Dhaka International University

Faculty of Science & Engineering
Department of Computer Science and Engineering

Syllabus for
M. Sc. in Computer Science & Engineering

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Preface

The prime objectives of Dhaka International University (DIU) are to provide excellent education at the undergraduate and graduate levels in coherence with the needs of the dynamic 21st century society. The courses and curricula are designed to enable our young generation to step into the competitive world of activities and to pursue higher study and knowledge of professional goals. The whole world is heavily dependent on Information Technology and our society cannot keep aloof from this technology. We have to equip our children so as to face the challenges of the 21st century. With these aims and objectives, DIU has designed a 4 years undergraduate program of B.Sc. in Computer Science & Engineering (B.Sc in CSE) from the session 1995-96 in the Department of Computer Science & Engineering. It has also designed the graduate program of study leading to M.Sc. in Computer Science & Engineering (M.Sc. in CSE) and Master of Computer Applications (MCA). The M.Sc. in CSE is to give emphasize on the theory and applications of both hardware and software with specialization in the respective fields. This graduate program has been designed as advised by the UGC. The program will be offered to serve the needs of the Computer Graduates who are in service or in practice.

Admission Requirements:

Individuals who hold a Bachelor's degree in CS/CSE/EEE/EETE/IT/ECE/Applied Physics from a recognized university having CGPA not less than 2.5 will be considered for admission into the Master of Science in Computer Science and Engineering program. Students from CS/EEE/EETE/ECE/IT/Applied Physics background will be required to take a number of prerequisite courses as decided by the Department of Computer Science and Engineering.

Grading System and Performance Evaluation:

The total performance of a student in a given course is based on a scheme of continuous assessment. For theory courses this continuous assessment is made through Attendance, Class Tests and Assignments. This assessment is also made through Mid-term Examination and Semester Final Examination. The total marks distribution is as follows:

a) Mid-term Examination 20%
b) Assignment 10%
c) Class Tests 10%
d) Attendance & Behavior 10%
e) Final Examination 50%

Grading System

Marks Range	Letter Grade		Grade Point
80% and above	A+	A Plus	4.00
75 – 79	A	A Regular	3.75
70 – 74	A-	A Minus	3.50
65 – 69	B+	B Plus	3.25
60 – 64	B	B Regular	3.00
55 – 59	B-	B Minus	2.75
50 – 54	C+	C Plus	2.50
45 – 49	C	C Regular	2.25
40 – 44	D	D Regular	2.00
Below 40	F	Fail	0.00

The M.Sc. in Computer Science & Engineering is divided into two groups: M.Sc. General Group and M.Sc. Thesis Group.

The course distributions for these groups are given as follows:

M.Sc General Group:

Theoretical Courses	30 Credits
Project Work & Viva	6 Credits

Total Credits: 36

M.Sc. Thesis Group:

Theoretical Courses	18 Credits
Thesis Work & Viva	18 Credits

Total Credits: 36

Duration of the Program:

The duration of the M. Sc. in CSE program is 3 semesters (1.5 Years).

Credit Load:

M. Sc. General Group

1st Semester: 12 credits (Theoretical).
2nd Semester: 12 credits (Theoretical)
3rd Semester: 6 credits (Theoretical) & 6 credits (Project Work & Viva).

M. Sc. Thesis Group

1st Semester: 12 credits (Theoretical).
2nd Semester: 6 credits (Theoretical) & 6 credits (Thesis Work).
3rd Semester: 12 credits (Thesis Work & Viva).

Course Selection:

The students of M. Sc. General Group and M. Sc. Thesis Group must take four courses in the 1st semester. The students of M. Sc. General Group must take 6 courses in the 2nd & 3rd semesters. On the other hand, the students of M. Sc. Thesis Group must take 2 courses in the 2nd semester.

List of Courses

Courses offered to the graduate students of Computer Science & Engineering (CSE) are listed below:

Serial No	Course No	Course Title	Credits
1.	CSE-501	Advanced Algorithm	3
2.	CSE -502	Advanced Networking	3
3.	CSE -503	Advanced Database	3
4.	CSE -504	Advanced Graph Theory	3
5.	CSE -505	Advanced Digital Signal Processing	3
6.	CSE -506	Pattern Recognition	3
7.	CSE -507	Advanced Simulation and Modeling	3
8.	CSE -508	Cryptography and Network Security	3
9.	CSE -509	Bioinformatics	3
10.	CSE -510	Parallel Algorithm	3
11.	CSE -511	Embedded System Design	3
12.	CSE -512	Advanced Wireless and Mobile Communication	3
13.	CSE -513	Advanced Optical Communication	3
14.	CSE -514	VLSI Layout Algorithm	3
15.	CSE -515	Robotics and Computer Vision	3
16.	CSE -516	Advanced Multimedia System	3
17.	CSE -517	Teletraffic Engineering	3
18.	CSE -518	Knowledge Engineering	3
19.	CSE -519	Machine Learning	3
20.	CSE -520	Wireless Sensor Network	3
21.	CSE -521	Channel Modeling	3
22.	CSE -522	Advanced Filter Design	3
23.	CSE -523	Fault Tolerant Computing and Design	3
24.	CSE -524	Advanced Digital Image Processing	3
25.	CSE -525	Speech Recognition	3
26.	CSE -526	Advanced Digital Communication	3
27.	CSE -527	Radio Frequency Technology	3
28.	CSE -528	Adaptive and Optimal Image Processing	3
29.	CSE -529	Advanced Logic Design	3
30.	CSE -530	Enterprise Application Integration	3
31.	CSE-531	Project Work	6
32.	CSE-532	Thesis Work	18

Contents of Theoretical Courses:

1. CSE-501: Advanced Algorithm [3 Credits]

Design and analysis of Algorithm, efficient sorting and searching algorithms, Polynomial time algorithm, graph algorithm, matching, Fibonacci heap, shortest path problem, flow network, max flow theorem & algorithm, Dynamic programming, branch-and-bound, greedy algorithms, Back Tracking, **parallel algorithms**: EREW, ERCW, CREW, CRCW, Approximation algorithms, completeness, lower bound theory.

