भारतीय प्रौद्योगिकी संस्थान जम्मू
INDIAN INSTITUTE OF TECHNOLOGY JAMMU

विद्याधनं सर्वधन प्रधानम्

Course Curriculum

for

Master of Technology (M.Tech.) Programme (Under RA scheme)

in

Computer Technology

Department of Electrical Engineering

&

Department of Computer Science and Engineering

Indian Institute of Technology Jammu

Mission and Vision

Computer Technology is an interdisciplinary approach and means to enable the realization of successful systems. The Computer Technology process coordinates and leads the translation of an operational need into a system designed to meet the need. It integrates the inputs of all the required technical disciplines including, Computer engineering, Mathematical models and electronics system into a coordinated effort that meets established performance, cost, and schedule goals. Computer technology engineers provide the leadership and coordination of the planning, development, and engineering of technical systems, including hardware and software components.

One of the major challenges faced by Industries today are unsolvable or unattainable by any specific area of engineering. Computer Technology emphasizes a systems thinking approach, which allows you to cross disciplines and analyze and understand relationships between various sub-components of a given system. This provides for the design and implementation of solutions that span disciplines (Electrical Engineering, Mathematics and Computer Science Engineering, etc.) and considers all aspects of the project or product lifecycle

The Master of Computer Technology at IIT Jammu is designed to provide an advanced training to students focusing on a research oriented career in academia or industry. The program requires students to establish the necessary foundation of computer technology in addition to advanced computer technology coursework. The program aims at helps in providing strong foundation with required analytical concepts in the field of System design, computing platform and design of mathematical model with communication systems.

Semester-wise Credit Distribution

Semester	Credits
I	08
II	11
III	09
IV	10
V	10
VI	10
Total Credits	58

M. Tech. Program
Semester-wise Distribution of Courses

Semester-I					
SI. No.	Course Code	Course Name	Total Credits (L-T-P)	Credits	Tentative Faculty Members to teach
1		Linear Algebra	(3-1-0)	4	Dr. Sartaj ul Hasan/Dr. Tanmay Sarkar
2		Data Organization and Retrieval	(3-0-0)	3	Prof. Virendra Singh/Dr. Yamuna P Shukla/Dr. Badri N Subudhi
3		Lab-I: Software Engineering Lab	(0-0-2)	1	Dr. Yamuna Prasad Shukla/TBD
4	Audit	Introduction to IoT	(1-0-0)	1	Ankit Dubey
Total Credits				08	

Semester-II					
SI. No.	Course Code	Course Name	Total Credits (L-T-P)	Credits	Tentative Faculty Members to teach
2		High performance Computer Systems	(3-0-2)	4	Prof. Virendra Singh/Dr. Satyadev Ahalyawat
2		Computer Networks	(3-0-2)	4	Dr. Ankit Dubey/Dr. Sudhakar Modem/Dr. Subhasish Bhattacharya
3		Embedded System Design	(3-0-0)	3	Prof. Virendra Singh/Dr. Satyadev Ahalyawat
Total Credits				11	

Semester-III					
SI. No.	Course Code	Course Name	Total Credits (L-T-P)	Credits	Tentative Faculty Members to teach
1		Elective-I	(3-0-0)	3	TBD
2		Advanced Digital Signal Processing	(3-0-0)	3	Karan Nathwani/Badri N Subudhi
3		Lab: Embedded System Design	(0-0-2)	1	Prof. Virendra Singh/Dr. Satyadev Ahalyawat
		Technical Writing and Communication Skills	(0-0-2)	1	TBD
		Seminar	(0-0-2)	1	TBD
Total Credits				09	

Semester-IV					
SI. No.	Course Code	Course Name	Total Credits (L-T-P)	Credits	Tentative Faculty Members to teach
1		Elective-II	(3-0-0)	3	TBD
2		Dissertation	(0-0-14)	7	TBD
Total Credits				10	

Semester-V					
SI. No.	Course Code	Course Name	Total Credits (L-T-P)	Credits	Tentative Faculty Members to teach
1		Dissertation	(0-0-20)	10	TBD
Total Credits				10	

Semester-VI					
SI. No.	Course Code	Course Name	Total Credits (L-T-P)	Credits	Tentative Faculty Members to teach
1		Dissertation	(0-0-20)	10	TBD
Total Credits				10	

List of Electives

Electives					
SI. No.	Course Code	Course Name	Total Credits (L-T-P)	Credits	Faculty member
1		Digital Image Processing	(L-T-P)	X	Badri N, Subudhi
2		Introduction to RF System	(L-T-P)	X	Dr. Kushmanda Saurav
3		Statistical Signal Processing	(L-T-P)	X	Dr. Badri N. Subudhi
4		Signal Theory	(L-T-P)	X	Dr. Ajay Singh
5		Information Theory & Coding	(L-T-P)	X	Ravikant Saini, Ankit Dubey
6		Spread Spectrum & Multicarrier Techniques	(L-T-P)	X	Ravikant Saini, Ankit Dubey
7		Array Signal Processing	(L-T-P)	X	Karan Nathwani
8		Multidimensional Signal Processing	(L-T-P)	X	Badri N. Subudhi

9		Speech and Audio Processing	(L-T-P)	X	Karan Nathwani
10		Image and Video Processing	(L-T-P)	X	Badri N. Subuhi
11		Multirate Signal Processing	(L-T-P)	X	Karan Nathwani
12		Optimization Techniques	(L-T-P)	X	Prof. Virendra Singh
13		Machine Learning	(L-T-P)	X	Dr. Yamuna P Shukla
14		Computer Vision	(L-T-P)	X	Dr. Vineet Jakhetiya
15		Soft Computing	(L-T-P)	X	Badri N Subudhi
16		VLSI Signal Processing	(L-T-P)	X	Dr. Satyadev Ahalyawat
17		Biomedical Signal Processing	(L-T-P)	X	TBD
18		Advanced Antenna Theory	(L-T-P)	X	Kushmanda Saurav
20		VLSI Testing and Testability	(L-T-P)	X	Dr. Satyadev Ahalyawat

21	EELXXX	VLSI Technology	(L-T-P)	X	Dr. Satyadev Ahalyawat
22		Microwave and Millimeter Wave Integrated circuit	(L-T-P)	X	Prof. S.K. Koul/ Kushmanda Saurav
23		Microwave Imaging	(L-T-P)	X	Kushmanda Saurav/Alok Kumar Saxena
25		Microwave Measurements	(L-T-P)	X	Kushmanda Saurav/Alok Kumar Saxena
26		Wireless Communications & Networks	(L-T-P)	X	Ravikant Saini, Ankit Dubey
27		Communications in Smart Grid	(L-T-P)	X	Ankit Dubey
28		Introduction to Cyber security	(L-T-P)	X	Dr. Sumit Pandey
29		Satellite Communication			Ankit Dubey
30		Optical Communication			Ankit Dubey

		Distributed Systems and Cloud Computing	(L-T-P)	X	Dr. Subhasish Bhattacharya

Linear Algebra:

Determinants- row reduction and cofactor expansions, Cramer's rule. Row picture, Column picture, Vector Spaces- Euclidean space, general (real) vector spaces, subspaces, linear independence, dimension, row, column and null spaces.
Inner products: norms, orthogonal bases and Gram-Schmidt orthogonalization; Matrix Multiplication Problems, Matrix Analysis, Gauss Elimination Technique, LU and LDU Decomposition methods, Diagonalization of a Matrix, Singular value decomposition.
Linear transformations: Kernel and range, inverse transformations, matrices of linear transformations, change of basis, similarity; Orthogonalizations and Least Squares, Parallel Matrix Computations, Unsymmetric Eigenvalue problem, Symmetric eigenvalue problem, Iterative methods for linear systems, Lanczos methods.

1. Golub and Loan, "Matrix Computations", Third Edition, John Hopkins University Press, 1996
2. Carl. D. Meyer, "Matrix Analysis and Applied Liner Algebra", SIAM, 2001
3. Gilbert Strang, "Introduction to Linear Algebra", Fourth Edition, Wellesley Cambridge Press, 2009

Data Organization and Retrieval

What is information retrieval, Function overview, Relationships between Digital library and IRS, Introduction to Information Retrieval by Manning, Data control and data presentation, Boolean system/model, Information Storage and Retrieval Systems by Korflage, Vector retrieval system/model, Information Retrieval by Manning, Probability Retrieval System/model, Automatic indexing and abstracting, Similarity measure algorithms, Automatic clustering approaches, Information Visualization, Internet Information Retrieval, Image Retrieval

1. Crestani, Fabio, Mounia Lalmas, Cornelis J. Van Rijsbergen, and Iain Campbell. 1998.
2. Fuhr, Norbert. 1992. Probabilistic models in information retrieval. Computer Journal 35(3):243–255.

Advanced Digital Signal Processing
3-0-0

Learning Outcomes:

The course will briefly provide the review of signals and systems. It explains about digital filtering which involves design and quantization effects of digital filters. Multirate filterings, Cyclostationarity and LPTV filters and wavelet transform are covered in the course.

Assessment Criterion

1)Laboratory : 30 %
2) Examination : 50 %
3) Course Work : 20 %

MODULE 1

Review of Signals and Systems: This module includes Band Pass Sampling and data reconstruction processes. Z Transform, Definition of Z Transform, Importance of Z transform over Fourier Transform, Properties of Z Transform and Inverse Z Transform. Discrete linear systems.

MODULE 2

Frequency domain design of Digital filters: This module includes design of FIR and IIR filters in frequency domain.

MODULE 3

Quantization effects in Digital Filters : This module includes Distribution of Truncation Errors, Quantization of Filter Coefficients and Quantization of Pole Locations.

MODULE 4

Discrete Fourier transform and FFT algorithms: This module includes definition of DFT and its properties. It also describes the fast computation of DFT which is FFT.

MODULE 5

High speed convolution and its application to digital filtering : This module includes Theory of Convolution Filters, Approximation to the Filters and Accuracy of the Approximation Filters.

