M.TECH
IN
VLSI SYSTEMS
SYLLABUS

Semester I

Course Code	Course Title	L	T	P	C
MA104	Advanced Computational Mathematics	3	1	0	4
VL101	Semiconductor Devices and Modelling Techniques	3	0	0	3
VL102	Advanced VLSI Design	3	0	0	3
VL103	Advanced Digital communication Techniques	3	0	0	3
VL104	Verilog Based Design Of Digital Systems	3	0	0	3
VL9XX	Elective – I	3	0	0	3
VL105	VLSI Design Lab	0	0	2	1
Total		**18**	**1**	**2**	**20**

MA104 ADVANCED COMPUTATIONAL MATHEMATICS **L T P C**
3 0 0 3

LINEAR ALGEBRAIC EQUATIONS **9**

Systems of linear algebraic equations-elimination and factorization methods-Multiple right hand sides-III conditioned systems-Symmetric abnd Banded systems-Gauss Siedel iteration for sparse systems.

EIGEN VALUES
9

Eigen value problems-Power method-Jacobi Method-Practical examples. Systems of Non-linear equations—Newton-Raphson Method

INTERPOLATIONS
9

Lagrangean and Hermitian interpolation-quadratic and cubic splines-Datasmoothing by least squares criterion-Non-polynomial models like exponential model and power equation-Multiple linear regression.

ERRORS
9

Errors in numerical computation-Taylor series expansion of functions-Ordinarydifferential equations first order equations solution by use of Taylor series Euler's methos and its modifications-rungeKutta method. Higher order equation of the initial value type-Predictor-corrector methods-Milne's method and Hamming's method-stability of solution.

DIFFERENTIAL EQUATION
9

Ordinary differential equations of the boundary value type-Finite difference solution. Weighted residual methods for initial value problems and boundary value problems-collocation method-Subdomain method-Method of least squares- Galerkin's method. Partial differential equations in two dimension Parabolic equations-Explicit finite difference method-Crank Nicholson implicit method. Elliptic equations-finite difference method-Problems with irregular boundaries.

Total: 45 Periods

REFERENCE BOOKS

1. S.C Chapra and R.P Canale, "Numerical Methods for Engineers",
2. G.D Smith, "Numerical Solution to Partial differential Equations",
3. KetteranmdPrawel, "Modern methods of Engineering computation",
4. S Rajasekharan, "Numerical Methods in science and Engineering",
5. S Rajasekharan, "Numerical Methods for Initial and Boundary value Problems",
6. Terrence J.Akai, "Applied Numerical Methods for engineers",

VL101 SEMICONDUCTOR DEVICES AND MODELING TECHNIQUES

L	T	P	C
3	0	0	3

PHYSICS OF SEMICONDUCTOR **9**

Review of quantum mechanics, Electrons in potentials (infinite barrier, potential well), Electrons in periodic lattices (KP Model), E-k diagrams, effective mass; Quasi-particles in semiconductors, electrons, holes (light holes and heavy

holes), optical and acoustic phonons, electron hole pair (EHP). Band diagram of silicon, intrinsic and extrinsic carrier concentration, relation between applied voltage and Fermi level, Carrier statistics; Generation-recombination, SRH theory, diffusion length, carrier life time, Continuity equation, Poisson's equation and solution, Boltzmann transport equation, Mobility and diffusivity; variation of mobility with temperature, doping, high filed mobility, low field mobility, Hall mobility/Hall experiment, sheet resistance, drift and diffusion.

JUNCTION DEVICES CHARACTERISTICS
9

PN junction diode: band diagrams, electrostatics of a pn junction diode, CV characteristics, IV characteristics, high level injection, low level injection, ac characteristics: admittance of a diode, break down phenomenon in diodes; MS contact, band diagrams, ohmic and non ohmic contacts, thermionic Emission model for current transport and current-voltage (I-V) characteristics, effect of interface states and interfacial thin electric layer on the Schottky barrier height and the I-V characteristics; Solar cells.

METAL OXIDE SEMICONDUCTOR 9

Semiconductor surfaces, Ideal MOS structure, MOS device in thermal equilibrium, Non-Ideal MOS: work function differences, charges in oxide, interface states, band diagram of non ideal MOS, flatband voltage, electrostatics of a MOS (charge based calculations), calculating various charges across the MOSC, threshold voltage, MOS as a capacitor (2 terminal device), Three terminal MOS, effect on threshold voltage.MOS transistor in dynamic operation, Large signal Modeling, small signal model for low, medium and high frequencies.

MOSFETS
9

MOSFET (Enhancement and Depletion MOSFETs), mobility, on current characteristics, off current characteristics, sub threhsold swing, effect of interface states on sub threshold swing, drain conductance and transconductance, effect of source bias and body bias on threshold voltage and device operation. Scaling, Short channel and narrow channel effects- High field effects.

SILICON ON INSULATOR
9

SOI concept, PD SOI, FD SOI and their characteristics, threshold voltage of a SOI MOSFET, Multi-gate SOI MOSFETs, Alternate MOS structures.

Total: 45 Periods

REERENCE BOOKS

1. M.S.Tyagi, "Introduction to Semiconductor materials and Devices", John Wiley & Sons.
2. Donald A Neamen, "Semiconductor Physics and Devices: Basic Principles" McGraw-Hill, 1997.
3. Ben. G. Streetman and Sanjay Banerjee, "Solid State Electronic Devices" 6th edition, Prentice Hall.
4. S.M. Sze, "Modern Semiconductor Device Physics", John Wiley & Sons 1998.
5. E.H. Nicollian and J. R. Brews, "Metal Oxide Semiconductor - Physics and Technology", John Wiley and Sons.
6. Nandita Das Gupta, Amitava Das Gupta, "Semiconductor Devices Modeling and Technology", Prentice Hall India
7. S M Sze, "High speed semiconductor devices", John Wiley, 1990
8. K.Kanaan, "Semiconductor devices",Prentice hall.
9. Jean- PierrieColinge, "Silicon-on-insulator Technology: Materials to VLSI", Kluwer Academic publishers group.

10. YannisTsividis, “Operation and Modeling of the MOS transistor”, Oxford University Press.

VL102 ADVANCED VLSI DESIGN **L T P C**
3 0 0 3

VLSI TECHNOLOGY **9**

Crystal growth and Wafer Preparation, Epitaxial growth, Oxidation, Diffusion, Ion implantation, Lithography, Etching, Metallization, packaging of chips

MOS INVERTERS **9**

Basic principle of MOSFETs, Introduction to large signal MOS models (long channel) for digital design. Static and Dynamic characteristics: Inverter principle, Depletion and enhancement load inverters, the basic CMOS inverter, transfer characteristics, logic threshold, Noise margins, and Dynamic behavior, transition time, Propagation Delay, Power Consumption

COMBINATIONAL AND SEQUENTIAL MOS LOGIC DESIGN **9**

MOS device layout: Transistor layout, Inverter layout, CMOS digital circuit layout. Static MOS design: Complementary MOS, Pass Transistor logic, Complex logic circuits, DSL, DCVSL and Transmission gate logic. Dynamic logic families and performances. Memory design-ROM & RAM cells design, Static latches, Flip flops & Registers, Dynamic Latches & Registers, CMOS Schmitt

trigger, Monostable sequential Circuits, Astable Circuits. Adders, Multiplier Circuits

MEMORY DESIGN
9

Memory design-ROM & RAM cells design, BiCMOS Logic Circuits Introduction, Basic BiCMOS Circuit behavior, Switching Delay in BiCMOS Logic circuits

ANALOG MOS DESIGN
9

MOS transistor, Low frequency MOSFET Models, High frequency MOSFET Models.Current Source, Sinks and References- MOS Diode/Active resistor, Simple current sinks and mirror, Basic current mirrors, Advance current mirror, Current and Voltage references, Bandgap references.CMOS Amplifier- Performances matrices of amplifier circuits, Common source amplifier, Common gate amplifier, Cascode amplifier, Frequency response of amplifiers and stability of amplifier

Total: 45 Period

REFERENCE BOOKS

1. SM Sze, "VLSI Technology", John Wiley & Sons, 2000.
2. Kang &Leblebigi "CMOS Digital IC Circuit Analysis & Design"- McGraw Hill, 2003.
3. Design of Analog CMOS Integrated Circuits by BehzadRazavi McGraw Hill.
4. Eshraghian&Pucknell, Introduction to VLSI, PHI.
5. Sedra& Smith, SPICE.