Books:

1. Thomas H. Cormen, Charles E. Leiserson, Clifford Stein, "Introduction to Algorithms", The MIT Press, 3rd Edition, 2009.
2. George T. Heineman, Gary Pollice, Stanley Selkow , "Algorithms in a Nutshell", O'Reilly Media, 1st Edition, 2008.
3. Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani , "Algorithms", McGraw-Hill Science/Engineering/Math, 1st Edition, 2006.
4. Robert Sedgewick, Kevin Wayne , "Algorithms", Addison-Wesley, 4th Edition, 2011.
5. Steven S. Skiena, "The Algorithm Design Manual", Springer, 2nd Edition, 2010.

2. CSE -502: Advanced Networking [3 Credits]

The TCP/IP protocol stack: IP, ARP, TCP and UDP, DNS, ICMP, Internet addressing, routing, IP multicast, RSVP, Next Generation IPping, **Interior gateway protocols**: RIPv2, IGRP, EIGRP, OSPF; **Wireless**: Radio basics, satellite systems, WAP, current trends, issues with wireless over TCP; **Congestion control**: control, avoidance, control and avoidance Algorithms, congestion in the Internet; **Network Security**: IP security, firewalls; **Management**: Quality of service (QoS), network vs. distributed systems management, integrated service, differentiated service, protocols, web-based management.

Books:

1. Palmer, Bruce Sinclair, "Advanced Networking Concepts", Course Technology, 1996.
2. Larry L. Peterson, "Computer Networks", Morgan Kaufmann, 5th Edition, 2011.
3. Andrew S. Tanenbaum, David J. Wetherall, "Computer Networks", Prentice Hall, 5th Edition 2010.

4. James F. Kurose, “Computer Networking: A Top-Down Approach”, Addison-Wesley, 5th Edition, 2009.
5. Behrouz Forouzan, “TCP/IP Protocol Suite”, McGraw-Hill, 4th Edition, 2009.
6. Qing Li, Jinmei Tatuya, Keiichi Shima, “IPv6 Advanced Protocols Implementation”, Morgan Kaufmann, 2007.

3. CSE-503: Advanced Database [3 Credits]

Object oriented database, Querying with complex data type, Query Optimization, Management of distributed Transaction, Concurrency control, Reliability, Parallel database, Multimedia database, Warehouse Architecture; Data Warehousing; Warehouse DBMS Decision support; Data Marts; OLAP vs. OLTP; the Multi-Dimensional data model; Dimensional Modeling; ROLAP vs. MOLAP; Star and snowflake schemas; the MOLAP cube; roll-up, slicing, and pivoting. Data mining, View of the KDD Process; Problems and Techniques; Data Mining Applications; Prospects for the Technology.

Books:

1. Abraham Silberschatz, “Database System Concepts”, McGraw-Hill, 6th Edition, 2010.
2. Carlos Coronel, Steven Morris, Peter Rob, “Database Systems: Design, Implementation, and Management”, Course Technology, 9th Edition, 2009.
3. Carlo Zaniolo, Stefano Ceri, Christos Faloutsos, Richard T. Snodgrass, “Advanced Database Systems”, Morgan Kaufmann, 1st Edition, 1997.
4. Suzanne W Dietrich, Susan D. Urban, “An Advanced Course in Database Systems”, Prentice Hall, 2004.
5. Nabil R. Adam, Bharat K. Bhargava, “Advanced Database Systems”, Springer, 1st Edition, 1993.

4. CSE-504: Advanced Graph Theory [3 Credits]

Preliminaries: Definition of Graph, path, cycle, degree sequence, directed graph, weighted graph, bipartite graph, graph operation, **Trees**: Properties, spanning trees, forests centroids, fundamental cycles. **Connectivity**: Vertex and edge connectivity cut points, blocks, Menger’s theorem, **Traversability**: Definitions, Kuratowski’s theorem, Euler Formula, duality, four color conjecture, **Embedding**: Embedding graphs of surfaces, genus, thickness and crossing number, **Digraph**: Strongly connected components, tournaments, network flow, matching, **External Properties**: Ramsey Theory, forbidden graph theory, Miscellaneous applications.

Books:

1. Jonathan L. Gross, Jay Yellen, "Handbook of Graph Theory", CRC Press, 1st Edition, 2003.
2. Adrian Bondy, U.S.R. Murty, "Graph Theory", Springer, 1st Edition, 2010.
3. Bela Bollobas, "Modern Graph Theory", Springer, 1st Edition, 1998.
4. Gary Chartrand, Linda Lesniak, Ping Zhang, "Graphs & Digraphs", Chapman and Hall/CRC, 5th Edition, 2010.
5. Geir Agnarsson, Raymond Greenlaw, "Graph Theory: Modeling, Applications, and Algorithms", Prentice Hall, 1st Edition, 2006.

5. CSE-505: Advanced Digital Signal Processing [3 Credits]

Discrete-Time Signals and Systems, Frequency Domain Representation of Discrete-Time Signals and Systems, Sampling of Continuous-Time Signals, The Z-Transformation, Transformation Analysis of LTI Systems, The Discrete Fourier Transformation(DFT), Implementation of Discrete-Time Systems, Design of Digital Filters, Digitals Signals Processors.

Books:

1. Glenn Zelniker, Fred J. Taylor, "Advanced Digital Signal Processing", CRC Press, 1st Edition, 1993.
2. Dag Stranneby, William Walker, "Digital Signal Processing and Applications", Newnes, 2nd Edition, 2004.
3. Dag Stranneby, "Digital Signal Processing: DSP and Applications", Newnes, 1st Edition, 2001.
4. John G. Proakis, Dimitris K Manolakis, "Digital Signal Processing", Prentice Hall, 4th Edition, 2006.
5. Sanjit Mitra, "Digital Signal Processing", McGraw-Hill, 3rd Edition, 2005.

