcomes: Upon completion of the course, the student should be able to

CO1: Consider the security issues related to network layer and transport layer.

CO2: Explain security principles in the application layer.

CO3: Explain computer forensics and utilization of forensics tools.

CO4: Analyze and validate forensics data.

Course Contents

Network Layer Security and Transport Layer Security

IPSec Protocol – IP Authentication Header – IP ESP – Key Management Protocol for IPsec. Transport layer Security: SSL protocol, Cryptographic Computations – TLS Protocol.

E-mail Security & Firewalls

PGP – S/MIME – Internet Firewalls for Trusted System: Roles of Firewalls – Firewall related terminology- Types of

Firewalls – Firewall designs – SET for E-Commerce Transactions.

Introduction to Computer Forensics

Introduction to Traditional Computer Crime, Traditional problems associated with Computer Crime. Introduction to Identity Theft & Identity Fraud. Types of CF techniques – Incident and incident response methodology – Forensic duplication and investigation. Preparation for IR: Creating response tool kit and IR team. – Forensics Technology and Systems – Understanding Computer Investigation – Data Acquisition.

Evidence Collection and Forensics Tools

Processing Crime and Incident Scenes – Working with Windows and DOS Systems. Current Computer Forensics Tools: Software/ Hardware Tools.

Computer Forensic Analysis and Validation

Validating Forensics Data – Data Hiding Techniques – Performing Remote Acquisition – Network Forensics – Email Investigations – Cell Phone and Mobile Devices Forensics.

Text/References:

1. Man Young Rhee, "Internet Security: Cryptographic Principles", "Algorithms and Protocols", Wiley Publications, 2003.
2. Nelson, Phillips, Enfinger, Steuart, "Computer Forensics and Investigations", Cengage Learning, India Edition, 2008.
3. John R.Vacca, "Computer Forensics", Cengage Learning, 2005
4. Richard E.Smith, "Internet Cryptography", 3rd Edition Pearson Education, 2008.
5. Marjie T.Britz, "Computer Forensics and Cyber Crime": An Introduction", 3rd Edition, Prentice Hall, 2013.

CS-553 Distributed Computing Systems **[3 0 0]**

Course Outcomes: At the completion of the course, students will be able to

CO1: Understanding of the concepts related to Distributed Computing systems

CO2: Understanding of the software components of distributed computing systems and knowledge about the communication and interconnection architecture of multiple computer systems.

CO3: Recognize the inherent difficulties that arise due to distributed-ness of computing resources.

CO4: Understanding of networks & protocols, mobile & wireless computing and their applications to real world problems.

Course Contents

Characterization of Distributed Systems: Introduction, system models –Architectural and fundamental models

Inter-Process communication: API for internet protocol, Marshalling. Client server communication, Group communication

Distributed objects and remote invocation: communication between Distributed objects, RPC, events and notification case study: Java RMI

Operating System Support: Operating System layer. Protection, Processes and threads, Operating System Architecture

Distributed File System: File service architecture, network file system, Sun network file system, Andrew file system

Name services: Name services and domain name system. Directory and discovery services

Transaction and concurrency control: transactions, nested transactions, Locks, optimistic concurrency control,

time stamp ordering, Comparison of methods for concurrency control

Distributed Transaction: Flat and nested distributed transactions. Atomic Commit protocol, Distributed dead locks

Distributed system Security: Overview of security techniques, Cryptographic algorithms, Digital Signatures

Distributed Object Based Systems: Architecture, Distributed Objects, Example: Enterprise Java Beans Distributed Shared Objects Case Study CORBA

Text / References:

1. George Coulouris, Jean Dollimore, Tim Kindberg and Gordon Blair, "Distributed Systems: Concepts and design", Pearson Education Asia, 5/e, 2011.
2. A.S. Tanenbaum, "Modern operating Systems", Prentience Hall, 3/e, 2007.
3. Randy Chow and Theodore Johnson, "Distributed Operating Systems and Algorithm Analysis", Addison-Wesley, 1997.
4. Gerald Tel, "Introduction to Distributed Algorithms", Cambridge Iniversity Press, 2/e, 2000.
5. Nancy Lynch, "Distributed Algorithms", Morgan Kaufmann, 1996.

CS- 511 Cryptography Laboratory **[0 0 3]**

Course Outcomes: Upon completion of the course, the student should be able to

CO1: Identify information security goals, classical encryption techniques and acquire fundamental knowledge on the concepts of finite fields and number theory.

CO2: Understand, compare and apply different encryption and decryption techniques to solve problems related to confidentiality and authentication

CO3: Apply the knowledge of cryptographic checksums and evaluate the performance of different message digest algorithms for verifying the integrity of varying message sizes

CO4: Apply different digital signature algorithms to achieve authentication and create secure applications

CO5: Apply network security basics, analyze different attacks on networks and evaluate the performance of firewalls and security protocols like SSL, IPSec, and PGP.

Students are required to perform the following list of practicals:

- Implementation of Substitution and Permutation
- Implementation of DES and RSA algorithms
- Implementation of Symmetric Encryption Algorithms (IDEA, Blowfish, Key Distribution etc)
- Implementation of Pseudo Random Number Generators
- Implementation of Prime Numbers and Testing for Primality
- Implementation of Electronic Mail Security (SSL and TSL)

This is only the suggested list of Practicals. Instructor may frame additional Practicals relevant to the course contents.

CS- 512 Advanced Computer Network Laboratory **[0 0 3]**

Course Outcomes: Upon completion of the course, the student should be able to

CO1: Implement various networks environment and passing packets through them using different routing

techniques.

CO2: Design various error control, flow control, and congestion control mechanism in TCP.

CO3: Implement networks environment for simulating various access techniques and Queuing algorithm.

Design scenarios for wireless networks using simulation tools.

Students are required to perform the following list of practicals:

Note: Implementation should be done using C/C++, QualNet/NS2 and other similar tools.

1. Write a program to transfer a file from one system to another system using TCP and UDP sockets.
2. Write a program to demonstrate communication between different processes using IPC.
3. Write a Program to implement Routing Information Protocol (RIP) for a set of nodes.
4. Write a program to implement flow control and congestion control in TCP.
5. Write a program to implement queuing algorithm which will discard the staled packets.
6. Write a congestion control algorithm for routers which will inform the host nodes to stop sending when threshold is reached.
7. Create a network of multiple routers and hosts to simulate RED and Drop Tail Queuing algorithm.
8. Write a program to simulate Group Communication and implement Carrier sensing techniques.
9. Design scenarios for wireless networks using simulation tools.

This is only the suggested list of Practicals. Instructor may frame additional Practicals relevant to the course contents.

CS- 513 Advanced Databases and Data mining Laboratory [0 0 3]

Course Outcomes: At the end of this course, students will be able to

CO1: Understand and implement advanced concepts of Data mining on real data.

CO2: Read literature related to the subject and suggest enhancements/ optimizations to the existing work.

CO3: Implement the Data warehouses and perform operations like drill, rollup, and slice etc.

Students are required to perform the following list of practicals:

- Building a Database Design using ER Modeling and Normalization Techniques
- Implementation of functions ,Procedures, Triggers and Cursors
- Feature Selection and Variable Filtering (for very large data sets)
- Association Mining in large data sets
- Interactive Drill-Down, Roll up, Slice and Dice operations
- Generalized EM & k-Means Cluster Analysis
- Generalized Additive Models (GAM)
- General Classification and Regression Trees (GTrees)
- General CHAID (Chi-square Automatic Interaction Detection) Models
- Interactive Classification and Regression Trees
- Boosted Trees
- Multivariate Adaptive Regression Splines (Mar Splines)

- Goodness of Fit Computations
- Rapid Deployment of Predictive Models

This is only the suggested list of Practicals. Instructor may frame additional Practicals relevant to the course contents.

CS- 514 Advanced Data Structure and Algorithm Laboratory [0 0 3]

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

CO1: Implement various advance problems using data structures such as stacks, queues, trees, graphs, etc. to solve various computing problems.

CO2: Understand how several fundamental algorithms work particularly those concerned with Stack, Queues, Trees and various Sorting algorithms.

CO3: Design new algorithms or modify existing ones for new applications and able to analyse the space & time efficiency of most algorithms.

CO4: Decide a suitable data structure and algorithm to solve a real-world problem.

Students are required to perform the following list of practicals:

1. Implementation of various algorithms & operations based on Arrays such as Insertion, Deletion, Sorting (Insertion, Bubble, Selection, Shell, Radix, Merge, Quick), Searching (Linear, Binary) and Sparse matrices such as addition, multiplication & transpose.
2. Implementation of Stacks & Queues including priority queues along with various operations on them such as Infix to Postfix conversion, postfix expression evaluation, get minimum element in O(1) time using O(1) additional space using stacks & calculate no. of page faults, reversal of the entire or a part of a queue.
3. Implementation of Linked list and doubly linked list along with solving various problems based on them such as removal of duplicate elements from sorted/Unsorted Linked List, Swapping of nodes by changing link, Segregating odd & even nodes together, binary Search, number of elements in a loop, print nth element from the last, finding the middle element.
4. Implementation of binary trees and various operations based on them such as preorder/ inorder/ postorder traversal using stack, level order traversal, level order traversal in spiral form, left/ right/ top/ bottom view of the tree, vertical order traversal, printing sum of inorder predecessor & successor for each node.
5. Implementation of binary search tree and various problem solving based on them such as finding minimum/ maximum element, traversal in ascending/ descending order, kth largest & kth minimum element, converting binary tree to binary search tree, finding a pair with a given sum.
6. Implementation of AVL trees and various operations based on them such as insertion, deletion and traversal.
7. Implementation of Red/Black trees and various operations based on them such as insertion, deletion and traversal.
8. Implementation of B trees and various operations based on them such as insertion, deletion and traversal.
9. Implementation of heaps & deaps along with various operations based on them such as insertion, deletion, extracting minimum/ maximum element, heap sort, priority queues.
10. Implementation of fibonacci & binomial heaps with various operations based on them such as insertion, union, deletion, extracting minimum/ maximum element.
11. Implementation of various graph based algorithms Dijkstra's shortest path, Warshall's all pair shortest path, breadth & depth first search.
12. Implementation of greedy algorithms like kruskal & prims to find the minimum spanning tree from a given set of nodes and edges.
13. Implementation of various string matching algorithms like brute force, Rabin-karp, Knuth_marries-Pratt and using finite automata.