VL103 ADVANCE DIGITAL COMMUNICATION TECHNIQUE **L T P C**
3 0 0
3

DIGITAL MODULATION SCHEME
9

Representation of Digitally Modulated Signals, Memory less Modulation Methods; Pulse Amplitude Modulation, Phase Modulation, Quadrature Amplitude Modulation, Multidimensional Signaling. Signaling Schemes With Memory; Continuous-Phase Frequency-Shift Keying, Continuous-Phase Modulation. Power Spectrum of Digitally Modulated Signals; Power Spectral Density of a

Digitally Modulated Signal With Memory, Power Spectral Density of Linearly Modulated Signals, Power Spectral Density of Modulated Schemes With a Markov Structure

OPTIMUM RECEIVERS FOR AWGN CHANNELS 9

Waveform and Vector Channel Models; Optimum Detection for a General Vector Channel. Waveform and Vector AWGN Channels; Optimal Detection for the Vector AWGN Channel, Implementation of the Optima Receiver for the AWGN Channels. Optimal Detection and Error Probability for Amplitude Shift Keying, Phase Shift Keying ,PAM AND QAM Signaling.

CARRIER AND SYMBOL SYNCHRONIZATION 9

Signal Parameter Estimation; The Likely hood Function, Carrier Recovery and Symbol Synchronization in Signal Demodulation. Carrier Phase Estimation; Maximum Likelyhood Carrier Phase Estimation, The Phase-Locked Loop, Effect of Additive Noise in the Phase Estimate. Symbol Timing Estimation; Maximum Likely hood Timing Estimation.

DIGITAL COMMUNICATION THROUGH BAND-LIMITED CHANNELS 9

Characterization of Band-Limited Channels. Signal Design for Band-Limited Channels; Design of Band-Limited Signals for No Intersymbol Interference-The Nyquist Criterion, Optimum Maximum-Likelihood Receiver,Multichannel Digital Communications in AWGN Channels; Binary Signals, M-ary Orthogonal Signals. Multicarrier Communications; Single Carrier verses Multicarrier Modulation, Capacity of a Nonideal Linear Filter Channel, OFDM, Modulation & Demodulation in an OFDM**.**

SPREAD SPECTRUM SIGNALS FOR DIGITAL COMMUNICATION 9

Model of Spread spectrum Digital Communication System. Direct Sequence Spread Spectrum Signals; Error Rate Performance of the Decoder, Some Applications of DS Spread Spectrum Signals. Frequency-Hopped Spread-Spectrum Signals; Performance of FH Spread Spectrum Signals in an AWGN Channel, A CDMA System Based on FH Spread Spectrum Signals**.**

Total: 45 Periods

TEXT BOOKS

1. John G. Proakis and MasoudSalehi, Digital Communication, McGraw-Hill, 5^{th}Edition

2. B.P.Lathi,Modern Digital and analog communication systems,3rd Edition, Oxford University Press,1998

REFERENCE BOOKS

1. Simon Haykin, Digital Communication, Willy

2. Taub& Schilling, Principle of Communication, PHI

VL104 VERILOG BASED DESIGN OF DIGITAL SYSTEMS **L T P C** **3 0 0 3**

INTRODUCTION TO DIGITAL DESIGN **9**

Design Methodology, Review of Logic design Fundamentals-combinational logic, Boolean algebra and algebraic simplification, Karnaugh maps, Building Blocks for Logic Design- NAND and NOR gates, Multiplexers, Demultiplexers, Encoders, Priority Encoder and Decoder, Priority Decoder, Glitches and Hazards in combinational networks, Flip-flops and latches, Moore and Mealy sequential network design, Busses and Three-State Devices, Equivalent states and reduction of state tables**.**

INTRODUCTION TO VERILOG HDL **9**

Verilog HDL, Behavioral Modeling, Data flow modeling, Structural modeling, Continuous Assignment Statement, Procedural Assignment Statement, Blocking Procedural Assignment, Non-blocking Procedural Assignment, Target of Assignment, Assignment Restrictions, Logical Operators, Arithmetic Operators-Unsigned Arithmetic, Signed Arithmetic, Modeling a Carry, Relational Operators, Equality Operators, Shift Operators, Vector Operations, Part-selects, Bit-selects-Constant Index, Non-constant Index in Expression, Non-constant Index in Target, Conditional Expression, Always Statement, If Statement, Case Statement, Loop Statement, Modeling Flip-flops-Local Use of Variables, Multiple Clocks, Multi-phase Clocks, With Asynchronous Preset and Clear, With Synchronous Preset and Clear, Functions, Tasks Gate Level Modeling, Module Instantiation Statement-Using Predefined Blocks, Instantiating User-built Multipliers, Instantiating User-specific Flip-flops, Parameterized Designs.

INTRODUCTION TO LOGIC DESIGN WITH VERILOG **9**

Structural Models of Combinational Logic, Verilog Primitives and Design Encapsulation, Verilog Structural Models, Module Ports, Some Language Rules,Top-Down Design and Nested Modules, Design Hierarchy and Source-Code Organization, Vectors in Verilog, Structural Connectivity, Logic Simulation, Design Verification, and Test Methodology, Four-Valued Logic and Signal Resolution in Verilog , Test Methodology, Signal Generators for Test benches, Event-Driven Simulation, Test bench Template, Sized Numbers, Propagation Delay, Inertial Delay, Transport Delay, Truth Table Models of Combinational and Sequential Logic with Verilog .

MODELLING OF LOGIC DESIGN WITH VERILOG
9

Modeling Combinational Logic, Modeling Sequential Logic, Modeling a Memory, Writing Boolean Equations, Modeling a Finite State Machine-Moore FSM, Mealy FSM and Encoding States-Using Integers and Parameter Declarations, Modeling an Universal Shift Register, Modeling an ALU, Modeling a Counter-Binary Counter, Modulo-N Counter, Johnson Counter, Gray Counter, Modeling a Parameterized Adder, Modeling a Parameterized Comparator, Modeling a Decoder, Modeling a Multiplexer, Modeling a Parameterized Parity Generator, Modeling a Three-state Gate, A Count Three l's Model, A Factorial Model, An UART Model, A Blackjack Model.

MODEL OPTIMIZATIONS AND VERIFICATION 9

Optimization- Resource Allocation, Common Subexpressions, Moving Code, Common Factoring, Commutativity and Associativity, Other Optimizations, Flip-flop and Latch Optimizations, Avoiding flip-flops and Latches, Design Size-Small Designs Synthesize Faster, Hierarchy and Macros as Structure, Using Parentheses. Verification-a test bench, delays in assignment statement, unconnected ports, Missing latches, Event list, synthesis directives, variable asynchronous preset, blocking and non blocking assignment.

Total: 45 Periods

REFERENCE BOOKS

1. J. Bhaskar, “Verilog HDL Synthesis”, Star Galaxy, 1998.

2. M Morris Mano “Digital Design” Pearson, 2004.

3. Michael D. Ciletti “Advanced Digital Design with the Verilog HDL” Prentice hall 2010.

4. J.F. Wakerly “Digital Design-Principles and Practices”, Prentice Hall, 2005.

5. Samir Palnitkar "Verilog HDL" Prentice hall, 2003.

6. G. De Micheli, "Synthesis and optimization of digital circuits", McGraw Hill, 1994.

Semester – II

Course Code	Course Title	L	T	P	C
VL151	System on Chip design	3	0	0	3
VL152	Low Power VLSI Design	3	0	0	3
VL153	DSP Architectures and Embedded Systems	3	0	0	3
VL9XX	Elective - II	3	0	0	3
VL9XX	Elective - III	3	0	0	3
VL9XX	Elective - IV	3	0	0	3
VL154	System on Chip design Laboratory	0	0	3	2
Total		**18**	**0**	**3**	**20**

VL151 SYSTEM ON CHIP DESIGN **L T P C**
3 0 0 3

INTRODUCTION TO THE CONCEPT OF A SOC
9

Backgrounder, microprocessor and Microcontroller based systems, Embedded systems. Differences between Embedded systems and SOCs.

SYSTEM DESIGN
9

Concept of system, importance of system architectures, introduction to SIMD, SSID, MIMD and MISD architectures, concept of pipelining and parallelism. Designing microprocessor /Microcontroller based system and embedded system. System design issues in SOCs.

SYSTEM BUSES
9

Introduction to busses used in SOCs. Introduction to AMBA bus. Detailed study of IBM's core connect bus, concept of PLB-processor local bus and OPB-on chip peripheral bus.

PROCESSORS USED IN SOCS
9

Introduction to CISC ,RISC, Von Neuman and Harward Architecture. Concept of Soft processors and study of Microblaze RISC processor. Study of IBM's power PC

SOC IMPLEMENTATION
9

Backgrounder – programmable logic and FPGA Architecture .Concept of embedded processors and study of virtex II PRO Architecture. Study of features like embedded RAMs ,multipliers ,Digital clock management etc.

Total: 45 Periods

TEXT BOOKS

1. Wyne wolf,“FPGA based system design” Prentice hall of India.
2. Giovanni De Micheli, Rolf Ernst, and Wayne Wolf, “Readings in hardware/software co-design” Morgan Kaufmanpublishers.