6. CSE-506: Pattern Recognition [3 Credits]

Introduction and General Pattern Recognition Concerns: Pattern Recognition, Classification and Description, feature extraction with examples, feature extraction from images, training and learning in PR system, pattern recognition approaches. **Bayesian Decision Theory**: Bayesian Decision making; Bayesian networks, linear discriminants, separability, multi-class discrimination; quadratic classifiers. Bayesian estimation; Random vectors, expectation, correlation, covariance. **Statistical Pattern Recognition**: Introduction to statistical pattern recognition, The Gaussian and Class Dependence, Discriminant Functions, Kalman filtering and smoothing, Classifier performance, risk and Errors. **Supervised Learning**: Parametric Estimation and Supervise Learning, maximum likelihood Estimation approach, Bayesian parameter estimation approach, Non-parametric approaches, Nearest Neighbor Rule, Mixture modeling. **Un-supervised learning and Clustering**: Formulation of Unsupervised learning Problems, Clustering for unsupervised learning and classification, vector quantization. **Syntactic Pattern Recognition**: Syntactic Pattern Recognition overview, Quantifying structure in pattern description and recognition, Grammar-Based approach and Applications, Elements of formal Grammars, Example of string generations as pattern description. **Applications**: Object detection and recognition, Biological object recognition, Tracking, Gesture recognition.

Books:

1. Sergios Theodoridis, Konstantinos Koutroumbas, "Pattern Recognition", Academic Press, 4th Edition, 2008.
2. Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2nd Edition, 2007.
3. Sergios Theodoridis, Aggelos Pikrakis, Konstantinos Koutroumbas, Dionisis Cavouras, "Introduction to Pattern Recognition: A Matlab Approach", Academic Press, 1st Edition, 2010.
4. Christopher M. Bishop, "Neural Networks for Pattern Recognition", Oxford University Press USA, 1st Edition, 1996.
5. M. Narasimha Murty, V. Susheela Devi, "Pattern Recognition: An Algorithmic Approach", Springer, 1st Edition, 2011.

7. CSE-507: Advanced Simulation and Modeling [3 Credits]

Basic aspects of modeling and simulation, simulation process, model and systems, Statistical problem related to simulation, Discrete and continuous simulation modeling, applications of simulation, SLAM, Basic network elements, Queuing systems, control statement, introduction to resource modeling, SLAM blocks and nodes used for resource simulation, modeling and

simulation of systems with machine and tool breakdown, modeling of port operation, Introduction to GATES, SLAM on traffic problems, SLAM for PERT network analysis, Batching and unbatching nodes as SLAM modeling tools, Simulation support systems, SLAM term project presentation.

Books:

1. Bernard P. Zeigler, Herbert Praehofer, Tag Gon Kim, "Theory of Modeling and Simulation", Academic Press, 2nd Edition, 2000.
2. Averill Law, "Simulation Modeling and Analysis", McGraw Hill, 4th Edition, 2006.
3. W. Kelton, Jeffrey Smith, David Sturrock, "Simio and Simulation: Modeling, Analysis, Applications", Learning Solutions, 1st Edition, 2010.
4. John A. Sokolowski, Catherine M. Banks, "Principles of Modeling and Simulation: A Multidisciplinary Approach", Wiley, 1st Edition, 2009.
5. Bernard P. Zeigler, Herbert Praehofer, Tag Gon Kim, "Theory of Modeling and Simulation", Academic Press, 2nd Edition, 2000.

8. CSE-508: Cryptography and Network Security [3 Credits]

A rigorous introduction to the design of cryptosystems and to cryptanalysis, Topics include cryptanalysis of classical cryptosystems, theoretical analysis of one-way functions, DES and differential cryptanalysis, the RSA cryptosystem, EL Gamal, clliptic, hyper elliptic and hidden monomial cryptosystems, attacks on signature schemes, identification schemes and authentication cods, secret sharing, Zero Knowledge, Network Security.

Books:

1. William Stallings, "Cryptography and Network Security: Principles and Practice", Prentice Hall; 5th Edition, 2010.
2. Niels Ferguson, Bruce Schneier, Tadayoshi Kohno, "Cryptography Engineering: Design Principles and Practical Applications", Wiley, 1st Edition, 2010.
3. William Stallings, "Network Security Essentials: Applications and Standards", Prentice Hall, 4th Edition, 2010.
4. Atul Kahate, "Cryptography and Network Security", McGraw-Hill, 2009.
5. Behrouz Forouzan, "Cryptography & Network Security", McGraw-Hill, 1st Edition, 2007.

9. CSE-509: Bioinformatics [3 Credits]

Introduction to the genome: DNA, RNA, amino acids, and proteins; Information flow from the genome: genes, transcription, and translation; **Integration of biological data**: data integration systems, biological queries, query processing, data warehouses, and data visualization; Genome and protein sequencing and analysis, spectrum graphs; **Clustering and classification**: microarrays, gene expression analysis, hierarchical clustering, k-means clustering, clustering and classification algorithms; **Drug discovery**: technologies and strategies, identification of drug target molecules, drug design approaches.

Books:

1. Jeremy Ramsden, "Bioinformatics: An Introduction", Springer, 2nd Edition, 2010.
2. Matthew He, Sergey Petoukhov, "Mathematics of Bioinformatics: Theory, Methods and Applications", Wiley-Interscience, 1st Edition , 2011.
3. Neil C. Jones, Pavel A. Pevzner, "An Introduction to Bioinformatics Algorithms", The MIT Press, 1st Edition, 2004.
4. Conrad Bessant, Ian Shadforth, Darren Oakley, "Building Bioinformatics Solutions: with Perl, R and MySQL", Oxford University Press USA, 1st Edition, 2009.
5. Jean-Michel Claverie, Cedric Notredame, "Bioinformatics For Dummies", For Dummies, 2nd Edition, 2006.

10.CSE-510: Parallel Algorithm [3 Credits]

Introduction, parallel processing, parallel models, performance of parallel algorithms, work-time presentation framework; **Basic Techniques**: Pointer jumping, balanced trees, divide and conquer, pipelining, partitioning, symmetry breaking; List ranking, Euler tour technique, tree contraction; Parallel searching, merging and sorting; Connected components; Minimum spanning trees; Bi-connected components; **Simulation between PRAM models**: EREW, CREW and CRCW.