This is only the suggested list of Practicals. Instructor may frame additional Practicals relevant to the course contents.

CS - 564 Network Security Laboratory [0 0 3]

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

CO1: Execute and evaluate network administration commands and demonstrate their use in different network scenarios

CO2: Demonstrate the installation and configuration of network simulator and Demonstrate and measure different network scenarios and their performance behavior.

CO3: Implement the socket programming for client server architecture.

CO4: Design and setup a organization network using packet tracer.

Students are required to perform practicals in C++ / Java

- Implementation of password and address based Authentication protocols.
- Implementation of PKI
- Implementation of IPsec
- Implementation of Communication protocols
- Implementation of Electronic Mail Security (SSL and TSL)

This is only the suggested list of Practicals. Instructor may frame additional Practicals relevant to the course contents.

DETAILED COURSE CONTENTS FOR M.TECH PROGRAMME IN COMPUTER SCIENCE & ENGINEERING

ELECTIVE COURSES

CS- 516 Formal Techniques for Software Reliability [3 0 0]

Course Outcomes: At the completion of the course, students will be able to

CO1: Understand the software reliability and various reliability prediction models.

CO2: Understand the concepts of software maintainability, availability, fault tolerance, fault intensity objectives, etc.

CO3: Understand the fault detection and correction approaches used in developing quality software.

CO4: Understand the design principles for achieving higher reliable software system and software reliability engineering process.

Course Contents

Problem, Process and Product, Software reliability engineering, SRE process, Software and hardware reliability

Software Reliability Models, Basic features, Single Failure and Growth Models, Exponential failure class Model, Bayesian and early life cycle Model, Determining overall reliability and availability objectives, common failure intensity objective, develop software failure intensity objectives, software reliability strategies, Strategies for failure intensity objective, serial and parallel system reliability, software process and product improvement, Fault tolerance

Developing and Implementing Operational Profiles, operations list, occurrence rates and probabilities, Applying operational profiles, graphical representation of the operational profile, module usage table, Learning operations and run concepts

Preparing test cases, Planning test, Allocating and distributing test cases, Detailing test cases, Preparing test procedures, using the graphical representation of the operational profile, Testing efficiently, Increasing test efficiency

Executing Test, Planning and allocating test time for the current release, Invoking test, Identifying failures Analyzing test output for deviations, Determining which deviations are failures, Establishing when failures

occurred, Testing multiple configurations, Handling uncertainties in establishing when failures occurred, Working with multiple releases, Invoking test, Counting failures

Tracking reliability growth, Estimating failure intensity, Certifying reliability, Estimating failure intensity for evolving programs Handling unreported failures, different risk levels and discrimination ratios, Operational profile variation, Understanding software reliability growth models, selecting models

Deploying SRE, Executing the deployment

Text/References:

1. John D. Musa, "Software Reliability Engineering", Mcgraw Hill, 1998.
2. Ann Marie Neufelder , "Ensuring Software Reliability", CRC Press, 1992..
3. Doron Peled, "Software Reliability Methods", Springer, 2001.
4. P. K. Kapur, R. B. Garg and S. Kumar, "Contributions to Hardware and Software Reliability", World Scientific Pub Co Inc, 1999.
5. M. Xie, "Software Reliability Modelling", Singapore, 1991.

CS-517 Decision Support Systems and Methods **[3 0 0]**

Course Outcomes: At the completion of the course, students will be able to

CO1: Distinguish among data processing systems, management information systems, and decision support/expert systems.

CO2: Recognize the relationship between business information needs and decision making.

CO3: Utilize commercial spreadsheet and database integrated packages to develop "what if" simulation models to support the decision making process.

CO4: Describe when/how heuristic expert systems models may be used to complement more analytic decision-making frameworks, such as spreadsheet models.

CO5: Appraise issues related to the development of DSS and Select appropriate modeling techniques

Course Contents

Decision-making and Computerized Support Management Support Systems: An Overview, Decision-Making Systems, Modeling, and Support.

Decision Support Systems, Decision Support Systems: An Overview Modeling and Analysis.

Business Intelligence: Data Warehousing, Data Acquisition, Data Mining, Business Analytics, and Visualization. Decision Support System Development.

Collaboration, Communication, enterprise decision support systems, and knowledge management

Collaborative Computing Technologies: Group Support Systems, Enterprise Information Systems, Knowledge Management, Intelligent decision support systems, Artificial Intelligence and Expert Systems. Knowledge-Based System, Knowledge Acquisition, Representation, and Reasoning.

Advanced Intelligent Systems, Intelligent Systems Over the Internet.

Implementing MSS in the e-Business Era, Electronic Commerce. Integration, Impacts, and the Future of Management-Support Systems.

Text/References:

1. George M. Marakas, "Decision Support Systems in 21st Century", Prentice Hall, 2/e, 2002.
2. Efraim Turban, Jay E. Aronson and Ting-Peng Liang, "Decision Support Systems and Intelligent Systems", 7/e, Edition PHI, 2004.

3. J. L. Bennett, "Buliding Decision Support System", Addison Wesley Publications, 2002.
4. Sprague and Watson, "Decision Support Systems: Theory and Practice", PHI, 2002.
5. R. Jaya Shankar, "Decision Support Systems", Tata McGraw Hill, 2002.

CS-518 Natural Language Processing and Information Retrieval [3 0 0]

Course Contents

Introduction: NLP introduction, origins of NLP, Language and Knowledge, The challenges of NLP, Language and Grammar, Processing Indian Languages, NLP applications, Some successful Early NLP systems, Information Retrieval

Language Modeling: Introduction, Various Grammars- based language models, Statistical Language Model.

Word Level Analysis: Introduction, Regular Expressions, Finite State Automata, Morphological Parsing, Spelling Error Detection and Correction, Words and Word Classes, Part-of-Speech Tagging.

Syntactic Analysis: Introduction, Context-Fee Grammar, Constituency, Parsing, Probabilistic Parsing, Indian Languages.

Semantic Analysis: Introduction, Meaning Representation, Lexical Semantics, Ambiguity, Word Sense Disambiguation.

Discourse Processing: Introduction, Cohesion, Reference Resolution, Discourse Coherence and Structure.

Natural Language Generation: Introduction, Architecture of NLG Systems, Generation Tasks and Representations, Application of NLG.

Machine Translation: Introduction, Problems in Machine Translation, Characteristics of Indian Languages, Machine Translation Approaches, Direct Machine Translation, Rule-based Machine Translation, Corpus-based Machine Translation, Semantic or Knowledge –based MT Systems, Translation involving Indian Languages.

Information Retrieval-1: Introduction, Design Features of Information Retrieval systems, Information Retrieval Models, Classical Information Retrieval Models, Non-classical models of IR, Alternative Models of IR, Evaluation of the IR Systems .

Information Retrieval-2: Introduction, Natural Language Processing in IR, Relation Matching, Knowledge-base Approaches, Conceptual Graphs in IR, Cross-lingual Information Retrieval.

Other Applications: Introduction, Information Extraction, Automatic Text Summarization, Question - Answering System.

Lexical Resources: Introduction, Word Net, Frame Net, Stemmers, Part -of-Speech Tagger

Text/References:

1. Tanveer Siddiqui and U. S. Tiwary, "Natural Language Processing and Information Retrieval", Oxford Higher Education, 2008.
2. James Allen, "Natural Language Understanding", 2/e, Pearson Education, 1994.
3. D. Jurafsky and J. H. Martin, "Speech and Language Processing", Prentice Hall, 2/e, 2008.
4. L.M. Ivansca and S. C. Shapiro, "Natural Language Processing and Language Representation", AAAI Press, 2000.
5. Akshar Bharti, Vineet Chaitanya and Rajeev Sangal, "NLP: A Paninian Perspective", Prentice Hall, New Delhi, 2004.

CS -519 OBJECT ORIENTED ANALYSIS AND DESIGN [3 0 0]

Course Outcomes: At the completion of the course, students will be able to

CO1: Explain the object- oriented software development process, including object-oriented methodologies and work flow.

CO2: Collect requirements and prepare their scenarios

CO3: Justify designs based on design principles, patterns, and heuristics.

CO4: Prepare diagrams by UML.

Course Contents

Introduction: What is Object Orientation? What is OO development? OO themes, OO modeling history, Modeling as Design Technique: Modeling, abstraction, The three models.

Process Overview: Development stages, Development life cycle.

Project Organization Concepts: Project Organizations, Roles, Tasks and Work Products, Schedule

Project Communication Concepts: Planned Communication, Unplanned Communication

Communication Mechanisms, Organizational Activities

Analysis: Problem Analysis, Problem Domain Classes, Defining the problem and the scope, Requirements Engineering, Types of Requirements. Requirements Validation, Completeness, Consistency, Clarity, and Correctness, Realism, Verifiability, and Traceability, Greenfield Engineering, Reengineering, and Interface Engineering

System Conception: Devising a system concept, elaborating a concept, preparing a problem statement, domain Analysis: Overview of analysis.

Class Modeling: Object and class concepts, Link and associations concepts, Generalization and inheritance, A sample class model, Navigation of class models, Advanced object and class concepts, Aggregation, Abstract classes, Packages.

State Modeling: Events, States, Transitions and Conditions, State diagrams, State diagram behavior, relation of class and state models

Interaction Modeling: Use case models, Sequence models, Activity models. Use case relationships.

Patterns: What is a pattern and what makes a pattern? Properties of Patterns, Pattern – A Three-part Schema, Different Types of Patterns: Layer Pattern, Broker Pattern, Shared-Data Pattern, Pipe and Filter Pattern, Model-View-Controller Pattern, Client-Server Pattern, Peer-to-Peer Pattern, Microkernel Pattern, Blackboard, Relationship between tactics and patterns, using tactics together.

Text/References:

1. Bernd Bruegge & Allen H. Dutoit, "Object-Oriented Software Engineering Using UML, Patterns, and Java" Third Edition, Pearson.
2. Len Bass, Paul Clements, Rick Kazman, Software Architecture in Practice, Pearson Education, Third edition, 2013.
3. Michael Blaha, James Rumbaugh, "Object Oriented Modeling and Design with UML", Second Edition, PHI.
4. Meilir Page-Jones, "Fundamentals of Object Oriented Design in UML", Pearson Education (2008).
5. Simon Benett, Steve Mc Robb, "Object Oriented Systems Analysis and Design using UML", Second Edition, TMH (2007).

