M.Tech. (ICT) for Engineering Graduate (2-Years)

2-Year M.Tech. (ICT) for Engineering Graduates

Specialization- Wireless Communication and Networks

SEMESTER I

Sr.No	Course Code	Courses	L-T-P	Credits
		THEORY		
1	EC531	Advanced Digital Communication System	3-1-0	4
2	EC533	Wireless Networks	3-1-0	4
3	EC539	Advanced Digital Signal Processing	3-1-0	4
4		Elective -2	3-0-0	3
5	SS101	Human Values & Buddhist Ethics	2-0-0	2
		PRACTICALS		
6	CS589	Programming Lab	0-0-3	2
7	EC581	Digital Communication Lab	0-0-3	2
8	GP531	General Proficiency	---	1
		Total	**14-3-6**	**22**
		Total Contact Hours	23	

Elective-2

Sr.No	Course Code	Courses
1.	EC541	Advanced Computer Networks
2.	EC565	Embedded System Design
3.	CS561	Principles of Artificial Intelligence
4.	CS523	Advance Computer Architecture
5.	EC535	Digital IC Design
6.	CS543	Data Mining

SEMESTER II

Sr. No.	Course Code	Courses	L-T-P	Credits
		THEORY		
1	MA402	Simulation and Modeling	3-1-0	4
2	EC532	Advanced Communication Networks	3-0-0	3
3	EC534	Wireless System Design	3-0-0	3
4		Elective-3	3-0-0	3
5		Elective-4	3-0-0	3
		PRACTICALS		
6	EC584	Design Lab-I	0-0-3	2
7	EC590	Major Project	0-0-10	5
8	GP532	General Proficiency	---	1
		Total	**15-1-13**	**24**
		Total Contact Hours	29	

M.Tech. (ICT) for Engineering Graduate (2-Years)

Electives (3 & 4)

Sr.No	Course Code	Courses
1.	EC542	Quality of Services in Networks
2.	EC566	VLSI for Wireless Communication
3.	EC536	VLSI Technology
4.	EC544	Advanced RF Engineering
5.	EC548	Probability and Stochastic Processes
6.	EC550	Advanced Microwave Communication
7.	EC552	Networking Protocols
8.	EC554	Mobile Computing
9.	EC556	Image Processing and Biometrics
10.	EC558	Network Programming
11.	EC576	CMOS RF Circuit Design
12.	EC570	Principles of MEMS Design
13.	CS447/CS547	Multimedia Techniques
14.	CS449/CS561	Soft Computing
15.	CS404/CS534	Open Source Software System

SEMESTER – III

Sr. No.	Course Code	Courses	L-T-P	Credits
		THEORY		
1	EC631	Security in Wireless Networks	3-0-0	3
2	CS633	Research Techniques in ICT	3-0-0	3
3		Elective-5	3-0-0	3
4		Elective-6	3-0-0	3
		PRACTICALS		
5	EC681	Computing Lab	0-0-3	2
7	EC691	Dissertation Part-I	0-0-14	7
8	GP631	General Proficiency	---	1
		Total	**12-0-17**	**22**
		Total Contact Hours	29	

Electives (5 & 6)

Sr.No	Course Code	Courses
1	EC641	Network Reliability
2	EC643	Smart Antenna Systems
3	EC645	Broadband Wireless Networks
4	EC647	Sensor Networks
5	EC649	Ad-hoc Wireless Networks
6	EC651	Multicast Communication
7	EC671	Modern Optimization Techniques
8	EC675	Mixed Signal VLSI Design
9	EC677	DSP Integrated Circuits

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SEMESTER-IV

Sr. No	Course Code	Courses	L-T-P	Credits
1	EC696	Dissertation Part-II	---	21
2	GP632	General Proficiency	---	1
		Total	**---**	**22**

Grand Total Credits = 90

M.Tech. (ICT) for Engineering Graduate (2-Years)

ADVANCED DIGTAL COMMUNCIATION SYSTEM			
Course Code:	**EC531**	**Credits:**	**4**
No. of Lectures (Hrs/Week):	**3+1T**	**Mid Sem Exam Hours:**	**2**
Total No. of Lectures:	**45**	**End Sem Exam Hours:**	**3**

Unit I: Pulse Modulation Analog Signals:- Sampling of Signal, Sampling Theorem for Low Pass and Band Pass Signals, Aliasing, Pulse Amplitude Modulation (PAM), Time Division Multiplexing (TDM), Channel Bandwidth for PAM-TDM Signal, Types of Sampling, Instantaneous, Natural and Flat Top (Mathematical and Spectral Analysis), Aperture Effect, Introduction to Pulse Position and Pulse Duration Modulation.

Unit II: Pulse Code Modulation Digital Signal:- Quantization, Quantization Error, Pulse Code Modulation (PCM), Signal-to-Noise Ratio in PCM, Companding, Data Rate and Bandwidth of Multiplexed PCM Signal, Inter-symbol Interference, Eye Diagram, Line Coding NRZ, RZ, Biphase, Duo Binary Etc ,Differential PCM (DPCM), Delta Modulation (DM), and Adaptive Delta Modulation (ADM), Slope Overload Error ,Granular Noise ,Comparison of various system in terms of Bandwidth and Signal-to-Noise Ratio.

Unit III: Digital Modulation Techniques :- Analysis, Generation and Detection (Block Diagram), Spectrum and Bandwidth of Amplitude Shift Keying (ASK), Binary Phase Shift Keying (BPSK), Differential Phase Shift Keying (DPSK), Offset and Non-offset Quadrature Phase Shift Keying (QPSK), M-ary PSK, Binary Frequency Shift Keying (BFSK), M-ary FSK, Minimum Shift Keying, Quadrature Amplitude Modulation (QAM), Comparison of digital modulation techniques on the basis of probability of error, Matched Filter.

Unit IV: Concept of Probability, Relative Frequency and Probability Conditional Probability and Independent Events, Random Variables, Discrete Random Variables, Cumulative Distribution Function(CDF), Probability Density Function(PDF),Statistical Averages (Means),Chebyshev's Inequality, Central Limit Theorem.

Unit V: Spread Spectrum Modulation: Pseudo random noise sequences, notion of spread spectrum, direct sequence, frequency hopping, processing gain. Convolution codes and Golay codes.

Text Books:

[1] B. Sklar, Digital Communication, Pearson Education.
[2] Tomasi: Advanced Electronics Communication Systems, 6th Edition, PHI

References:

[1] Taub & Schilling, Principles of Communication system, TMH.
[2] Lathi B.P., Modern Analog and Digital Communication systems, Oxford Uni. Press.
[3] Haykin Simon, Digital Communication, Wiley Publication.
[4] Proakis, Digital communication, McGraw Hill
[5] Schaum's Outline series, Analog and Digital Communication.
[6] Singh and Sapre: Communication System, TMH
[7] Couch: Digital and Analog Communication, Pearson Education
[8] David Smith: Digital Transmission Systems, Springer- Macmillan India Ltd

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WIRELESS NETWORKS			
Course Code:	**EC533**	**Credits:**	**4**
No. of Lectures (Hrs/Week):	**3+1T**	**Mid Sem Exam Hours:**	**2**
Total No. of Lectures:	**45**	**End Sem Exam Hours:**	**3**

Unit I: Cellular fundaments, SIR calculation, capacity enhancement techniques, channel allocation schemes, handover, path loss modeling, multipath, channel measurements, simulation of radio channels cellular wireless networks-2G TDMA, 2G-CDMA, 3G systems, cordless systems, , IMT 2000, UMTS, CDMA2000, All-IP based cellular networks, WLL, Mobile data networks-CDPD, GPRS

Unit II: Multiple access techniques-TDMA, FDMA, spread spectrum technology-DS-SS, FH-SS, code division multiple access, generation of spreading sequences, SDMA, packet radio- protocols, CSMA protocols, reservation protocols

Unit III: Wireless LAN: evolution of WLAN, IEEE802.11 Physical layer, MAC layer, IEEE 802.11(a,b,e,f,g,h,i) Wireless routing protocols, Mobile IP, IPv4, IPv6, wireless TCP, TCP performance over wireless links, protocols for 3G and 4G networks, Integration of voice and data, VoIP applications

Unit III: WPAN and Geo-location systems: IEEE 802.15 WPAN, wireless geo-location technologies, geo-location standards channel coding, delay, cross layer techniques, .mobility management, radio resources and power management, mobility models, Satellite communication-parameters and configurations, capacity allocation,

Unit-IV: Bluetooth-overview, radio specifications, baseband specifications, link manager specifications, logical ink control and adaptation protocol, iEEE802.15, Design of wireless modem, power efficiency, out of band radiation, UWB pulse transmission

Unit V: Issues in wireless networks-security and privacy issues, authentication in mobile networks, power management, energy awareness computing

Text Books:

[1] William Stallings, " Wireless communications and Networks," "PHI
[2] Kaveh Pahlavan, Prashant Krishnamurthy, " Principles of Wireless Networks" Perason eduction 2002
[3] Theodore S. Rappaport, " Wireless Communication, Principles and Practice, PHI

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ADVANCED DIGITAL SIGNAL PROCESSING			
Course Code:	**EC539**	**Credits:**	**4**
No. of Lectures (Hrs/Week):	**3+1T**	**Mid Sem Exam Hours:**	**2**
Total No. of Lectures:	**45**	**End Sem Exam Hours:**	**3**

Unit I: Digital Filter Design

Amplitude and phase responses of FIR filters - Linear phase filters - Windowing techniques for design of Linear phase FIR filters - Rectangular, Hamming, Kaiser windows - frequency sampling techniques - IIR Filters - Magnitude response - Phase response - group delay - Design of Low Pass Butterworth filters (low pass) - Bilinear transformation - prewarping, impulse invariant transformation.

Unit II: Discrete Random Signal Processing

Discrete Random Processes- Ensemble averages, stationary processes, Autocorrelation and Auto covariance matrices. Parseval's Theorem, Wiener-Khintchine Relation- Power Spectral Density- Periodogram Spectral Factorization, Filtering random processes, Low Pass Filtering of White Noise, Parameter estimation: Bias and consistency.