Books:

1. Joseph JaJa, "Introduction to Parallel Algorithms", Addison-Wesley, 1st Edition, 1992.
2. Frank Thomson Leighton, "Introduction to Parallel Algorithms and Architectures: Arrays, Trees, Hypercubes", Morgan Kaufmann, 1st Edition, 1991.
3. Fayez Gebali, "Algorithms and Parallel Computing", Wiley, 1st Edition, 2011.

4. Alan Gibbons, Wojciech Rytter, “Efficient Parallel Algorithms”, Cambridge University Press, 1989.

11.CSE-511: Embedded System Design [3 Credits]

Hardware design for embedded systems; Software development for embedded systems; Network based embedded systems; Sensors and Transducers for embedded systems; Case study on advanced embedded system; Co-design using FPGAs; Multiprocessor systems; Case study on multiprocessor systems; Introduction to digital control; Its use within embedded systems; Case study on digital control in embedded systems; **Design examples**: a telephone PBX, Personal Digital Assistant (PDA).

Books:

1. Steve Heath, “Embedded Systems Design”, Newnes, 2nd Edition, 2002.
2. Jack Ganssle, “The Art of Designing Embedded Systems”, Newnes, 2nd Edition, 2008.
3. James K. Peckol, “Embedded Systems: A Contemporary Design Tool”, Wiley, 1st Edition, 2007.
4. Daniel D. Gajski, Samar Abdi, Andreas Gerstlauer, Gunar Schirner, “Embedded System Design: Modeling, Synthesis and Verification”, Springer, 1st Edition, 2009.
5. Arnold S. Berger, “Embedded Systems Design: An Introduction to Processes, Tools and Techniques”, CMP Books, 1st Edition, 2001.

12.CSE-512: Advanced Wireless and Mobile Communication [3 Credits]

Introduction and History of Wireless Systems, Cellular Systems, Wireless LANs, Satellite Systems, Paging Systems; **Radio Propagation**: free space propagation, propagation mechanisms, link budget design using path loss model, outdoor propagation models, indoor propagation models; Introduction to small-scale fading, impulse response model of multipath fading, parameters of multipath channel, type of small scale fading, Rayleigh and Ricean Distribution; **Media Access Control**: FDMA, TDMA, and CDMA, Aloha, CSMA, MACA; **GSM Overview**: Standards, services and structure, **GSM air interface physical layer**: physical channels, logical channels, frame structures, modulation, coding and interleaving, **GSM Signaling**: Data link layer, radio resource management, mobility management, Handover, location update and roaming in GSM; Short message service (SMS), circuit switched data, General Packet Radio Service (GPRS), Enhanced GPRS (EGPRS); **CDMA Digital Cellular System (IS-95)**: Forward CDMA Channel, Reverse CDMA Channel; **Satellite mobile communications**: History, Localization, Handover, Routing; Broadcast System: Unidirectional distribution systems, DAB architecture, DVB-container; WCDMA in 3rd generation system, Difference between WCDMA and 2G air interface, 3rd generation standards.

Books:

1. Andrea Goldsmith, "Wireless Communications", Cambridge University Press, 2005.
2. Theodore S. Rappaport, "Wireless Communications: Principles and Practice", Prentice Hall, 2nd Edition, 2002.
3. David Tse, Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press, 2005.
4. Jochen Schiller, "Mobile Communications", Addison Wesley, 2nd Edition, 2003.
5. James E. Katz, "Handbook of Mobile Communication Studies", The MIT Press, 2008.

13.CSE-513: Advanced Optical Communication [3 Credits]

Introduction to optical communication: Communication system, basic optical communication system, evolution of optical communication, advantages and disadvantages of optical communication; **Optical fiber waveguides**: construction, classification of fibers, modes of light propagation, transmission characteristics; **Optical sources**: Light emitting diodes (LED), semiconductor laser diodes, optical detectors: p-n photodiode, p-in photodiode, and avalanche photodiodes (APDs); **Fiber connection**: Fiber joints and fiber couplers, wavelength MUX and DeMUX, optical add-drop MUX; **Optical amplifiers**: optoelectronic amplifiers, fiber amplifiers, Raman and Brillouin amplifiers; Optical modulation and detection schemes, **direct and coherent detection receivers**: Configuration, operation, noise sources, sensitivity and loss calculation, and performance curves; Digital and analog receivers; **Fiber nonlinearities**: Kerr effects–SPM, XPM, and FWM; Scattering effects–SRS and SBS; **Transmission link analysis**: point-to-point and pointto- multi point links, system configuration, link power budget, line-coding schemes. **Optical multiplexing schemes**: WDM, OFDM, OTDM and OCDMA; Optical networks.

Books:

1. Rajiv Ramaswami, Kumar Sivarajan, Galen Sasaki, "Optical Networks: A Practical Perspective", Morgan Kaufmann, 3rd Edition, 2009.
2. Biswanath Mukherjee, "Optical WDM Networks", Springer, 1st Edition, 2006.
3. Vivek Alwayn, "Optical Network Design and Implementation", Cisco Press, 1st Edition, 2004.
4. Lawrence Harte, David Eckard, "Introduction to Optical Communication, Lightwave Technology, Fiber Transmission, and Optical Networks", Althos Publishing, 2005.

14.CSE-514: VLSI Layout Algorithm [3 Credits]

Introduction: VLSI design process, layout styles, difficulties in physical design, definitions and notations; Circuit Partitioning: problem definition, cost functions and constraints, Kernighan-Lin algorithm and its variations, simulated annealing; **Floorplanning**: problem definition, models, cost functions and constraints, cluster growth, simulated annealing, dual graph technique; **Placement**: problem definition, models and cost functions, approaches to placement; **Grid routing**: problem definition, cost functions and constraints, maze routing algorithms, line search algorithms; **Global routing**: problem definition, cost functions and constraints, routing regions, sequential global routing, hierarchical global routing; Channel routing algorithms; Layout generation.