REFERENCE BOOKS

1. Marilyn Wolf,“Computers as components:principles of embedded computing system design” Morgan Kaufman publishers.

2. Ahmed Jerrya and Wayne Wolf, “Multiprocessors systems-on-chips” Morgan Kaufman publishers.

VL152 LOW POWER VLSI DESIGN **L T P C** **3 0 0 3**

INTRODUCTION
9

Need for low power VLSI chips, Sources of power dissipation in Digital Integrated circuits. Emerging low power approaches. Physics of power dissipation in CMOS devices. Dynamic dissipation in CMOS, Transistor sizing & gate oxide thickness, Impact of technology Scaling, Technology & Device innovation.

POWER ESTIMATION
9

Simulation Power analysis- SPICE circuit simulators, Gate level logic simulation, Capacitivepower estimation, Static state power, Gate level capacitance estimation, Architecture level analysis, Data correlation analysis in DSP systems. Monte Carlo simulation.Probabilistic power analysis- Random logic signals, Probability & frequency, Probabilisticpower analysis techniques.

LOW POWER DESIGN
9

Low Power Design: Circuit level- Power consumption in circuits, Flip Flops & Latches design, High capacitance nodes, Low power digital cells library. Logic level- Gate reorganization, Signal gating, Logic encoding, State machine encoding, Pre-computation logic.

LOW POWER ARCHITECTURE & SYSTEMS
9

Power & performance management, Switching activity reduction, Parallel architecture with voltage reduction, Flow graph transformation, Low power arithmetic components, Low power memory design.

ALGORITHM & ARCHITECTURAL LEVEL METHODOLOGIES 9

Introduction, design flow, algorithmic level analysis & optimization, architectural level estimation & synthesis. Low Power Clock Distribution: Power dissipation in clock distribution, single driver vs distributed buffers, zero skew vs tolerable skew, chip& package co design of clock network

Total: 45 Periods

TEXT BOOKS

1. Gary K. Yeap, Practical Low Power Digital VLSI Design, KAP, 2002
2. Rabaey and Pedram, Low power design methodologies, Kluwer Academic,1997

REFERENCES TEXT BOOKS

1. Kaushik Roy, Sharat Prasad, Low-Power CMOS VLSI Circuit Design, Wiley, 2000

VL 153 DSP ARCHITECTURES AND EMBEDDED SYSTEMS L T P C

3 0 0

3

ORTHOGONAL TRANSFORMS
9

Discrete Fourier Transform, Properties of DFT, Computation of DFT, FFT-Decimation in time, Decimation in frequency; Linear convolution using DFT, Discrete Cosine Transform and Haar Transform.

DIGITAL FILTER STRUCTURES
9

Basic FIR/IIR filter structures, FIR/IIR Cascaded lattice structures, Parallel realization of IIR transfer functions, Computational complexity of filter structures; Adaptive Filter Algorithms- LMS and RLS, Introduction to Kalman Filtering.

MULTI-RATE SIGNAL PROCESSING
9

Basic structures for sampling rate conversion, Decimators and Interpolators; Multistage design of interpolators and decimators; Polyphase decomposition and FIR structures; Different interpolation algorithms-Lagrange interpolation, Spline interpolation; Applications in subband coding;

DIGITAL SIGNAL PROCESSORS INTRODUCTION **9**

Computational characteristics of DSP algorithms and applications; Techniques forenhancing computational throughput: Harvard architecture, parallelism, pipelining, dedicated multiplier, split ALU and barrel shifter;

TMS320C64XX ARCHITECTURE **9**

CPU data paths and control, general purpose register files, register file cross paths, memory load and store paths, data address paths, parallel operations and resource constraints.

Total: 45 periods

TEXT BOOKS

1. R. Chassaing and D. Reay, Digital signal processing and applications with TMS320C6713 and TMS320C6416, Wiley, 2008.
2. S. K. Mitra, Digital Signal Processing: A Computer Based Approach,3rd Edition, TMH, 2008.

REFFERENCE BOOK

1. J. G. Proakis and D. G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, Pearson Prentice Hall, 2007

Semester – III

Course Code	Course Title	L	T	P	C
VL201	Advanced Computer Architecture	3	1	0	4
VL9XX	Elective - V	3	0	0	3
VL9XX	Elective - VI	3	0	0	3
VL202	Comprehensive Viva- Voce	0	0	0	1
VL203	Project Phase - I	0	0	12	6
Total		**12**	**1**	**12**	**20**

VL201 ADVANCED COMPUTER ARCHITECTURE **L T P C**

3 0 0 3

OVERVIEW
9

Introduction and Review of basic computer architecture - Instruction and Instruction Sequencing – Addressing Modes - Quantitative techniques in computer design - measuring and reporting performance - Flynn's Classification of Computers (SISD, MISD, MIMD) – RISC – CISC

INSTRUCTION LEVEL PARALLELISM
9

Basic concepts of Pipelining – static pipeline – dynamic pipeline - instruction pipeline - data hazards -control hazards - structural hazards - techniques for handling hazards - Pipeline optimization techniques.

DATA LEVEL PARALLELISM
9

Brief introduction of Array processor - detailed study of Interconnection Network - Boolean cube, Mesh, omega, shuffle network - various concepts illustrated by studying detailed SIMD algorithms, viz., Matrix multiplication.

THREAD LEVEL PARALLELISM
9

Multi-threading – Multiprocessors - Centralized and Distributed Shared Memory Architectures – Cache Coherence Issues - Performance Issues – Synchronization Issues – Models of Memory Consistency - Interconnection Networks – Buses, Crossbar and Multi-Stage Switches – Multi-Core Processor Architectures - Large Scale Multiprocessors - Warehouse-Scale Computers.

MEMORY HIERARCHY DESIGN 9

Basic Concepts - Issues in the Design of Memory Hierarchies - Fallacies and Pitfalls in the Design of Memory Hierarchies - Optimizations of Cache Performance - Memory Technology and Optimizations.

Total: 45 Periods

REFERENCES

1. John L. Hennessey and David A. Petterson: "Computer Architecture - A Quantitative Approach", Morgan Kaufmann / Elsevier, Fifth edition, 2012
2. Kai Hwang "Advanced Computer Architecture - Parallelism, Scalability, Programmability", Tata McGraw Hill, 2010.
3. Hwang & Briggs "Advanced Computer Architecture and Parallel Processing", McGraw Hill.
4. Richard Y. Kain, "Advanced Computer Architecture a Systems Design Approach", PHI, 2011

Semester – IV

Course Code	Course Title	L	T	P	C
VL251	Project phase - II	0	0	24	12
Total		**0**	**0**	**24**	**12**

ODD

SEMESTER

ELECTIVES

Course Code	Course Title	L	T	P	C
VL901	Soft Computing	3	0	0	3
VL902	Fibre Optics Communication Technology	3	0	0	3
VL903	Characterization of Semiconductor Materials & Devices	3	0	0	3

VL904	Device Modelling for Circuit Simulation	3	0	0	3
VL905	Optimization Methods in Signal Processing and Communication	3	0	0	3
VL906	Speech Signal Processing and Coding	3	0	0	3
VL907	Advanced Digital Image Processing	3	0	0	3
VL908	Advanced CMOS Devices and Technology	3	0	0	3
VL909	Instrumentation for Nanotechnology	3	0	0	3
VL910	CAD for VLSI circuits	3	0	0	3
VL911	Optimal and Adaptive Signal Processing	3	0	0	3
VL912	Optical Imaging Techniques	3	0	0	3
VL913	Compact Modeling of Devices for IC Design	3	0	0	3
VL914	Optical Sensors	3	0	0	3
VL915	Analog VLSI Design	3	0	0	3
VL916	Quantum Electronics	3	0	0	3

VL901 SOFT COMPUTING **L T P C**

3 0 0

3

ARTIFICIAL NEURAL NETWORKS **9**

Introduction Artificial Neural Network, Basic-concepts-single layer perception, Multi layer perception, Supervised and unsupervised learning, back propagation networks, Recurrent Neural Networks, Applications;

FUZZY SYSTEMS
9

Fuzzy sets and Fuzzy reasoning, Fuzzy matrices, Fuzzy functions, decomposition, Fuzzy automata and languages, Fuzzy control methods, Fuzzy decision making, Adaptive Control, Applications;

NEURO, FUZZY MODELLING **9**

Adaptive networks based Fuzzy interfaces, Classification and Representation trees, algorithms, Rule base structure identification, Neuro-Fuzzy controls;

GENETIC ALGORITHM **9**

Survival of the fittest, pictures computations, cross overmutation, reproduction, rank method, rank space method, Applications;

SOFT COMPUTING AND CONVENTIONAL AI
9

AI Search algorithm, Predicate calculus rules of interface, Semantic networks-frames-objects-Hybrid models, Applications;

Total: 45 periods

TEXT BOOKS

1. Neuro Fuzzy and Soft computing- Jang J.S.R., Sun C.T and Mizutami E, Prentice Hall.
2. Neural Networks- Simon Haykin, pearson Education.