Unit III: Spectrum Estimation

Estimation of spectra from finite duration signals, Non-Parametric Methods-Correlation Method, Periodogram Estimator, Performance Analysis of Estimators -Unbiased, Consistent Estimators- Modified periodogram, Bartlett and Welch methods, Blackman –Tukey method. Parametric Methods - AR, MA, ARMA model based spectral estimation, Parameter Estimation -Yule-Walker equations, solutions using Durbin's algorithm

Unit IV: Adaptive Filters

FIR adaptive filters -adaptive filter based on steepest descent method-Widrow-Hoff LMS adaptive algorithm, Normalized LMS. Adaptive channel equalization-Adaptive echo cancellation-Adaptive noise cancellation- Adaptive recursive filters (IIR), RLS adaptive filters-Exponentially weighted RLS-sliding window RLS.

Unit V: Multirate Digital Signal Processing

Mathematical description of change of sampling rate - Interpolation and Decimation, Decimation by an integer factor - Interpolation by an integer factor, Sampling rate conversion by a rational factor, Filter implementation for sampling rate conversion- direct form FIR structures, Polyphase filter structures, time-variant structures, Multistage implementation of multirate system. Application to sub band coding - Wavelet transform and filter bank implementation of wavelet expansion of signals.

Text Books:

[1] Monson H.Hayes, Statistical Digital Signal Processing and Modeling, John Wiley and Sons, Inc.,Singapore, 2002.
[2] John G.Proakis, Dimitris G.Manolakis, Digital Signal Processing Pearson Education, 2002.
[3] Rafael C. Gonzalez, Richard E.Woods, Digital Image Processing, Pearson Education, Inc., 2nd Edition, 2004.

References:

[1] John G.Proakis et.al., Algorithms for Statistical Signal Processing, Pearson Education, 2002.
[2] Dimitris G.Manolakis et.al., Statistical and adaptive signal Processing, McGraw Hill, Newyork,2000.

M.Tech. (ICT) for Engineering Graduate (2-Years)

ADVANCED COMPUTER NETWORKS			
Course Code:	**EC541**	**Credits:**	**3**
No. of Lectures (Hrs/Week):	**3**	**Mid Sem Exam Hours:**	**2**
Total No. of Lectures:	**45**	**End Sem Exam Hours:**	**3**

Unit I: Principles Of Computer Communications
Introduction to data communications and networks, protocol architecture, networking protocols, reference models, TCP/IP and OSI model, standards organizations, data transmission signal propagation, bandwidth of a signal and a medium; data transmission rate and bandwidth, modes of data transmission, guided media and wireless transmission, multiplexing; types of multiplexing; FDM vs. TDM, switching.

Unit II: Data Link and Network Layer Issues
Design issues in data link and network layers, framing, error control, flow control, sliding window protocols, Medium Access Control Sub layer (MACS), Multiple access Ethernet, Wireless LAN, factors affecting routing algorithms, routing algorithm.

Unit III: Advanced Internetworking and Mobility
Internetworking, addressing, routing and routing algorithms, congestion control algorithms, IPv4, ICMP, ARP, IPv6 and ICMPv6 extensions and functionality, mobile IP, service integration and quality of service (QoS) in IP networks.

Unit IV: Advanced Transport Issues and Signaling
Transport services, element of transport protocols, TCP and UDP, RTP, performance issues, congestion control and QoS, techniques to improve QoS, integrated services, signaling for multi-constrained services and applications.

Unit V: Self Organizing Networks
Introduction to Adhoc, sensor and mesh networks, routing in these networks, socket programming, SMTP, HTTP, Remote login, DNS, FTP.

Text Books:
[1] S. Tanenbaum, Computer Networks, 4th edition, Prentice Hall, 2008.
[2] W. Stallings," Data and Computer Communications, 8th edition, Prentice Hall, 2007.
[3] Forouzan,",Data Communications and Networking," 4th edition, McGraw Hill, 2007.

Reference:
[1] B.A. Forouzan," TCP/IP Protocol Suite", TMH, 3rd edition, 2006.
[2] Jochen H. Schiller, "Mobile Communications," Pearson Education, 2003.
[3] H. Soliman, :Mobile IPv6 - Mobility in a Wireless Internet, Addison-Wesley, 2004.
[4] Douglus E. Comer, "TCP/IP Principles, Protocols and Architecture", Pearson Education.

M.Tech. (ICT) for Engineering Graduate (2-Years)

EMBEDDED SYSTEM DESIGN			
Course Code:	**EC565**	**Credits:**	**3**
No. of Lectures (Hrs/Week):	**3**	**Mid Sem Exam Hours:**	**2**
Total No. of Lectures:	**45**	**End Sem Exam Hours:**	**3**

Unit I: Introduction to an embedded systems design

Introduction to Embedded system, Embedded System Project Management, ESD and Co-design issues in System development Process, Design cycle in the development phase for an embedded system, Use of target system or its emulator and In-circuit emulator, Use of software tools for development of an ES.

Unit II: RTOS & its overview

Real Time Operating System: Task and Task States, tasks and data, semaphores and shared Data Operating system Services-Message queues-Timer Function-Events-Memory Management, Interrupt Routines in an RTOS environment, basic design Using RTOS.

Unit III: Microcontroller

Role of processor selection in Embedded System (Microprocessor V/s Micro-controller), 8051 Microcontroller: Architecture, basic assembly language programming concepts, Instruction set, Addressing Modes, Logical Operation, Arithmetic Operations, Subroutine, Interrupt handling, Timing subroutines, Serial data transmission, Serial data communication

Unit IV: Embedded system development

Embedded system evolution trends. Round - Robin, robin with Interrupts, function-One-Scheduling Architecture, Algorithms. Introduction to-assembler-compiler-cross compilers and Integrated Development Environment (IDE). Object Oriented Interfacing, Recursion, Debugging strategies, Simulators.

Unit V: Networks for Embedded Systems

The I^2C Bus, The CAN bus, SHARC link Ports, Ethernet, Myrinet, Internet, Introduction to Bluetooth: Specification, Core Protocol, Cable replacement protocol. IEEE 1149.1 (JTAG) Testability: Boundary Scan Architecture

Text Books:

[1] Raj Kamal, Embedded Systems,TMH.
[2] K.J. Ayala, "The 8051 Microcontroller", Penram International.
[3] J. B. Peatman, "Design with PIC Microcontrollers", Prentice Hall

References

[1] David E. Simon, "An Embedded Software Primer," Pearson Education
[2] John Catsoulis ,"Designing Embedded Hardware," O'reilly
[3] Frank Vahid, Tony Givargis ,"Embedded System Design," John Wiley & Sons, Inc
[4] Karim Yaghmour, "Building Embedded Linux Systems", O'reilly
[5] Michael Barr ,"Programming Embedded Systems," O'reilly

M.Tech. (ICT) for Engineering Graduate (2-Years)

DIGITAL IC DESIGN			
Course Code:	**EC535**	**Credits:**	**3**
No. of Lectures (Hrs/Week):	**3**	**Mid Sem Exam Hours:**	**2**
Total No. of Lectures:	**45**	**End Sem Exam Hours:**	**3**

Unit I: Introduction
Digital number systems and information representation; arithmetic operations, decimal and alphanumeric codes, Binary logic, Boolean algebra (identities, functions and manipulation), standard forms, simplification, Logic gates, switch-level and logic CMOS implementation, integrated circuits.

Unit II: Combinational Logic Design
Components of Combinational Design, Multiplexer and Decoder, Multiplexer Based Design of Combinational Circuits, Implementation of Full Adder using Multiplexer and Decoder, Types of PLD, Combinational Logic Examples, PROM - Fixed AND Array and Programmable OR Array Implementation of Functions using PROM, PLA, PAL, Comparison of PROM, PLA and PAL Implementation of a Function using PAL, Types of PAL Outputs, Device Examples

Unit III: Sequential Logic Design
Introduction to Sequential Circuits, R-S Latch and Clocked R-S Latch, D Flip Flop, J-K Flip Flop, Master Slave Operation, Edge Triggered Operation, Clocking of Flip-flops, Setup and Hold Times, Moore Circuit, Mealy Circuit Clocking Rules, Sequential Circuits – Design Rules, Sequential Circuit Design Basics, Design of a 4-bit Full Adder using D Flip-flop, Pattern Identifier, State Graph , Transition Table, Implementation of Pattern Identifier, MUX Based Realization, ROM Based Realization, PAL Implementation

Unit IV: Synchronous Design Using Programmable Devices
PLD families, ROMs, Logic array (PLA), Programmable array logic, GAL, bipolar PLA, NMOS PLA, PAL 14L4, Xilinx logic cell array, I/O Block, Programmable interconnect, Xilinx – 3000 series and 4000 series FPGAs, Altera CPLDs, Altera FLEX 10K series PLDs, Designing a synchronous sequential circuit using PLA/PAL, Realization of finite state machine using PLD

Unit V: System Design using HDL
HDL operators , Arrays, concurrent and sequential statements , packages, Data flow, Behavioral – structural modeling, compilation and simulation of HDL code, Test bench, Realization of combinational and sequential circuits using HDL, Registers, counters, sequential machine, serial adder , Multiplier-Divider , System Design examples.