CS-520 Quantitative Techniques **[3 0 0]**

Course Contents

Introduction: modelling approach and various real life situations, Linear programming problems & Applications, Various components of LP problem formulation, Solving Linear Programming problem using simultaneous equations, Graphical Method.

Simplex Method & Extensions: Sensitivity analysis, Duality theory, Revised Simplex, Dual Simplex, Transportation and Assignment Problems.

Network Analysis including PERT-CPM: Concepts of network, The shortest path, minimum spanning tree problem, Maximum flow problem, Minimum cost flow problems, The network simplex method, Project planning & control with PERT & CPM.

Integer Programming Concepts: Formulation solution and applications.

Dynamic Programming Concepts: Formulation, solution and application, Game Theory.

Queuing Theory & Applications: Linear Goal Programming methods and applications, Simulation.

Text/References:

1. F. S. Hillier and G. J. Lieberman, "Introduction to OR", McGraw Hill Int. Series, 1995.
2. A. Ravindran, "Introduction to OR", John Wiley & Sons, 1993.
3. R. Kapoor, "Computer Assisted Decision Models", Tata McGraw Hill, 1989.
4. P. C. Tulsian "Quantitative Techniques: Theory & Problems", Pearsons Education, 2002.
5. J. D. Wiest and F. K. Levy "Management Guide to PERT/CPM", 2/e, 2005.

CS-521 Embedded systems **[3 0 0]**

Course Contents

Introduction to Embedded systems: An embedded system, processor in the system**,** software embedded into a system, Embedded system on chip (SOC) and in VLSI circuit and Understand the concepts, issues, and process of system-level design of embedded systems, i.e., hardware-software design. Understand hardware, software, and interface synthesis Understand issues in interface design. Use contemporary software tools within a co design environment.

Software engineering practices in the embedded software Development process: Software algorithm complexity**,** software project management and maintenance, UML and real time operating systems, real time operating system programming tools.

Embedded Systems Programming: Embedded System Design Issues, Challenges & Trends in Embedded Systems, Assemblers, Compilers, Linkers, Loaders, Debuggers, Profilers & Test, overage Tools, Utilities like make, ranlib, objcopy & objdump , Configuring & Building GNU Cross-Toolchain , Building RTOS/EOS Image for Target Hardware, Porting RTOS & Embedded Operating Systems, Writing Time & Space Sensitive Programs.

Wireless Embedded Systems Design: Protocol Design and Validation, Network Embedded Systems (Operating Systems and programming) , Bluetooth and IrDA , Wireless Sensor Networks and ZigBee , Wireless LAN - IEEE 802.11 , RFID , GSM and GPRS , Ubiquitous Computing.

Texts /References

1. F. Vahid and T. Givargis, "Embedded System Design: A Unified Hardware/Software Approach", John Wiley and Sons, 2001.
2. D. D. Gajski, F. Vahid, S. Narayan and J. Gong, "Specification and Design of Embedded Systems", Prentice Hall, Englewood Cliffs, NJ, 1994.
3. J. Staunstrup and W. Wolf, editors, "Hardware/Software Co-Design: Principles and Practice", Kluwer Academic Publishers, 1997.

CS- 522 Mobile and Wireless Communications **[3 0 0]**

Course Contents

Concepts of cellular communication: Basic wireless cellular system, Performance criterion, uniqueness of mobile radio environment, operation of cellular systems, planning a cellular system, analog and digital cellular systems, Generations: 2G systems, GSM specifications and air interface-specifications of various units. 2.5 G systems: GPRS/EDGE specifications and features, 3G systems: UMTS and CDMA-2000 standards and specifications.

Interference: Introduction to co-channel interference, real-time co-channel interference, Frequency reuse, determining the frequency reuse distance, analysis of co-channel interference, Handoff strategies: concepts of hard and soft handoff strategies, Spectral efficiency, grade of service, Improving capacity in cellular systems, Cell splitting, Sectorization.

Cell coverage for signal and traffic Engineering: General introduction, obtaining mobile point to point mode, propagation over water or flat open area, foliage losses, near distance propagation, long distance propagation, point to point propagation model- characteristics, cell site, antenna heights and signal coverage cells, mobile to mobile propagation.

Digital Communication through fading multi-path channels: Fading channels and their characteristics- channel modeling, Digital signaling over a frequency non-selective channel- frequency selective slowly fading channel, Calculation of error probabilities, tapped delay line model-RAKE demodulator- performance, concept of diversity branches and signal paths, combining methods selective diversity combining, pre-detection and post detection combining, switched combining, maximal ratio combining, equal gain combining.
GSM: Objectives, Specifications and an interface, GSM PLMN Services, GSM Architecture, GSM channel & frame structure, GSM speech processing, GSM call flow scenarios, MSC performance.

Fundamental concepts of spread spectrum systems: Direct sequence spread spectrum- Frequency Hopping systems- Time Hopping spread spectrum systems, anti jamming analysis, PN sequence: Generation of PN sequence, maximal length sequences, gold sequences, PN code acquisition and tracking, Capacity of cellular CDMA networks, reverse link power control, Effect of imperfect power control, soft handoffs, multicarrier CDMA, IS95, multiuser detection, SIC, PIC receivers and performance.

Cell site antennas and mobile antennas: Characteristics, antenna at cell site, mobile antennas.

Frequency management and channel assignment: Frequency management, fixed channel assignment, non-fixed channel assignment.

Text/References:

1. Jochen Schiller, “Mobile Communications”, Pearson Education, 2/e, 2003.
2. William Stallings, “Wireless Communications and Networks”, Pearson Education, 2/e, 2004.
3. Kaveh Pahlavan and Prasanth Krishnamoorthy, “Principles of Wireless Networks”, Pearson Education, 2003.
4. C.K.Toh, “AdHoc Mobile Wireless Networks”, Pearson Education, 2002.
5. T. S. Rappaport, “Wireless Communications - Principles and Practice”, Prentice Hall, 2/e, 2001.

CS- 523 System and Network Administration [3 0 0]

Course Contents

Introduction to System & Network Administration, roles and responsibilities of a system and network administrator, Scope, Goals, Duties, Ethics, Career Paths.

Introduction to Operating Systems, operating system concepts, Characterize different file system formats, operating system installation procedures, Operating Systems: Windows and Unix Variants, Processes and Job Control, Memory Management, Concept of Swap Space, File Systems, File Systems and Standards (UFS, NFS, NTFS), File System Layout (inode and FAT based file systems), Formatting, Partitioning and Building a File System, Installation of Operating Systems, Linux Boot Process, Single OS, Dual Boot, Cloning, Host Management, Plan and execute system management procedures.

Booting and Shutting Down of an Operating System, Installation and configuration of Software, Proprietary Software, Open Source Software, Installation and configuration of devices and drivers, Super user/Administrator Privileges, User Management, Adding / Removing users, Controlling User Resources, Disk Space Allocation and quotas, Process Management and Monitoring, Scheduling Processes, Killing/Stopping processes, Restarting a Process, Monitoring Process Activity, Maintaining Log Files, File System Repair, Backup and Restoration, Handling Man Pages/ Help System, Kernel Customization, Managing Heterogeneous Systems, File System Sharing (Samba), Printer Sharing (Samba/CUPS), User IDs, Passwords and Authentication (LDAP), Systems Performance

Tuning .

Introduction to Network Administration Approaches, TCP/IP Networking Basics, IP Addressing and Sub-netting VLAN Principles and Configuration, Routing Concepts , Network Address Translation , Configuring a Linux Box for Networking, LAN and Wireless LAN, Dial-up and Broadband, Configuring a Linux Box as a Router Configuring a Web Server (Apache) , Configuring a DNS Server (BIND), Configuring Mail Transfer Agents Configuring a Proxy Caches (Squid), TCP/IP Troubleshooting: ping, traceroute, ifconfig, netstat, ipconfig.

Network Management, SNMP ver 2 Basic Components, Commands , Management Information Base , RMON Security Planning & System Audits, Security standards and Levels (ISO 15408 standard), Password Security, Access Control and Monitoring: Wrappers, Firewalls, Filtering Rules, Detection and Prevention of Denial of Service (DOS) Attacks, Automatic Identification of Configuration Loopholes (Tripwire), Intrusion Detection Systems, Security Information Resources: CERT automating System Administration, Use of Scripting tools, Shell Scripting, Perl/Python Scripting, Use of Make Option.

Text/References:

1. Mark Burgess, “Principles of Network and System Administration”, John Wiley and Sons Ltd, 2/e, 2004.
2. Craig Hunt, “TCP/IP Network Administration”, O’Reilly and Associates Inc., 3/e, 2002.
3. Matthias Kalle Dalheimer and Matt Welsh, “Running Linux”, O’Reilly and Associates Inc., 5/e, 2007.
4. Eleen Frisch, “Essential System Administration”, O’Reilly and Associates Inc., 3/e, 2003.
5. T. Chan, “UNIX Systems Programming using C++”, PHI Pvt Ltd., 1996.

CS- 524 Mobile Computing Technologies [3 0 0]

Course Contents

Introduction: Challenges in mobile computing, coping with uncertainties, resource poorness, bandwidth, etc.

Mobile IP Protocol Architecture: Mobile IP and IP v6 and its application in mobile computing, Cellular Digital Packet Data CDPD, VOIP, GPRS Services, Wireless Local Loop-WLL system.

File System Support for Mobility: Distributed file sharing for mobility support, Coda and other storage manager for mobility support.

Ad hoc Network Routing Protocols: Ad hoc network routing protocols, destination sequenced distance vector algorithm, cluster based gateway switch routing, global state routing, fish-eye state routing, dynamic source routing, ad hoc on-demand routing, location aided routing, zonal routing algorithm.

Mobile Transaction and Commerce: Models for mobile transaction, Kangaroo and joey transactions, team transaction, Recovery model for mobile transactions, Electronic payment and protocols for mobile commerce.

Distributed Mobile Computing: Distributed OS and file systems, Mobile Computing Software (Pervasive Computing) Development Strategies and tools, Data Management for Mobile Computing.