REFERENCE BOOKS

1. Fuzzy Logic Engineering Applications- Timothy J.Ross; McGraw Hill.
2. Fuzzy Sets and Fuzzy Logic- George J.Klir and Bo Yuan, Prentice Hall.

VL 902 FIBRE OPTICS COMMUNICATION TECHNOLOGY L T P C

3 0

0 3

OPTICAL SOURCES AND DETECTORS
9

Light-emitting diode: Principles, Structures, LED characteristics, Modulation of LED.

Lasers: Principles, Laser diode structures and radiation pattern, Laser characteristics, Modulation of Semiconductor Laser. Photo detectors: Principles, Quantum efficiency, Responsitivity of P.I.N photodiode, and Avalanche photodiode.

OPTICAL FIBER SENSORS AND DEVICES
9

Overview of fibre optic sensors – advantages over conventional sensors, broadband classification.Intensity Modulated Optical Fibre Sensors: Introduction, intensity modulation through light interruption shutter/ schlieren multimode fibre optic sensors – reflective fibre optic sensors, evanescent wave fibre sensors - microbend optical fibre sensors – fibre optic refractometers, intensity modulated fibre optic thermometers, distributed sensing with fibre optics.

OPTICAL FIBER SENSORS AND COUPLERS
9

Interferometric Optical Fibre Sensors: Introduction, basic principles of interferometric optical fibre sensors, components and applications of interferometric sensors.Fused Single Mode Optical Fibre Couplers: Introduction, physical principles (coupling coefficient) polarization effect, experimental properties, theoretical modelling, and comparison with experiment.

OPTICAL FIBER COMPONENTS
9

Single Mode All Fibre Components: Introduction, directional couplers, polarizes, polarization splitters polarization controllers, optical isolators, single mode fibre filters wave length multiplexers and demultiplexers, switches and intensity modulators, phase and frequency modulators.

OPTICAL FIBER MULTIPLEXING
9

Fibre Optic Sensor Multiplexing: Introduction, general topological configuration, and incoherent and coherent detection.Signal Processing in MonomodeFibre Optic Sensor Systems: Introduction, Transduction mechanisms, Optical Signal Processing, Electronic Processing.

Total: 45 Periods

TEXT BOOKS

1. Optical Fiber Communications – Gerd Keiser, 3 rd Ed. McGraw Hill.
2. Fundamentals of Fibre Optics in Telecommunication and Sensor Systems – Bishnu P PAL Wiley Eastern Ltd. (1994).
3. J.M. Senior, 'Optical Fibre Communication – Principles and Practice', Prentice Hall of India,1985.
4. J. Wilson and J.F.B. Hawkes, 'Introduction to Opto Electronics', Prentice Hall of India, 2001.

REFERENCES TEXT BOOKS

1. G. Keiser, 'Optical Fibre Communication', McGraw Hill, 1995.
2. M. Arumugam, 'Optical Fibre Communication and Sensors', Anuradha Agencies, 2002.
3. Optical Fiber Communications and Sensors – Dr. M. Arumugam.

VL903 CHARACTERIZATION OF SEMICONDUCTOR MATERIALS AND DEVICES **L T P C**

3 0 0 3

INTRODUCTION
9

Various Semiconductor materials and their advantages & disadvantages applied to VLSI and Nano-electronics.

PROPERTIES OF SEMICONDUCTOR
9

Crystal structure, Band theory, Carrier concentration at thermal equilibrium, Density of states, Fermi energy, Ionization of impurity in semiconductor and Quantum aspect of semiconductors. Resistivity, conductivity, Band gap etc.

SEMICONDUCTOR CARRIER DYNAMICS
9

Scattering of carrier in semiconductors, Low field effect in semiconductor, Very high field effect in semiconductor, Carrier transport phenomena, Charge injection and quasi equilibrium, Generation and recombination of electron and holes and Basic equation for semiconductor device operation.

SEMICONDUCTOR JUNCTION WITH METAL, INSULATOR AND SEMICONDUCTORS
9

Characteristics and energy band diagrams of PN Junction diodes-step and graded junction, Schottky barrier diode, Ohmic contact, Insulator-semiconductor junction.

COMPOUND SEMICONDUCTOR AND ITS APPLICATIONS 9

Classifications: Energy band diagram, Phase diagram, Electronic properties of compoundSemiconductor materials: Microwave Devices. Applications: PN Junction, Solar cells, P-I-N photodetector and Semiconductor lasers.

Total: 45 Periods

TEXT BOOKS

1. S.M. Sze, "Physics of semiconductor devices", Wiley Pub.

2. B.G. Streetman, "Solid State Electronics Devices", Prentice Hall, 2002.

REFERENCE BOOKS

1. M.S.Tyagi, "Semiconductor Materials and Devices," Wiley Pub.

VL 904 DEVICE MODELLING FOR CIRCUIT SIMULATION L T P C
3 0 0 3

FUNDAMENTALS
9

Semiconductor Physics, Principle of circuit simulation and its objectives. Introduction to SPICE: AC, DC, Transient, Noise, Temperature extra analysis.

MODELLING OF JUNCTION DIODES AND BJT
9

Junction diodes modelling: DC, Small signal, Large signal, High frequency and noise models of diodes, Measurement of diode model-parameters.

Modelling BJT: DC, small signal, high frequency and noise models of bipolar junction transistors.Extraction of BJT model parameters.

MOSFETS MODELS
9

DC, small signal, high frequency and noise models of MOSFETs, MOS Capacitors. MOS Models: Level-1 and level-2 large signal MOSFET models. Introduction to BSIM models.Extraction of MOSFET model parameters.

DEVICE SCALING
9

Short and narrow channel MOSFETs. MOSFET channel mobility model, DIBL, charge

sharing and various non-linear effects.

JFET, MESFETs & HBTs
9

Modeling of JFET & MESFET and extraction of parameters. Principles of hetro-junction

devices, HBTs, HEMT.

Total: 45 Periods

TEXT BOOKS

1. S.M.Kang&Y.Leblibici, CMOS Digital Integrated Circuits-Analysis & Design, TMH, 3rd Ed.
2. B.G. Streetman & S. Baneerjee, Solid State Electronic Devices, PHI.
3. H.M. Rashid, Introduction to PSPICE, PHI.

REFERENCES TEXT BOOKS

1. R. Raghuram, Computer Simulation of Electronic Circuits, Wiley Eastern Ltd.
2. Bar Lev, Basic Electronics.
3. S.M. Sze, Physics of Semiconductor Devices, Wiley Pub.

VL905 OPTIMIZATION METHODS IN SIGNAL PROCESSING&COMMUNICATIONS

L	T	P	C
3	0	0	3

FUNDAMENTALS **9**

Mathematical Background: Sequences and Subsequences- Mapping and functions-Continuous functions- Infimum and Supremum of functions-

Minima and maxima of functions- Differentiable functions. Vectors and vector spaces- Matrices- Linear transformation- Quadratic forms- Definite quadratic forms- Gradient and Hessian- Linear equations- Solution of a set of linear equations-Basic solution and degeneracy.

CONVEX SETS AND CONVEX CONES
9

Convex sets and Convex cones- Introduction and preliminary definition- Convex sets and properties- Convex Hulls- Extreme point- Separation and support of convex sets- Convex Polytopes and Polyhedra- Convex cones- Convex and concave functions- Basic properties- Differentiable convex functions- Generalization of convex functions.

LINEAR OPTIMIZATION TECHNIQUES
9

Linear Programming: Introduction -Optimization model, formulation and applications- Classical optimization techniques: Single and multi variable problems-Types of constraints. Linear optimization algorithms: The simplex method -Basic solution and extreme point -Degeneracy-The primal simplex method -Dual linear programs - Primal, dual, and duality theory - The dual simplex method -The primal-dual algorithm-Duality applications

NON-LINEAR OPTIMIZATION TECHNIQUES
9

Nonlinear Programming: Minimization and maximization of convex functions- Local & Global optimum- Convergence-Speed of convergence. Unconstrained optimization: One dimensional minimization - Elimination methods: Fibonacci & Golden section search - Gradient methods - Steepest descent method.

CONSTRAINED OPTIMIZATION TECHNIQUES **9**

Constrained optimization: Constrained optimization with equality and inequality constraints. Lagrangian method - Sufficiency conditions - Kuhn-Tucker optimality conditions- Rate of convergence-Engineering applications Quadratic programming problems-Convex programming problems.