Books:

1. Wai-Kai Chen, "The VLSI Handbook", CRC Press LLC, USA. 2000.
2. Neil H. E. Weste, Kamran Eshraghian, "Principles of CMOS VLSI Design", 2nd Edition, Addison – Wesley, 1993.
3. C. Mead and L. Conway, "Introduction to VLSI Systems", Addison – Wesley, 1980.

15. CSE-515: Robotics and Computer Vision [3 Credits]

Robot definition, laws of robots, robotics systems and robot anatomy, historical background, forward and reverse kinematics of robot arm, kinematic equations using homogeneous transformation, robot sensors, drivers actuators ad control: de motors and transfer functions, stepper motor, Robot end- effectors, classification, drive system, force analysis, gripper design, computer interfacing and applications of robots.

Books:

1. Linda G. Shapiro, George C. Stockman, "Computer Vision", Prentice Hall, 1st Edition, 2001.
2. Peter Corke, "Robotics, Vision and Control: Fundamental Algorithms in MATLAB", Springer, 1st Edition, 2011.
3. Michael C. Fairhurst, "Computer Vision for Robotic Systems: An Introduction", Prentice Hall, 1988.
4. John X. Liu, "Computer Vision & Robotics", Nova Science, 2006.

16. CSE-516: Advanced Multimedia System [3 Credits]

Introduction to Multimedia and data Stream, Traditional Data stream characteristics, Sound and audio, MIDI, Speech, Image and graphics, Video and Animation, **Data Compression**: source, Entrophy and hybrid coding, JPEG, DCT, H.261, MPEG, MPEG-2, DVI, Multimedia OS, **Network system**: FDDI, ATM, UDP, Multimedia communication system, Multimedia database, User interface, Synchronization, MM applications.

Books:

1. Ralf Steinmetz, Klara Nahrstedt, "Multimedia Systems", Springer, 2nd Edition, 2010.
2. James E. Shuman, "Multimedia Concepts", Course Technology, 2nd Edition, 2002.
3. Parag Havaldar, Gerard Medioni, "Multimedia Systems: Algorithms, Standards, and Industry Practices", Course Technology, 1st Edition, 2009.
4. Tay Vaughan, "Multimedia: Making it Work", McGraw-Hill Osborne Media, 7th Edition, 2006.
5. Mihaela van der Schaar, Philip A Chou, "Multimedia over IP and Wireless Networks: Compression, Networking, and Systems", Academic Press, 1st Edition, 2007.

17.CSE-517: Teletraffic Engineering [3 Credits]

Introduction: traffic sources, resources, operational modes and traffic, unit of traffic, interarrival time and call holding time, traffic variation and busy hours; **Random variables**: Random variables, probability distribution function, probability density function, moments, Bernoulli random variable, uniform discrete random variable, Binomial distribution, Poisson distribution, negative exponential distribution, quality of service circuit switching voice networks, packet switched networks, probabilities of traffic systems; **Models for circuit switched networks**: Kendall notation, Erlang's loss formula (M/M/n/n) and examples, marginal utility, Wilkinson's model, equivalent random method and examples, overflow routing in circuit switched networks; **Models for packet switched networks**: M/M/1, M/G/1, M/G/1 priority queues, Erlang's delay formula (M/M/n), **System simulation**: random number and random variable generation, event-by- event simulation method, sampling theory, simulation program organization, use of GSPN and other simulation tools.

Books:

1. Haruo Akimaru, Konosuke Kawashima, "Teletraffic: Theory and Applications", Springer, 2nd Edition, 1999.

2. Ezio Biglieri, Luigi Fratta, Bijan Jabbari, “Multiaccess, Mobility and Teletraffic in Wireless Communications”, Springer, 1st Edition, 2010.
3. Bijan Jabbari, Philippe Godlewski, Xavier Lagrange, “Multiaccess, Mobility and Teletraffic for Personal Communications”, Springer, 1st Edition, 1996.
4. P. Key, D. Smith, “Teletraffic Engineering in a Competitive World”, Elsevier Science, 1999.
5. J.M. de Souza, N.L.S. da Fonseca, E.A.S. Silva, “Teletraffic Engineering in the Internet Era”, North Holland, 2001.

18.CSE-518: Knowledge Engineering [3 Credits]

Representation of Knowledge: Predicate logic, rules, Semantic Networks, Frames; Conceptual graphs, Scripts Fuzziness and uncertainty, Fuzzy logic, Statistical techniques for determining probability, Methodologies for developing knowledge based systems; **The KBS Development Life Cycle**: Knowledge acquisition, Prototyping, Implementation, Development environments; Meta-Knowledge, Search Techniques, Reasoning with uncertainty. **Building an Expert System**: Problem Selection, Development Methodology, Knowledge Acquisition, Pitfalls; **Evaluation of Expert Systems**: Test Cases, Refinement, Performance; **Applications**: Expert systems, Natural language processing, Machine vision and robotics, Data mining and intelligent business support.

Books:

1. Simon Kendal, Malcolm Creen, “An Introduction to Knowledge Engineering”, Springer, 1st Edition, 2006.
2. Ronald Brachman, Hector Levesque, “Knowledge Representation and Reasoning”, Morgan Kaufmann, 1st Edition, 2004.
3. Nicholas Ross Milton, “Knowledge Acquisition in Practice: A Step-by-step Guide”, Springer, 1st Edition, 2010.
4. Clive L. Dym, Raymond Elliot Levitt, “Knowledge-Based Systems in Engineering”, Mcgraw-Hill, 1991.

19.CSE-519: Machine Learning [3 Credits]

Introduction to machine learning: Overview of different tasks: classification, regression, clustering, control. Concept learning, **information theory and decision trees**: Concept learning (algorithms and limitations), Shannon's entropy, mutual information and gain, ID3 and extensions. **Introduction to probabilistic modelling**: Probability distributions and densities,

Bayes' rule, maximum likelihood, Bayesian inference. **Unsupervised learning**: Clustering (Gaussian mixtures, EM-algorithm, k-means), Dimensionality reduction (PCA). **Non-linear regression and classification**: Feed-forward neural networks, support vector machines. **Sequence learning**: Markov chains, hidden Markov models.