Application of Mobile computing: ASP and Dynamic WAP Sites, XML and XSLT, Dynamic WML Generation with ASP and XSLT, Developing WAP Applications using Emulators.

Text/References:

1. Yi Bing Lin and Imrich Chlamtac, “Wireless and Mobile Networks Architecture”, John Wiley, 2000.
2. T. Imielinski and H.F. Korth, “Mobile Computing”, Kluwer Academic Press, 1996.
3. Uwe Hansmann, Lothar Merk, Martin S. Nicklons and Thomas Stober, “Principles of Mobile Computing”, Springer, New York, 2003.
4. Jochen Burkhardt, “Pervasive Computing, Technology and Architecture of Mobile Internet Applications”, Addison Wesley, 2002.
5. Jochen Schiller, “Mobile Communications”, Pearson Education, 2/e, 2003.

CS-525 Optical Networks **[3 0 0]**

Course Contents

Introduction: Overview of optical networks, Optical Layer: Line systems, Basics of transmitting bits, Fiber and Components, Fiber, transmitters, receivers, amplifiers, simple couplers, channel impairment parameters (signal power attenuation, dispersion, noise etc.).

Architecture for Access Networks: Multiplexing Level, WDM–Passive Optical Network: Wavelength Allocation Strategies, Dynamic Network Reconfiguration Using Flexible WDM, Static WDM PONs, Wavelength Routed PON, Reconfigurable WDM PONs, Wavelength Broadcast-and-Select Access Network, Wavelength Routing Access Network, Geographical, Optical and Virtual Topologies: Star, Tree, Bus, Ring and Combined, Tree with Ring or Redundant Trunk, Arrayed Waveguide Grating Based Single Hop WDM/TDM PON, Compatibility with Radio Applications UWB, UMTS, WiFi, Next Generation G/E-PON Standards Development Process, Development of 10G EPON, Next Generation GPON Systems.

Components for Access Networks: Tunable Optical Network Unit, Fast-Tunable Laser at the Optical Line Terminal, Arrayed Waveguide Gratings, Wavelength Router Functionality, Applications in Access Networks, Arrayed Waveguide Grating Characterization, Reflective Receivers and Modulators, Electroabsorption Modulator, Semiconductor Optical Amplifiers, Reflective Semiconductor Optical Amplifier, Erbium Doped Waveguide Amplifiers and Integration with RSOA and REAM for High Performance Colourless ONT.

Enhanced Transmission Techniques: Advanced Functionalities in PONs: Wavelength Conversion, Tolerance to Wavelength Conversion Range, Bidirectional Single Fiber Transmission with Colourless Optical Network Unit: Remodulation by Using Reflective Semiconductor Optical Amplifiers, Fabry Perot Injection Locking with High Bandwidth and Low Optical Power for Locking, Characterization of Rayleigh Backscattering, Strategies to Mitigate Rayleigh Backscattering, ASK-ASK Configuration Using Time Division Multiplexing, FSK-ASK Configuration Using Modulation Format Multiplexing, Subcarrier Multiplexing by Electrical Frequency Multiplexing, Rayleigh Scattering Reduction by Means of Optical Frequency Dithering, Spectral Slicing, Alternative Modulation Formats to NRZ ASK, Bidirectional Very High Rate DSL Transmission Over PON: Heterodyning Systems, Optical Frequency Multiplying Systems, Coherent Systems, Active and Remotely-Pumped Optical Amplification: Burst Traffic, Raman Amplification in PONs, Remote Powering, Variable Splitter, Variable Multiplexer.

Integrated Broadband Optical Fibre/Wireless LAN Access Networks: Introduction, Directly Modulated Radio-Over-Fiber Systems, RoF Systems Deploying Optical Frequency: Conversion, Heterodyning Systems, Optical Frequency Multiplying System: OFM System Analysis, Impact of Dispersion in Multimode Fiber Systems, Impact of Dispersion in Single-Mode Fiber Systems, Bi-Directional Multiple-Access System, Installation Aspects of In-Building Radio-Over-Fiber Systems, Dynamically Allocating Radio Capacity.

Text/References:

1. Josep Prat, “Next-Generation FTTH Passive Optical Networks-Research Towards Unlimited Bandwidth Access”, Springer Science, 2008.
2. Chinlon Lin, “Broadband Optical Access Networks and Fiber-to-the-Home-Systems Technologies and Deployment Strategies”, John Wiley & Sons Ltd, 2006.
3. Maode Ma, “Current Research Progress of Optical Networks”, Springer Science, 2009.
4. Rajiv Ramaswami and Kumar Sivarajan, “Optical Networks”, Morgan Kaufmann, 3/e, 2009.
5. Robert C. Elsenpeter and Toby J. Velte, “Optical Networking: A Beginner’s Guide”, McGraw-Hill/Osborne, 2002.

CS-526 Biometric Security **[3 0 0]**

Course Contents

Introduction: Authentication and Biometrics Overview, How Authentication Technologies Work, How Biometrics Work, Where can Biometrics be applied.

Types of Biometrics: Fingerprint and Hand Geometry, Facial and Voice Recognition, Eye Biometrics: Iris and Retina Scanning, Signature Recognition and Keystroke Dynamics, Esoteric Biometrics.

Issues Involving Biometrics: Biometric Liveness Testing, Biometrics in Large-Scale Systems, Biometric Standards.

Biometric Testing and Evaluation: Privacy, Policy, and Legal Concerns Raised by Biometrics, Biometrics and Privacy, Legal Considerations of Government Use of Biometrics.

Case Study: Super Bowl Surveillance, The Law and Private-Sector Use of Biometrics

Review of Selected Biometrics Programs: Government and Military Programs, Private-Sector Programs

Text/References:

1. J. Ashbourn, "Practical Biometrics - From Aspiration to Implementation", Springer Verlag, 2004.
2. R. M. Bolle, J. H. Connel, S. Pankanti, N. K. Ratha, A. W. Senior, "Guide to Biometrics", Springer Verlag, 2004.
3. J. Chirillo, S. Blaul, "Implementing Biometric Security", Wiley, 2003.
4. S. Nanavati, M. Thieme, R. Nanavati, "Biometrics - Identity Verification in a Networked World", Wiley, 2002.
5. J. D. Woodward, N. M. Orlans, P. T. Higgins, "Biometrics - Identity Assurance in the Information Age", McGraw-Hill Osborne Media, 2002.

CS-527 Numerical Methods **[3 0 0]**

Course Contents

Introduction to Numerical Computing, Analog Computing, Digital Computing, Process and Characteristics of Numerical Computing, New trends in Numerical Computing, Approximations and Errors in Computing, Stability and Convergence of Iterative Processes.

Roots of Nonlinear Equations, Methods of Solution, Bisection Method, False Position Method, Netwton-Raphson Method, Secant Method, Fixed Point Method, Multiple Roots by Newton's Method, Complex Roots Bairstow Method, Muller's Method.

Solution of Linear Equations, Guass Elimination Method, Guass-Jordon Method, Triangular Factorization Methods, Matrix Inversion Method, Jacobi Iteration Method, Guass-Seidal Method, Relaxation Method.

Linear Interpolation, Lagrange Interpolation Polynomial, Newton Interpolation Polynomial, Divided Difference Method, Forward and Backward Difference Table, Spline Interpolation, Chebyshev Interpolation Polynomial, Least Squares Regression, Multiple Linear Regression, Ill-Conditioning in Least-Squares Methods.

Numerical Differentiation, Differentiating Continuous, Tabulated Functions, Richardson Extrapolation. Numerical Integration, Newton-Cotes Methods, Trapezoidal Rule, Simpson's 1/3 Rule, Simpson's 3/8 Rule, Romberg Integration, Gaussian Integration.

Numerical Solution of Ordinary Differential Equations, Picard's Method, Euler's Method, Polygon Method, Runge-Kutta Methods, One-Step and Multi-step Methods, Initial Value and Boundary Value Problems, Predictor-Corrector Method, Shooting Method, Finite Difference Methods, Finite Element Methods.

Text/References:

1. M. K. Jain, S. R. K. Iyengar and R. K. Jain, "Numerical Methods for Scientific and Engineering Computation", New Age International Publishers, 4/e, 2005.
2. E. Balaguruswamy, "Numerical Methods", Tata McGraw-Hill, 1999.
3. K. Sankara Rao, "Numerical Methods for Scientists and Engineers", PHI Pvt. Ltd., 3/e, 2013.
4. Steven C. Chapra and Raymond P. Canale, "Numerical Methods for Engineers", Tata McGraw-Hill, 6/e, 2009.

5. S. S. Sastry, "Introductory Methods of Numerical Analysis", PHI Pvt. Ltd., 5/e, 2012.

CS- 528 Image Understanding and Pattern Recognition [3 0 0]

Course Contents

Image Processing: filtering, convolution, edge detection, image pyramids, image warping (parametric transformations, resampling, morphing algorithms, texture mapping), image compositing (alpha blending, color mosaics), segmentation and matting (snakes, scissors, and normalized cuts), texture modeling and synthesis.

Image Mosaics: applications of image mosaics, mosaic representations, rendering with mosaics, image registration (manual and automatic methods).

Motion Estimation: optical flow, parametric motion estimation, course-to-fine estimation, feature tracking, patch tracking, condensation.

Single View Geometry: projective geometry (homogeneous coordinates, vanishing points, homographies, the cross ratio), 3D modeling from a single image.

Multiview Geometry: epipolar geometry, the fundamental matrix, the trifocal tensor, robust estimation techniques.

Pose Estimation and Calibration: camera calibration from known 3D points, self-calibration, structure from motion, bundle adjustment (nonlinear optimization), match move: inserting synthetic objects into video.

Estimating Depth: correlation-based stereo, energy minimization with graph cuts.

Sprites, Layers, and 2.5D layer representations, layer extraction (from video, from stereo), rendering with layers, Bayesian inference.

Face Analysis and Synthesis: face modeling from a single image, tracking and modeling facial expressions.

Pattern Recognition: Introduction, image classification, decision surfaces, Unsupervised classification: K-means clustering, ISODATA, Supervised classification: Maximum likelihood, parallelepiped, and minimum distance to means, K-NN, Training areas and their characteristics, sampling, refinement of training data.

Feature selection: Divergence analysis, Bhattacharya and Mahalanobis distance, JM distance, separability analysis.