Total: 45 Periods

TEXT BOOKS

1. David G Luenberger, "Linear and Non Linear Programming", Addison-Wesley, 2nd Ed, 1984.

2. S.S.Rao, "Engineering Optimization, Theory and Practice",Revised 3rd Edition, New Age International Publishers, New Delhi.

3. R. Fletcher, "Practical methods of optimization", John Wiley, 1980.

4. Hillier and Lieberman, "Introduction to Operations Research", McGraw-Hill, 8th edition, 2005.

REFERENCES TEXT BOOKS

1. S. I. Gass, "Linear programming", McGraw-Hill, 5th edition, 2005.

2. M.S.Bazarra, H.D. Sherali and C.M.Shetty, "Nonlinear Programming Theory and Algorithms," John Wiley, New York, 1979.

3. Kalyanmoy Deb, "Optimization for Engineering Design-Algorithms and Examples,"Prentice Hall India, 1998.

VL906 SPEECH SIGNAL PROCESSING AND CODING **L T P C**

3 0 0 3

SPEECH PRODUCTION
9

Physiological and Mathematical Model, Relating the Physiological and Mathematical Model, Categorization of Speech Sounds - Source-System Model, Articulatory Model.

SPEECH SIGNAL PROCESSING
9

Discrete Time Speech Signals, Fast Fourier Transform and Z-Transform, Convolution,

Linear and Non Linear Filter Banks, Spectral Estimation, Pole-Zero Modeling of Speech, Linear Prediction (LP) Analysis of Speech, Real and Complex Cepstrum, Application of Cepstral Analysis.

SPEECH RECOGNITION
9

Feature Extraction- Static and Dynamic Features for Speech Recognition, Robustness Issues, Discrimination in the Feature Space, Feature Selection, Mel Frequency Cepstral Co-efficients (MFCC), Linear Prediction Cepstral Coefficients (LPCC), and Perceptual LPCC. Distance Measures for Comparing Speech Patterns- Log Spectral Distance, Cepstral Distances, Weighted Cepstral Distances, Distances for Linear and Warped Scales.

SPEECH RECOGNITION MODEL
9

Dynamic Time Warping for Isolated Word Recognition, Statistical Models for Speech Recognition, Vector Quantization Models for Speaker Recognition, Gaussian Mixture Modeling for Speaker and Speech Recognition, Discrete and Continuous Hidden Markov Modeling for Isolated Word and Continuous Speech Recognition, HTK tool.

SPEECH CODING
9

Speech Apparatus, Models of Vocal Tract, Speech Coding using Linear Prediction, CELP Coder, Waveform Coding, Vocoders, Vocoders Attributes.

Total: 45 periods

TEXT BOOKS

1. Digital Processing of Speech Signals, L. R. Rabinerand R. W. Schafer, Pearson Education.

2. Discrete-Time Speech Signal Processing: Principles and Practice, Thomas F. Quatieri, Cloth, ISBN: 013242942X Published: OCT 29, 2001.

3. Fundamentals of Speech Recognition, L. Rabiner and B. Juang, Prentice-Hall Signal Processing Series, Year of Publication: 1993, ISBN:0-13-015157-2.

REFERENCE BOOKS

1.Discrete Time Processing of Speech Signals, JRDeller, JG Proakis, JH Hansen, Year ofPublication: 1993, ISBN:0023283017.

2. Hidden Markov Models for Speech Recognition, XDHuang, Y Ariki, MA Jack, Edinburgh University Press.

VL907 ADVANCED DIGITAL IMAGE PROCESSING **L T P C**

3 0 0

3

INTRODUCTION
9

Digital Image definitions, Characteristics of Image Operations - Types ofOperations, Types of neighbourhoods, Video parameters; 2D convolution, 2DFourier Transforms, Statistical Description of Images, Steps in Digital ImageProcessing - Human Eye and visual perception - Brightness - Contrast - Hue - Saturation, Color Image Fundamentals - RGB, HSI models Optical illusions.

IMAGE SAMPLING AND QUANTIZATION
9

Two dimensional Sampling theory, Extensions of sampling theory- Non Rectangular Grid sampling, Hexagonal sampling, Optimal sampling; The Optimum Mean Square Lloyd-Max quantizer, Visual quantization, Vector Quantization.

IMAGE TRANSFORMS
9

Two dimensional orthogonal and unitary transforms- Separable unitarytransforms, Basis images, Dimensionality of Image Transforms; Discrete linearorthogonal-DFT, WHT, KLT, DCT and SVD; Quantization of Transformcoefficients, Transform Coding of Color images.

IMAGE ENHANCEMENT AND RESTORATION
9

Contrast and dynamic Range Modification, Histogram-based operations,Smoothing operations, Edge Detection-derivative based operation, ImageInterpolation and Motion Estimation, Pseudo coloring, Degradation Estimation, Reduction of Additive Noise, Reduction of Image Blurring, Simultaneous reduction of noise and blurring, Reduction of Signal dependent noise, Temporal filtering for Image Restoration, Extrapolation of Band limited Signals.

IMAGE COMPRESSION
9

Redundancies - Coding - Fidelity, Source and Channel Encoding - Elements ofInformation Theory - Lossless and Lossy Compression - Run Length Coding,Differential Encoding - DCT - Vector Quantization - Entropy Coding - LZW Coding; Image Compression Standard: JPEG, JPEG 2000, MPEG - Video compression.

Total: 45 periods

TEXT BOOKS

1. Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing", Pearson, Second Edition, 2004.

REFERENCE BOOKS

1. William K. Pratt, "Digital Image Processing", John Wiley, New York, 2002.
2. D, E. Dudgeon and RM. Mersereau, "Multidimensional Digital Signal Processing", Prentice Hall Professional Technical Reference, 1990.
3. Anil K. Jain, "Fundamentals of Digital Image Processing", Pearson, 2002.

VL908 ADVANCED CMOS DEVICES AND TECHNOLOGY **L T P C**

3 0 0

3

FUNDAMENTALS
9

History of Si technology, Review of CMOS scaling.Problems with traditional geometric scaling.Power crisis. Review of basic quantum mechanics. Mobility enhancement techniques.Review of stress and strain, how it affects band structure of silicon.Types and realization of stress elements.Problems with stress elements.

HIGH-K GATE DIELECTRIC AND PROCESS
9

Gate oxide scaling trend.Urgency to switch gate dielectric material.High K material selection. Fermi level pinning Processintegration of high K gate dielectrics and metal gates Multi-gate transistors. Ways of realization. Fabrication issues and integration challenges.

SOI DEVICES
9

Basic principle of MOSFETs, Introduction to classical planer bulk MOSFETsVMOSdevices.Introduction to SOI Technology, radiation hardness capability. Partially depleted SOI MOSFET, Fully depleted SOI MOSFET. Single gate SOI MOSFET, Double Gate SOI MOSFET.kink effect, Floating Body effect. Applications of SOI MOSFET.Comparison with Classical planer bulk MOSFET.

MULTIGATE CMOS DEVICES
9

Introduction to Finfets.Ways of realization. Fabrication issues and integration challenges.

CMOS COMPATIBLE MEMORY DEVICES **9**

Analog and digital benchmarking of models.Layout dependent effects. Test structures used for characterization.Variations and how it can affect scaling. Basics of sub wavelength lithography. Design for manufacturability.

Total: 45 Periods

TEXT BOOKS

1. Hei Wong, “Nano-CMOS Gate Dielectric Engineering,” CRC, 2011.

2. J.P. Colinge, “FinFETs and Other Multi-Gate Transistors,” Springer, 2010.

REFERENCE BOOKS

1. B. Wong, A. Mittal, Y. Cao, G. Starr, “Nano-CMOS Circuit and Physical Design”, Wiley Inter-science 2004.

2. A. Dimoulas, E. Gusev, P. McIntyre, M. Heyns, "Advanced Gate Stacks for High-Mobility Semiconductors ", Springer 2007.

VL909 INSTRUMENTATION FOR NANOTECHNOLOGY **L T P C**
3 0 0
3

INTRODUCTION **9**

Importance and basic concepts of measurements at the nanoscale. Characteristics of measurements: Error analysis, Precision, Accuracy, Standards and Calibration.

PERFORMANCE CHARACTERISTICS OF INSTRUMENTATION SYSTEMS **9**

Electromechanical instruments; Measurement of very low voltage and current; Measurement of resistance, inductance, capacitance, power, energy; Classification of

TRANSDUCERS AND INSTRUMENTATION AMPLIFIER **9**

Measurement of displacement, strain, pressure, flow, temperature, force; Signal conditioning, Instrumentation amplifier, Isolation amplifier, Signal recovery, Data transmission and telemetry; Data acquisition and conversion.

ELECTRONIC TEST EQUIPMENTS **9**

Oscilloscope, DMM, Frequency counter, Wave - Harmonic Distortion - Spectrum analyzers. Micro controllers, PC based instrumentation, Computer controlled test systems.High and ultrahigh vacuum techniques, Measurements of magnetic, thermal, mechanical and optical properties of nano materials.