Text Books:
[1] Charles H.Roth Jr “Fundamentals of Logic Design” Thomson Learning 2004
[2] J.Bhaskar, A Verilog Primer, BSP, 2003.
[3] J.Bhaskar, A Verilog HDL Synthesis BSP, 2003

References:
[1] Nripendra N Biswas “Logic Design Theory” Prentice Hall of India,2001
[2] Parag K.Lala “Digital system Design using PLD” B S Publications,2003
[3] Charles H Roth Jr.”Digital System Design using VHDL” Thomson learning, 2004
[4] Douglas L.Perry “VHDL programming by Example” Tata McGraw Hill – 2006

M.Tech. (ICT) for Engineering Graduate (2-Years)

ADVANCED COMMUNCIATION NETWORKS			
Course Code:	**EC402/EC532**	**Credits:**	**3**
No. of Lectures (Hrs/Week):	**3**	**Mid Sem Exam Hours:**	**2**
Total No. of Lectures:	**45**	**End Sem Exam Hours:**	**3**

Unit I: Digital switching systems-analysis, hierarchy, evolution, SPC, call processing, communication and control- level 1,2,& 3 control, interface control, network control processor, central processor, control architecture, multiplexed highways, switching fabric-space division switching, time division switching, STS, TST, TTT, switching system software-architecture, OS, database management

Unit II: MPLS-label stack and label distribution, traffic engineering, design of switching systems, and routers, switching networks-crossbar switches, multistage switches, shared memory switches, optical networks, DWDM techniques, IP over optical core switches

Unit III: Congestion control: integrated services, differentiated services, congestion control, congestion control in packet switching, frame relay congestion control, flow control at link level, TCP congestion control

Unit IV: Voice over IP: basic IP telephone system, digital voice sampling, compression techniques, protocol for VoIP, session initiation protocol

Unit V: Internetworking-connection mode network service, x.75 internetworking, network through ISDN, internetworking SNA, and x.25, x.300 internetworking standards, personal computer networking, data transmission in PTN, Data network standards, voice-data integration, fast packet switches

Text books:

[1] Syed R. Ali, " Digital Switching Systems, System Reliability and analysis, Tata McGraw-Hill
[2] William Stallings, " High Speed Networks and Internet" 2nd ed. Perason edu, 2005
[3] Bellamy John, " Digital Telephony" Wiley 3rd Ed, 2000
[4] Viswanathan, T, "Telecommunications Switching Systems and Networks, " PH

References:

[1] Andrew S. Tanenbaum: Computer networks, PHI.
[2] W. Stallings: Data and computer communications, MC, Milan.
[3] Alberto Leon-Gercia, India Widjaja: Communication networks, fundamental concepts and key architecture, TATA McGraw Hill.
[4] Bertsekas D. and Gallager R.: Data Networks, PHI.
[5] Keshav S: An Engineering Approach to computer Networking, Addison Weslay.

M.Tech. (ICT) for Engineering Graduate (2-Years)

WIRELESS SYSTEM DESIGN			
Course Code:	**EC404/EC534**	**Credits:**	**3**
No. of Lectures (Hrs/Week):	**3**	**Mid Sem Exam Hours:**	**2**
Total No. of Lectures:	**45**	**End Sem Exam Hours:**	**3**

Unit-I: Overview of wireless systems, digital modulation techniques, basics of equalization, diversity, and channel coding, Fundamentals of system design-linear system, memoryless nonlinear systems, multiple input effects in nonlinear systems, frequency response of LTI systems, pulse shaping techniques, error probability of detection, SNR, CNR, RAKE receiver

Unit-II: Superheterodyne architecture-configuration and frequency planning, Low IF architecture, bandpass sampling radio architecture, quadratic signal generation, phase noise, Frequency synthesis-PLL, RF synthesizer, frequency dividers, direct signal synthesis, Transmitter design, architecture, performance tests

Unit-III: Power amplifiers, low noise amplifiers-input matching, stability, performance tradeoffs, high efficiency power amplifiers, linearization techniques, RF mixers: design of mixers, performance, noise in mixers, Receiver design- basics, requirements of key devices and performance evaluation, architecture, dynamic range, AGC for mobile stations

Unit-IV: Antenna- small antenna design, dipoles, monopoles, patch antennas, path loss, fading, applications of system design-multimode and multiband super heterodyne transceiver-selection of a frequency plan, receiver system design, transmitter system design, direct conversion transceiver

Unit-V: RF design, network design and system design considerations, packaging, power, heat dissipation, parameter tradeoffs, minimization of power dissipation, reconfigurable wireless systems-CR and SDR

Text Books:

[1] Pozar, "Microwave and RF Design of Wireless Systems," J. Wiley
[2] Qizheng Gu, " RF System Design of Transceivers for wireless communications" Springer
[3] Clint Smith, P.E. Daniel Collins, "3G Wireless Networks" Tata McGraw-Hill, 2nd Edition

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QOS IN NETWORKS			
Course Code:	**EC406/EC542**	**Credits:**	**3**
No. of Lectures (Hrs/Week):	**3**	**Mid Sem Exam Hours:**	**2**
Total No. of Lectures:	**45**	**End Sem Exam Hours:**	**3**

Unit I: IP Quality Of Service
Level of QoS, IP QoS history, performance measures, QoS functions, layer 2 QoS technologies, multiprotocol label switching, end-to-end QoS.

Unit II: QOS Architectures
Intserv architecture; RSVP, reservation style, service types, RSVP media support, RSVP scalability, along with their case studies. Diffserv architecture; network boundary traffic conditioners, PHB, resource allocation policy, packet classification.

Unit III: Network Boundary Traffic Conditioners and Resource Allocation
Packet classification, packet marking, need of traffic rate management, traffic policing, traffic shaping along with their case studies. Scheduling of QoS support, sequence number computation based WFQ, flow based WFQ, flow based distributed DWFQ, class based WFQ, priority queuing, schedule mechanisms for voice traffic, MWRR, MDRR along with their case studies.

Unit IV: Congestion Avoidance
TCP slow start and congestion avoidance, TCP traffic behavior in a trial drop scenario, REDproactive queue management for congestion avoidance, WRED, flow WRED, ECN, SPD along with their case studies.

Unit V: QOS in MPLS-Based Networks
MPLS, MPLS with ATM, MPLS QoS, MPLS VPN, MPLS VPN QoS along with their case studies. traffic engineering; MPLS traffic engineering, the layer 2 overlay model, RRR, TE trunk definition, TE tunnel attributes, link resource attributes, distribution of link resource information, path selection policy, TE tunnel setup, link admission control, TE path maintenance, TE RSVP, IGP routing protocols, TE approaches along with their case studies.

Text Books:
[1] Srinivas Vegesna, “IP Quality of Service,” CISCO PRESS, 2001.
[2] Santiago alvarez, “Qos for IP/MPLS Networks,” Cisco Press, Pearson Education, 2006.

References:
1. IETF website: www.ietf.org

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VLSI FOR WIRELESS NETWORKS			
Course Code:	**EC408/EC566**	**Credits:**	**3**
No. of Lectures (Hrs/Week):	**3**	**Mid Sem Exam Hours:**	**2**
Total No. of Lectures:	**45**	**End Sem Exam Hours:**	**3**

Unit I: Introduction
Standards, Communication Systems, Overview of Modulation Scheme, QPSK, BPSK, MSK, Classical Channel, Wireless Channel Description, Path Environment, Path Loss, Friss Equation, Time Varying Channel Models, Envelope Fading, Frequency Selective Fading, Fast Fading.

Unit II: Receiver Architectures
Introduction, Receiver Front: Motivations, Heterodyne and other Architecture, Filter Design: Band Selection Filter, Image Rejection Filter, Channel Filter, Nonidealities and Design Parameters: Nonlinearity, Noise, Derivation of NF, IIP_3 of receiver Front end.

Unit III: Low Noise Amplifier (LNA)
Introduction, Matching Networks, Wideband LNA Design, DC bias, Gain and Frequency Response, Noise Figure, Narrowband LNA, Impedance Matching, Interpretation of Power Matching, Quality Factor, Core Amplifier, Noise Figure, Power Dissipation, Noise Contribution from other sources.

Unit IV: Active Mixers
Unbalanced Mixers, Single Balanced Mixers, Qualitative Description of Gilbert Mixer, Conversion Gain, Distortion analysis of Gilbert Mixer, Comparison of Sample and Hold Circuit and Sampling Mixer.

Unit V: Passive Mixers
Switching Mixers, Distortion in Unbalanced Switching Mixer, Conversion Gain in Unbalanced Switching Mixer, Noise in Unbalanced Switching Mixer, Sampling Mixer, Conversion Gain in Single Ended Sampling Mixer, Distortion in single ended sampling mixer, Intrinsic and Extrinsic noise.

Text Books:
[1] Bosco Leung, "VLSI for Wireless Communication", PHI.

References:
[1] Emad N Farag, M.I Elmasry, "Mixed Signal VLSI Wireless Design Circuits and Systems", Kluwer Publication.
[2] David Tsee, Pramod Viswanath," Fundamentals of Wireless Communication", Cambridge Univ Press.

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VLSI TEHCNOLOGY			
Course Code:	**EC410/EC536**	**Credits:**	**3**
No. of Lectures (Hrs/Week):	**3**	**Mid Sem Exam Hours:**	**2**
Total No. of Lectures:	**45**	**End Sem Exam Hours:**	**3**

Unit I: Crystal Growth, Wafer Preparation, Epitaxy and Oxidation
Electronic Grade Silicon, Czochralski crystal growing, Silicon Shaping, processing consideration, Vapor phase Epitaxy, Molecular Beam Epitaxy, Silicon on Insulators, Epitaxial Evaluation, Growth Mechanism and kinetics, Thin Oxides, Oxidation Techniques and Systems, Oxide properties, Redistribution of Dopants at interface, Oxidation of Poly Silicon, Oxidation induced Defects.

Unit II: Lithography and Relative Plasma Etching
Optical Lithography, Electron Lithography, X-Ray Lithography, Ion Lithography, Plasma properties, Feature Size control and Anisotropic Etch mechanism, relative Plasma Etching techniques and Equipments

Unit III: Deposition, Diffusion, Ion Implantation and Metallization
Deposition process, Polysilicon, plasma assisted Deposition, Models of Diffusion in Solids, Flick's one dimensional Diffusion Equation – Atomic Diffusion Mechanism –Measurement techniques - Range theory- Implant equipment. Annealing Shallow junction – High energy implantation – Physical vapour deposition – Patterning.