MODULE 6

Introduction to Multirate signal processing: This module deals with decimation and interpolation concepts of sampling theorem.

MODULE 7

Multirate filtering and Filter banks: This module presents Polyphase decomposition and perfect reconstruction.

MODULE 8

Cyclostationarity and LPTV filters : This module describes Cyclostationary and Linear Periodically Time Varying (LPTV) filters.

MODULE 9

Introduction to Wavelet Transform : This module deals with Wavelet transform, its similarities and differences over Fourier Transform. It also explain its application in speech and audio processing.

References:

1. Discrete-Time Signal Processing, 3/E, Alan V. Oppenheim and Ronald W. Schafer
2. Digital Signal Processing, 3/e, Sanjit K Mitra

<u>Computer Networks</u>
<u>3-0-2</u>

Learning Outcomes:
At the end of this course, students will be able to
1. Understand basic data communication system and network technology
2. Identify the different types of network topologies and protocols, exposure of the layers of the OSI model
3. Apply mathematical foundations to solve computational problems in communication networks
4. Identify and understand various routing and access control techniques in network layer with routing algorithms
5. Identify and understand various switching techniques and digital switching network.

Assesment Criterion:
Theory: 70%
Laboratory: 30%

Course Content:
Module I: Introduction and overview: Types of Networks; Circuit and Packet switching, Interconnection of networks, Layered communication Architecture, Network model ISO-OSI model, primitives and services, X 25 Protocol, System Network Architecture, Stop and Wait Protocol, Go-Back-N Protocol, Throughput analysis and Optimum packet length, High level data link Control, Throughput analysis, Balanced HDLC

Module II: Analysis of Window Flow-control Mechanisms: Virtual circuit model, Sliding window model, Acknowledge at end of window control, SNA path control, Queuing network, Product form solution, Exponential networks, Open Queuing Networks, closed queuing networks, Mean value analysis, Input buffer limiting for congestion control.

Module III: Bifurcated Routing, Shortest path routing, Decentralized version of Algorithm B, Examples of Routing in Networks and Network Architectures, Performance analysis of Distributed routing algorithms: Distributed algorithm B, Predecessor algorithm, Loop-free Distributed routing algorithms, Comparative performance.

Module IV: Controlled Access: Polling, Roll-call polling, hub polling, Random Access Techniques: Pure aloha, Slotted aloha, comparison of polling and Random-access techniques, Random Access using CSMA/CD, Comparative performance, CSMA/CD and
token Ring, IEEE 802 local area network standards: Ethernet-CSMA/CD local area network, token passing ring.

Module V: Simple Model, Circuit Switching: Queued Mode, Circuit and Packet Switching Compared: Simple Model, Elements of Traffic Engineering, Digital Switching Networks, Time-division Switching, Blocking Probability Analysis of Multistage Switches: Lee Approximation, Improved Approximate Analysis of Blocking Switch, Examples of Digital Switching Systems.

Text Books :
[T1] Telecommunication Networks: Protocol Modeling and Analysis, Pearson Education
[T2] Behrouz A. Forouzan, “Data Communication and networking,4TH edition.
[T3] Leon Garacia Widjaja, “Communication networks”, Tata McGraw Hill, 2000.
Reference Books:
[R1] R. Gallager and D. P. Bertsekas, Data Networks, 2nd edition, Prentice-Hall, Inc., 1991.

Introduction to IoT
1-0-0

Learning Outcomes:
At the end of this course, students will be able to
1. Understand the types of technologies that are available and in use today and can be utilized to implement IoT solutions.
2. Apply these technologies to tackle scenarios in teams of using an experimental platform for implementing prototypes and testing them as running applications.

Course Content:
Module I: Smart cities and IoT revolution, From IT to IoT, M2M and peer networking concepts. Software Defined Networks (SDNs), Principles of Edge/P2P networking, Protocols to support IoT communications, modular design and abstraction.
Module II: IOT networks (PAN, LAN and WAN), Edge resource, pooling and caching, client-side control and configuration, Smart objects as building blocks for IoT. Applications of IoT, connected cars IoT

Text Books:
[T1] A Bahaga, V. Madisetti, “Internet of Things- Hands on approach”, VPT publisher, 2014.
[T2] A. McEwen, H. Cassimally, “Designing the Internet of Things”, Wiley, 2013.
References Books:
[R1] CunoPfister, “Getting started with Internet of Things”, Maker Media, 1st edition, 2011.
[R2] Samuel Greenguard, “Internet of things”, MIT Press, 2015.
Web Resources:
[W1] http://www.datamation.com/open-source/35-open-source-tools-for-the-internet-ofthings1.
html
[W2] https://developer.mbed.org/handbook/AnalogIn
[W3] http://www.libelium.com/50_sensor_applications/
[W4] M2MLabs Mainspring http://www.m2mlabs.com/framework
[W5] Node-RED http://nodered.org/

Microwave and Millimeter Wave Integrated Circuits
3-0-0

Learning Outcomes:
Equip students with an understanding of microwave and millimeter wave integrated circuits with a special emphasis on active circuits.
Assessment Criterion

1) TermPaper/mini Project : 30 %
2) Examination : 70 %

MODULE 1
Introduction to Microwaves and Millimeter Waves 2 Hours
MODULE 2 2 Hours
Transmission Lines for Microwave and Millimeter Waves- Microstrip, Suspended Microstrip, Suspended Stripline, Fin-lines, Dielectric Integrated Guides
MODULE 3 6 Hours
Microwave and Millimeter wave Switches
P-i-n diode switches: basic configurations, Insertion loss and isolation of series and shunt switches, Series and shunt switches in microstrip, Device reactance compensation, Isolation improvement techniques, SPDT switches, Application of p-i-n diode switches, Design Examples
MODULE 4 12 Hours
Microwave and Millimeter Wave Phase Shifters
Analog versus digital Phase Shifters, Principle of ferrite Phase Shifters, Reciprocal versus non-reciprocal phase shifters, Different types of p-i-n diode phase shifters, Reflection and Transmission type phase shifter: Switched line, loaded line, hybrid coupled, low pass type, Series and shunt type switched line phase shifters, Broad banding techniques, MEMS Switches and phase shifters, Design Examples
MODULE 5 12 Hours
Small Signal Amplifiers
Low Noise, Maximum Gain, Stability, Narrow band Design, Broadband Design, Noise Analysis, Power amplifiers, Design Examples.
MODULE 6 4 Hours
Microwave and Millimeter Wave Mixers
MODULE 7 4 Hours
Millimeter Wave Transceiver Design

References:
1. Handouts given in the class
2. B.Bhat and Shiban K Koul, Strip line like transmission line for Microwave Integrated Circuits, New Age Publishers, Delhi.
3. Shiban K Koul and B.Bhat, Microwave Phase shifters, Volume-I and II, Artech House, USA
4. T.C.Edwards et al, Microstrip Circuit Design, John Wiley, USA

5. T.T.Ha, Microwave Amplifier Design, John Wiley, USA
6. G.Gonzales, Microwave Transistor Amplifiers, Prentice Hall, USA
7. D.M.Pozar, Microwave Engineering, John Wiley, USA
8. Shiban.K.Koul, Millimeter Wave and Optical Dielectric Integrated Guides and Circuits, (563 Pages) John Wiley and Sons, NY, USA, April 1997.
9. B.Bhat and Shiban.K.Koul, Analysis, Design and Applications of Fin-lines, (475 pages), Artech House (Mass.), USA, 1987.
10. Shiban. K.Koul and Sukomal Dey, Radio Frequency Microwave Switches, Switching Networks and Phase Shifters, CRC Press, August 2018.

Digital Image Processing
3-0-0

Learning Outcomes:
Equip students with an understanding of digital image processing: image enhancement, color image analysis, segmentation.

Assessment Criterion

1)Laboratory : 30 %
2) Examination : 50 %
3) Course Work : 20 %

MODULE 1 4 Hours
Digital image Fundamentals:
Elements of Visual Perception, Light and the Electromagnetic Spectrum, Image Sensing and Acquisition, Image Sampling and Quantization, Some Basic Relationships between Pixels, Linear and Nonlinear Operations.

MODULE 2 8 Hours
Image Enhancement in spatial domain:
Basic Gray Level Transformations, Histogram Processing, Basics of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters.

MODULE 3 5 Hours
Color Image Processing:
Color Fundamentals, Color Models, Pseudocolor Image Processing, Basics of Full-Color Image Processing, Color Transformations, Smoothing and Sharpening, Color Segmentation.

MODULE 4 6 Hours
Image Segmentation:
Detection of Discontinuities, Edge Linking and Boundary Detection, Thresholding, Region-Based Segmentation, Segmentation by Morphological Watersheds.

MODULE 5 6 Hours
Morphological Image Processing:
Morphological Image Processing, Dilation and Erosion, opening and Closing, Extensions to Gray-Scale Images.

MODULE 6 6 Hours
Image Compression:
Coding, Interpixel and Psychovisual Redundancy, Image Compression models, Compression standards

References:

1. Digital Image Processing, 3rd Ed. (DIP/3e) by Gonzalez and Woods © 2008
2. Fundamentals of Digital Image Processing by Anil K. Jain, Prentice Hall, 1989

<u>Computational Electromagnetics</u>
3-0-0

<u>Learning Outcomes:</u>
The course provides a basic review of electromagnetic theory and an introduction to computational electromagnetic. It will help students to understand finite difference methods, method of moments and finite element methods.

<u>Assessment Criterion</u>

1)Laboratory : 30 %
2) Examination : 50 %
3) Course Work : 20 %

MODULE 1 **6 Hours**
Review of electromagnetic theory, Introduction to computational electromagnetic

MODULE 2 **12 Hours**
Finite difference methods: Basic components of finite difference solvers, Wave equation (1-D FDTD method), Laplace's equation (2-D FDM), 2-D FDTD method, 3-D FDTD method, Perfectly matched layer

MODULE 3 **12 Hours**
Method of Moments: Integral formulation of electrostatics, Capacitance problem in unbounded 2D region, Electromagnetic scattering, Scattering on thin wires, Analysis of microstrip antennas and circuits, EM absorption in human body

MODULE 4 **12 Hours**
Finite element method: Overview, Laplace's equation (1-D FEM), Boundary condition for FEM, Helmholtz equation (2-D FEM), Finite element method-boundary element method, FEM/MOM hybrid, Time domain FEM, Fast multipole method.