Text/References:

1. Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing", Pearson Education, 3/e, 2007.
2. Sonka, Hlavac and Boyle, "Digital Image Processing and Computer Vision", Brooks/Cole, 3/e, 2007.
3. Bhabatosh Chanda and Dwijesh Dutta Majumder, "Digital Image Processing and Analysis", PHI Learning Pvt. Ltd., 2004.
4. Richard O. Duda, Peter E. Hart & David G. Stork, "Pattern Classification", Wiley & Sons

CS-529 Search Techniques [3 0 0]

Course Contents

Introduction: Information Retrieval, Search Engines, Architecture of a Search Engine, What is an Architecture?, Basic Building Blocks, Breaking It Down, Text Acquisition, Text Transformation, Index Creation, User Interaction, Ranking, Evaluation, Crawling and Indexing, Directories, Clustering and Classification, Hyperlink Analysis, Resource Discovery and Vertical Portals, Structured Vs. Unstructured Data Mining.

Crawling the Web: HTML and HTTP Basics, Crawling Basics, DNS Caching, Pre fetching and Resolution, Multiple Concurrent Fetches, Link Extraction and Normalization, Eliminating Already Visited URLs, Spider Traps, Avoiding Repeated Expansion of Links on Duplicate Pages, Load Monitor and Manager, Per-Server Work- Queues, Design of core components of a Crawler.

Web Search and Information Retrieval: Boolean Queries and Inverted Index, Stop words and Stemming, Batch Indexing and Updates, Index Compression Techniques, Relevance Ranking: Recall and Precision, Vector-Space Model, Relevance Feedback, Probabilistic Relevance Feedback Models, Similarity Search: Handling "Find Similar"

Queries, Eliminating Near Duplicates Via Shingling, Detecting Locally Similar Sub graphs of the Web.

Similarity and Clustering : Formulations and Approaches, Bottom up and Top-Down Paradigms, Clustering and Visualization, Probabilistic Approaches to Clustering, Collaborative Filtering.

Supervised Learning: The Supervised Learning Scenario, Overview of Classification Strategies, Evaluating Text Classifiers, Nearest Neighbor Learners, Feature Selection, Bayesian Learners, Exploiting Hierarchy, Maximum Entropy Learners, Discriminative Classification, Hypertext Classification.

Semi Supervised Learning: Expectation Maximization, Reducing the belief in Unlabeled Documents, Modeling Labels using many mixture Components, Labeling Hypertext Graphs, Absorbing Features from Neighboring pages, A Relaxation Labeling Algorithm, A Metric Graph- Labeling Problem, Co-training.

Text/References

1. Bruce Croft, Donald Metzler, Trevor Strohman, “Search Engines: Information Retrieval in Practice”, Addison-Wesley, 2009.
2. C. J. VanRijsbergen,“ Information Retrieval“, Butterworth-Heinemann,2/e, 1979.
3. Win ship and R. Ian, “World Wide Web searching tools, an evaluation", MCB UP Ltd.
4. Greg R. Notess, “Searching the World Wide Web: Lycos, WebCrawler, and more" *Online,* July 1995.
5. Alfred and Emily Gloss Brenner, “Search Engines for the World Wide Web”, 3/e, Peach pit Press, 2001.

CS- 530 Game Theory and its Applications [3 0 0]

Course Contents

Introduction to game theory, An introduction to games and their theory, Game theory and the theory of competitive equilibrium, Games of chance, Nash equilibrium for two-person games, Mixed strategies and mixed strategy equilibrium, n-person games in normal form.

Noncooperative market games in normal form, Credibility and sub game perfect equilibrium, Repeated games, Signaling games and sequential equilibrium, Games between a principal and an agent, Auctions.

2-player Zero sum games and the Minimax theorem: Introduction to linear programming, the simplex algorithm and LP Duality.

Computing Solutions for General finite Strategic Games, Dominance and iterated strategy elimination and Nash Equilibrium.

Games in normal and extensive and strategic form and games of perfect Information and games on graphs etc.

Text/References:

1. Bierman and Fernandez, “Game Theory with Economic Applications”, Addison Wesley, 2/e, 1998.
2. Fudenberg and Tirole, “Game Theory”, MIT Press, 1991.
3. Gibbons, “Game Theory for Applied Economists”, Princeton University Press, 1992.
4. Krishna, “Auction Theory”, Academic Press, 2002.
5. Luce and Raiffa, “Games and Decisions”, Wiley, 1957.

CS-531 Secure M-Commerce [3 0 0]

Course Contents

M Commerce and its Security challenges: Definition of M commerce, Mobile Devices, Differences to E-Commerce, Security Challenges.

Security Challenges relevant for M Commerce: Security of Network technologies GSM, Units WLANs, Transport Layer Security.

M Payment: Background on payment systems, Categorization of E payment system, Standardization and Forums

Wireless Computing Security: develops understanding of the security implications of all forms of wireless computing systems and the strategies that can be used to protect them from attack.

Mobile Software Engineering: develops skills in mobile software design, implementation and evaluation as well as the ability to advise senior management on the technical aspects of wireless systems developments.

Text/References:

1. Norman Sadeh, "M Commerce: Technologies, Services, and Business Models", Wiley, 2002.
2. P J Louis, "M-Commerce Crash Course: The Technology and Business of Next Generation Internet Services"**,** McGraw-Hill, 2001.
3. Kim M. Bayne, "Marketing Without Wires: Targeting Promotions and Advertising to Mobile Device Users", Wiley, 2002.
4. Jouni Paavilainen, "Mobile Business Strategies: Understanding the Technologies and Opportunities", Addison-Wesley Professional, 2002.
5. Matt Haig, "Mobile Marketing: the message Revolution", Kogan Page Business Books, 2002.

CS-532 Cloud Computing & Communication [3 0 0]

Course Contents

Introduction: Cloud-definition, benefits, usage scenarios, History of Cloud Computing – Cloud Architecture – Types of Clouds – Business models around Clouds – Major Players in Cloud Computing – issues in Clouds – Eucalyptus – Nimbus – Open Nebula, CloudSim, Risks Involved in Cloud Computing.

Cloud Services: Types of Cloud services: Software as a service – Platform as a Service – Infrastructure as a Service – database as a Service – Monitoring as a Service – Communication as services, Service providers – Google, Amazon, Microsoft Azure, IBM, Salesforce.

Collaborating Using Cloud Services: Email Communication over the Cloud – CRM Management – Project Management – Event Management – Task Management – Calendar – Schedules – Word Processing – Presentation – Spreadsheet – Databases – Desktop – Social Networks and Groupware, Work Loan Management in Cloud.

Virtualization For Cloud: Need for Virtualization – Pros and cons of Virtualization – Types of Virtualization – System Vm, Process VM, Virtual Machine monitor – Virtual machine properties – Interpretation and binary translation, HLL VM – Hypervisors – Xen, KVM, VMWare, Virtual Box, Hyper-V.

Other Ways to Collaborate Online: Collaborating via Web - Based Communication Tools - Evaluating Web Mail Services – Evaluating Web Conference Tools – Collaborating via Social Networks and Groupware - Collaborating via Blogs and Wikis.

Security, Standards and Applications: Security in Cloud: Cloud security challenges – Software as a Service Security, Common Standards: The Open Cloud Consortium – The Distributed Management Task Force – Standards for application Developer – Standards for Messaging – Standards for Security, End user access to cloud computing, Mobile Internet devices and the cloud.

Text/ References:

1. John Rittinghouse and James Ransome, "Cloud Computing, Implementation, Management and Strategy", CRC Press, 2009.
2. Michael Miller, "Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate", Que Publishing, August 2008.
3. James E Smith and Ravi Nair, "Virtual Machines", Morgan Kaufmann, 2006.
4. David E. Y. Sarna, "Implementing and Developing Cloud Application", CRC press 2011.

5. Lee Badger, Tim Grance, Robert Patt-Corner and Jeff Voas, NIST Draft cloud computing synopsis and recommendation, 2011.
6. Anthony T Velte, Toby J Velte and Robert Elsenpeter, "Cloud Computing: A Practical Approach", Tata McGraw-Hill, 2009.
7. Haley Beard, "Best Practices for Managing and Measuring Processes for On-demand Computing, Applications and Data Centers in the Cloud with SLAs", Emereo Pty Limited, 2/e, 2009.
8. G. J. Popek and R. P. Godber, "Formal requirements for virtualizabale third generation Architectures", Communications of the ACM, No.7 Vol. 17, July 1974.

CS- 533 Mathematical Models for Internet

Course Contents

Introduction to optimization models, discrete methods for solving problems of different areas of application.

Combinatorial Enumeration, Numerical solutions of various problems, boundary value problems and evolutionary equations, Numerical modeling and high performance Numerical Computing.

Essentials of MATLAB**,** Vectors, matrices and the colon operator, M-Files: scripts and functions, Symbolic Math Toolbox. Advanced and MATLAB features, including MEX files.

An Introduction to games and their theory, Game theory and the theory of competitive equilibrium, Games of chance, Nash equilibrium for two-person games, mixed strategies and mixed strategy equilibrium, n-person games in normal form.

Linear optimization, Some Mathematical software issues, measuring efficiency and performance, probability, prototyping and templates and web based problem solving and case study LAPACK

Network Flow theory**,** Numerical optimization: Unconstrained Optimization. Optimality conditions, properties of quadratic functions, Linearly Constrained Optimization. Theory and optimality conditions for equality and inequality constraints, Reduced gradient and active set methods.

Computational Optimization, Mathematical optimization, Deterministic OR model and the mathematics of public key and cryptography.

Text/References:

1. Costas Courcoubetis, Richard Weber, "An advanced course on mathematical modeling and pricing", Willey, 2005.
2. Robert Donald Smith, "Mathematics for Machine technology", Willey, 2005.
3. Gene H. Golub and Charles F. Van Loan. " Matrix Computations", Johns Hopkins University Press, Baltimore, MD, USA, third edition, 1996
4. Nicholas J. Higham, "Accuracy and Stability of Numerical Algorithms" Society for Industrial and Applied Mathematics, Philadelphia, PA, USA, second edition, 2002.
5. David S. Watkins, "Fundamentals of Matrix Computations" Wiley, New York, 1991.