Unit IV: Process Simulation and VLSI Process Integration
Ion implantation – Diffusion and oxidation – Epitaxy – Lithography – Etching and Deposition- NMOS IC Technology – CMOS IC Technology – MOS Memory IC technology - Bipolar IC Technology – IC Fabrication.

Unit V: Assembly Techniques and packaging of VLSI Devices
Analytical Beams – Beams Specimen interactions - Chemical methods – Package types – banking design consideration – VLSI assembly technology – Package fabrication technology.

Text Books:
[1] S.M.Sze, "VLSI Technology", Mc.Graw.Hill Second Edition. 2002.
[2] Douglas A. Pucknell and Kamran Eshraghian, "Basic VLSI Design", Prentice Hall India, 2003.

References:
[1] Amar Mukherjee, "Introduction to NMOS and CMOS VLSI System design, Prentice Hall India, 2000.
[2] Wayne Wolf ,"Modern VLSI Design", Prentice Hall India.1998.

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ADVANCED RF ENGINEERING			
Course Code:	**EC412/EC544**	**Credits:**	**3**
No. of Lectures (Hrs/Week):	**3**	**Mid Sem Exam Hours:**	**2**
Total No. of Lectures:	**45**	**End Sem Exam Hours:**	**3**

Unit I: INTRODUCTION TO RF ELECTRONICS

Introduction to RF Design and Wireless Technology: Design and Applications,

Unit II: COMPLEXITY AND CHOICE OF TECHNOLOGY

Basic concepts in RF design: Nonlinearly and Time Variance, Inter symbol interference, random processes and noise. Sensitivity and dynamic range, conversion of gains and distortion

Unit III: RF MODULATION

Analog and digital modulation of RF circuits, Comparison of various techniques for power efficiency, Coherent and non-coherent detection, Mobile RF communication and basics of Multiple Access techniques. Receiver and Transmitter architectures, direct conversion and two-step transmitters. RF Testing: RF testing for heterodyne, Homodyne, Image reject, Direct IF and sub sampled receivers.

Unit IV: BJT AND MOSFET BEHAVIOR AT RF FREQUENCIES

BJT and MOSFET behavior at RF frequencies, modeling of the transistors and SPICE model, Noise performance and limitations of devices, integrated parasitic elements at high frequencies and their monolithic implementation Overview of RF Filter design, Active RF components & modeling,

Unit V: RF CIRCUITS DESIGN

Matching and Biasing Networks. Basic blocks in RF systems and their VLSI implementation, Low noise Amplifier design in various technologies, Design of Mixers at GHz frequency range, Various mixers- working and implementation. Oscillators- Basic topologies VCO and definition of phase noise, Noise power and trade off. Resonator VCO designs, Quadrature and single sideband generators. Radio frequency Synthesizers- PLLS, Various RF synthesizer architectures and frequency dividers, Power Amplifier design, Liberalization techniques, Design issues in integrated RF filters.

Text Books :

[1] B. Razavi, “RF Microelectronics” PHI 1998
[2] R. Jacob Baker, H.W. Li, D.E. Boyce “CMOS Circuit Design, layout and Simulation”, PHI 1998.

References:

[1] Thomas H. Lee “Design of CMOS RF Integrated Circuits” Cambridge University press 1998.
[2] Y.P. Tsividis, “Mixed Analog and Digital Devices and Technology”, TMH 1996
[3] David M. POZAR: Microwave Engineering. - John Wiley & Sons - 2nd Edition (2003).

M.Tech. (ICT) for Engineering Graduate (2-Years)

PROBABILITY AND STOCHASTIC PRICESSES			
Course Code:	**EC424/EC548**	**Credits:**	**3**
No. of Lectures (Hrs/Week):	**3**	**Mid Sem Exam Hours:**	**2**
Total No. of Lectures:	**45**	**End Sem Exam Hours:**	**3**

Unit I:
Probability models, Algebra of events, probability axioms, conditional probability, Baye's rules, Bernoulli traits. **Discrete Random Variables**: Discrete random variables, probability mass functions, discrete distribution functions-Bernoulli, Binomial, geometric, Poisson, hyper geometric & uniform distributions, probability generating function.

Unit II:
Continuous Random variable: Exponential distribution, memory less property, application to reliability, hypo exponential, Erlang, Gamma, hyper exponential & Normal distributions ,order statistics, distribution of sums.

Unit III:
Stochastic Process, Classification, Discrete and continuous time markov chain, Poisson process, renewal process, littles's formula, Erlang Loss Model, M/M/1 Queue, M/M/m Queue Multidimensional Queue.

Unit IV:
Solution Techniques: Steady-State Solutions of Markov Chains, Solution for a Birth Death Process, Matrix-Geometric Method: Quasi-Birth-Death Process, Heisenberg Matrix: Non-Markovian Queues, Transient analysis, stochastic Petri nets, Numerical Solution: Direct Methods, Numerical Solution: Iterative Methods, Comparison of Numerical Solution Methods, Performance Measures,

Unit V:
Queueing Networks. Definitions and Notation. Performance Measures. Product-Form Queueing Networks. Algorithms for Product-Form Networks, priority Networks.

Reference Books:

[1] Research Methodologies, R. Panneerselvam, Prentice Hall, 2007.
[2] Research in Education, Best John V. and James V Kahn, Wiley eastern, 2005.
[3] Elements of Educational Research, Sukhia, S.P., P.V. Mehrotra, and R.N. Mehrotra, PHI publication, 2003.
[4] Methodology of Research Education, K. Setia, IEEE publication, 2004.
[5] Research methodology, Methods and Techniques, Kothari, C.R., 2000.

M.Tech. (ICT) for Engineering Graduate (2-Years)

ADVANCED MICROWAVE COMMUNICATION			
Course Code:	**EC426/EC550**	**Credits:**	**3**
No. of Lectures (Hrs/Week):	**3**	**Mid Sem Exam Hours:**	**2**
Total No. of Lectures:	**45**	**End Sem Exam Hours:**	**3**

Unit I: Microwave And Millimeter Wave Devices
Overview of microwave and millimeter wave vacuum tube devices, limitations of microwave vacuum tubes, gyratron vacuum tube devices. Advances in microwave and millimeter wave solid state devices, Gunn devices, oscillator using, Gunn diode, and injection locked oscillators, IMPATT devices, and microwave and mm wave performance of IMPATT. Other solid state devices like Tunnel diode, BARITT and TRAPAT. Microwave and mm wave circuits:

Unit II: Microwave and MM Wave Circuits
Review of scattering matrix concept in the light of vector network analyzer, impedance matching network, couplers, power dividers, resonators and filters. Detectors, mixers, attenuators, phase shifters, amplifier and oscillator, Ferrite based circuits.

Unit III: Antennas
Hertzian dipole, loop antenna, helical antenna, frequency independent antenna: Du0Hamel principle, log spiral and log periodic dipole antenna array. Babinet principle, waveguide slot antenna, microstrip antenna, horn antenna, parabolic reflector. Antenna arrays and phased array antenna.

Unit IV: Satellite Communication
Orbital parameters, satellite trajectory, period, geostationary satellites, non-geostationary constellations. Communication satellites – Space craft subsystems, payload – repeater, antenna, attitude and control systems, telemetry, tracking and command, power sub system and thermal control. Earth stations antenna and feed systems, satellite tracking system, amplifiers, fixed and mobile satellite service earth stations. Terrestrial: line of sight transmission, relay towers and distance considerations. Communication link design: Frequency bands used, antenna parameters, transmission equations, noise considerations, link design, propagation characteristics of fixed and mobile satellite links, channel modeling, very small aperture terminals (VSAT), VSAT design issues.

Unit V: Microwave and MM Wave Propagation.
Overview of basic radio wave propagation mechanisms, Friis transmission formula, plane earth propagation model, troposcatter systems, ionosphere propagation, duct propagation, microwave radio link and calculation of link budget. Effect on radio wave propagation due to rain, fog, snow, ice, atmospheric gases, Earth's magnetic field.

Text Books:
[1] David M Pozar, Microwave Engineering, John Wiley & Sons
[2] R E Collin, Antenna & Radio wave Propagation, McGraw Hill Book Co.

References:
[1] M Richharia: 'Satellite Communication Systems'.(Second Ed.),Macmillan Press Ltd.
[2] Ferdo Ivanek (Editor): 'Terrestrial Digital Microwave Communications', Artech House
[3] E. Hund: 'Microwave Communications', IEEE Press
[4] Jordan & Balman, Electromagnetic waves & Radiating System
[5] R E Collin, Microwave Engineering, McGraw Hill CO.

M.Tech. (ICT) for Engineering Graduate (2-Years)

NETWORKING PROTOCOLS			
Course Code:	**EC414/EC552**	**Credits:**	**3**
No. of Lectures (Hrs/Week):	**3**	**Mid Sem Exam Hours:**	**2**
Total No. of Lectures:	**45**	**End Sem Exam Hours:**	**3**

Unit I: Protocols of Physical Layer
Overview of physical layer operations of wired and wireless networks, Protocol Architecture: IEEE 802.3 Local Area Network Protocols, VLAN- Virtual Local Area Network, WLAN-Wireless LAN by IEEE 802.11 Protocols, FDDI-Fiber Distributed Data Interface, Token Ring- IEEE 802.5 LAN Protocol, DQDB-Distributed Queue Dual Bus(IEEE 802.6), SMDS- Switched Multimegabit Data Service, WiMAX- Broadband Wireless MAN (IEEE802.16).

Unit II:Protocols of Data Link Layer
Overview of data link layer operations of wired and wireless networks, medium access control protocols including CSMA, collision free protocols, WDMA protocols, wireless LAN protocols, ARP, RARP, X.25.