MEASUREMENTS AT LOW AND HIGH TEMPERATURES. **9**

Principles and advanced applications of characterization instruments: UV-Visible, Raman and FTIR Spectrophotometers, Scanning Probe Microscopes, Scanning and transmission electron microscopes (SEM and TEM), and X-ray Diffractometer (XRD).

Total: 45 Periods

TEXT BOOKS

1. A. D. Helfrick and W. D. Cooper, "Modern Electronic Instrumentation and Measuring Techniques", Prentice-Hall of India, 1990.
2. E. O. Deobelin, "Measurement Systems - Applications and Design", McGraw-Hill, 1990.
3. C. F. Coombs,"Electronic Instruments Handbook", McGraw-Hill, 1995.
4. Frank A. Settle,"Handbook of instrumental techniques for analytical chemistry", Prentice Hall, 1997.

VL910 CAD OF VLSICIRCUITS **L T P C**
3 0 0 3

HIERARCHICAL AND STRUCTURED DESIGN
9

Introduction to hierarchical and structured design, Role of CAD tools in the VLSI design process; CAD algorithms for switch level and circuits simulation, Techniques and algorithms for symbolid layout, Algorithms for physical design – Placement and routing algorithms, Compaction, circuit extraction and testing.

INTRODUCTION TO VHDL
9

Specification of combinational systems using VHDL, Introduction to VHDL, Basic language element of VHDL, Behavioral Modeling, Data flow modeling, Structural modeling, Subprograms and overloading, VHDL description of gates.

DESIGN OF SEQUENTIAL CIRCUITS **9**

Description and design of sequential circuits using VHDL, Standard combinational modules, Design of a Serial Adder with Accumulator, State Graph for Control Network, design of a Binary Multiplier, Multiplication of a Signed Binary Number, Design of a Binary Divider.

REGISTER-TRANSFER LEVEL AND DATA SUBSYSTEMS
9

Execution Graph, Organization of System, Implementation of RTL Systems, Analysis of RTL Systems, Design of RTL Systems.Data Subsystems, Storage Modules, Functional Modules, Data paths, Control Subsystems, Micro programmed Controller, Structure of a micro programmed controller, Micro instruction Format, Micro instruction sequencing, Micro instruction Timing, Basic component of a micro system, memory subsystem.

I/O SUBSYSTEM
9

Processors, Operation of the computer and cycle time. Binary Decoder, Binary Encoder, Multiplexers and Demultiplexers,Floating Point Arithmetic-Representation of Floating Point Number, Floating Point Multiplication. Adders, Multipliers.

Total: 45 Periods

TEXT BOOKS

1. J. Bhaskar, “A VHDL Primer”, Addison Wesley, 1999.
2. M. Ercegovac, T. Lang and L.J. Moreno, “Introduction to Digital Systems”, Wiley, 2000
3. C. H. Roth, “Digital System Design using VHDL”, PWS Publishing
4. G. DeMicheli, “Synthesis and optimization of digital circuits”, McGraw Hill.

REFERENCEBOOKS

1. J.F. Wakerly, “Digital Design-Principles and Practices”, PHL
2. Douglas Perry, “VHDL”, MGH
3. Michae John Sebastian Smith, “Application-Specific Integrated Circuits”, Addison-Wesley.
4. Z. Navabi, “VHDL-Analysis and Modeling of Digital Systems”, MGH
5. W. Fichtner, and M. Martin, “VLSI CAD tools and Applications” Kluwer Academic Publishers, 1987

VL911 OPTIMAL AND ADAPTIVE SIGNAL PROCESSING **L T P C**
3 0 0 3

ADAPTIVE SYSTEMS:
9

Adaptive systems - definitions and characteristics - applications - properties- examples -

adaptive linear combiner-input signal and weight vectors - performance function-gradient andminimum mean square error - introduction to filtering-smoothing and prediction – linearoptimum filtering-orthogonality - Wiener – Hopf equation-performance surface

THEORY OF ADAPTATION WITH STATIONARY SIGNALS
9

Searching performance surface-stability and rate of convergence - learning curve-gradientsearch - Newton's method - method of steepest descent - comparison - gradient estimation -performance penalty - variance - excess MSE and time constants – misadjustments

IMPORTANT ADAPTIVE ALGORITHMS
9

LMS algorithm convergence of weight vector-LMS/Newton algorithm - properties -

sequential regression algorithm - adaptive recursive filters - random-search algorithms -

lattice structure - adaptive filters with orthogonal signals

APPLICATION OF ADAPTIVE SIGNAL PROCESSING
9

Applications-adaptive modeling and system identification-adaptive modeling for multipathcommunication channel, geophysical exploration, FIR digital filter synthesis, inverseadaptive modeling, equalization, and deconvolution-adaptive equalization of telephonechannels-adapting poles and zeros for IIR digital filter synthesis

GRADIENT ESTIMATION AND ITS EFFECTS ON ADAPTATION 9

Gradient component estimation by derivative,measurement, performance penalty, Variances of the gradient estimate, effects on the weight – vectorsolution, Excess mean square error and time constants, misadjustments, total misadjustments and otherpractical considerations

Total: 45 Periods

TEXT BOOKS

1 Bernard Widrow and Samuel D. stearns, “Adaptive Signal Processing”, Person Education, 2005.

2 Simon Haykin, “Adaptive Filter Theory”, Pearson Education, 2003.

3 John R. Treichler, C. Richard Johnson, Michael G. Larimore, “Theory and Design of Adaptive Filters”, Prentice-Hall of India, 2002

REFERENCES TEXT BOOKS

1 S. Thomas Alexander, “Adaptive Signal Processing - Theory and Application”, Springer-Verlag.

2 D. G. Manolokis, V. K. Ingle and S. M. Kogar, “Statistical and Adaptive Signal Processing”, McGraw Hill International Edition, 2000

VL912 OPTICAL IMAGING TECHNIQUES **L T P C**

3 0 0 3

INTRODUCTION **9**

Classes of optical phenomena: quantum optics - geometrical (ray) optics - physical (wave) optics - Nature of Light - Wave Model- 1-D Oscillations longitudinal and transverse oscillations harmonic and anharmonic oscillations amplitude - period –frequency - angular frequency - phase Mathematical representation of harmonic oscillations sinusoids complex notation - complex numbers - phasors

SUPERPOSITION AND COHERENCE **9**

Superposition of oscillations with same frequency - linear and nonlinear media - computing resultants: amplitude and phase - Superposition of oscillations with different frequencies - linear and nonlinear media - average and modulation frequencies - examples: beats, aliasing, Moiré fringes - Coherence - Fourier representation of oscillations, spectra - Traveling waves, derivation of representations - dispersion - phase and group velocities

IMAGING IN RAY MODEL **9**

Fermat's principle - Snell's Law for reflection and refraction - Refraction from a single spherical surface, paraxial approximation - Thin lens equation - Lens Systems - Multiple thin lenses - Thick lenses

IMAGING IN WAVE MODEL 9

Interference and interferometers - Division of wavefront (Young's experiment, Fresnel mirror) - Division of amplitude (Michelson) - Multiple-beam interference - Thin films - Optical coatings to enhance and diminish reflectivity -Fabry-Perot interferometer

DIFRRACTION AND EFFECTS ON IMAGING SYSTEMS 9

Diffraction - Huygens-Fresnel principle, spherical "wavelets" - Diffraction integrals - Fresnel diffraction, the Fresnel Zone Plate -Diffraction gratings - Fraunhofer diffraction – holography - Effects of diffraction on imaging systems - blur circles – OTF - MTF

Total: 45 Periods

TEXT BOOKS

1. Okan K. Ersoy, “Diffraction, Fourier Optics and Imaging”, J. Wiley, 2007.
2. J. W. Goodman, “Introduction to Fourier Optics”, McGraw Hill, second edition, 1996.

3. R.G. Wilson, “Fourier series and Optical Transform Techniques in Contemporary Optics”, J. Wiley, 1995.

REFERENCE BOOKS

1. H. Stark, “Applications of Optical Fourier Transforms”, Academic Press, 1982.
2. B. E. Saleh, “M. C. Teich, Fundamentals of Photonics”, J. Wiley, 1991.
3. M.V. Klein, T.E. Furtak, “Optics”, J. Wiley, 2nd edition, 1986.
4. D. Marcuse, “Theory of Dielectric Optical Waveguides”, Academic Press, 1991.

VL913 COMPACT MODELING OF DEVICES FOR IC DESIGN **L T P C**
3 0 0
3

Fundamentals 9

Basic Semiconductor Physics: Distribution function and carrier concentration. Heavy doping effects and band gap narrowing. Majority and minoritycarrier mobilities.SRH and Auger models for recombination.