Books:

1. Stephen Marsland, "Machine Learning: An Algorithmic Perspective", Chapman and Hall/CRC, 1st Edition, 2009.
2. Tom M. Mitchell, "Machine Learning", McGraw-Hill, 1st Edition, 1997.
3. Ethem Alpaydin, "Introduction to Machine Learning", The MIT Press, 2nd Edition, 2009.
4. Ethem Alpaydin, "Introduction to Machine Learning", The MIT Press, 2004.

20. CSE-520: Wireless Sensor Network [3 Credits]

The Sensor Network Concept: Introduction, Applications, **Deployment & Configuration**: Localization and calibration, Coverage and connectivity, **Wireless Communications**: Link quality, shadowing and fading effects, **Medium Access**: Scheduling sleep cycles, **Data Gathering**: Tree construction algorithms and analysis, Asymptotic capacity, Lifetime optimization formulations, **Routing and Querying**: Publish/Subscribe mechanisms, Geographic routing, Robustness, Storage and retrieval, **Collaborative Signal Processing and Distributed Computation**: Detection, estimation, classification problems, Energy-efficient distributed algorithms, **Security**: Privacy issues, Attacks and countermeasures.

Books:

1. Holger Karl, Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", Wiley-Interscience, 1st Edition, 2007.
2. Waltenegus Dargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice", Wiley, 1st Edition, 2010.
3. Edgar H. Callaway Jr., "Wireless Sensor Networks: Architectures and Protocols", Auerbach Publications, 1st Edition, 2003.
4. Kazem Sohraby, Daniel Minoli, Taieb Znati, "Wireless Sensor Networks: Technology, Protocols, and Applications", Wiley-Interscience, 1st Edition, 2007.
5. Ian F. Akyildiz, Mehmet Can Vuran, "Wireless Sensor Networks", Wiley, 1st Edition, 2010.

6. Fei Hu, Xiaojun Cao, "Wireless Sensor Networks: Principles and Practice", Auerbach Publications, 1st Edition, 2010.

21. CSE-521: Channel Modeling [3 Credits]

Propagation Mechanisms: Free space propagation, reflection and transmission, diffraction, scattering on rough surfaces, wave guiding, **Statistical Description of Wireless Channels**: The time-invariant two-path model, time-variant two-path model, small-scale fading without line-of-sight, small-scale fading with line-of-sight, Doppler spectra, level crossing rate and random FM, large-scale fading, **Wideband Channel Characterization**: Narrowband vs. wideband systems, system-theoretic description of propagation channels, the WSSUS model, description methods for time dispersion, description methods for angular dispersion, **Channel Models**: Narrowband models, wideband models, spatial models, deterministic models, models for ultra wideband channels (UWB), **Channel Sounding**: Time-domain methods, frequency-domain methods, generalizations, spatially resolved methods, **Antenna aspects in wireless systems**: Requirements for antennas in mobile radio, antennas for mobile stations, antennas for base stations, aspects of multiple antenna systems (MIMO).

Books:

1. Simon Saunders, Alejandro Aragón-Zavala, "Antennas and Propagation for Wireless Communication Systems", Wiley, 2nd Edition, 2007.
2. Andrea Goldsmith, "Wireless Communications", Cambridge University Press, 2005.
3. Thushara Abhayapala, Merouane Debbah, Rodney A. Kennedy, "Space-Time Channel Modeling for Wireless Communications", Hindawi Publishing Corp US SR, 2007.
4. Claude Oestges, Bruno Clerckx, "MIMO Wireless Communications: From Real-World Propagation to Space-Time Code Design", Academic Press, 1st Edition, 2007.
5. William H. Tranter, Brian D. Woerner, Theodore S. Rappaport, Jeffrey H. Reed, "Wireless Personal Communications: Channel Modeling and Systems Engineering", Springer, 1st Edition, 1999.

22. CSE-522: Advanced Filter Design [3 Credits]

Characteristics of FIR filters, The four types of linear-phase FIR filters, Construction of linear-phase FIR filters, least-square approximation, the Chebyshev approximation, the Remes algorithm, Linear programming, Quadratic programming, Minimum-phase and complex approximation, Optimal amplitude Chebyshev design, Minimum phase, Complex least-square approximation, Complex Chebyshev approximation, Construction of IIR filters, Butterworth,

Chebyshev, Inverted Chebyshev, Elliptic filters, Construction of half-band filters, Filter construction with spectral factorization, Optimal windows.

Books:

1. Anthony Zaknich, "Principles of Adaptive Filters and Self-learning Systems", Springer, 1st Edition, 2005.
2. B. A. Shenoi, "Introduction to Digital Signal Processing and Filter Design", Wiley-Interscience, 1st Edition, 2005.
3. Rusty Allred, "Digital Filters for Everyone", Creative Arts & Sciences House, 2010.
4. T. W. Parks, C. S. Burrus, "Digital Filter Design", Wiley-Interscience, 1st Edition, 1987.
5. Arthur Williams, Fred Taylor, "Electronic Filter Design Handbook", McGraw-Hill Professional, 4th Edition, 2006.
6. Pierre Jarry, Jacques Beneat, "Advanced Design Techniques and Realizations of Microwave and RF Filters", Wiley-IEEE Press, 1st Edition, 2008.

23. CSE-523: Fault Tolerant Computing and Design [3 Credits]

Principles of fault tolerance, structures and techniques, goals. Error model and Fault model, logical Stuck-at fault, Design philosophy to combat fault, **Design technique to achieve FT**: Redundancy, NMR, TMR, dynamic redundancy, Duplex system, Information redundancy, Codes for control and correction of information. Cyclic codes, Fire codes, BCH and RS, Checksum, Convolution codes. Modeling, estimation and control of reliability. Fail-safe systems. Architecture of FT systems. Fault tolerance at VLSI level. Fault tolerance in computer units, computer systems and communication networks. Distributed tolerant systems, fault tolerant software.