<u>References:</u>

1. K. F. Warnick, "*Numerical methods for engineering*," SciTech, 2011.
2. A. Bondeson, T. Rylander and P. Ingelstrom, *"Computation Electromagnetics*," Springer, 2005.
3. M. N. O. Sadiku, "*Numerical Techniques in Electromagnetics*," CRC Press, 2001.
4. J. M. Jin, "*Theory and Computation of Electromagnetic Fields*," John Wiley, 2010.
5. D. B. Davidson, *"Computational Electromagnetics for RF and Microwave Engineering*," Cambridge University Press, 2011

Statistical Signal Processing
3-0-0

Learning Outcomes:

The course provides strong theoretical foundation for statistical characterization and analysis of signals to the students. It helps understanding the performance of adaptive filtering algorithms.

Assessment Criterion

1)Laboratory : 30 %
2) Examination : 50 %
3) Course Work : 20 %

MODULE 1	**3 Hours**
Random variables, geometric concepts, GS Orthogonalization	
MODULE 2	**6 Hours**
Random process, autocorrelation and PSD, properties of autocorrelation matrices	
MODULE 3	**15 Hours**
Optimum linear filtering, LMS and its performance, least squares	
MODULE 4	**8 Hours**
SVD and QR decompositions, RLS and its performance	
MODULE 5	**10 Hours**
Kalman filtering, spectrum modeling	

References:

1. Simon Haykin, “Adaptive Filter Theory,” Pearson, fourth edition.
2. Monson Hayes, “Statistical Digital Signal Processing and Modelling,” Wiley, 2009.

Communications Networks
3-0-0

Learning Outcomes:

The course will introduce students with the basic concepts of networking, TCP and UDP, TCP analysis. It will help them in understanding the algorithms for shortest path routing, routing protocols, optimal routing. Various performance measures and analysis of the network are discussed.

Assessment Criterion

1)Laboratory : 30 %
2) Examination : 50 %
3) Course Work : 20 %

MODULE 1 **6 Hours**
Introduction to networking, TCP and UDP, TCP analysis

MODULE 2 **10 Hours**
IP, optimal routing, algorithms for shortest path routing, routing protocols, Mobile IP

MODULE 3 **10 Hours**
ARQ schemes and analysis, random access, random/slotted ALOHA, splitting algorithms, CSMA-CD, wireless LANs CSMA/CA, IEEE 802.11 MAC

MODULE 4 **10 Hours**
Modeling and performance analysis in networks; deterministic analysis, scheduling; stochastic analysis - traffic models

MODULE 5 **6 Hours**
Performance measures, Little's Theorem, M/G/1 model, Priority queuing

References:

1. A. Kumar, D. Manjunath, and J. Kuri, Communication Networking: An Analytical Approach, Morgan Kaufman Publishers, 2004.
2. D. Bertsekas and R. Gallager, Data Networks, 2nd Edition, Prentice-Hall India, 2002.
3. J. F. Kurose and K. W. Ross, Computer Networking: A Top-Down Approach Featuring the Internet, Pearson Education Asia, 2001.

Information Theory and Coding

3-0-0

Learning Outcomes:

This course is aimed for conveying basics of the information theory. This course provides in-depth understanding of the basic concepts like asymptotic equipartition property, entropy rate for a random process, proofs of Shannon capacity theorems, capacity of Gaussian channels, rate-distortion theory, and data compression.

Assessment Criterion

1)Laboratory : 30 %
2) Examination : 50 %
3) Course Work : 20 %

MODULE 1	**3 Hours**
Introduction to entropy, relative entropy, mutual information, fundamental inequalities	
MODULE 2	**8 Hours**
Asymptotic equipartition property, entropy rates of stochastic process	
MODULE 3	**8 Hours**
Data compression, Differential entropy	
MODULE 4	**15 Hours**
Channel Capacity, The Gaussian channel	
MODULE 5	**8 Hours**
Rate distortion theory	

References:

1. T. M. Cover and J. A. Thomas, Elements of Information Theory, 2nd ED.,John Wiley & Sons, New Jersey, USA, 2006.
2. T. S. Han, Information-Spectrum Method in Information Theory, Springer-Verlag Berlin Heidelberg, 2003.
3. I. Csiszar and J. Korner, Information Theory: Coding Theorems for Discrete Memoryless Systems, 2nd edition, Cambridge University Press, 2011.

Array Signal Processing
3-0-0

Learning Outcomes:

The focus of the course is to enable the students to understand the one to one correspondence of spatial signals with time domain signals and hence equip them to apply the time domain signal processing techniques in spatial domain.

Assessment Criterion

1)Laboratory : 30 %
2) Examination : 50 %
3) Course Work : 20 %

MODULE 1 **10 Hours**

Spatial Signals:- Signals in space and time,Spatial frequency, Direction vs. frequency, Wave fields, Far field and Near field signals.

MODULE 2 **12 Hours**

Sensor Arrays:- Spatial sampling, Nyquist criterion. Sensor arrays. Uniform linear arrays, planar and random arrays. Array transfer (steering) vector. Array steering vector for ULA. Broadband arrays.

MODULE 3 **10 Hours**

Spatial Frequency :- Aliasing in spatial frequency domain. Spatial Frequency Transform, Spatial spectrum. Spatial Domain Filtering. Beam Forming. Spatially white signal.

MODULE 4 **10 Hours**

Direction of Arrival Estimation :- Non parametric methods – Beam forming and Capon methods. Resolution of Beam forming method. Subspace methods – MUSIC, Minimum Norm and ESPRIT techniques. Spatial Smoothing.

References:

1. Dan E. Dugeon and Don H. Johnson. (1993). Array Signal Processing: Concepts and Techniques. Prentice Hall.
2. Petre Stoica and Randolph L. Moses. (2005, 1997) Spectral Analysis of Signals. Prentice Hall.
3. Bass J, McPheeters C, Finnigan J, Rodriguez E. Array Signal Processing [Connexions Web site]. February 8, 2005. Available at: http://cnx.rice.edu/content/col10255/1.3/

Multidimensional Signal Processing
3-0-0

Learning Outcomes:

The course will help in Comprehending the concepts of multi-dimensional signals and systems, Apply these concepts to acquire, process and display two or multi-dimensional signals. The students are able to understand the concept of 2D sampling theorem and sampling with different sampling geometries. It will help in designing and implementation of various types of two-dimensional digital filters given a set of specifications. The course helps in exploring various applications and related research areas.

Assessment Criterion

1)Laboratory : 30 %
2) Examination : 50 %
3) Course Work : 20 %

MODULE 1 **14 Hours**

Multidimensional Systems- Fundamental operations on Multidimensional signals, Linear Shift - Invariant systems-cascade and parallel connection of systems- separable systems, stable systems- Frequency responses of 2D LTI Systems- Impulse response, Multidimensional Fourier transforms, z-transforms, properties of the Fourier and z-transforms

MODULE 2 **14 Hours**

Multidimensional Discrete Fourier Transform: - Properties of DFT, Circular convolution- Calculation of DFT- Fast Fourier transform for periodically sampled signals Sampling continuous 2D signals Periodic sampling with rectangular geometry- sampling density, Aliasing effects created by sampling - Periodic sampling with different sampling geometrics: rectangular, hexagonal and Quincunx - comparison

MODULE 3 **14 Hours**

Multidimensional Digital Filter Design- Separable Filters- Linear phase filters- FIR Filters- Implementation of FIR filters - design of FIR filters using windows-Two dimensional window functions, Filter design using transformations, McClellan transformation-disadvantages, New transformations such as T1, T2, P1, and H1 transformations-Contour approximation errors- Circularly symmetric and fan type filters – implementation- applications in image processing

References:

1. John W Woods, Multidimensional Signal Image and Video Processing and Coding, Academic Press, 2006
2. Dudgeon Dan E., Multidimensional Digital Signal Processing, Prentice Hall, Englewood Cliffs, New Jersey, 1989
3. Jae S. Lim, Two- Dimensional Signal and Image Processing, Prentice Hall Englewood Cliffs, New Jersey, 1990.

Speech and Audio Processing
3-0-0

Learning Outcomes:

Various digital models for the speech signal and time domain models for speech processing are discussed in more detail. The focus of the course is to enable the students to understand digital representations of the speech, Homomorphic Speech Processing, Speech Enhancement and automatic speech recognition.

Assessment Criterion

1)Laboratory : 30 %
2) Examination : 50 %
3) Course Work : 20 %

MODULE 1 **5 Hours**

Digital Models For The Speech Signal: Process of speech production, Acoustic theory of speech production, Lossless tube models, and Digital models for speech signals.

MODULE 2 **7 Hours**

Time Domain Models for Speech Processing: Time dependent processing of speech, Short time energy and average magnitude, Short time average zero crossing rate, Speech vs silence discrimination using energy & zero crossings, Pitch period estimation, Short time autocorrelation function, Short time average magnitude difference function, Pitch period estimation using autocorrelation function, Median smoothing.

MODULE 3 **8 Hours**

Digital Representations of the Speech Waveform: Sampling speech signals, Instantaneous quantization, Adaptive quantization, Differential quantization, Delta Modulation, Differential PCM, Comparison of systems, direct digital code conversion. Short Time Fourier Analysis: Linear Filtering interpretation, Filter bank summation method, Overlap addition method, Design of digital filter banks, Implementation using FFT, Spectrographic displays, Pitch detection, Analysis by synthesis, Analysis synthesis systems.