Unit III: Protocols of Network Layer
Overview of network layer operations of wired and wireless networks, IP-Internet Protocol (IPv4), IPv6-Internet Protocol version 6, ICMP & ICMPv6-Internet Message Control Protocol and ICMP version 6,BGP (BGP-4)-Border Gateway Protocol, EGP- Exterior Gateway Protocol, IRDP- ICMP Router Discovery Protocol, Mobile IP-IP Mobility Support Protocol for IPv4 & IPv6, NHRP- Next Hop Resolution Protocol, OSPF- Open Shortest Path First Protocol, RIP- Routing Information Protocol (RIP2), RIPng- Routing Information Protocol next generation for IPv6,RSVP- Resource ReSerVation Protocol, VRRP- Virtual Router Redundancy Protocol, BGMP-Border Gateway Multicast Protocol, DVMRP-Distance Vector Multicast Routing Protocol, IGMP- Internet Group Management Protocol, MARS-Multicast Address Resolution Server, MBGP-Multiprotocol BGP, MOSPF- Multicast Extensions to OSPF MSDP-Multicast Source Discovery Protocol, PGM-Pragmatic General Multicast Protocol, PIM-DM-Protocol Independent Multicast-Dense Mode, PIM-SM-Protocol Independent Multicast - Sparse Mode, MPLS-Multiprotocol Label Switching, RSVP-TE-Resource Reservation Protocol.

Unit IV: Protocols of Transport Layer
Overview of transport layer operations, Protocols: TCP-Transmission Control Protocol, UDP -User Datagram Protocol, RUDP- Reliable User Datagram Protocol, SCTP- Stream Control Transmission Protocol, CUDP-Cyclic UDP, DCCP-Datagram Congestion Control Protocol, FCP-Fiber Channel Protocol, IL-IL Protocol, NBF- NetBIOS Frames protocol, µTP-Micro Transport Protocol, RSVP , ECN, H.323, H.261- Video CODEC for Low Quality Videoconferencing,H.263: Video CODEC for Medium Quality Videoconferencing, H.264 / MPEG-4: Video CODEC For High Quality Video Streaming wireless TCP and UDP.

Unit V: Protocols of Application Layer
Overview of application layer operations, Protocols: DNS, SMTP, HTTP, BGP, DHCP , FTP , LDAP, MGCP, NNTP , NTP, POP, RIP, RPC, RTP , SIP ,SNMP, SSH, Telnet , XMPP, security protocols.

References:
[1] Internetworking with TCP/IP Volume 1: Principles Protocols, and Architecture, Douglas Comer and Prentice Hall, fifth edition, 2006.
[2] TCP/IP Protocol Suite, B.A. Forouzan, TMH, 3rd edition, 2006.
[3] Computer Networks, S. Tanenbaum, 4th edition, Prentice Hall, 2003.
[4] Network Protocols: Signature Edition, Matthew G. Naugle. Mcgraw-Hill Signature Series.
[5] Network Protocols Handbook, Javlin, 4th edition, Javvin Technologies, Inc.

M.Tech. (ICT) for Engineering Graduate (2-Years)

MOBILE COMPUTING			
Course Code:	**EC416/EC554**	**Credits:**	**3**
No. of Lectures (Hrs/Week):	**3**	**Mid Sem Exam Hours:**	**2**
Total No. of Lectures:	**45**	**End Sem Exam Hours:**	**3**

Unit I: Mobile Computing Architecture
Introduction to Mobile Communications and Computing : novel applications, limitations, and architecture. GSM: Mobile services, System architecture, Radio interface, Protocols, Localization and calling, Handover, Security, and New data services.

Unit II: Client Programming
Desktop vs. mobile, hardware overview, mobile phones, PDA, design constraints in applications for handheld devices.

Unit III: Programming For the Palm OS
History of palm OS, palm OS architecture, application development, communication in palm OS, multimedia, and enhancements in the current release. Wireless devices with symbian OS; Introduction to Symbian OS, Symbian OS architecture, application for Symbian, control and compounds controls, active objects, localization, security on the Symbian OS, different flavors of windows CE, windows CE architecture, windows CE development environment.

Unit IV: Wireless Application Protocol (WAP)
Overview of the WAP, component of the WAP standards, protocol architecture, and treatment of protocols of all layers, services supporting WAP client, WAP architecture design principle, Bluetooth,J2ME.

Unit V: Special Topics in Mobile Computing
Mobile agent & its application, mobile data management, security framework for mobile environment, m-commerce: emerging applications, different players in m-commerce, m-commerce life cycle, mobile financial services, mobile entertainment services, and proactive service management.

Text Books:
[1] Mobile Computing, Asoke. K Talukder and Roopa R. Yavagal, TMH, 2005
[2] Mobile Communication, Jachan Schiller, Adison-Wesley, 2nd edition, 2003.

References:

[1]Wireless Communication: T. S. Rappapost, Peasson Education, New Delhi, 2001
[2] Wireless Networks: Kareh Pallavan & P. Krishnamurthy, Peasson Education, New Delhi, 2nd edition, 2004.
[3] Mobile Commerce and Applications, Upkar Varshney, A tutorial at IEEE International Conference on Wireless Communications (WCNC), 1999.

M.Tech. (ICT) for Engineering Graduate (2-Years)

IMAGE PROCESSING AND BIOMETRICS			
Course Code:	**EC418/EC556**	**Credits:**	**3**
No. of Lectures (Hrs/Week):	**3**	**Mid Sem Exam Hours:**	**2**
Total No. of Lectures:	**45**	**End Sem Exam Hours:**	**3**

Unit I: Image Processing and Image Enhancement
Introduction, An image model, sampling & quantization, Basic relationships between Pixels, imaging geometry, Properties of 2 – D Fourier transform, FFT algorithm and other separable image transforms, Components of an image processing System., Digital Image Fundamentals- elements of visual perception, image sensing and acquisition, Basic relationships between pixels
Fundamentals of spatial filtering, smoothing spatial filters (linear and non-linear).

Unit II: Pattern Recognition
Fundamentals of Pattern Recognition , Recognition Measurement, Errors, and Statistics, Recognition measurement and testing, Identification System Errors and Performance Testing, Computer Security, Bayesian decision theory, Multilayer neural networks, Unsupervised Learning and Clustering.

Unit III: Biometrics
Introduction to Biometrics, Fingerprints: Ridges, Furrows, Types of Fingerprints, Image and Signal Processing, Biometric Signal Processing, Other Biometric Modalities, Comparing Biometrics, Passwords, and Tokens, Multimodal Biometrics, Biometric Resources and Standards, Large Scale Biometrics and Systems Case Studies.

Unit IV: Analysis in Biometrics
Large-Scale Biometric Identification: Challenges and Solutions, Issues Involving the Human Biometric Sensor Interface, Fundamentals of Biometric-Based Training System Design, Biometric Systems and Applications, Force Field Feature Extraction for Fingerprint Biometrics, Behavioral Biometrics for Online Computer User Monitoring.

Unit V: Synthesis in Biometrics:
Introduction to Synthesis in Biometrics, Local B-Spline Multiresolution with Example in Iris Synthesis and Volumetric Rendering, image smoothing filters (Butterworth and Guassian low pass filters), image sharpening filters (Butterworth and Guassian high pass filters), selective filtering, Computational Geometry and Image Processing in Biometrics: On the Path to Convergence, **,** A Statistical Model for Biometric Verification.

Text Books:
[1] Practical Algorithms for Image Analysis: Description, Examples, and Code, Seul, O'Gorman, Sammon, 2000.
[2] S. Annadurai and R. Shanmugalakshmi: Fundamentals of Digital Image Processing, Pearson Education.
[3] R. C. Gonzalez and R. E. Woods: Digital Image Processing, 3rd Edition, Pearson Education.
[4] A. K. Jain: Fundamentals of Digital Image Processing, PHI Learning.

References:
[1] M. Sonka, V. Hlavac and R. Boyle: Digital Image Processing and Computer Vision: Cengage Learning.
[2] B. Chanda and D. D. Majumder: Digital Image Processing and Analysis, PHI Learning.
[3] S. Jayaraman, S. Esakkirajan and T. Veerakumar: Digital Image Processing, TMH.

M.Tech. (ICT) for Engineering Graduate (2-Years)

NETWORK PROGRAMMING			
Course Code:	**EC420/EC558**	**Credits:**	**3**
No. of Lectures (Hrs/Week):	**3**	**Mid Sem Exam Hours:**	**2**
Total No. of Lectures:	**45**	**End Sem Exam Hours:**	**3**

Unit I: Introduction to Network Programming
OSI model, LINUX/UNIX standards, TCP and UDP & TCP connection establishment and format, buffer sizes and limitation, standard internet services, protocol usage by common internet application.

Unit II: Sockets
Address structures, value result arguments, byte ordering and manipulation function and related functions, elementary TCP sockets, connect, bind, listen, accept, fork and exec function, concurrent servers, close function and related function.

Unit III: TCP Client Server
TCP echo server functions, normal startup, terminate and signal handling server process termination, crashing and rebooting of server host shutdown of server host.

Unit IV: I/O Multiplexing and Socket Options
I/O models, select function, batch input, shutdown function, poll function, TCP echo server, getsockopt and stockpot functions. socket states, generic socket option IPV6 socket option ICMPV6 socket option IPV6 socket option and TCP socket options.
Elementary UDP Sockets
UDP echo server function, lost datagram, summary of UDP example, lack of flow control with UDP, determining outgoing interface with UDP, elementary name and address conversions, DNS, get host by name function, resolver option, function and IPV6 support, unnamed function, other networking information.

Unit V: IPC and Remote Login
File and record locking, Pipes, FIFOs streams and messages, Name spaces, system IPC, Message queues, Semaphores, Seminal line disciplines, Pseudo-terminals, terminal modes, Control-Terminals, login, RPC Transparency Issues.

References:
[1] Keir Davis, John Turner, Nathan Yocom, "The Definitive Guide to Linux Network Programming, ,Apress, 2004.
[2] Warren Gay, Linux Socket by Example, Programming 2000.
[3] Graham Glass, King abls, "UNIX for Programmers and Users", 3rd edition, Pearson Education, 1998.
[4] M. J. Rochkind, "Advanced UNIX Programming", 2nd edition, Pearson Education, 2004.