CS-534 Information Warfare **[3 0 0]**

Course Contents

Introduction to Information System Security, Offensive and Defensive Information Warfare: Cyber Crime - Fraud and Abuse, National Security, Offensive Information Warfare, Privacy Rights, Ethics, Censorship, Harassment.

Intellectual Property – Piracy, Insider Threat, Corporate Espionage, Monitoring - Eavesdropping, Traffic Analysis, Surveillance, Defensive Information Warfare Telecommunication Security, Computer Network Security, Computer Break-Ins, Cryptographic Techniques, Steganography.

Prevention Techniques - Access Control, Misuse Detection, Vulnerability Monitoring, Security Policy, Risk Management, Incident Handling, Law Enforcement and Cyber Crime.

Text/References:

1. M. Erbschloe and J. R. Vacca, "Information Warfare: How to Survive Cyber Attacks", McGraw-Hill, 2001.
2. Jones, G. L. Kovacich, and P. G. Luzwick, "Global Information Warfare: How Business, Governments, and Others Achieve Objectives and Attain Competitive Advantages", CRC Press, 2002.
3. D. Denning, "Information Warfare and Security", Addison Wesley, 1998.
4. Gregory J. Rattray, "Strategic Warfare in Cyberspace", MIT Press, 2001.
5. Abraham N. Shulsky and Gary J. Schmitt, "Silent warfare understanding of the World of Intelligence", Potomac Books Inc, 3/e, 2002.

CS-535 Information Storage and Management [3 0 0]

Course Contents

Introduction to Storage Technology: Data proliferation and the varying value of data with time & usage, Sources of data and states of data creation, Data center requirements and evolution to accommodate storage needs, Overview of basic storage management skills and activities, The five pillars of technology, Overview of storage infrastructure components, Evolution of storage, Information Lifecycle Management concept, Data categorization within an enterprise, Storage and Regulations.

Storage Systems Architecture: Intelligent disk subsystems overview, Contrast of integrated vs. modular arrays, Component architecture of intelligent disk subsystems, Disk physical structure components, properties, performance, and specifications, Logical partitioning of disks, RAID & parity algorithms, hot sparing, Physical vs. logical disk organization, protection, and back end management, Array caching properties and algorithms, Front end connectivity and queuing properties, Front end to host storage provisioning, mapping, and operation, Interaction of file systems with storage, Storage system connectivity protocols.

Introduction to Networked Storage: JBOD, DAS, SAN, NAS, & CAS evolution, Direct Attached Storage (DAS) environments: elements, connectivity, & management, Storage Area Networks (SAN): elements & connectivity, Fibre Channel principles, standards, & network management principles, SAN management principles, Network Attached Storage (NAS): elements, connectivity options, connectivity protocols (NFS, CIFS, ftp), & management principles, IP SAN elements, standards (SCSI, FCIP, FCP), connectivity principles, security, and management principles, Content Addressable Storage (CAS): elements, connectivity options, standards, and management principles, Hybrid Storage solutions overview including technologies like virtualization & appliances.

Introduction to Information Availability: Business Continuity and Disaster Recovery Basics, Local business continuity techniques, Remote business continuity techniques, Disaster Recovery principles & techniques.

Managing & Monitoring: Management philosophies (holistic vs. system & component), Industry management standards (SNMP, SMI-S, CIM), Standard framework applications, Key management metrics (thresholds, availability, capacity, security, performance), Metric analysis methodologies & trend analysis, Reactive and pro-active management best practices, Provisioning & configuration change planning, Problem reporting, prioritization, and handling techniques, Management tools overview.

Text/References:

1. Kowalski, Gerald and Mark T Maybury, "Information Retrieval Systems: Theory and Implementation", Springer, 2/e, 2000.
2. William B. Frakes, Ricardo Baeza-Yates, "Information Retrieval Data Structures and Algorithms", Prentice Hall, 1992.
3. Ricardo Baeza-Yates and Berthier Ribeiro-Neto, "Modern Information Retrival", Pearson Education, 2004.
4. Robert Korfhage, "Information Storage & Retieval", John Wiley & Sons, 1997.
5. Soumen Charabarti, "Mining the Web", Morgan-Kaufmann, 2002.

CS-536 Optical IP Networks **[3 0 0]**

Course Contents

Concepts related to IP over WDM infrastructure and ways to implement it in real networks, along with challenges facing designers and system engineers, Layering options in IP over WDM, Methods for network resilience assurance, including optical network and GMPLS recovery, Access methods to optical networks, concentrating on traffic grooming and optical Metropolitan Area Networks, Control plane for optical networks, ASON and GMPLS approaches, The issue of all-optical networks is discussed, including solutions based on optical circuit, packet, and burst switching.

Text/References:

1. J.-P. Vasseur, M. Pickavet and P. Demeester, "Network Recovery: Protection and Restoration of Optical, SONET-SDH, IP, and MPLS", Morgan Kaufmann, 2004.
2. IETF and ITU-T documents.
3. Lecture notes, http://www.eit.agh.edu.pl
4. Rajiv Ramaswami and Kumar Sivarajan, "Optical Networks", Morgan Kaufmann Publishers, 3/e, 2009.
5. Robert C. Elsenpeter and Toby J. Velte, "Optical Networking: A Beginner's Guide", McGraw-Hill Companies, 2001.

CS-537 Software Metrics and Quality Engineering **[3 0 0]**

Course Contents

Overview of Software Metrics: The Basics of Measurement, Metrology, Property-oriented measurement Meaningfulness in measurement, Measurement quality, Measurement process, Scale, Measurement validation, Object-oriented measurement, Subject-domain-oriented measurement.

Goal based framework for software measurement: Software measure classification, Goal-based paradigms: Goal-Question-Metrics(GQM) and Goal-Question-Indicator-Metrics (GQIM),Applications of GQM and GQIM

Empirical Investigation: Software engineering investigation, Investigation principles, Investigation techniques, Formal experiments: Planning, principles, Types, selection.

Measuring Internal Product attributes: Software Size, Length, reuse, Functionality, Complexity.

Measuring internal product attributes: Software structural measurement, Control flow structure, Cyclomatic Complexity, Data flow and data structure attributes Architectural measurement.

Measuring Cost & Effort: Software cost model, COCOMO and COCOMO II, Constraint model Software Lifecycle Management (SLIM), Cost models: advantages and drawbacks.

Measuring external product attributes: Software quality, Software quality models: Boehm's model, McCall's model, Basic software quality metrics, Quality management models, Measuring customer satisfaction, Software Quality Assurance (SQA).

Measuring software Reliability: Concepts and definitions, Software reliability models and metrics, Fundamentals of software reliability engineering (SRE), Reliability management model.

Software test metrics: Test concepts, definitions and techniques, Estimating number of test case, Allocating test times ,Decisions based on testing ,Test coverage measurement ,Software testability measurement.

Object–oriented metrics: Object-Oriented measurement concepts, Basic metrics for OO systems, OO analysis and design metrics, Metrics for productivity measurement, Metrics for OO software quality.

Text/References:

1. Stephen H. Kan, "Metrics and Models in Software Quality Engineering", Addison-Wesley Professional, 2/e, 2002.

2. Norman E. Fenton, S. L. Pfleeger, "Software Metrics: A Rigorous and Practical Approach", published by International Thomson Computer Press, 2/e, 1998.
3. Robert B. Grady, "Practical Software Metrics for Project Management And Process Improvement", Prentice Hall, 1992.
4. Conte, S. D., H. E. Dunsmore, and V. Y. Shen, "Software Engineering Metrics and Models", Benjamin/Cummings, 1984.

CS-538 Applications of Artificial Intelligence and Neural Networks [3 0 0]

Course Contents

Introduction: Introduction to AI, agents and environments, development of logic, Turing test, applications of AI. **Problem Solving Techniques:** Problem state spaces, Search space control: Uninformed search- Depth first search, Breadth first search, Heuristic search - A* algorithm, AO* algorithm, Minimax search procedure (game playing), Alpha beta cutoffs.

Knowledge Representation: Propositional and predicate logic, resolution in predicate logic, Semantic networks, Frames and scripts, conceptual graphs, conceptual dependencies.

Languages for AI Problem Solving: Introduction to Prolog- syntax and data structures, representing objects and relationships, built in predicates. Introduction to LISP- basic and intermediate LISP programming.

Introduction to: Neural Networks, Neural network resources, Models of Neuron.

Analysis of Feed forward Neural Networks: Linear associative networks for pattern association; Single layer and Multilayer Perception network for pattern classification; Multilayer feed forward neural networks for pattern mapping.

Analysis of Feedback Neural Networks: Linear auto associative networks; Hopfield model for pattern storage; stochastic networks; Boltzmann machine for pattern environment storage.

Competitive Learning Neural Networks: Basic competitive learning laws; Analysis of pattern clustering networks; Analysis of self-organizing feature mapping networks.

Applications of Artificial Neural Networks: Pattern classification problems; Optimization; Control.

Neural Networks and Soft Computing Paradigms: Soft Computing, Neural Networks and Fuzzy Logic.

Text/References

1. Eugene Charniak and D. McDermott, "Introduction to Artificial Intelligence", Addison-Wesley, 1985.
2. Matt Ginsburg, "Essentials of Artificial Intelligence", Morgan Kaufmann, 1993.
3. Nils J. Nilsson, "Artificial Intelligence : A new synthesis", Morgan Kaufmann, 1998.
4. N. P. Padhy, "Artificial Intelligence and Intelligent Systems", Oxford Press, 2005.
5. Stuart Russell and Peter Norvig, "Artificial Intelligence: A modern approach", Pearson Education, 3/e, 2009.

CS-539 Advanced Computer Architecture [3 0 0]

Course Contents

Quantitative Principles of Computer Design: The Task of a Computer Designer, Technology and Computer Usage Trends, Cost and Trends in Cost, Measuring and Reporting Performance, Benchmarks and metrics.

Instruction Set Principles and Examples: Classification of Instruction Set Architectures, Instruction Formats and Semantics, Memory Addressing Modes, Operations in the Instruction Set, Encoding and Instruction Set, The Role of Compilers.

Advanced Pipelining and Instruction-Level Parallelism: Basic Pipeline Operations, Data and Control Pipeline Hazards, Instruction-Level Parallelism, Dynamic Instruction Scheduling and Branch Prediction.

Memory-Hierarchy Design: Cache Design Issues, Performance Evaluation, Virtual Memory Addressing, Memory Protection Mechanisms, Memory coherency techniques.