MODULE 4 **7 Hours**

Homomorphic Speech Processing: Homomorphic systems for convolution, Complex cepstrum, Pitch detection, Formant estimation, Homomorphic vocoder. Linear Predictive Coding of Speech: Basic principles of linear predictive analysis, Solution of LPC equations, Prediction error signal, Frequency domain interpretation, Relation between the various speech parameters, Synthesis of speech from linear predictive parameters, Applications

MODULE 5 **7 Hours**

Speech Enhancement: Spectral subtraction & filtering, Harmonic filtering, parametric re-synthesis, Adaptive noise cancellation. Speech Synthesis: Principles of speech synthesis, Synthesizer methods, Synthesis of intonation, Speech synthesis for different speakers, Speech synthesis in other languages, Evaluation, Practical speech synthesis.

MODULE 6 **8 Hours**

Automatic Speech Recognition: Introduction, Speech recognition vs. Speaker recognition, Signal processing and analysis methods, Pattern comparison techniques, Hidden Markov Models, Artificial Neural Networks. Audio Processing: Auditory perception and psychoacoustics - Masking, frequency and loudness perception, spatial perception, Digital Audio, Audio Coding -

High quality, low-bit-rate audio coding standards, MPEG, AC- 3, Multichannel audio - Stereo, 3D binaural and Multichannel surround sound.

References:

1. L. R. Rabiner and R. W. Schafer, “Digital Processing of Speech Signals", Pearson Education (Asia) Pte. Ltd., 2004.
2. D. O’Shaughnessy, “Speech Communications: Human and Machine”, Universities Press, 2001.
3. L. R. Rabiner and B. Juang, “Fundamentals of Speech Recognition”, Pearson Education (Asia) Pte. Ltd., 2004.
4. Z. Li and M.S. Drew, “Fundamentals of Multimedia”, Pearson Education (Asia) Pte. Ltd., 2004.

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Image and Video Processing
3-0-0

Learning Outcomes:

The course is meant for graduate level students and covers in detail image processing and video processing. Within the image processing, it covers topics related to image perceptions, image enhancement, image transformations, image compression.

Assessment Criterion

1)Laboratory : 30 %
2) Examination : 50 %
3) Course Work : 20 %

MODULE 1 — 6 Hours

Introduction: 2D systems, Mathematical preliminaries – Fourier Transform, Z Transform, Optical & Modulation transfer function, Matrix theory, Random signals, Discrete Random fields, Spectral density function.

MODULE 2 — 7 Hours

Image Perception: Light, Luminance, Brightness, Contrast, MTF of the visual system, Visibility function, Monochrome vision models, Fidelity criteria, Color representation, Chromaticity diagram, Color coordinate systems, Color difference measures, Color vision model, Temporal properties of vision.

Image Sampling and Quantization: Introduction, 2D sampling theory, Limitations in sampling & reconstruction, Quantization, Optimal quantizer, Compander, Visual quantization.

MODULE 3 — 7 Hours

Image Transforms: Introduction, 2D orthogonal & unitary transforms, Properties of unitary transforms, DFT, DCT, DST, Hadamard, Haar, Slant, KLT, SVD transform.

Image Representation by Stochastic Models: Introduction, one-dimensional Causal models, AR models, Non-causal representations, linear prediction in two dimensions.

MODULE 4 — 7 Hours

Image Enhancement: Point operations, Histogram modeling, spatial operations, Transform operations, Multispectral image enhancement, false color and Pseudo-color, Color Image enhancement.

Image Filtering & Restoration: Image observation models, Inverse & Wiener filtering, Fourier Domain filters, Smoothing splines and interpolation, Least squares filters, generalized inverse, SVD and Iterative methods, Maximum entropy restoration, Bayesian methods, Coordinate transformation & geometric correction, Blind de-convolution.

MODULE 5 — 8 Hours

Image Analysis & Computer Vision: Spatial feature extraction, Transform features, Edge detection, Boundary Extraction, Boundary representation, Region representation, Moment representation, Structure, Shape features, Texture, Scene matching & detection, Image segmentation, Classification Techniques.

Image Reconstruction from Projections: Introduction, Radon Transform, Back projection operator, Projection theorem, Inverse Radon transform, Fourier reconstruction, Fan beam reconstruction, 3D tomography.

Image Data Compression: Introduction, Pixel coding, Predictive techniques, Transform coding, Inter-frame coding, coding of two tone images, Image compression standards**.**

MODULE 6 **7 Hours**

Video Processing: Fundamental Concepts in Video – Types of video signals, Analog video, Digital video, Color models in video, Video Compression Techniques – Motion compensation, Search for motion vectors, H.261, H.263, MPEG I, MPEG 2, MPEG 4, MPEG 7 and beyond, Content based video indexing.

References:

1. K. Jain, "Fundamentals of Digital Image Processing", Pearson Education (Asia) Pte. Ltd./Prentice Hall of India, 2004.
2. Z. Li and M.S. Drew, "Fundamentals of Multimedia", Pearson Education (Asia) Pte. Ltd., 2004.
3. R. C. Gonzalez and R. E. Woods, "Digital Image Processing", 2nd edition, Pearson Education (Asia) Pte. Ltd/Prentice Hall of India, 2004.
4. M. Tekalp, "Digital Video Processing", Prentice Hall, USA, 1995

Multirate Signal Processing
3-0-0

Learning Outcomes:
The course provides knowledge about fundamentals of multirate systems. Various M-channel perfect reconstruction filter banks, perfect reconstruction filter banks and cosine modulated filter banks are discussed.

Assessment Criterion

1)Laboratory : 30 %
2) Examination : 50 %
3) Course Work : 20 %

MODULE 1 **10 Hours**

Fundamentals of Multirate Theory: The sampling theorem - sampling at sub nyquist rate - Basic Formulations and schemes. Basic Multirate operations- Decimation and Interpolation - Digital Filter Banks- DFT Filter Bank- Identities- Polyphase representation Maximally decimated filter banks: Polyphase representation - Errors in the QMF bank- Perfect reconstruction (PR) QMF Bank - Design of an alias free QMF Bank.

MODULE 2 **10 Hours**

M-channel perfect reconstruction filter banks: Uniform band and non uniform filter bank - tree structured filter bank- Errors created by filter bank system- Polyphase representation- perfect reconstruction systems.

MODULE 3 **12 Hours**

Perfect reconstruction (PR) filter banks: Paraunitary PR Filter Banks- Filter Bank Properties induced by paraunitarity- Two channel FIR paraunitary QMF Bank- Linear phase PR Filter banks- Necessary conditions for Linear phase property- Quantization Effects: -Types of quantization effects in filter banks. - coefficient sensitivity effects, dynamic range and scaling.

MODULE 4 **10** Hours

Cosine Modulated filter banks: Cosine Modulated pseudo QMF Bank- Alas cancellation- phase - Phase distortion- Closed form expression, Polyphase structure- PR Systems.

References:

1. P.P. Vaidyanathan, “Multirate systems and filter banks”, Prentice Hall. PTR. 1993.
2. N.J. Fliege, “Multirate digital signal processing” John Wiley.
3. Fredric J. Harris, “Multirate Signal Processing for Communication Systems”, Prentice Hall, 2004
4. Ljiljana Milic, “Multirate Filtering for Digital Signal Processing: MATLAB Applications”, Information Science Reference; 1/e, 2008
5. Sanjit K. Mitra, “Digital Signal Processing: A computer based approach”, McGraw Hill. 1998.
6. R.E. Crochiere. L. R. Rabiner, “Multirate Digital Signal Processing”, Prentice Hall. Inc.1983.
7. J.G. Proakis. D.G. Manolakis, “Digital Signal Processing: Principles. Algorithms and Applications”, 3rd Edn. Prentice Hall India, 1999

Optimization Techniques
3-0-0

Learning Outcomes:

The course deals with the unconstrained and nonlinear constraint optimization techniques, and an introduction to graph theory and combinatorial optimization.

Assessment Criterion

1)Laboratory : 30 %
2) Examination : 50 %
3) Course Work : 20 %

MODULE 1 **10 Hours**

Unconstrained optimization: - Necessary and sufficient conditions for local minima, one dimensional search methods, gradient methods - steepest descent, Inverse Hessian, Newton's method, conjugate direction method, conjugate gradient algorithm, quasi Newton methods

MODULE 2 **12 Hours**

Linear Programming: - Convex polyhedra, standard form of linear programming, Basic solutions, Simplex algorithm, Matrix form of the simplex algorithm, Duality, non simplex methods : Khachiyan method, Karmarkar's method

MODULE 3 **10 Hours**

Nonlinear Constrained Optimization: - equality constraints – Lagrange multipliers, inequality constraints – Kuhn-Tucker conditions, Convex optimization, Geometric programming, Projected gradient methods, Penalty methods

MODULE 4 **10 Hours**

Introduction to graph theory and combinatorial optimization:- Routing-traveling salesman; Assignment – satisfiability, constraint satisfiability, graph coloring; Subsets- set covering, partitioning; Scheduling; Shortest path and Critical path algorithms

References:

1. Edwin K. P. Chong, Stanislaw H. Zak, An Introduction to Optimization,2nd Ed, John Wiley & Sons
2. Stephen Boyd, Lieven Vandenberghe, Convex Optimization, CUP, 2004.
3. R. Fletcher, Practical methods of Optimization, Wiley, 2000
4. Jonathan L Grosss, Jay Yellen, Chapmamn and Hall, Graph theory and its application, 2e, CRC pub,
5. Alan Tucker, Applied Combinatorics, John wiley and Sons

Machine Learning
3-0-0

Learning Outcomes:

- Appreciation of basic knowledge about the machine learning and its classification.
- Ability to understand the regression techniques, ensemble methods and graphical models.

Assessment Criterion

1)Laboratory : 30 %
2) Examination : 50 %
3) Course Work : 20 %

MODULE 1 — 8 Hours
Introduction to machine learning. Classification: nearest neighbour, decision trees, perceptron, support vector machines, VC-dimension.

MODULE 2 — 8 Hours
Regression: linear least squares regression, support vector regression. Additional learning problems: multiclass classification, ordinal regression, ranking.