M.Tech. (ICT) for Engineering Graduate (2-Years)

CMOS RF CIRCUIT DESIGN			
Course Code:	**EC428/EC576**	**Credits:**	**3**
No. of Lectures (Hrs/Week):	**3**	**Mid Sem Exam Hours:**	**2**
Total No. of Lectures:	**45**	**End Sem Exam Hours:**	**3**

Unit I: Introduction to RF design and Wireless Technology

Design and Applications, Complexity and Choice of Technology. Basic concepts in RF design: Nonlinearly and Time Variance, Intersymbol interference, random processes and noise. Sensitivity and dynamic range, conversion of gains and distortion.

Unit II: RF Modulation

Analog and digital modulation of RF circuits, Comparison of various techniques for power efficiency, Coherent and non-coherent detection, Mobile RF communication and basics of Multiple Access techniques. Receiver and Transmitter architectures. Direct conversion and two-step transmitters.

Unit III: RF Testing

RF testing for heterodyne, Homodyne, Image reject, Direct IF and sub sampled receivers.

Unit IV: BJT and MOSFET Behavior at RF Frequencies

BJT and MOSFET behavior at RF frequencies, Modeling of the transistors and SPICE model, Noise performance and limitations of devices, integrated parasitic elements at high frequencies and their monolithic implementation

Unit V: RF Circuits Design

Overview of RF Filter design, Active RF components & modeling, Matching and Biasing Networks. Basic blocks in RF systems and their VLSI implementation, Low noise Amplifier design in various technologies, Design of Mixers at GHz frequency range, Mixers- working and implementation. Oscillators- Basic topologies VCO and definition of phase noise, Noise power and trade off. Resonator VCO designs, Quadrature and single sideband generators. Radio frequency Synthesizers- PLLS, Various RF synthesizer architectures and frequency dividers, Power Amplifier design, Liberalization techniques, Design issues in integrated RF filters.

Text Book:

[1] Thomas H. Lee "Design of CMOS RF Integrated Circuits" Cambridge University press 1998.

References:

[1] B. Razavi "RF Microelectronics" PHI 1998

[2] R. Jacob Baker, H.W. Li, D.E. Boyce " CMOS Circiut Design, layout and Simulation" PHI 1998

[3] Y.P. Tsividis "Mixed Analog and Digital Devices and Technology" TMH 1996

M.Tech. (ICT) for Engineering Graduate (2-Years)

PRINCIPLES OF MEMS DESIGN			
Course Code:	**EC422/EC570**	**Credits:**	**3**
No. of Lectures (Hrs/Week):	**3**	**Mid Sem Exam Hours:**	**2**
Total No. of Lectures:	**45**	**End Sem Exam Hours:**	**3**

Unit I: Introduction to MEMS
MEMS and Microsystems, Miniaturization, Typical products, Micro sensors, Micro actuation, MEMS with micro actuators, Micro-accelerometers and Micro fluidics, MEMS materials, Micro fabrication

Unit II: Mechanics for MEMS Design
Elasticity, Stress, strain and material properties, Bending of thin plates, Spring configurations, torsional deflection, Mechanical vibration, Resonance, Thermo mechanics – actuators, force and response time, Fracture and thin film mechanics.

Unit III: Electrostatic Design
Electrostatics: basic theory, electro static instability. Surface tension, gap and finger pull up, Electro static actuators, Comb generators, gap closers, rotary motors, inch worms, Electromagnetic actuators. bistable actuators.

Unit IV: Circuit and System Issues
Electronic Interfaces, Feedback systems, Noise, Circuit and system issues, Capacitive Accelerometer, Piezoelectric pressure sensor, Modeling of MEMS systems, CAD for MEMS.

Unit V: Introduction to Optical and RF MEMS
Optical MEMS, - System design basics – Gaussian optics, matrix operations, resolution. Case studies, MEMS scanners and retinal scanning display, Digital Micro mirror devices. RF Memes – design basics, case study – Capacitive RF MEMS switch, performance issues.

Text Books:
[1] Stephen Santuria," Microsystems Design", Kluwer publishers, 2000.
[2] Nadim Maluf," An introduction to Micro electro mechanical system design", Artech House, 2000.

References:
[1] Mohamed Gad-el-Hak, editor," The MEMS Handbook", CRC press Baco Raton,2000.
[2] Tai Ran Hsu," MEMS & Micro systems Design and Manufacture" Tata McGraw Hill, New Delhi, 2002.

M.Tech. (ICT) for Engineering Graduate (2-Years)

SECURITY IN WIRELESS NETWORKS			
Course Code:	**EC501/EC631**	**Credits:**	**3**
No. of Lectures (Hrs/Week):	**3**	**Mid Sem Exam Hours:**	**2**
Total No. of Lectures:	**45**	**End Sem Exam Hours:**	**3**

Unit I: Security goals, attacks, services and mechanisms, cryptography and steganography

Unit II: Symmetric key ciphers-substitution ciphers, transposition ciphers, stream and block ciphers, algebraic structures and GF (2^n) fields in cryptography

Unit III: Modern block ciphers, modern stream ciphers, DES and AES, Elliptic curve cryptosystems

Unit IV: Message integrity, random oracle model, message authentication , Hash function, Integrity authentication , Digital signature- process, services, attacks, schemes, key management-symmetric key distribution, kerbros, symmetric key agreement, public key distribution

Unit V: Security in wireless LAN, IEEE802.11 security, eavesdropping, unauthorized access, interference and jamming, physical threats, counter majors, WEP, encryption, authentication, WPA, authorization, non repudiation, authentication and secure session, security architecture, VPN, wireless access to the Internet

Text book

[1] Behrouz A. Forouzan, " Cryptography & Network Security" Tata McGraw Hill

M.Tech. (ICT) for Engineering Graduate (2-Years)

NETWORK RELIABILITY			
Course Code:	**EC505/EC641**	**Credits:**	**3**
No. of Lectures (Hrs/Week):	**3**	**Mid Sem Exam Hours:**	**2**
Total No. of Lectures:	**45**	**End Sem Exam Hours:**	**3**

Unit I: Reliability Fundamentals

Causes of Failures, Useful Life of Components, Hazard Functions, Bathtub Curve, Characteristic Type of Failures: Early Failures, Constant Failure Rate, Wear-Out Failures, Failure Data Analysis, Mean Time to Failure (MTTF), Mean Residual Life (MRL), Reliability Measures

Unit II: Reliability Mathematics

Classical Set Theory, Boolean algebra, Sample Space, Probability Theory, Bayes Theorem, Probability Distributions, Cumulative Distributions, Variance, Moments, Estimation Theory, Laplace Transform, Markov Processes, Random Number Generation, Probability Plots

Unit III: System Reliability Analysis

Reliability Block Diagrams, Series Systems, Series Parallel Systems, Open and short Circuit Failures, Standby Systems, System Modeling, Assumptions for Modeling, Two State Modeling, Three State Models, Statistical Estimation of Failure Data, Interval Estimates, Hazard Models.

Unit IV: Reliability Modeling

Stress-Strength Model, System Modeling, Assumptions for Modeling, Two State Modeling, Three-state Modeling, Graphical Approach, Path Set/Cut Set Approach: Inclusion-Exclusion Method, Calculation of Bounds Method, Monte Carlo Simulation Method, Domination Theory, Sum of Disjoint Product Method, Non-path Set/cut Set approach: State Enumeration Method Transformation Method Topological Method BDD/OBDD/ROBDD Method, Reliability Measures: Connectivity Measures, Multicommdity Flow Measures, Maximum Flow (Capacity) Measures, Performability Measures.

Unit V: Maintability and Availablity Analysis

Availability Prediction, Effects of Repair Strategies, Fault Trees, Event Tree Analysis, FMEA, FMECA, Theoretical and Analytical Overview of Availability and Maintainability in Communication System Design: Prediction in Assessment, Preliminary in Design, Evaluation in Detail Design. Application Modeling of Availability and Maintainability in Engineering Design

Text Books:

[1] Misra K. B., Reliability Analysis and Prediction: A Methodology Oriented Treatment, Elsevier Publication
[2] Aggarwal K. K., Reliability Engineering, Kluwer Academic Publishers, Boston Publication

Reference Books:

[1] Kapur K. C. and L. R. Lamberson, Reliability in Engineering Design, John Wiley & Sons,
[2] Ramakumar R., Reliability Engineering: Fundamentals and Applications, Prentice Hall
[3] Martin L Shooman, Reliability of Computer Systems and Networks, Johan Wiley Sons

M.Tech. (ICT) for Engineering Graduate (2-Years)

SMART ANTENNA SYSTEMS			
Course Code:	**EC507/EC643**	**Credits:**	**3**
No. of Lectures (Hrs/Week):	**3**	**Mid Sem Exam Hours:**	**2**
Total No. of Lectures:	**45**	**End Sem Exam Hours:**	**3**

Unit I: Basic Concepts of Radiation

Radiation mechanism: Basic sources of Radiation- Current distribution on antennas, Basic antenna parameters.

Unit II: Analysis And Synthesis of Antennas

Vector potential, Antenna theorems and definitions, dipole, loop, reflector, slot antennas. Types of linear arrays, current distribution in linear arrays, Antenna array synthesis techniques.

Unit III: Smart Antennas

Spatial processing for wireless systems: Introduction, Vector channel impulse response & the spatial signature. Spatial processing receivers, fixed beam forming Networks, switched beam systems, Adaptive antenna systems, Wide band smart antennas, Digital radio receiver & software radio for smart antennas.

Unit IV: Smart Antenna Techniques for CDMA

Non-coherent & coherent CDMA spatial processors, spatial processing rake receiver, Multi-user spatial processing, dynamic resectoring, down link beam forming for CDMA, MIMO.

Unit V: Micro Strip Antenna

Radiation Mechanism and Excitation techniques : Microstrip dipole; Patch ,Rectangular patch, Circular patch, and Ring antenna – radiation analysis from cavity model; input impedance of rectangular and circular patch antenna; Microstrip array and feed network; Application of microstrip array antenna.