Storage Systems: Types of Storage Devices, Buses-Connecting I/O Devices to CPU/Memory, I/O Performance Measures, Reliability, Availability, and RAID, Interfacing to an Operating System.

Interconnection Networks: Interconnection network Media, Connecting More Than Two Computers, Practical Issues for Commercial Interconnection Networks, Examples of Interconnection Networks.

Multiprocessors (Time Permitting): Characteristics of Application Domains, Centralized Shared-Memory Architectures, Distributed Shared-Memory Architectures, Execution Synchronization, Models of Memory Consistency.

Text/References:

1. John L. Hennessy and David A. Patterson, "Computer Architecture: A Quantitative Approach", Morgan Kaufmann, 5/e, 2011.
2. William Stallings, "Computer Organization and Architecture", Prentice Hall, 9/e, 2012
3. Alexander Klaiber, "The Technology Behind Crusoe Processors", Transmeta's Website.

CS- 540 Statistical Methods for Research [3 0 0]

Course Contents

Introduction to Statistics: Role of Statistics in Engineering.

Introduction to Probability: Basic concepts; random variables; probability functions, laws of probability, Mean and standard deviation of discrete and continuous random variables; Percentile of a random variable; Binomial Distribution, Normal distributions; normal probability plot; Poisson Distribution.

Probability and fitting of standard frequency distributions: Sampling techniques, Sampling distributions

Correlation and Regression: Simple correlation and regression analysis, Partial, Multiple and Intraclass correlation, Multiple Regression analysis.

Large sample tests and confidence intervals: t- Test, Chi Square Test Analysis of Variance for one-way and two-way classification, Transformation of Data.

Text/References:

1. Sukhwinder Singh, M. L. Bansal, T. P. Singh and R K Jindal, "Statistical Methods for Research Workers", 1995.
2. S P Gupta, "Statistical Methods", Sultan Chand & Sons, 2011.
3. Jai P. Gupta and S. S. Saini, "Introduction to Statistical methods", Kalyani Publishers, 1980.
4. Ayub Bilal, and Richard H. McCuen, "Probability, Statistics, & Reliability for Engineers", Boca Raton, Florida: CRC Press, 1997.
5. Jay L. Devore, "Probability and Statistics for Engineering and the Sciences", Pacific Grove, California: Brooks/Cole, 5/e, 2000.

CS- 541 Agile Software Engineering [3 0 0]

Course Outcomes: Upon completion of the course, the student should be able to

CO1: Learn the fundamental principles and practices associated with each of the agile development methods.

CO2: Compare agile software development to the traditional software development models and identify the benefits and pitfalls of transitioning to agile.

CO3: Learn how agile methods scale to large and distributed projects, including the role of systems engineering.

CO4: Acquire in-depth explorations into aspects of agile development and apply agile practices to their software

engineering practices.

Course Contents

Overview of Software Engineering: Process, Project, Product, Method, Tool, Modern Life cycle, Traditional development approaches

Advanced Process models: V-Model, Component based development model, Agile Development Model, Unified Process Model, Extreme Programming, Feature Driven development, Lean Software Development, Service Oriented Architecture, Aspect Oriented Development

Agile Project Management: Agile Scrum Framework, Project Planning, Scheduling, Agile Estimation, Iterative Planning, Roles

Software Specification: New paradigms in software specification and design, Agile Specification, Short review of UML.

Design Engineering: Software architecture, Object-oriented Design, Software Patterns, Pattern-oriented Design, Component-oriented design. Software Frameworks, Agile Design

Agile Testing and Test Driven Development: The Agile lifecycle and its impact on testing, Test-Driven Development (TDD), xUnit framework and tools for TDD, Testing user stories - acceptance tests and scenarios, Planning and managing testing cycle, Exploratory testing, Risk based testing, Regression tests, Test Automation, Tools to support the Agile tester

Text/References

1. Software Engineering, A practitioner's Approach- Roger S. Pressman, 7th edition. McGraw Hill International Edition.
2. Software Engineering- Sommerville, 7th edition, Pearson education.
3. Agile Software Development with Scrum By Ken Schawber, Mike Beedle, Pearson, 21 Mar 2008
4. Agile Software Development, Principles, Patterns and Practices By Robert C. Martin, Prentice Hall, 25 Oct 2002

CS-542 Big Data Analytics **[3 0 0]**
Course Contents

Introduction: Big Data Overview, The rising and importance of data sciences, Big data analytics in industry verticals

Hadoop Architecture: Hadoop Architecture, Hadoop ecosystem components, Hadoop Storage: HDFS, Hadoop Processing: MapReduce Framework, Hadoop Server Roles

Data Analytics Lifecycle and methodology: Business Understanding, Data Understanding, Data Preparation, Modeling, Evaluation, Communicating results, Deployment, Data exploration & preprocessing

Data Analytics - Theory & Methods: Measures and evaluation, Supervised learning, Linear/Logistic regression, o Decision trees, Naïve Bayes, Unsupervised learning, K-means clustering, Association rules, Unstructured Data Analytics, Technologies & tools, Text mining, Web mining

The Endgame: Opertionalizing an Analytics project, Data Visualization Techniques, Creating final deliverables

Text/References

1. Hadoop: The Definitive Guide by Tom White
2. Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph by David Loshin
3. Machine Learning by Tom M. Mitchell

CS-543 Information Theory and Coding **[3 0 0]**

Course Contents

Introduction: Measuring information, and the game of twenty questions, Lossless compression, Lossless transmission, Lossy compression, Kolmogorov Complexity, Probability review, Discrete probabilities, Continuous probabilities, Random variables, Probability densities, Expectations.

Foundations: Entropy, joint entropy, conditional entropy, Chain rules, Relative entropy, Mutual information, Inequalities and their applications, Jensen's inequality, The data processing inequality, Markov chains, statistical mechanics, and the second law of thermodynamics, Statistical mechanics and the ergodic theorem, Markov chains, Time's arrow and the second law of thermodynamics

The law of large numbers and asymptotic equipartitioning

The law of large numbers, Independent and identically distributed random variables, Chebyshev's inequality, The weak law of large numbers, The Asymptotic Equipartition Property, typical sequences and the AEP, Compression of sequences, Efficient lossless compression,

Source codes, A hierarchie of source codes, Non-singular codes, Uniquely decodable codes, Instantaneous codes, Code lengths and the Kraft inequality, Optimal codes, Bounds on average code length, Optimal codes for single source symbols: Huffman coding. Binary codes, D-ary codes, Proof of optimality, Near-optimal codes for strings of source symbols: arithmetic coding

Efficient transmission of information over noisy channels

Noisy channels and error correcting codes, The discrete memoryless channel, Channel codes, Codes and transmission rates, Error probabilities, Example: Hamming code, The AEP and a conjecture about channel capacity ,Channel capacity, Definition, Examples Properties ,The channel coding theorem, Statement, Proof: achieving capacity, Proof of converse: achieving no more than capacity, Putting it all together: source and channel coding ,Separate source and channel coding, Joint source and channel coding, What to do when source entropy exceeds channel capacity

Efficient lossy compression, Lossy code books, Rates, distortions, and the rate distortion theorem,

Kolmogorov complexity, Introduction, Preliminaries: Turing machines and universal Turing machines, Kolmogorov complexity, Shannon entropy, Examples

Text/References:

1. Thomas M. Cover and Joy A. Thomas, "Elements of Information Theory", Wiley-Interscience, 1991.
2. S. Ling and C. Xing, "Coding Theory - A First Course", Cambridge University Press, 2004.
3. R. Roth, "Introduction to Coding Theory", Cambridge University Press, 2006.
4. S. Roman, "Introduction to Coding and Information Theory", Springer-Verlag, 1997.
5. R. Hill, "A First Course in Coding Theory", Oxford University Press, 1986.

CS-544 Wireless Data Networking **[3 0 0]**

Course Contents

Basics of wireless data transmission: frequencies & regulations, signal propagation, propagation models, modeling the propagation loss, multiplexing, spread spectrum, antennas, cellular systems.

Cellular system concept: Cellular Hierarchy, System Management, Cellular Reuse Pattern, Ways of increasing the system capacity, Channel assignment to the cells

Media Access Techniques: SDMA, FDMA, TDMA, CDMA, Aloha, CSMA, BTMA, DBTMA, FAMA, PUMA, DAMA, PRMA, C-PRMA, MACA, MACA-BI, MACAW, CARMA, CSMA/CA, polling.

Wireless LANs: IEEE 802.11 a/b/e/f/g/i, HIPERLAN, HomeRF, OpenAir.

Wireless PANs: Bluetooth: IEEE 802.15,. UWB PAN Technology

Wireless MAN (IEEE 802.16): IEEE 802.16-2004(802.16d) for fixed WiMAX and 802.16(802.16e) for mobile WiMAX

Wireless Telecommunication Systems: Basic architecture and working of followings: WLL, GSM, Handover process, GPRS, EDGE, UMTS, CDMA2000, 3G and 4G Systems,

Software defined Radio: The Software Radio concept, Minimum radio standard, Basic elements of Software Radio architecture

Emerging wireless technologies for mobile data networking.

Text/References:

1. Michel Daoud Yacoub, "Wireless Technology: Protocols, Standards, and Techniques", CRC Press, 2001.
2. K. Wesołowski, "Mobile Communication Systems", Wiley Publication, 2002.
3. J. Schiller, "Mobile Communications", Addison-Wesley, 2004.
4. J. Geier, "Wireless LAN", 2/e, SAMS, 2001.
5. G. Held, "Data Over Wireless Networks", McGraw-Hill, 2001.

CS-545 Adhoc and Wireless Sensor Network **[3 0 0]**

Course Contents

Introduction: What is an Ad Hoc Network?, Types of Ad hoc Mobile Communications , Types of Mobile Host Movements, Challenges Facing Ad hoc Mobile Networks, Ad hoc wireless Internet, Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks, Classifications of Routing Protocols: Table–Driven Routing Protocols, Destination Sequenced Distance Vector (DSDV), Wireless Routing Protocol (WRP), Cluster Switch Gateway Routing (CSGR), Source–Initiated On–Demand Approaches, Ad hoc On–Demand Distance Vector Routing (AODV), Dynamic Source Routing (DSR), Temporally Ordered Routing Algorithm (TORA), Signal Stability Routing (SSR), Location–Aided Routing (LAR), Power–Aware Routing (PAR), Zone Routing Protocol (ZRP).