Books:

1. Israel Koren, C. Mani Krishna, "Fault-Tolerant Systems", Morgan Kaufmann, 1st Edition, 2007.
2. Daniel P. Siewiorek, Robert S. Swarz, "Reliable Computer Systems: Design and Evaluation", A K Peters/CRC Press, 3rd Edition, 1998.
3. Martin L. Shooman, "Reliability of Computer Systems and Networks", Wiley-Interscience, 1st Edition, 2001.

4. Michel Banatre, Peter A. Lee, "Hardware and Software Architectures for Fault Tolerance", Springer, 1st Edition, 1994.

24. CSE-524: Advanced Digital Image Processing [3 Credits]

Overview of digital signal processing: Bandpass signals lowpass equivalent signals, Bandpass sampling, concept of digital frequency, DFT-based filtering, windows, frequency measurement; **Spectral estimation**: Introduction and periodogram, classical methods, minimum variance method, parametric methods; **Multirate signal processing**: Applications motivation, decimation and interpolation, sample rate conversion for rational D/I, approximate sample rate conversion for irrational D/I, polyphase implementation of sampling rate conversion, DFT filter banks, general filter banks – alias cancellation and perfect reconstruction; **Adaptive signal processing**: Applications motivation,Wiener filtering, the Widrow LMS algorithm, performance analysis of LMS algorithm, introduction to the RLS algorithm; **Probability and random processes**: Overview of probability, probability density function, mean, variance, correlation/covariance, Gaussian random variables, overview of random processes, classification, multiple random processes, examples.

Books:

1. Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing", Prentice Hall, 2nd Edition, 2002.
2. Crochiere, "Multirate Digital Signal Processing", Prentice Hall, 1st Edition, 1983.
3. Bernard Widrow, Peter N. Stearns, "Adaptive Signal Processing", Prentice Hall, 1st Edition, 1985.
4. Jacob Benesty, Yiteng Huang, "Adaptive Signal Processing", Springer, 1st Edition, 2010.
5. Tulay Adali, Simon Haykin, "Adaptive Signal Processing", Wiley-IEEE Press, 2010.
6. Steven M. Kay, "Modern Spectral Estimation", Prentice Hall, 1st Edition, 1999.

25. CSE-525: Speech Recognition [3 Credits]

Modeling human speech perception: Auditory, neural and cognitive processing, pattern matching, linguistic processing; **Representations of speech signal**: Bandpass filter energies, formants, LPC and ARMA, cepstrum and mel-cepstrum, auditory model based representations, difference coefficients, comparison of parametric representations; **Recognition modes and modalities**: Speaker dependency, isolated and continuous words, vocabulary size, speaking environment, perplexity, real-time operation; Stochastic models, linguistic models, prosodic knowledge sources; **Knowledge-based approaches**: Templates versus features, segmentation, labeling, fuzzy reasoning; **Stochastic approaches**: Hidden Markov Models (HMM), training and

testing algorithms; **Connectionist approaches**: Neural networks, learning algorithms; **Applications**: Dictation systems, voice- voice-based communications, system control, security systems, speaker verification.

Books:

1. Claudio Becchetti, Lucio Prina Ricotti, "Speech Recognition: Theory and C++ Implementation", Wiley, 1999.
2. Daniel Jurafsky, Daniel Jurafsky, "Speech and Language Processing", Pearson Prentice Hall, 2nd Edition, 2008.
3. Lawrence Rabiner, Ronald Schafer, "Theory and Applications of Digital Speech Processing", Prentice Hall, 1st Edition, 2010.
4. Frederick Jelinek, "Statistical Methods for Speech Recognition", The MIT Press, 1998.
5. Lawrence Rabiner, Biing-Hwang Juang, "Fundamentals of Speech Recognition", Prentice Hall, 1st Edition, 1993.
6. Wendy Holmes, "Speech Synthesis and Recognition", CRC Press, 2nd Edition, 2001.

26. CSE-526: Advanced Digital Communication [3 Credits]

Characteristics of different types of channels, storage channels; Digital modulation schemes, **Digital transmission**: Mapping, impulse shaping, receiver design, inter-symbol interference, eye diagram, noise, symbol error probability for multilevel transmission, partial response technique; Equivalent baseband channel; Equalizer, adaptive equalizer; System design with joint Nyquist and matched filter condition; Orthogonal signals, correlation receiver and equivalent matched filter receiver; **Optimum detection**: Bayes, Maximum Likelihood (ML) and Maximum Aposteriori Probability (MAP) detection, ML symbol by symbol and sequence detection, soft and hard decision, Viterbi algorithm, Viterbiequalizer; Soft input decoding of convolutional codes; Principles of Code Division Multiplex and Access (CDMA), near-far problem, multi-user interference, synchronous orthogonal receiver; Time varying multipath channels for mobile communication, time and Doppler-variant transfer function, statistical channel description, scattering function, AWGN channel with Rayleigh-fading, error probability; Principles of Turbo Coding.

Books:

1. John Proakis, Masoud Salehi, "Digital Communications", McGraw-Hill, 5th Edition, 2007.
2. Kamilo Feher, "Advanced Digital Communications", Prentice Hall, 1st Edition, 1986.
3. Bernard Sklar, "Digital Communications", Prentice Hall, 2nd Edition, 2001.

4. Hwei P. Hsu, “Analog and Digital Communications”, McGraw-Hill, 2nd Edition, 2002.

27. CSE-527: Radio Frequency Technology [3 Credits]

Antennas: Launching of waves, transmission, definition of antennas, reciprocity, wave propagation, **principal of equivalent sources**: electric and magnetic surface current, uniqueness principle, Huygens principle, Hertzian vector, image theory; **Aperture antennas**: Rectangular apertures, horn antenna, corrugated horn, circular aperture, reflector and lens antennas; **Linear antennas**: Field calculation, current distribution, linear dipoles and monopoles, design and feeding of dipole antennas, electrically short antennas, elementary dipole. **group antennas**: Directivity, group factor, phased arrays, parasitic antennas; **Electronic noise**: Characteristics of noise voltages and currents, **calculations with noise**: Fourier analysis, correlation, superposition of noise quantities, transmission through linear networks, **noise of 2-port networks**: noise factor and temperature, noise matching, concatenation of noisy 2-port-networks; **RF amplification**: 2-terminal amplifiers, **2-port amplifiers**: design with scattering parameters, selection of the point of operation, stability, unilateral design, wide-band amplifiers.