MODULE 3 — 8 Hours
Ensemble methods: boosting. Probabilistic models: classification, regression, mixture models (unconditional and conditional), parameter estimation, EM algorithm.

MODULE 4 — 10 Hours
Beyond IID, directed graphical models: hidden Markov models, Bayesian networks. Beyond IID, undirected graphical models: Markov random fields, conditional random fields.

MODULE 5 — 8 Hours
Learning and inference in Bayesian networks and MRFs: parameter estimation, exact inference (variable elimination, belief propagation), approximate inference (loopy belief propagation, sampling). Additional topics: semi-supervised learning, active learning, structured prediction.

References:

1. Bishop. C M, Pattern Recognition and Machine Learning. Springer, 2006.
2. Duda, R O, Hart P E and Stork D G. Pattern Classification. Wiley-Interscience, 2nd Edition, 2000.
3. Hastie T, Tibshirani R and Friedman J, The Elements of Statistical Learning: Data Mining, Inference and Prediction. Springer, 2nd Edition, 2009.
4. Mitchell T, Machine Learning. McGraw Hill, 1997.

Soft Computing

3-0-0

Learning Outcomes:

- Appreciation of the unified and exact mathematical basis as well as the general principles of various soft computing techniques.
- Appreciation of basic knowledge about the theory and key algorithms that form the foundation for artificial neural network and practical knowledge of learning algorithms and methods
- Appreciation of basic knowledge about the theory and key algorithms that form the foundation for fuzzy logic and become aware of the use of fuzzy inference systems in the design of intelligent or humanistic systems.
- Ability to understand the principles, advantages, limitations and possible applications of learning.
- Ability to identify and apply the appropriate learning technique to classification, pattern recognition, optimization and decision problems.

Assessment Criterion

1)Laboratory : 30 %
2) Examination : 50 %
3) Course Work : 20 %

MODULE 1 **7 Hours**

Overview of course and Basic of Soft Computing, Introduction of Neural Networks

MODULE 2 **8 Hours**

Learning Process and Learning Task, Supervised Learning – Single and Multi Layer Network, Associative Memory, Self organizing Maps, Neuro-Dynamics, Hopfield Network

MODULE 3 **12 Hours**

Fuzzy Logic and Systems-Fuzzy Sets and Membership Functions, Operations on Fuzzy Sets, Fuzzification. Fuzzy Numbers- Uncertain Fuzzy Values, Fuzzy Numbers and its L-R representation, Operations on Fuzzy Numbers

MODULE 4 **8 Hours**

Fuzzy Relations, Fuzzy Inference Systems- Architecture of Fuzzy Inference System, Fuzzy Inference Rules and Reasoning, Defuzzification, Applications of Fuzzy Logic

MODULE 5 **7 Hours**

Genetic algorithms and evolutionary computation, Applications of Genetic Algorithms & Hybrid Systems

References:

1. Soft Computing and Its Applications : R.A. Aliev, R.R. Aliev
2. Neuro-Fuzzy and Soft Computing: A computational Approach to Learning & Machine Intelligence; Roger Jang, Tsai Sun, Eiji Mizutani, PHI.
3. Neural Network: A Comprehensive Foundation; Simon Haykin, PHI.
4. Elements of artificial Neural Networks; Kishan Mehtrotra, S. Ranka, Penram International Publishing (India).
5. Fuzzy Logic with Engineering Applications; Timothy Ross, McGraw-Hill.
6. Neural Networks and Fuzzy Systems: Bar Kosko , PHI.

VLSI Signal Processing
3-0-0

Learning Outcomes:
1. Understand VLSI design methodology for signal processing systems.
2. Be familiar with VLSI algorithms and architectures for DSP.
3. Be able to implement basic architectures for DSP using CAD tools.

Assessment Criterion

1)Laboratory : 30 %
2) Examination : 50 %
3) Course Work : 20 %

MODULE 1 **10 hours**
Pipelining and Parallel Processing: Introduction, Pipelining of FIR Digital Filters, Parallel Processing. Pipelining and Parallel Processing for Low Power. Retiming: Introduction, Definition and Properties, Solving System of Inequalities, Retiming Techniques.

MODULE 2 **12 hours**
Unfolding: Introduction an Algorithms for Unfolding, Properties of Unfolding, Critical Path, Unfolding and Retiming Application of Unfolding. Folding: Introduction to Folding Transformation, Register Minimization Techniques, Register Minimization in Folded Architectures, Folding in Multirate Systems.

MODULE 3 **10 hours**
Systolic Architecture Design: Introduction, Systolic Array Design Methodology, FIR Systolic Arrays, Selection of Scheduling Vector, Matrix Multiplication and 2D Systolic Array Design, Systolic Design for Space Representations Containing Delays.

MODULE 4 **10 hours**
Fast Convolution: Introduction, Cook, Toom Algorithm, Winogard Algorithm, Iterated Convolution, Cyclic Convolution, Design of Fast Convolution Algorithm by Inspection.

References:

1. Keshab K. Parhi. VLSI Digital Signal Processing Systems, Wiley-Inter Sciences, 1999
2. Mohammed Ismail, Terri, Fiez, Analog VLSI Signal and Information Processing, McGraw Hill, 1994.
3. Kung. S.Y., H.J. While house T.Kailath, VLSI and Modern singal processing, Prentice Hall, 1985.
4. Jose E. France, YannisTsividls, Design of Analog Digital VLSI Circuits for Telecommunications and Signal Processing' Prentice Hall, 1994.

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Biomedical Signal Processing
3-0-0

Learning Outcomes:

1. Understand biomedical for signal processing systems.
2. Be familiar with EEG, ECG,EMG.

Assessment Criterion

1)Laboratory : 30 %
2) Examination : 50 %
3) Course Work : 20 %

MODULE 1 **10 Hours**

Introduction: Genesis and significance of bioelectric potentials, ECG, EOG, EMG and their monitoring and measurement, Spectral analysis, digital and analog filtering, correlation and estimation techniques, AR / ARMA models, Adaptive Filters.

MODULE 2 **12 Hours**

ECG: Pre-processing, Measurements of amplitude and time intervals, Classification, QRS detection, ST segment analysis, Baseline wander removal, wave form recognition, morphological studies and rhythm analysis, automated diagnosis based on decision theory ECT compression, Evoked potential estimation.

MODULE 3 **10 Hours**

EEG: evoked responses, Epilepsy detection, Spike detection, Hjorth parameters, averaging techniques, removal of Artifacts by averaging and adaptive algorithms, pattern recognition of alpha, beta, theta and delta waves in EEG waves, sleep stages,

MODULE 4 **10 Hours**

EMG: wave pattern studies, biofeedback, Zero crossings, Integrated EMG. Time frequency methods and Wavelets in Biomedical Signal Processing

References:

1. Willis J Tompkins, ED, “Biomedical Digital Signal Processing”, Prentice-Hall of India, 1996.2.
2. R E Chellis and R I Kitney, “Biomedical Signal Processing”, in IV parts, Medical and Biological Engg. And current computing, 1990-91.
3. Special issue on “Biological Signal Processing”, Proc. IEEE 1972
4. Arnon Kohen, “Biomedical Signal Processing”, Volumes I & II, CRC Press.
5. Metin Aray, “Time frequency and Wavelets in Biomedical Signal Processing”, IEEE Press, 1999.Current Published literature.

Advanced Antenna Theory
3-0-0

Learning Outcomes:

- Understand planar antennas, planar array, broadband antennas, aperture antennas and antennas for mobile communication.
- Be familiar with array theory.

Assessment Criterion

1)Laboratory : 30 %
2) Examination : 50 %
3) Course Work : 20 %

MODULE 1 **7 Hours**

Planar Antennas - Microstrip rectangular and circular patch antennas- Analysis and design, feeding methods, circularly polarized microstrip antennas, Broadbanding techniques, and printed slot antennas.

MODULE 2 **7 Hours**

Array Theory – Linear array; Broadside and end fire arrays; Self and mutual impedance of between linear elements, grating lobe considerations

MODULE 3 **7 Hours**

Planar array- Array factor, beamwidth, directivity. Example of microstrip patch arrays and feed networks, Electronic scanning

MODULE 4 **7 Hours**

Broadband Antennas- Folded dipole, Sleeve dipole, Biconical antenna- Analysis, characteristics, matching techniques, Yagi array of linear elements and printed version, Log-periodic dipole array. Frequency Independent Antennas- Planar spiral antenna, Log periodic dipole array.

MODULE 5 **7 Hours**

Aperture Antennas- Field equivalence principle, Babinet's principle, Rectangular waveguide, horn antenna, parabolic reflector antenna

MODULE 6 **7 Hours**

Antennas for mobile communication - Handset antennas, Base station antennas. Beam steering and antennas for MIMO applications; Active and smart microstrip antennas, Design and analysis of microstrip antenna arrays

References:

1. C. A. Balanis, Antenna Theory and Design, John Wiley & Sons, 1997.
2. J.D. Kraus, Antennas, McGraw-Hill, 1988
3. R.A. Sainati, CAD of Microstrip Antennas for Wireless Applications, Artech House, 1996.
4. R. Garg, P. Bharhia, I. Bahl, and A. Ittipiboo, Microstrip Antenna design Handbook, Artech House.
5. J. R. James, P.S. Hall and C.Wood, Microstrip Antennas: Theory & Design, Peter Peregrinns , UK

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VLSI Testing and Testability

3-0-0

Learning Outcomes:

This course covers introduction to the concepts and techniques of VLSI (Very Large Scale Integration) design verification and testing. Details of test economy, fault modeling and simulation, defects, Automatic Test Pattern Generation (ATPG), design for testability, and built-in self-test (BIST) also covered.

Assessment Criterion

1)Laboratory : 30 %
2) Examination : 50 %
3) Course Work : 20 %

MODULE 1 **12 Hours**

Fundamental of VLSI testing: Basic of VLSI testing, Scope of testing and verification in VLSI design process, Issues in test and verification of complex chips, embedded cores and SOCs.