Wireless Sensor Networks: Introduction to Wireless sensor networks, Single-sink single-hop WSN, Single-sink multi-hop WSN, Multi-sink multi-hop WSN, Advantages of ad-hoc/sensor networks, Node and Network Architectures, Wireless Sensor Device Architecture, Network Architectures, Main features of WSANs, Current and future research on WSANs

Applications of WSNs: Positioning and animals tracking, Entertainment, Logistics, Transportation, Industrial Control and Monitoring, Home Automation and Consumer Electronics, Security and Military Sensing, Asset Tracking and Supply Chain Management, Intelligent Agriculture and Environmental monitoring, Health Monitoring.

Technologies for WSNs: ZigBee technology, Ultrawide bandwidth technology, Bluetooth technology, Comparison among technologies

The Physical Layer: Introduction, Wireless Propagation Models: The Free Space Propagation Model, The Two-Ray Ground Model, The Log-Distance Path Model, Energy Dissipation Model, Error Models: The Independent Error Model, The Two-State Markov Error Model, Sensing Models: The Binary Sensing Model, The Probabilistic Sensing Model

Communication protocols for WSNs

MAC protocols: Scheduled protocols, LEACH protocol, Guo protocol, TRAMA protocol, Contention-based protocols, Zhong protocol, DMAC protocol, PAMAS protocol, SMAC protocol

Routing protocols: Issues in designing routing protocols, Classification of routing protocols, Flat routing, Flooding and gossiping, SPIN protocol, Directed diffusion protocol, Rumour routing, Gradient-based routing, Hierarchical routing, LEACH protocol, PEGASIS protocol, TEEN protocol, MECN protocol, SPAN protocol, Location-based routing protocols, GAF protocol, GEAR protocol, GeRaF protocol, Rugin protocol

Case Studies: Simulation of a Sensor Network

Text/References:

1. Roberto Verdone, Davide Dardari, Gianluca Mazzini and Andrea Conti, "Wireless Sensor and Actuator Networks: Technologies, Analysis and Design", Academic Press, 2008.
2. Miguel A. Labrador and Pedro M. Wightman, "Topology Control in Wireless Sensor Networks-with a companion simulation tool for teaching and research", Springer Science, 2009.
3. Azzedine Boukerche, "Handbook of Algorithms for Wireless Networking and Mobile Computing", Chapman & Hall/CRC, 2005.

CS- 566 Information Security Risk Management **[3 0 0]**

Course Contents

Introduction to information Security, Types of information security controls and purposes of Information Security Management, Allocation of information security responsibilities.

Telecommunications Security Objectives, Threats and Countermeasures, Identification of Security threats and development of countermeasures, Technologies and Security policies.

An introduction to LAN/WAN Security and internet Security , Security Management for the World Wide Web and Internet firewalls and Assessing inherent wireless network security deficiencies, Wireless LAN Problems, Wireless Equivalent Protocol Flaws, Short term solutions and Long term solutions.

Risk Management and Business Continuity Planning and Risk Analysis, Risk Analysis and Assessment, Available Standards (ISF, ISO and Commercial Sources), Risk verses standards etc.

Description of Various Security risk analysis tools, Techniques to secure networks from unauthorized activity, authentication procedures, encryption standards and implementations, ports and protocols that hackers manipulate, and how to engage in proactive detection and response/reporting methods.

Overview of IT Security, Hacking and Intrusion Attacks, Denial of Service Attacks (DoS), Viruses, how these get past the Firewall, how they work and the impact they can have on operations and business, Detection and Prevention Mechanisms, The self-Hack Audit and network security.

Current trends in breaches to IT Security, Current trends in IT Security detection and prevention, Examples of the types of IT security breaches most common and what can be expected in the future.

An overview of the ISO/IEC 17799:2000 "Information technology – Code of Practice for information security management" standards and how to apply these standards to IT environment, How is risk assessment related to ISO/IEC 17799 and BS 7799 Part 2?

Text / References:

1. S. Cimato and C.Galdi, "Security in Communication Networks", Springer, 2003.
2. H. Chan and V. Gligor, "Information Security", Springer, 2002.
3. UPTEC Computer Consultancy Limited, "Information Technology Tools and Applications", Elsevier, 2005.
4. V. Rajaraman, "Introduction to Information technology", Prentice Hall of India, 2/e, 2013.
5. Thomas M. Thomas, D. Stoddard, "Network Security", Pearson Education, 2/e, 2005.

CS-567 Computer Crime Investigation and Forensic **[3 0 0]**

Course Contents

Introduction to Computer and Internet Technology: Computer components; Computer media; The Internet, the Web, and TCP/IP; The Internet hacker subculture.

Internet/Computer Demographics: Computer/network user statistics; Computer crime statistics.

Types of Computer and Internet Crime: Types of crimes involving computers; Computer crimes; Network crimes; Criminals, hackers, and crackers.

Investigations: The investigation life cycle; Legal methods to obtain the computer; Jurisdictions and agencies; Internet investigations (e-mail, IRC, chat rooms, etc.); IP addresses and domain names; Investigative methods.

Evidence collection: Working with ISPs and telephone companies; Examining computer, server, and network logs; Anonymous services.

Legal issues: Constitutional law, search and seizure guidelines, case law; Privacy Protection Act (PPA); Electronic Communications Privacy Act (ECPA); Seizing electronic evidence; Investigative and testimonial challenges; Future challenges; International computer crime laws.

Forensics: Types of computers (e.g., laptops, watches, PDAs); Windows and UNIX file storage; Handling computers and media (seizure and maintaining the integrity of evidence); Searching and retrieving information; Encryption and steganography basics.

Text/References:

1. Warren G. Kruse II and Jay G. Heiser, "Computer Forensics: Incident Response Essentials", Addison Wesley, 2001.
2. Bill Nelson, Amelia Phillips and Christopher Steuart, "Guide to Computer Forensics and Investigations", 4/e, 2009.
3. Eoghan Casey, "Digital Evidence and Computer Crime", 3/e, 2011.
4. P. Ashley and M. Vandenwauver, "Practical Intranet Security", Kluwer Academic Publishers, 1999.
5. S. Garfinkel, "Web Security & Commerce", O'Reilly & Associates, 1997.

CS- 568 Computer Security, Audit and Assurance [3 0 0]
Course Contents

Introduction to computer based systems and their Security, Policy standards and Organization, Information Classification and Security awareness.

Information System Audit and Assurance – An Overview, Determination of policy (ies) and the degree of assurance required from controls, Information Security Management System (ISMS), Audit and review of ISMS.

Internal Control and Information System Audit information Security Governance and Assurance and Audit Security Controls, Systems Assurance and Control (SAC), Systems Audit ability and Control (SAC) reports, Control Objectives for Information and Related Technologies, Attack and Threat Analysis, various types of Attacks and Threats and their Analysis on Security.

Security Management techniques, The policy led approach, Infrastructure assessments, System assessments, Business case assessments for improvements.

Study of various tools and techniques available for Security risk analysis.

Operating System Security, Study of the latest security industry recommendations and how to protect Windows 2000 and Linux servers in a variety of settings.

Security Controls, Physical Security, Virtual Private Networks (VPNs), IPsec, Access Controls, Identification and Authentication Techniques, Managed Firewalls, Data Monitoring Software, Email Security, and Cryptology.

Security Policies and Procedures, An investigation into the types of policies and procedures you need to consider, How to formulate your IT Security Policy, IT Policy standards, Creating, implementing, and managing controls and monitoring mechanisms, as well as other important security policies and procedures.

IT Security Audits, Systematic technical assessments of how well the security policy is working, personal interviewing, vulnerability scanning, examining operating system settings, analysis of network shares, review of firewall management, physical security, penetration test techniques, reviewing audit logs, look at encryption used, and view documentation from any changes to systems or software.

Audit tools, enterprise Computing, Report Card, OS/400i Series, PS Audit, Auditor's Computer Audit etc.

Management of Information Assurance**,** The identification of technical and human factors in prevention, detection and reporting of computer and information system weaknesses; the vulnerability, threat, risk, and impact on information assurance; and the significance of these factors on an organization's intellectual property and viability.

Text/References:

1. Fischer & Jordan, "Security Analysis and portfolio Management", Prentice Hall of India, 6/e, 2005.
2. Rajaraman, "Introduction to Information technology", Prentice Hall of India, 2005.
3. Chris Edwards, John Ward and Andy Bytheway, "The essence of Information Systems", Prentice Hall of India, 2/e, 2005.
4. Murdick, Ross and Claggett, "Information Systems for Modern management", Prentice Hall of India, 3/e, 2005.
5. A. Blyth and G. L. Kovacich, "Information Assurance", Springer, 2005.

CS-569 Computer Intrusion Detection [3 0 0]

Course Contents

The state of threats against computers, and networked Systems

Overview of computer security solutions and why they fail Vulnerability assessment, firewalls, VPNs

Overview of Intrusion Detection and Intrusion prevention Network and host-based IDS

Classes of attackers, Kids/hackers/sophisticated groups, automated: Drones, Worms and Viruses A general IDS model and taxonomy, Signature based Solutions, Snort, Snort rules

Evaluation of IDS, Cost Sensitive IDS Anomaly Detection Systems and algorithms Network Behavior Based Anomaly Detectors (rate based)

Host Based Anomaly Detectors, Software Vulnerabilities State transition, immunology, Payload Anomaly Detection

Attack trees and Correlation of alerts

Autopsy of Worms Email/IM Security issues, Viruses/Spam, From signatures to thumbprints to zero-day detection Identity theft issues, Masquerade and Impersonation, Future Collaborative Security

Text/References:

1. Paul E. E. Proctor, "The Practical Intrusion Detection Handbook", Pearson Education, 2000.
2. Jack Koziol, "Intrusion Detection with Snort", Pearson Education, 2/e, 2003.
3. Stephen Northcutt, "Network Intrusion Detection", Pearson Education, 3/e, 2002.
4. Carl Endrof, "Intrusion Detection and Prevention", Tata Mcgraw Hill, 2003.
5. Kerry Cox, "Managing Security with SNORT and IDS Tools", O'Reilly Media, 2004.