Modelling of BJT 9

Bipolar Transistors, modern bipolar transistors, regional approach, DC characteristics under various injection levels, transit time and capacitance components, high current effects, integral charge control relation (ICCR), field based modeling, one dimensional intrinsic bipolar transistor model development, internal base impedance, two/three dimensional effects and complete transistor modeling, temperature effects.

Industry Standard Models 9

Industry standard models like SGP, VBIC and MEXTRAM. Hierarchical modeling strategy and application circuits.

MOS Modelling 9

MOS Transistors: Pao-Sah model, charge sheet approximation, surface potential, large signal modeling of MOSFET: quasi-static and non-quasi-static effects, threshold voltage based models, gummel symmetry and its effects in

compact MOS models, charge based EKV model, surface potential based model formulation, LDMOS model development, PSP model features, future MOS model scenario.

Modelling of JFET and MESFET **9**

Models for JFET and MESFET: Draincurrents of JFET and MESFET. Classical description and models for short channel transistors.

Total: 45 Periods

TEXT BOOKS

1. SM Sze, "Modern Semiconductor Device Physics", John Wiley & Sons, 2000.
2.
3. B.G. Streetman & S. Baneerjee, Solid State Electronic Devices, PHI.
4. YannisTsividis and Colin McAndrew, "Operation and Modeling of MOS Transistor",Oxford University Press, 2011.
5. JorgBerkner, "Compact Models for Bipolar Transistors," Infineon Technologies Munich, 2002.
6.

REFERENCES TEXT BOOKS

1. Chih-Tang Sah, Fundamentals of Solid-State Electronics, World Scientific Publishing Company, Singapore pp. 1001, 1991.
2. Process and Device Simulation for MOS-VLSI Circuits, edited by P. Antognetti, D.A. Antoniadis , Robert W. Dutton, W.G. Oldham, kluwer Academic Publisher, 2000.
3. Kang &Leblebigi "CMOS Digital IC Circuit Analysis & Design"- McGraw Hill, 2003

VL 914 OPTICAL SENSORS **L T P C**

3 0 0 3

FUNDAMENTAL OF SENSORS
9

Sensor characteristics: nonlinearities – hysteresis - cross sensitivity - Transfer characteristics - sensor response - Temperature sensors – Pressure sensor – Optical sensors.

OPTOELECTRONICS AND OPTICAL MODULATION
9

Optoelectronic materials - propagation in slabs - coupled mode theory - edge couplers- switches - integrated optical modulators – Electro optic and acousto-optic modulation.

OPTICAL COMPONENTS
9

Integrated optic gates – memories - signal processing technology - Optical A/D, D/A converters - Spectrum analysers - F-P resonators - Self focusing and optical polarization - TE-TM modesplitter,

OPTICAL SENSORS
9

Photonic counters - light dependent resistors (LDRs) - photo diodes - semiconductor physics; Charge accumulation and charge transfer elements - charge coupled devices (CCDs) - Time-of-flight principle

COUPLERS AND OPTICAL AMPLIFIERS
9

Quantum well structures parametric devices - Tunable couplers - Optical amplifiers- Raman amplifiers - Photonic switching based on quantum well structure.

Total: 45 Periods

TEXT BOOKS

1. J Haus, "Optical sensors: Basic and applications", Wiley – VCH, 1st edition, 2010.

VL915 ANALOG VLSI DESIGN **L T P C**

3 0 0 3

INTRODUCTION TO ANALOG VLSI **9**

Analog integrated circuit design, Circuit design consideration for MOS challenges in analog circuit design, Recent trends in analog VLSI circuits. Analog MOSFET Modelling MOS transistor, Low frequency MOSFET Models, High frequency MOSFET Models, Temperature effects in MOSFET, Noise in MOSFET.

CURRENT SOURCE, SINKS AND REFERENCES
9

MOS Diode/Active resistor, Simple current sinks and mirror, Basic current mirrors, Advance current mirror, Current and Voltage references, Bandgap references.

CMOS AMPLIFIER AND CMOS FEEDBACK AMPLIFIER
9

Performances matrices of amplifier circuits, Common source amplifier, Common gate amplifier, Cascode amplifier, Frequency response of amplifiers and stability of amplifier. Feedback equation, Properties of negative feedback on amplifier design, Feedback Topology, Stability.

CMOS DIFFERENTIAL AMPLIFIER AND CMOS OPERATIONAL AMPLIFIER
9

Differential signalling, source coupled pair, Current source load, Common mode rejection ratio, CMOS Differential amplifier with current mirror load,, Differential to single ended conversion. Block diagram of Op-amplifier, Ideal characteristics of Op-Amplifier, Design of two stage OpAmplifier, Compensation of Op-Amplifier, Frequency response of Op-Amplifier, Operational Transconductance Amplifier OTA.

CMOS COMPARATOR AND INTRODUCTION TO SWITCHED CAPACITOR CIRCUITS
9

Characteristic of a comparator, Two stage open loop comparator, Special purpose comparator, Regenerative comparator, High output current amplifier, High speed comparator. Switched capacitor circuits, Switched capacitor amplifiers, Switch capacitor integrators.

Total Periods:45

TEXT BOOK

1. Design of Analog CMOS Integrated Circuits by Behzad Razavi McGraw Hill.
2. CMOS: Circuit Design , Layout and Simulation by R. Jacob Baker, Harry W. Li, and David E. Boyce, Prentice Hall of India

REFERENCE BOOKS

1. Analog Integrated circuit Design by David A. Johns and Ken Martin, John Wiley & Son

VL916 QUANTUM ELECTRONICS **L T P C**
3 0 0
3

SEMICONDUCTOR LASER
9

Homojunction laser: Population inversion at a junction, Emission spectra, The basic semiconductor laser; Heterojunction: Formation of ideal heterojunctions between (a) a p-type wide band-gap semiconductorand an n-type narrower band-gap semiconductor, (b) an n-type wide band-gap semiconductor and a p-type narrower band-gap semiconductor, (c) wide and lightly doped narrower band gap n-type semiconductors; Anderson's model of ideal heterojunction. Heterojunction laser: Single and double heterojunction laser; Analysis of carrier confinement in a single heterojunction laser.

ELECTRONS IN QUANTUM STRUCTURES
9

Energy level and wave functions for quantum well, quantum wire and quantum dot; Density of statesfor quantum well, quantum wire and quantum dot; Modulation - doped quantum well; Multiplequantum well; Coupling between quantum wells.Super lattice: The concept of a super lattice; Krönig-Penney model of a super lattice - zone folding,tight binding approximation for a super lattice

ELECTRO-OPTIC EFFECT AND TRANSPORT IN QUANTUM STRUCTURES

9

Franz-Keldysh effect in Semiconductor, Electro-optic effect in quantum wells, Electro-optic effect insuper lattice.High field electron transport - Hot electrons in quantum structures, Double barrier resonant-tunnelingstructures, Super lattices and ballistic injection devices.

GUIDED WAVE OPTICS
9

Waveguide modes, Modes characteristics for a planar waveguide, Step index planar waveguide, Maxwell equations in inhomogeneous media: TE modes and TM modes, Radiation modes, Guided modes, Leaky modes,Quasi modes.Propagation in optical fibre, Numerical aperture, Pulse dispersion in fibres, Scalar wave equation and modes of the fibre, Modal analysis for a step index fibre.

QUANTUM TRANSISTOR AND MASER
9

Resonant-tunneling unipolar and bipolar transistor; Velocity modulation and quantum interferencetransistor.Ammonia beam maser, Energy levels, Methods for population inversion, Maser operation.

Total: 45 Periods

TEXT BOOKS

1. Mitin, Kochelap and Stroscio, "Quantum Heterostructures: Microelectronics and Optoelectronics", 1st edition, Cambridge University Press.
2. A. Yariv, "Quantum Electronics", 3rd edition, Wiley publication.
3. O. Svelto, "Principles of Lasers", 5th edition, Springer.

REFERENCE BOOKS

1. A.K. Ghatak and K. Thyagarajan, “Optical Electronics”, Cambridge university press.
2. Martinez-Duart, Martin-Palma, Agullo-Rueda, “Nanotechnology for Microelectronics and Optoelectronics”, Elsevier Science & Technology Books, 2006.
3. P. Bhattacharyya, “Semiconductor Optoelectronics Devices”, Prentice Hall.
4. R.W. Boyd, “Nonlinear Optics”, 3rd edition. Academic press.
5. T. Suhara, “Semiconductor laser fundamentals”, 1st edition, CRC press.
6. S.M. Sze, “Physics of Semiconductor Devices”, Wiley publication.