Text Books:

[1] Balanis A., "Antenna Theory Analysis and Design", John Wiley and Sons, New York, 1982.

[2] Joseph C. Liberti, Theodore S. Rappaport – "Smart Antennas for Wireless Communications: IS95 and third generation CDMA Applications", Prentice Hall, Communications Engineering and Emerging Technologies Series.

References:

[1] Kraus J.D., "Antennas", II edition, John Wiley and Sons, New York, 1977.

[2] Collin R.E. and Zucker F. – "Antenna theory" Part I, Tata Mc Graw Hill, New York, 1969.

[3] I.J. Bahl and P. Bhartia," Microstrip Antennas",Artech House,Inc.,1980

[4] W.L.Stutzman and G.A.Thiele,"Antenna Theory and Design", 2nd edition,John Wiley& Sons Inc.,1998.

M.Tech. (ICT) for Engineering Graduate (2-Years)

BRAODBAND WIRELESS NETWORKS			
Course Code:	**EC509/EC645**	**Credits:**	**3**
No. of Lectures (Hrs/Week):	**3**	**Mid Sem Exam Hours:**	**2**
Total No. of Lectures:	**45**	**End Sem Exam Hours:**	**3**

Unit I: Introduction to broadband wireless, fixed broadband wireless, mobile broadband wireless, 3G cellular systems, spectrum options for BW, BW channels, fading, modeling of broadband fading channels, mitigation of fading

Unit II:OFDM-basics, timing and frequency synchronization, PAR computational complexity, simulation of OFDM systems, , MAC layer, performance enhancement, architecture, performance characterization, Multiple antenna techniques-spatial diversity, receiver diversity, transmit diversity, beam foaming, spatial multiplexing, channel estimation for MIMO-OFDM, advanced techniques for MIMO,OFDMA in WiMAX

Unit III: WiMAX, Physical layer- channel coding, hybrid ARQ, interleaving, symbol mapping, symbol structure, sub channel and subcarrier permutations, slot and frame structure, ranging power control, channel quality measurements, MAC layer-convergence SL, MAC PDU, bandwidth request, and allocation, QoS, network entry, an initialization, power saving, mobility management

Unit IV: WiMAX network architecture- design principle, reference model, protocol layering, network discovery and selection, IP address assignment, authentication and security, QoS architecture, mobility management, radio resource management, link level performance-methodology, AWGN channel performance, fading channel performance, advanced receiver architecture, system level architecture-channel modeling, methodology, system level simulation,

Unit V: Ultrawideband, Unlicensed wireless access, IEEE 802.20 MBWA, FOMA, iMODE, WiBRO, FWA, AWS, Multimedia-MedaiFLO, T-DBM, DVB-H, MVNO

Text Books:

[1] Jeffrey G. Andrews, Arunabha Ghosh, Rias Muhamed, " Fundamentals of WiMAX, Understanding Broadband Wireless Networking", Pearson

[2] Clint Smith, P.E. Daniel Collins, " 3G Wireless Networks" Tata McGraw-Hill, 2nd Edition

M.Tech. (ICT) for Engineering Graduate (2-Years)

SENSOR NETWORKS			
Course Code:	**EC511/EC647**	**Credits:**	**3**
No. of Lectures (Hrs/Week):	**3**	**Mid Sem Exam Hours:**	**2**
Total No. of Lectures:	**45**	**End Sem Exam Hours:**	**3**

Unit I: Sensor Network Operations
Overview of mission-oriented sensor networks, trends in sensor development, mission oriented sensor networks, dynamic systems perspective, Dense sensor networks, robust sensor positioning in wireless ad hoc sensor networks, trigonometric k clustering (TKC) for censored distance estimation, sensing coverage and breach paths in surveillance wireless sensor networks.

Unit II: Lower Layer Issues-Mac, Scheduling, And Transmission
Medium access control for sensor networks, comprehensive performance study of IEEE 802.15.4, providing energy efficiency for wireless sensor networks, link adaptation techniques.

Unit III: Network Routing
Load balanced query protocols for wireless sensor networks, energy efficient and MAC aware routing for data aggregation in sensor networks, ESS low energy security solution for large-scale sensor networks based on tree ripple zone routing scheme.

Unit IV: Sensor Network Applications
Evader centric program, Pursuer centric program, hybrid pursuer evader program, efficient version of hybrid program, Implementation and simulation results

Unit V: Embedded Soft Sensing For Anomaly Detection
Mobile robot simulation setup, software anomalies in mobile robotic networks, soft sensor, software anomaly detection architecture, anomaly detection mechanisms, test bed for software anomaly detection in mobile robot application, multisensor network-based framework; Basic model of distributed multi sensor surveillance system, super resolution imaging, optical flow computation, super resolution image reconstruction, experimental results.

Text Books:
[1] Shashi Phoha, Thomas F. La Porta , Chrisher Griffin, "Sensor Network Operations", Wiley-IEEE Press March 2006.
[2] Jr. Edger H. Callaway, "Wireless sensor networks", CRC Press.

References:
[1] I. F. Akyildiz and M. C. Vuran, "Wireless Sensor Networks", John Wiley and Sons Publ. Company
[2] Feng Zho, Morgan Kaufmann ,"Wireless Sensor Networks: An Information Processing Approach".

M.Tech. (ICT) for Engineering Graduate (2-Years)

AD-HOC WIRELESS NETWORKS			
Course Code:	**EC513/EC649**	**Credits:**	**3**
No. of Lectures (Hrs/Week):	**3**	**Mid Sem Exam Hours:**	**2**
Total No. of Lectures:	**45**	**End Sem Exam Hours:**	**3**

Unit I : Introduction to Wireless Communication
Electromagnetic spectrum, radio propagation mechanisms, characteristics of the wireless channel, modulation techniques, multiple access techniques, voice coding, error control, computer network software, computer network architecture, IEEE 802 networking standards, wireless networks, issues in ad hoc wireless networks, Ad Hoc, wireless Internet.

Unit II: MAC Protocols For Wireless Networks
Issues in designing a MAC protocol for ad hoc wireless networks, design goals of a MAC protocol for ad hoc wireless networks, classifications of MAC protocols, contention-based protocols, contention-based protocols with reservation mechanisms, contention-based MAC protocols with scheduling mechanisms.
Routing Protocols for Ad Hoc Wireless Network
Issues in designing a routing protocol for ad hoc wireless networks, classifications of routing protocols, table-driven routing protocols, on-demand routing protocols, hybrid routing protocols, routing protocols with efficient flooding mechanisms, hierarchical routing protocols, power-aware routing protocols.

Unit III: Multicast Routing In Ad Hoc Wireless Networks
Issues in designing a multicast routing protocol, operation of multicast routing protocol, an architecture reference model for multicast routing protocol, classifications of multicast routing protocol, tree based multicast routing protocol, mesh-based multicast routing protocol, energy-efficient multicasting, multicasting with QoS guarantees, application- dependent multicast routing.

Unit IV: Transport Layer And Security Protocols For Ad Hoc Wireless Networks
issues in designing a transport layer protocol for ad hoc wireless networks, design goals of a transport layer protocol, classification of transport layer solutions, TCP over ad hoc wireless networks, other transport layer protocol for ad hoc wireless networks, security in ad hoc wireless networks, network security requirements, issues and challenges in security provisioning, network security attacks, key management, secure routing in ad hoc wireless networks.

Unit V: Quality of Service In Ad Hoc Wireless Networks
Issues and challenges in providing QoS in ad hoc wireless networks, classifications of QoS solutions, MAC layer solutions, network layer solutions, QoS frameworks for ad hoc wireless networks. energy management in ad hoc wireless networks, need for energy management in ad hoc wireless networks, classification of energy management schemes, battery management schemes, transmission power management schemes, system power management schemes.

Text Books:
[1] C. Siva Ram Murthy, B.S. Anoj, "Ad Hoc Wireless Networks, Architectures and Protocols", Prentice Hall, 2004.
[2] C. K. Toh, "Ad Hoc Mobile Wireless Networks 1/e: Protocols and Systems, "PH PTR, 2001.

References:
[1] Hekmat Ramin,"Ad-hoc Networks: Fundamental Properties and Network Topologies", Springer Publication.
[2] Mohammad IIyas, "The Handbook of Ad Hoc Wireless Networks", CRC Press

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MULTICAST COMMUNICATION			
Course Code:	**EC515/EC651**	**Credits:**	**3**
No. of Lectures (Hrs/Week):	**3**	**Mid Sem Exam Hours:**	**2**
Total No. of Lectures:	**45**	**End Sem Exam Hours:**	**3**

Unit I: Multicast Communication
Types of Communication, Scalability, Applications of Group Communication, Characteristics of Groups - Special Aspects of Group Communication Quality of Service: What is QOS?, Describing a stream, Queuing techniques, Signalling QOS requirements, Integrated Services, RSVP, ST2, Differentiated Services, Differences and Integration Options, Multi Protocol Label Switching, Subnet Bandwidth Manager, Improving QOS in the best effort class - Issues in slow links

Unit II: Multicat Routing
Multicast Routing: Introduction, frame work, Controlling scope, delivery tree, Basic Routing Algorithms, Group Dynamics, Scoping and Multicast Address Allocation, Source-Based Routing, Steiner Trees, Trees with Rendezvous Points, Multicast Routing in the Internet, DVMRP ,MOSPF, PIM ,CBT, Multicast Routing between Domains

Unit III: Multicast in IP
The IP -Host Name Resolution - IP multicast, RTP, RTCP, RSVP, RTSP, Ipv6, IGMP (v1, v2 & v3), IP multicast applications - IP multicast security issues, Switching technology, multicast,Replication, Mirroring and Caching , IP TV.