MODULE 2 **12 Hours**

Fault Modeling and testing: Fault models, fault detection and redundancy, fault equivalence and fault location, fault dominance, automatic test pattern generation, Design for testability, Scan design, Test interface and boundary scan. System testing and test for SOCs. Delay fault testing.

MODULE 3 **10 Hours**

Test automation and Design verification: BIST for testing of logic and memories, Test automation, Design verification techniques based on simulation, analytical and formal approaches.

MODULE 4 **8 Hours**

Functional and Timing verification: Functional verification, Timing verification, Formal verification, Basics of equivalence checking and model checking, Hardware emulation.

References:

1. M. Abramovici, M. A. Breuer and A. D. Friedman, Digital Systems Testing and Testable Design, Jaico Publishing House, 1990.
2. T. Kropf, Introduction to Formal Hardware Verification, Springer Verlag, 2000.
3. Neil H. E. Weste and Kamran Eshraghian, Principles of CMOS VLSI Design, Addison Wesley, Second Edition, 1993.
4. Neil H. E. Weste and David Harris, Principles of CMOS VLSI Design, Addison Wesley, Third Edition, 2004.
5. M. Bushnell and V. D. Agrawal, Essentials of Electronic Testing for Digital, Memory and Mixed Signal VLSI Circuits, Kluwer Academic Publishers, 2000.

VLSI Technology
3-0-0

Learning Outcomes:
This course aims at understanding the manufacturing methods and their underlying scientific principles in the context of technologies used in VLSI chip fabrication.

Assessment Criterion

1)Laboratory : 30 %
2) Examination : 50 %
3) Course Work : 20 %

MODULE 1 **12 Hours**

Crystal Growth, Wafer manufacturing and Clean rooms: CMOS Process flow starting from Substrate selection to multilevel metal formation, comparison between bulk and SOI CMOS technologies. Crystal structure, Czochralski and FZ growth methods, Wafer preparation and specifications, SOI Wafer manufacturing, Clean rooms, wafer cleaning and gettering: Basic concepts, manufacturing methods and equipment, Measurement methods.

MODULE 2 **10 Hours**

Photolithography and Oxidation:

Photolithography: Light sources, Wafer exposure systems, Photoresists, Baking and development, Mask making, Measurement of mask features and defects, resist patterns and etched features.

Oxidation: Wet and Dry oxidation, growth kinetics and models, defects, measurement methods and characterization.

MODULE 3 **8 Hours**

Diffusion and Ion-implantation:

Diffusion: Models for diffused layers, Characterization methods, Segregation, Interfacial dopant pileup, oxidation enhanced diffusion, dopant-defect interaction.

Ion-implantation: Basic concepts, High energy and ultralow energy implantation, shallow junction formation & modeling, Electronic stopping, Damage production and annealing, RTA Process & dopant activation

MODULE 4 **12 Hours**

Thin film Deposition, Etching Technologies and Back-end Technology:

Thin film Deposition: Chemical and physical vapour deposition, epitaxial growth, manufacturing methods and systems, deposition of dielectrics and metals commonly used in VLSI, Modeling deposition processes.

Etching Technologies: Wet etching, Plasma etching, RIE, Etching of materials used in VLSI, Modeling of etching,

Back-end Technology: Contacts, Vias, Multi-level Interconnects, Silicided gates and S/D regions, Reflow & planarization, Multi-chip modules and packaging.

References:

1. James Plummer, M. Deal and P.Griffin, Silicon VLSI Technology, Prentice Hall Electronics, 2000.
2. Stephen Campbell, The Science and Engineering of Microelectronics, Oxford University Press, 1996.

3. S. M. Sze (Ed), VLSI Technology, McGraw Hill, Second Edition, 1988.
4. S.K. Gandhi, VLSI Fabrication Principles, John Wiley Inc., New York, 1983.
5. C.Y. Chang and S. M. Sze (Ed), ULSI Technology, McGraw Hill Companies Inc, 1996.

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Microwave Imaging

3-0-0

Learning Outcomes:

The course helps students in understanding electromagnetic scattering, electromagnetic inverse scattering problem, imaging configurations and model approximations. Various qualitative reconstruction methods and imaging techniques are discussed.

Assessment Criterion

1)Laboratory : 30 %
2) Examination : 50 %
3) Course Work : 20 %

MODULE 1 — 8 Hours

Electromagnetic Scattering: Maxwell's equation, interface conditions, constitutive equations, Wave Equations and Their Solutions, Volume Scattering by Dielectric Targets, Volume Equivalence Principle, Integral Equations, Surface Scattering by Perfectly Electric Conducting Targets.

MODULE 2 — 6 Hours

Electromagnetic Inverse Scattering Problem: Two-Dimensional Inverse Scattering, Discretization of the Continuous Model, Scattering by Canonical Objects: The Case of Multilayer Elliptic Cylinders

MODULE 3 — 8 Hours

Imaging Configurations and Model Approximations: Objectives of the Reconstruction, Multi illumination Approaches, Tomographic Configurations, Scanning Configurations, Configurations for Buried-Object Detection, Born-Type Approximations, Extended Born Approximation, Rytov Approximation, Kirchhoff Approximation.

MODULE 4 — 8 Hours

Qualitative Reconstruction Methods: Generalized Solution of Linear Ill-Posed Problems, Regularization Methods, Singular Value Decomposition, Regularized Solution of a Linear System Using Singular Value Decomposition, Qualitative Methods for Object Localization and Shaping, Synthetic Focusing Techniques, Qualitative Methods for Imaging Based on Approximations.

MODULE 5 — 6 Hours

Imaging Techniques: Back projection, w-k, beamforming, synthetic aperture imaging, Kirchoff method

MODULE 6 — 6 Hours

Microwave Imaging Apparatuses, Systems and Applications: Scanning Systems for Microwave Tomography, Antennas for Microwave Imaging, Civil and Industrial Applications, Medical Applications of Microwave Imaging, Shallow Subsurface Imaging.

References:

1. V. C. Chen and H. Ling, "Time-Frequency Transforms for Radar Imaging and Signal Analysis", Artech House 2002
2. Bernard D. Steinberg, "Microwave Imaging Techniques", Wiley & Sons 1991
3. Taylor, D.J., "Introduction to Ultra-wideband Radar Systems", CRC Press. 1995
4. D. R. Wehner, "High-Resolution Radar", 2nd Ed.,, Artech House 1994

Microwave Measurements

3-0-0

Learning Outcomes:

- Gain proficiency regarding microwave circuit concepts and relation between different parameters.
- Design impedance matching networks and familiarity with passive microwave components. Design of basic microwave laboratory set up along with measurement of parameters. Knowledge of VNA will help in the measurement of S parameters of different microwave devices.
- Familiarity with VNA concept can be used for finding gain, phase, reflection and transmission coefficient etc.

Assessment Criterion

1)Laboratory : 30 %
2) Examination : 50 %
3) Course Work : 20 %

MODULE 1 **8 Hours**

Introduction to microwave circuit concepts, Relation between [s], [z], [y] parameter

MODULE 2 **10 Hours**

Microwave circuits & theorems, Impedance matching, Passive microwave components

MODULE 3 **14 Hours**

Measurement of Wavelength, Frequency and Impedance-Introduction, Equivalent circuit of Cavity wave meters, Typical wave meters, resonant cavities, Methods of frequency measurements direct method - Interpolation method, Standard wave reflectors, Measurement of reflection coefficient, Low, Medium, High VSWR measurements, Standing wave pattern, Slotted Line section and its limitation, Impedance measurement techniques, Reflectometer

MODULE 4 **10 Hours**

Vector Network analyzer, Concept and description, Reflection and Transmission measurements, magnitude and Phase, measurement of S- Parameters, SWR and Impedances measurements, errors and corrections

References:

1. Microwave circuit, By J.L. Altmen, D van Nostrand Co.,Inc.
2. Foundations for microwave engineering, By R. E. Collins., John Wiley & Sons
3. Microwave Circuit Theory and Analysis, By R. N. Ghosh, McGraw Hill

Wireless Communications & Networks

3-0-0

Learning Outcomes:

- Basic understanding of communication networks.
- Familiarize students with cellular wireless networks, wireless LAN technology.

Assessment Criterion

1. **Laboratory : 30 %**
2. **Examination : 50 %**
3. **Course Work : 20 %**

MODULE 1 **14 Hours**

Communication Networks: LANs, MANs, WANs, Switching techniques, Wireless ATM networks, TCP/IP protocol architecture, OSI protocol architecture, Internetworking Wireless Communication Technology: Propagation modes, LOS transmission, Fading in the mobile environment. Signal encoding: Criteria, Digital data-analog signals, Analog data-Analog signals, Analog data-Digital signals. Coding and Error Control: Error detection, Block error correction codes, convolution codes, Automatic repeat request

MODULE 2 **14 Hours**

Cellular Wireless Networks - Principles of cellular network, first, second and third Generation systems. Cordless Systems and WLL: Cordless systems, Wireless Local Loop, IEEE 802.16 fixed broadband wireless access standard. Mobile IP and wireless Access Protocol: Mobile IP, Wireless Application Protocol, Internet control message protocol, Message authentication, Service primitives and parameters.

MODULE 3 **14 Hours**

Wireless LAN Technology: Overview, Infrared LANs, Spread spectrum LANs, Narrowband microwave LANs. IEEE 802.11 Wireless LAN: IEEE 802 protocol architecture, IEEE 802.11 architecture and services, IEEE 802.11 MAC, IEEE 802.11 physical layer. Bluetooth: Overview, Radio specification, baseband specification, Link manager specification, Logical Link control and adaptation protocol.

References:

1. Wireless Communications & Networks, by William Stallings, 2 Edition, 2009,nd Pearson Education.
2. Wireless communication and Networking by V.K. Garg, Morgan Kauffman Publisher, 2009.
3. Wireless Communication & Network, 3G & beyond, by Iti Saha Misra, McGrawHill, 2009.