Books:

1. Jon B. Hagen, “Radio-Frequency Electronics”, Cambridge University Press, 2nd Edition, 2009.
2. Albert A. Smith, “Radio Frequency Principles and Applications”, Wiley-IEEE Press, 1st Edition, 1998.
3. Christopher Coleman, “An Introduction to Radio Frequency Engineering”, Cambridge University Press, 2011.
4. Wes H. Hayward, “Introduction to Radio Frequency Design”, Amer Radio Relay League, 1995.

28. CSE-528: Adaptive and Optimal Image Processing [3 Credits]

Random Processes: Discrete-Time Random Processes, Correlation functions, Spectral Density Functions, Cross-Spectral Density Functions, and Stochastic models. Optimal **Signal Processing**: Estimation, The least squares errors, the normal equation, the least squares filter, prediction, and inverse filtering. **Adaptive signal processing**: Introduction to concept of Adaptive Signal Processing, iterative solutions, adaptive LMS filter, stability and convergence. Application such as noise and vibration reduction, signal enhancement and echo cancelling.

Books:

1. Kim-Hui Yap, Ling Guan, Stuart William Perry, Hau San Wong, "Adaptive Image Processing", CRC Press, 2nd Edition, 2009.
2. Andrzej Cichocki, Shun-ichi Amari, "Adaptive Blind Signal and Image Processing", Addison-Wesley, 1st Edition, 2002.
3. N. Kalouptsidis , Sergios Theodoridis , "Adaptive System Identification and Signal Processing Algorithms", Prentice Hall, 1993.
4. Peter M. Clarkson, "Optimal and Adaptive Signal Processing", CRC-Press, 1st Edition, 1993.
5. K.J. Astrom, G.C. Goodwin, P.R. Kumar, "Adaptive Control, Filtering, and Signal Processing", Springer, 1st Edition, 1995.

29.CSE-529: Advanced Logic Design [3 Credits]

Functional Decomposition and Symmetric Functions, Graph optimization problems and algorithms, Logic level synthesis and optimization, sequential logic optimization, Reed-Muller expansions and their minimization, Reed-Muller expansions and their minimization, Binary Decision Diagrams, Synthesis and verification of finite state machine, Lookup table (LUT), FPGA, Technology Mapping, Boolean Matching, Synthesis of Reversible Logic, Reversible Circuit Testing, Fuzzy Reversible Circuit Synthesis, Ternary Reversible Circuits, Nanotechnology and its' impact, Quantum Logic, quantum cost calculations.

Books:

1. Giovanni De Micheli, "Synthesis and Optimization of Digital Circuits", McGraw-Hill Inc. 1994.
2. Tsutomu SASAO , "Logic Synthesis and Optimization", Kluwer Academic Publishers, Boston, USA. 1993.
3. Srinivas Devadas, Abhijit Ghosh, Kurt Keutzer, "Logic Synthesis", McGraw-Hill Inc. 1994.
4. Gary D. Hachtel, Fabio Somenzi, "Logic Synthesis and Verification Algorithms", Kluwer Academic Publishers, Boston, USA. 1996.

30.CSE-530: Enterprise Application Integration [3 Credits]

Approaches and issues in EAI: Design and develop data integration systems using XML, Design and develop Web service applications, integration area (e.g., Web 2.0), Identify other alternative technologies in the area Specifically (facts and knowledge), Architecture and communication patterns in enterprise systems, Middleware and conventional approaches to enterprise such as DCOM, CORBA, RMI, application integration, Data services and Service Oriented Architecture(SOA), SOA Layers, **Application to application Communication Protocol**: SOAP, REST, SOAP, SOAP-RPC and SOAP-Document, SOAP Encoding, SOAP-body, SOAP-fault, SOAP Binding and HTTP, Development of Web services, Web service Description Language(WSDL), Role of WSDL and main element of WSDL, WSDL: portType, Binding, Operation, **Case Study**: Amazon and Google web service, UDDI: Service Registry, Service Discovery, WSDL and UDDI Mapping, publishing UDDI, Implementing a web service with AXIS, Bottom-Up development Pattern, Top-Down Development Pattern, Client program development, BPM: Business process modeling and work-flow management system, **Application Integration Models(B2B)**: Point-to-Point, Bus, **EAI Platform**: Enterprise service hub/bus model, Workflow management system: static modeling, process modeling, Workflow concept: case, task process and routing, Petri Nets, **BPEL**: Web Service an Business process, Interacting with a Web Service, Web Service Coordination Protocol, Conversation among multiple web service, **Web Service UML modeling**: Activity, Web Service Composition, XLANG and WSFL, BPEL execution environment, BPEL process. BPEL Fault handling, **REST**: philosophy, Uniform Interface, REST Web Services, Resource Presentation Format, REST Complex Query, Building REST Web Services. XML-RPC, REST and SOAP, REST vs. RPC, REST vs. SOAP Protocol and Design Methodology, Data Service: XSLT and Xquery.

Books:

1. David S. Linthicum, "Enterprise Application Integration", Addison-Wesley, 1st Edition, 1999.
2. Gregor Hohpe, Bobby Woolf, "Enterprise Integration Patterns", Addison-Wesley, 1st Edition, 2003.
3. Waseem Roshen, "SOA-Based Enterprise Integration", McGraw-Hill Osborne Media, 1st Edition, 2009.
4. William A. Ruh, Francis X. Maginnis, William J. Brown, "Enterprise Application Integration", Addison-Wesley, 1st Edition, 2000.
5. David S. Linthicum, "B2B Application Integration", Addison-Wesley, 1st Edition, 2000.

31. CSE-531: Project Work [6 Credits]

32. CSE-532: Thesis Work [18 Credits]