Unit IV: Multicast in Transport Protocols
UDP , XTP, MTP ,RMP, LBRM, SRM, RMTP, PGM, MFTP Inter-domain multicast routing, Multicast caveats, multicast on non-broadcast media, flooding, address allocation,Multicast in LANs

Unit V: Mbone and Multicast Security
the Multicast Backbone of the Internet, MBone Architecture, MBone Tools, Mbone Applications, Multicast routing and Mobile Systems, Multicast and DiffServ, Active Networks for Supporting Group Communication - Group Management for Large Dynamic Groups - Video conferencing, SDR : session directory, VIC & VAT , Reliable Multicast, Security issue of Source, Security issues of receivers.

Text Books:
[1] Multicast Communication: Protocols, Programming, & Applications, Morgan Kaufmann in Networking, Ralph Wittmann, Martina Zitterbart, Edition 2001, Academic Press, USA.
[2] Multicast Networking And Application, Kennet Miller AW Publication , 1999
[3] IP Telephony, Oliver Hersent, David Gurle, Jean - Pierre Petit, A, Pearson Asia , LPE, 2001
[4] Multicast Sockets: Practical Guide for Programmers by David Makofske, Kevin Almeroth, Edition 2003, Elsevier, USA.
[5] Introduction to Data Multicasting, IP Multicast Streaming for Audio and Video Media Distribution Lawrence Harte, First Edition, 2008, Althos Publishing House.
References:
[1] Multicast Communication: Protocols, Programming, & Applications, Morgan Kaufmann in Networking, Ralph Wittmann, Martina Zitterbart, Edition 2001, Academic Press, USA.
[2] Multicast Networking And Application, Kennet Miller AW Publication , 1999
[3] IP Telephony, Oliver Hersent, David Gurle, Jean - Pierre Petit, A, Pearson Asia , LPE, 2001
[4] Multicast Sockets: Practical Guide for Programmers by David Makofske, Kevin Almeroth, Edition 2003, Elsevier, USA.

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MODERN OPTIMIZATION TECHNIQUES			
Course Code:	**EC517/EC671**	**Credits:**	**3**
No. of Lectures (Hrs/Week):	**3**	**Mid Sem Exam Hours:**	**2**
Total No. of Lectures:	**45**	**End Sem Exam Hours:**	**3**

Unit I: Artificial Neural Networks (ANN)
Objectives-History-Biological inspiration, Neuron model, Single input neuron, Multi-input neuron, Network architecture, Single layer of neurons, Multi-layers of Neurons.

Unit II: Perceptron and Learning
Perceptron architecture, Stingle-neuron perceptron, Multi-neuron perceptron- Perceptron Learning Rule, Constructing learning rules, Training multiple neuron perceptrons. Associative Learning: Simple associative network, Unsupervised Hebbrule- Hebb rule with decay, Instar rule, Kohonen rule. Widro-Hoff Learning: Adaline Network, Single Adaline, Mean square Error, LMS algorithm, Analysis of Convergence.

Unit III: Neural Network Roles in VLSI Design
Applications of Artificial Neural Networks to Function Approximation, Regression, Time Series and Forecasting.

Unit IV: Genetic Algorithms and its Mathematical Foundations
Introduction, robustness of traditional optimization and search methods, goals of optimization, difference between genetic algorithms and traditional methods, a simple genetic algorithm, hand simulation, Grist for the search mill, similarity templates, learning the lingo. Foundation theorem, schema processing, the two armed and k-armed bandit problem, schemata processing, building block hypothesis, minimal deceptive problem (MDP), extended schema analysis, MDP results, similarity templates as hyper planes.

Unit V: Advance Topics
Data structures, reproduction, crossover and mutation, a time to reproduce and a time to cross, main program and results, mapping objective functions to fitness form, fitness scaling, codings, a multiparameter mapped fixed point coding, discretization, constraints.

Text Books:
[1] Neural Network Design, PWS publishing company, 1995.
[2] Introduction to Artificial Neural Systems, Jaico Pub.House, Bombay, 1994.
[3] Van Nastrand Reinhold," Neural Computing : Theory and practice", 1989.

References
[1] Haykin S., "Neural Networks-A Comprehensive Foundations", Prentice-Hall International, New Jersey, 1999.
[2] Freeman J.A., D.M. Skapura, "Neural Networks: Algorithms, Applications and Programming Techniques", Addison-Wesley, Reading, Mass, (1992).
[3] Golden R.M., "Mathematical Methods for Neural Network Analysis and Design", MIT Press, Cambridge, MA, 1996.

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MIXED SIGNAL VLSI DESIGN			
Course Code:	**EC519/EC675**	**Credits:**	**3**
No. of Lectures (Hrs/Week):	**3**	**Mid Sem Exam Hours:**	**2**
Total No. of Lectures:	**45**	**End Sem Exam Hours:**	**3**

Unit I: Signals, Filters, and Tools
Sinusoidal Signals, Pendulum Analogy, Amplitude in the x-y Plane, In-Phase and Quadrature Signals, Complex (z-) Plane, Comb Filters, Digital Comb Filter, Digital Differentiator, Intuitive Discussion of the z-Plane, Comb Filters with Multiple Delay Elements, Digital Integrator, Delaying Integrator, Exponential Fourier Series, Fourier Transform, Dirac Delta Function .

Unit II: Sampling and Aliasing
Sampling, Impulse Sampling, Time Domain Description of Reconstruction, Decimation, Sample-and-Hold, S/H Spectral Response, Reconstruction Filter, Circuit Concerns for Implementing the S/H, Track-and-Hold (T/H), Interpolation, Zero Padding, Hold Register, Linear Interpolation, K-Path Sampling, Switched-Capacitor Circuits, Non-Overlapping Clock Generation, Circuits Implementing the S/H, Finite Op-Amp Gain-Bandwidth, Auto zeroing,

Unit III: Analog Filters
Integrator Building Blocks, Lowpass Filters, Active-RC Integrators, Effects of Finite Op-Amp Gain Bandwidth Product, Active-RC SNR, MOSFET-C Integrators, gm-C Integrators, Common-Mode Feedback Considerations, High-Frequency Transconductor, Discrete-Time Integrators, Frequency Response of an Ideal Discrete-Time Filter, Filtering Topologies, Bilinear Transfer Function, Active-RC Implementation, Transconductor-C Implementation.

Unit IV: Digital Filters
Models for DACs and ADCs, Ideal DAC, Modeling of Ideal DAC, Ideal ADC, Number Representation, Increasing Word Size, Adding Numbers and Overflow, Two's Complement Sinc-Shaped Digital Filters, Counter, Aliasing, Accumulate-and-Dump, Lowpass Sinc Filters, Averaging without Decimation, Cascading Sinc Filters, Finite and Infinite Impulse Response Filters, Bandpass and Highpass Sinc Filters, Frequency Sampling Filters.

Unit V: Data Converter SNR
Quantization Noise, Quantization Noise Spectrum, Bennett's Criteria, RMS Quantization Noise Voltage, Quantization Noise as a Random Variable, Quantization Noise Voltage Spectral Density, Power Spectral Density, SNR, Effective Number of Bits, Coherent Sampling, SNDR, Spurious Free Dynamic Range, Dynamic Range, Specifying SNR and SNDR, Clock Jitter.

Text Books:
[1] Jacob Baker, CMOS Mixed Signal Circuit Design.

References:
[1] Yannis Tsividis ,"Mixed Analog-Digital VLSI Device and Technology",.
[2] Roubik Gregorian ,"Introduction to CMOS Opamps and Comparators".

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DSP INTEGRATED CIRCUITS			
Course Code:	**EC521/EC677**	**Credits:**	**3**
No. of Lectures (Hrs/Week):	**3**	**Mid Sem Exam Hours:**	**2**
Total No. of Lectures:	**45**	**End Sem Exam Hours:**	**3**

Unit I: DSP Integrated Circuits and VLSI Circuit Technologies
Standard digital signal processors, Application specific IC's for DSP, DSP systems, DSP system design, Integrated circuit design. MOS transistors, MOS logic, VLSI process technologies, Trends in CMOS technologies.

Unit II: Digital Signal Processing
Digital signal processing, Sampling of analog signals, Selection of sample frequency, Signal- processing systems, Frequency response, Transfer functions, Signal flow graphs, Filter structures, Adaptive DSP algorithms, DFT-The Discrete Fourier Transform, FFT-The Fast Fourier Transform Algorithm, Image coding, Discrete cosine transforms.

Unit III: Digital Filters and Finite Word length Effects
FIR filters, FIR filter structures, FIR chips, IIR filters, Specifications of IIR filters, Mapping of analog transfer functions, Mapping of analog filter structures, Multirate systems, Interpolation with an integer factor L, Sampling rate change with a ratio L/M, Multirate filters. Finite word length effects -Parasitic oscillations, Scaling of signal levels, Round-off noise, Measuring round-off noise, Coefficient sensitivity, Sensitivity and noise.

Unit IV: DSP Architectures and Synthesis of DSP Architectures
DSP system architectures, Standard DSP architecture, Ideal DSP architectures, Multiprocessors and multicomputers, Systolic and Wave front arrays, Shared memory architectures. Mapping of DSP algorithms onto hardware, Implementation based on complex PEs, Shared memory architecture with Bit – serial PEs.

Unit V: Arithmetic Units and Integrated Circuit Design
Conventional number system, Redundant Number system, Residue Number System, Bit-parallel and Bit-Serial arithmetic, Basic shift accumulator, Reducing the memory size, Complex multipliers, Improved shift-accumulator. Layout of VLSI circuits, FFT processor, DCT processor and Interpolator as case studies. Cordic algorithm.

Text Books:
[1] Lars Wanhammer, "DSP Integrated Circuits", 1999 Academic press, New York
[2] A.V.Oppenheim et.al, "Discrete-time Signal Processing", Pearson Education, 2000.

References:
[1] Emmanuel C. Ifeachor, Barrie W. Jervis, " Digital signal processing – A practical approach", Second Edition, Pearson Education, Asia.
[2] Keshab K.Parhi, "VLSI Digital Signal Processing Systems design and Implementation", John Wiley & Sons, 1999.