Satellite Communication

3-0-0

Learning Outcomes:

This course aims at providing thorough information of the conventional and upcoming satellite communication technology. The course covers the fundamental aspects of the satellite communications like orbital theory and link budget analysis. The course would be taught from physical layer signal processing point-of-view and it would cover teaching of famous channel model of the land mobile satellite (LMS) links and also some recently discovered channel models. The multiple antennas based satellite communication would also be explained. The hybrid satellite-terrestrial satellite communication technology would also be introduced.

Assessment Criterion

1)Laboratory : 30 %
2) Examination : 50 %
3) Course Work : 20 %

MODULE 1 **5 Hours**
Introduction to satellite communication and orbital theory
MODULE 2 **8 Hours**
Satellite antennas, Satellite link design
MODULE 3 **12 Hours**
Channel models for satellite links, Modulation, multiple access techniques for satellite communication, and VSAT
MODULE 4 **6 Hours**
Introduction to MIMO systems and error analysis
MODULE 5 **13 Hours**
Multiple antenna based satellite communication, Hybrid satellite-terrestrial communication system

References:

1. T. Pratt, C. Bostian, and J. Allnutt, Satellite Communications, 2nd ed.John Wiley & Sons, 2003.
2. K. Y. Jo, Satellite Communications Network Design and Analysis,ARTECH HOUSE, 2011.
3. Recent research papers on MIMO satellite and hybrid satellite-terrestrial communication
4. E. G. Larsson and P. Stoica, Information Theory, Space-Time Block Coding for Wireless Communications, Cambridge University Press, 2003.

Distributed Systems and Cloud Computing

3-0-2

Course Objective:
The objective of this course is to give students a basic grounding in designing and implementing distributed and cloud systems. Developers of cloud services question how those services should be implemented. This course will combine hands-on experience in developing cloud services, with a firm grounding in the tools and principles of building distributed and cloud applications, including advanced architectures such as peer-to-peer, publish-subscribe and streaming. Besides cloud services, we will also be looking at cloud support for batch processing, such as the Hadoop and Pig frameworks, and their use with NoSQL data stores such as Cassandra.

Course Outcome:
Students after completion of the course would be able to:

- Install and Deploy Cloud and Distributed frameworks.
- Create and Destroy VMs for various purposes.
- Execute and Benchmarking.
- Have Hands-on experience with our existing real cloud infrastructure.
- Write and execute the parallel code on CPU and GPU nodes

Course Contents:
Introduction to distributed systems and cloud computing. Cloud architectures: SaaS, PaaS, IaaS. End-to-end system design. Networks and protocol stacks, Client-server computing. Sockets and remote procedure call, Distributed file systems and cache consistency. NFS, AFS. Storage in the Cloud: Google/ Hadoop file system. Web services and REST. Example: Amazon S3. The JAX-RS API. Persistent cloud services. Failure models and failure detectors. Asynchrony: publish-subscribe. Server-side events and REST. Web sockets. Vert.x: Node.js for Java. Distributed snapshots. Distributed debugging. Time and ordering of events. Causal broadcasts. Batch cloud computing: map-reduce and Hadoop. Domain-specific languages for cloud data processing: Pig and Hive. Transactions. Serializability and recoverability. Long-lived transactions. Transactions. Atomic commitment protocols:2PC and 3PC. Highly available services. Replicated services and quorum consensus. The CAP Theorem. NoSQL data stores. Table-based (Google BigTable), key-based (Amazon Dynamo), and Cassandra. The Hector API. Query processingwith Map-reduce. Consensus and the Paxos algorithm. Applications in the cloud: Google Chubby, Yahoo Zookeeper. Peer-to-peer systems. Distributed hash tables. Applications in multiplayer game-playing.

References:

1. Dominic Duggan , Enterprise Software Architecture and Design ,

2. Antonio Goncalves , Beginning Java EE 6 with Glassfish 3 , Springer Apress, 2009

Detailed Modules:

	Brief Description of Modular Course Engagement (Tentative)

Module No.	Topic Covered	No. of Hours
1	Introduction to distributed systems and cloud computing. Cloud architectures: SaaS, PaaS, IaaS. End-to-end system design. Networks and protocol stacks.	3
2	Client-server computing. Sockets and remote procedure call	2
3	Distributed file systems and cache consistency. NFS, AFS. Storage in the Cloud: Google/ Hadoop file system.	2
4	Web services and REST. Example: Amazon S3. The JAX-RS API. Persistent cloud services.	3
5	Failure models and failure detectors.	2
6	Asynchrony: publish-subscribe. Server-side events and REST. Web sockets. Vert.x: Node.js for Java. Distributed snapshots.	5
7	Distributed debugging. Time and ordering of events. Causal broadcasts.	3
8	Batch cloud computing: map-reduce and Hadoop. Domain-specific languages for cloud data processing: Pig and Hive.	5
9	Transactions. Serializability and recoverability. Long-lived transactions.	2
10	Transactions. Atomic commitment protocols:2PC and 3PC.	2
11	Highly available services. Replicated services and quorum consensus. The CAP Theorem.	2
12	NoSQL data stores. Table-based (Google BigTable), key-based (Amazon Dynamo), and Cassandra. The Hector API. Query processing with Map-reduce.	5
13	Consensus and the Paxos algorithm. Applications in the cloud: Google Chubby, Yahoo Zookeeper.	3
14	Peer-to-peer systems. Distributed hash tables. Applications in multiplayer game-playing.	3
	Total Lecture Hours (14 times 'L')	42

	Brief Description of Practical / Practice Activities

Module No.	Description	No. of Hours
1	Each module includes a practical/lab assignment including installation	28
	Total Practice / Practical Hours (14 times ‘P’)	28

Software Engineering Lab
0-0-2

Course Objective:

The objective of this course is to give students basic programming skills in C/C++/Python. This will also include various problems related to Data Structures and Algorithms, Program Verification tools and various software tools

Course Outcome:

Students after completion of the course would be able to:

- Install and Deploy various softwares.
- Program simple and complex programs.
- Apply various softwares for specific problems.
- Have Hands-on experience with our existing computing platform.
- Have exposure on ATLAS

Module No.	Topic Covered	No. of Hours
1	Programming Skills (C/C++/Python)	10
2	Memory leakage, resource utilisation, debugging (Valgrind, gdb)	4
3	Application Softwares (tensorflow, keras, scikit-learn, nltk), Matlab, CVX_optimization	6
4	Installation of various softwares	2
5	Program Behaviour and Verification with ATLAS	6
	Total Lab Hours (14 times 'L')	28

References:

1. C/C++ and Python Programming (online books)
2. ATLAS: http://www.ensoftcorp.com/atlas/academic_trial_confirmation.php
3 tensorflow.org, sk-learn, eras, NLTK, Mallet, mathworks.com etc

COURSE TEMPLATE

(Please avoid changing the headings, but fill only the columns relevant to the template by editing the columns)

1.	Discipline/Center/ School proposing the course	Department of Computer Science & Engineering		
2.	Course Title	Distributed Systems and Cloud Computing		
3.	L-T-P Structure	3-0-2		
4.	Credits	4	Non-Graded Units	
5.	Course Number	———		
6.	Course Status (Course Category of Program) Elective (MTech (CT))			

Institute Core for all UG Programs	NO
Program Linked Core for:	
Departmental Core for:	
Minor Area / Interdisciplinary Special Core for	
Minor Area / Interdisciplinary Elective Core for	MTech (CT)/BTech (CSE/EE)
Program Core for:	
Program Elective for:	Computer Technology
Open Category Elective for all other programs (No if Institute Core)	Yes

7.	**Pre-Requisite (s)**	Programming, Data Structures and Algorithms

8.	**Frequency of offering**	

9.	**Faculty who will teach the course** Dr. Subhasis Bhattacharjee

10.	**Will the course require any visiting faculty**	

11.	**Course Objective:** The objective of this course is to give students a basic grounding in designing and implementing distributed and cloud systems. Developers of cloud services question how those services should be implemented. This course will combine hands-on experience in developing cloud services, with a firm grounding in the tools and principles of building distributed and cloud applications, including advanced architectures such as peer-to-peer, publish-subscribe and streaming. Besides cloud services, we will also be looking at cloud support for batch processing, such as the Hadoop and Pig frameworks, and their use with NoSQL data stores such as Cassandra.

12.	**Course Outcome:** Students after completion of the course would be able to: − Install and Deploy Cloud and Distributed frameworks. − Create and Destroy VMs for various purposes. − Execute and Benchmarking. − Have Hands-on experience with our existing real cloud infrastructure. − Write and execute the parallel code on CPU and GPU nodes
13.	**Course Contents:** Introduction to distributed systems and cloud computing. Cloud architectures: SaaS, PaaS, IaaS. End-to-end system design. Networks and protocol stacks, Client-server computing. Sockets and remote procedure call, Distributed file systems and cache consistency. NFS, AFS. Storage in the Cloud: Google/ Hadoop file system. Web services and REST. Example: Amazon S3. The JAX-RS API. Persistent cloud services. Failure models and failure detectors. Asynchrony: publish-subscribe. Server-side events and REST. Web sockets. Vert.x: Node.js for Java. Distributed snapshots. Distributed debugging. Time and ordering of events. Causal broadcasts. Batch cloud computing: map-reduce and Hadoop. Domain-specific languages for cloud data processing: Pig and Hive. Transactions. Serializability and recoverability. Long-lived transactions. Transactions. Atomic commitment protocols:2PC and 3PC. Highly available services. Replicated services and quorum consensus. The CAP Theorem. NoSQL data stores. Table-based (Google BigTable), key-based (Amazon Dynamo), and Cassandra. The Hector API. Query processingwith Map-reduce. Consensus and the Paxos algorithm. Applications in the cloud: Google Chubby, Yahoo Zookeeper. Peer-to-peer systems. Distributed hash tables. Applications in multiplayer game-playing.

14.	Brief Description of Modular Course Engagement (Tentative)	
Module No.	Topic Covered	No. of Hours
1	Introduction to distributed systems and cloud computing. Cloud architectures: SaaS, PaaS, IaaS. End-to-end system design. Networks and protocol stacks.	3
2	Client-server computing. Sockets and remote procedure call	2
3	Distributed file systems and cache consistency. NFS, AFS. Storage in the Cloud: Google/ Hadoop file system.	2
4	Web services and REST. Example: Amazon S3. The JAX-RS API. Persistent cloud services.	3
5	Failure models and failure detectors.	2
6	Asynchrony: publish-subscribe. Server-side events and REST. Web sockets. Vert.x: Node.js for Java. Distributed snapshots.	5
7	Distributed debugging. Time and ordering of events. Causal broadcasts.	3
	Batch cloud computing: map-reduce and Hadoop. Domain-specific languages for cloud data processing: Pig and Hive.	5
	Transactions. Serializability and recoverability. Long-lived transactions.	2
	Transactions. Atomic commitment protocols:2PC and 3PC.	2
	Highly available services. Replicated services and quorum consensus. The CAP Theorem.	2
	NoSQL data stores. Table-based (Google BigTable), key-based (Amazon Dynamo), and Cassandra. The Hector API. Query processing with Map-reduce.	5
	Consensus and the Paxos algorithm. Applications in the cloud: Google Chubby, Yahoo Zookeeper.	3
	Peer-to-peer systems. Distributed hash tables. Applications in multiplayer game-playing.	3
	Total Lecture Hours (14 times 'L')	42

16.	Brief Description of Practical / Practice Activities

Module No.	Description	No. of Hours
1	Each module includes a practical/lab assignment including installation	28
	Total Practice / Practical Hours (14 times 'P')	28

17.	Brief description of module-wise activities pertaining to self-learning component (If any- include topics that the students would do self-learning from books / resource material: Do not include term papers / assignments etc.)
Module No.	**Description**

18.	Suggested texts and reference materials STYLE: Author name and / or initials, Title, Publisher, Edition, Year
1.	Dominic Duggan , Enterprise Software Architecture and Design
2.	Antonio Goncalves , Beginning Java EE 6 with Glassfish 3 , Springer Apress, 2009

19.	Resources required for the course (itemized student access requirements, if any)	
19.1	Software	Name of software, number of licenses, etc.
19.2	Hardware	Name of hardware, number of access points, etc.
19.3	Teaching aids (videos, etc.)	Type of aid required, specify details
19.4	Laboratory	Type of facility required, number of students, etc.
19.5	Equipment	Type of equipment required, number of students, etc.
19.6	Class room infrastructure	Type of facility required, number of students, etc.
19.7	Site visits	Type of Industry / Site, typical number of visits, number of students, etc.
19.8	Others (please specify)	

20.	Design content of the course (percentage of student time with examples, if possible)

20.1	Design type problems	e.g. 25% of student time of practical / practice hours: sample Circuit Design exercise from industry
20.2	Open-ended problems	
20.3	Project type activity	Students will be involved in project for solving flow sheet problems
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date: (Signature of Head of Department / Center / School)

Date of Approval of Template by Senate	

This information on this template is an on the date of its approval and is likely to evolve with time.

Embedded Systems

Syllabus:

The concept of embedded systems design. Architectural Issues: CISC, RISC, DSP Architectures. Embedded microcontroller cores, embedded memories. Examples of embedded systems.; Programming in Assembly Language.

Technological aspects of embedded systems: interfacing between analog and digital blocks, signal conditioning, digital signal processing. sub-system interfacing, interfacing with external systems, user interfacing.

Designing Embedded Systems : Design Issues, Hardware- Software Co-design, Design trade-offs due to process compatibility, thermal considerations, etc.;.

Embedded System Software: Program Optimization, Concurrent Programming, Realtime Scheduling and I/O management;

Real-time concepts, Required RTOS services/capabilities (in contrast with traditional OS) Resource Management/scheduling paradigms: static priorities, static schedules, dynamic scheduling, best effort current best practice in scheduling (e.g. Rate Monotonic vs. static schedules), Real-world issues: blocking, unpredictability, interrupts, caching.

References:

Jack Ganssle, "The Art of Designing Embedded Systems", Newnes, 1999.
David Simon, "An Embedded Software Primer", Addison Wesley, 2000.

High Performance Computer Systems

Objective:

- Understand computer systems (processor architecture and memory subsystem (incl. cache) from a programmer’s viewpoint to maximize performance of his/her applications
- Understand underlying Operating Systems concepts (programmer’s viewpoint) - process, threads, memory management, file system
- Understand parallel processing systems (programmer’s viewpoint)
- Improving program’s performance

Syllabus

Module1:
Introduction to computer systems: Processors, Memory, I/O Devices; Cost, timing and scale (size) models; Program Execution: Machine level view of a program; typical RISC instruction set and execution.

Module 2:
Caching and Virtual Memory. Temporal and spatial locality. Typical compiler optimizations. Identifying program bottlenecks – profiling, tracing. Simple high level language optimizations – locality enhancement, memory disambiguation.

Module 3:
OS Concepts: Process and memory management
File System Interface and Implementation - Concept, Access Methods, Structures, Allocation, Implementation, Efficiency, NFS
Storage Structures - Scheduling, Management, Implementation, RAID, I/O Systems

Module 4:
Interprocess communication, Synchronization - Mutual exclusion, critical section, locks, test and wait, semaphores, classical problems, Threads, Multi-threading

Module 5:
Parallel Computing: Introduction to parallel architectures and interconnection networks, communication latencies. Program parallelization; task partitioning and mapping; data distribution; message passing; synchronization and deadlocks. Distributed memory programming using MPI/PVM. Shared memory parallel programming. Multithreading.

Reference Books

1. Bryant and O'Hallaron, Computer Systems - A Programmer's Perspective
2. Silberschatz, Galvin and Gagne, Operating System Concepts**,** John Wiley & Sons.
3. David Culler, Jaswant Singh, Parallel Computing Architecture, Morgan Kauffman

Introduction to IoT

(1-0-0)

Learning Outcomes:

At the end of this course, students will learn

1. The basic terminologies related to IoT, brief history, and evolution of IoT
2. The overview of IoT architecture, current trends, impact on the society
3. The challenges of IoT systems

Course Content:

Module	Topics	Lecture hours
Module: 1	Definition and Keywords of Internet of Things (IoT); Brief History and evolution of IoT	**4**
Module: 2	Architecture of IoT	**2**
Module: 3	Current Trends in the Adoption of IoT; Practical examples of IoT systems	**4**
Module: 4	Impact on Society: Benefits of IoT	**2**
Module: 5	Challenges: Risks, Privacy, and Security Issues of IoT	**2**
	Total	**14**

Text Books:

[T1] A Bahaga, V. Madisetti, “Internet of Things- Hands on approach”, VPT publisher, 2014.
[T2] A. McEwen, H. Cassimally, “Designing the Internet of Things”, Wiley, 2013.

References Books:

[R1] CunoPfister, “Getting started with Internet of Things”, Maker Media, 1st edition, 2011.
[R2] Samuel Greenguard, “Internet of things”, MIT Press, 2015.

Web Resources:

[W1]
http://www.datamation.com/open-source/35-open-source-tools-for-the-internet-of-things1.html
[W2] https://developer.mbed.org/handbook/AnalogIn
[W3] http://www.libelium.com/50_sensor_applications/
[W4] M2MLabs Mainspring http://www.m2mlabs.com/framework
[W5] Node-RED http://nodered.org/

COURSE TEMPLATE

(Please avoid changing the headings, but fill only the columns relevant to the template by editing the columns)

1.	Discipline/Center/ School proposing the course	Department of Computer Science & Engineering		
2.	Course Title	Software Engineering Lab		
3.	L-T-P Structure	0-0-2		
4.	Credits	1	Non-Graded Units	
5.	Course Number	———		
6.	Course Status (Course Category of Program) Core (MTech (CT))			

Institute Core for all UG Programs	NO
Program Linked Core for:	
Departmental Core for:	
Minor Area / Interdisciplinary Special Core for	
Minor Area / Interdisciplinary Elective Core for	
Program Core for:	MTech Computer Technology
Program Elective for:	
Open Category Elective for all other programs (No if Institute Core)	

7.	**Pre-Requisite (s)**	

8.	**Frequency of offering**	Alternate semesters

9.	**Faculty who will teach the course** Dr. Yamuna Prasad

10.	**Will the course require any visiting faculty**	

11.	**Course Objective:** The objective of this course is to give students basic programming skills in C/C++/Python. This will also include various problems related to Data Structures and Algorithms, Program Verification tools and various software tools

12.	**Course Outcome:** Students after completion of the course would be able to: − Install and Deploy various softwares. − Program simple and complex programs. − Apply various softwares for specific problems. − Have Hands-on experience with our existing computing platform. − Have exposure on ATLAS
13.	**Course Contents:Progra**

14.	Brief Description of Modular Course Engagement (Tentative)	
Module No.	Topic Covered	No. of Hours
1	Programming Skills (C/C++/Python)	10
2	Memory leakage, resource utilisation, debugging (Valgrind, gdb)	4
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4	Installation of various softwares	2
5	Program Behaviour and Verification with ATLAS	6

	Total Lab Hours (14 times 'L')	28

16.	Brief Description of Practical / Practice Activities	
Module No.	Description	No. of Hours
1	Each module includes a practical/lab assignment including installation	28
	Total Practice / Practical Hours (14 times 'P')	28

17.	Brief description of module-wise activities pertaining to self-learning component (If any- include topics that the students would do self-learning from books / resource material: Do not include term papers / assignments etc.)
Module No.	Description

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2.	ATLAS: http://www.ensoftcorp.com/atlas/academic_trial_confirmation.php
3	tensorflow.org, sk-learn, eras, NLTK, Mallet, mathworks.com etc

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19.6	Class room infrastructure	Type of facility required, number of students, etc.
19.7	Site visits	Type of Industry / Site, typical number of visits, number of students, etc.
19.8	Others (please specify)	

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20.2	Open-ended problems	
20.3	Project type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date: (Signature of Head of Department / Center / School)

Date of Approval of Template by Senate	

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