EVEN

SEMESTER

ELECTIVES

Course Code	Course Title	L	T	P	C
VL951	Transducers for Instrumentation and Process	3	0	0	3
VL952	Testing of VLSI Circuits	3	0	0	3
VL953	Telecommunication Switching Systems	3	0	0	3
VL954	CMOS RF Circuit Design	3	0	0	3
VL955	RF System Design	3	0	0	3
VL956	FPGA Based System Design	3	0	0	3
VL957	Solar Cells, Device Physics and Materials Technology	3	0	0	3
VL958	Nanoelectronics: Devices and Materials	3	0	0	3
VL959	Information and Coding Theory	3	0	0	3
VL960	Bio-Medical Electronic Systems	3	0	0	3

VL961	Advanced Wireless Mobile Communication	3	0	0	3
VL962	VLSI Signal Processing	3	0	0	3
VL963	Wavelet Transforms and Applications	3	0	0	3
VL964	Integrated Optoelectronic Devices and Circuits	3	0	0	3

VL951 TRANSDUCERS FOR INSTRUMENTATION & PROCESS L T P C
3 0 0 3

FUNDAMENTALS
9

Measurements and measurement systems: measuring instruments, measurementsystems functional elements and block diagram of a measurement

system. Classification of measuringinstruments, standards calibration of measuring instruments.Generalised performance characteristics Amplitude modulation for data handling Demodulator circuits

PASSIVE TRANSDUCERS
9

Passive Transducers: Resistance potentiometers - Nonlinearity due to electrical loading, Linearisation, Strain guagesassociated electrical circuitry.Temperature compensation, Load cells, Torque and pressure measurement using strain guages Resistance Thermometers - Three lead arrangement - Thermistors

INDUCTANCE TRANSDUCERS
9

Measurement of direction of flow - Inductance Transducers: General factors governing the design of inductance transducers - Transverse armature and plunger types - Sensitivity and nonlinearity - Associated Bridge circuits - Choice of components - LVDT - Expression for mutual inductance variation, Null voltage, Lead and lag networks, Application of LVDTs.

CAPACITANCE TRANSDUCERS
9

Capacitance transducers: Various configurations - Sensitivity and non-linearity factors-Associated circuits - Seismic Pickups: Transfer function, frequency response - Force balance Transducers: Theory - Servo-systems for measurement of non-electrical quantities –

ACTIVE TRANSDUCERS
9

Active Transducers: Electrodynamic transducers- thermocouples - piezoelectric sensors - use of charge amplifier with piezoelectric sensors - Overall instrumentation system for measurement of nonelectrical quantities like displacement, velocity, acceleration, force, pressure, sound, flow, temperature etc.

Total: 45 Periods

TEXT BOOKS

1. C.S. Rangan, G.R. Sarma and V.S.V. Mani "Instrumentation Devices and Systems", Tata Mcgraw-Hill Publishing Company Ltd. New Delhi, 1983.
2.
3. A.K. Sawhney, "Electrical and electronic measurements and instrumentation".

REFERENCES TEXT BOOKS

1. H K P Neubert, "Instrument Transducers", Oxford University Press, 1963.

2. B. C. Nakra and K. K. Choudhari, "InstrumentationMeasurement and Analysis," Tata McGraw Hill Pub, 1985.

VL952 TESTING OF VLSI CIRCUITS **L T P C**
3 0 0 3

MOTIVATION FOR TESTING **9**

Design for testability, the problems of digital and analog testing, Design for test, Software testing.Faults in Digital Circuits: General introduction, Controllability

and Observability, Fault models - stuck-at faults, Bridging faults, Intermittent faults.

DIGITAL TEST PATTERN GENERATION
9

Test pattern generation for combinational logic circuits, Manual test pattern generation,

Automatic test pattern generation - Roth's D-algorithm, Developments following Roth's D-algorithm, Pseudorandom test pattern generation, Test pattern generation for sequential circuits, Exhaustive, non-exhaustive and pseudorandom 70 test pattern Generation, Delay fault testing .

SIGNATURES AND SELF TEST
9

Input compression output compression arithmetic, Reed-Muller and spectral coefficients,

Arithmetic and Reed-Muller coefficients,Spectral coefficients, Coefficient test signatures, Signature analysis and online self test.

TESTABILITY TECHNIQUES
9

Partitioning and ad-hoc methods and scan-path testing, Boundary scan and IEEE standard 1149.1, Offline built in Self Test (BIST), Hardware description languages and test.

TESTING OF ANALOG AND DIGITAL CIRCUITS 9

Testing techniques for Filters, A/D Converters, RAM, Programmable logic devices and DSP, Test generation algorithms for combinational logic circuits – fault table, Boolean difference, Path sensitilization, D-algorithm, Podem, Fault simulation techniques – serial single fault propagation, Deductive, Parallel and concurrent simulation, Test generation for a sequential logic, Design for testability – adhoc and structured methods, Scan design, Partial scan, Boundary scan, Pseudo-random techniques for test vector generation and response compression, Built –in-Self- test, PLA test and DFT.

Total: 45 Periods

TEXT BOOKS

1. M. Abramovici, M.A Breuer and A.D. Friendman, Digital systems and Testing and Testable Design, Computer Science Press 1990.
2. Michael L. Bushnell and Vishwani D. Agrawal, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwer Academic Publishers: New York.

REFERENCE BOOKS

1. Stanley L. Hurst, VLSI Testing: digital and mixed analogue digital techniques Pub: Inspec / IEE, 1999

VL953 TELECOMMUNICATION SWITCHING SYSTEM **L T P C**
3 0 0
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TELECOMMUNICATION SWITCHING AND TRAFFIC **9**

Message switching, Circuit switching, Manual switching and Electronic Switching. Digital switching: Switching functions, space division switching, time division switching, two dimensional switching, digital cross connect systems, Traffic measurement, A mathematical model, Lost- call systems: Theory, traffic performance, loss systems in tandem. Queuing systems: Erlang Distribution, probability of delay, Finite queue capacity, systems with a single server, Queues in tandem, delay tables and application of Delay formulae. Analysis: Traffic Characteristics: Arrival Distributions, Holding time Distribution

SWITCHING **NETWORKS**
9

Single Stage Networks, Gradings: Principle, Design of progressive grading, Traffic capacity of gradings, Applications of gradings. Link Systems: General, 2-stage networks, 3-stage networks, 4-stage networks. Grades of service of link systems: General, 2-stage networks, 3-stage networks, 4-stage networks ,Call packing, Rearrangeable networks, Strict sense non blocking networks, Sectionalized switching networks Control of Switching Systems: Call processing Functions: Sequence f operations, Signal exchanges, State transition diagrams.Common Control, Availability and Security.Signaling:Customer linesignaling.Outband signaling, Inband signaling**.**

NETWORK SYNCHRONIZATION AND MANAGEMENT 9

Timing: Timing Recovery, Clock Instability, Elastic Stores, Jitter measurements, systematic jitter. Timing Inaccuracy: Slips, Asynchronous Multiplexing, Waiting time jitter. Network Synchronization: Plesiochronous, pulse stuffing, mutual synchronization, Network master, Master – Slave synchronization, Hierarchical synchronization Processes. Network management: Routing control, Flow control 31**.**

NETWORKS 9

Data Networks: Data Transmission in PSTN, Data Communication Architecture, Link to link layers, End to End layers, Satellite based Data networks, LANs, MANs, Fibre optic networks, Data network Standards, Protocol stacks, Interworking. Integrated Services Digital Networks: ISDN, Network and protocol Architecture, Transmission Channels, User network interfaces, signaling, Numbering and Addressing, ISDN Standards, Broadband ISDN, Voice Data Integration**.**

CELLULAR TELEPHONE CONCEPTS 9

Mobile telephone services, cellular telephone, Frequency reuse, Interference, Cellular system topology, Roaming and handoffs, Cellular telephone network

components, Cellular telephone call processing. Cellular Telephone systems: Digital cellular telephone, IS–95. GSM GPRS for Mobile communications, Personal Satellite communication system**9**

Total: 45Periods

TEXT BOOKS

1. J. E. Flood , "Telecommunications Switching, Traffic and Networks", Pearson Education
2. ThiagarajanVishwanathan, "Telecommunication Switching Systems and Networks"; PHI Publications

REFERENCE BOOKS

1. John C. Bellamy, "Digital Telephony", Third Edition; Wiley Publications
2. Wayne Tomasi, "Electronic Communications Systems"; 5th Edition; Pearson Education

VL954 CMOS RF CIRCUIT DESIGN **L T P C**
3 0 0 3

INTRODUCTION TO RF DESIGN AND WIRELESS TECHNOLOGY 9

Design and Applications, 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.

RF MODULATION AND RF TESTING 9

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

BJT AND MOSFET BEHAVIOR AT RF FREQUENCIES 9

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.

RF CIRCUITS DESIGN 9

RF filter: Overview; Basic resonator and filter configuration, Special filter realizations, Filter implementations, Coupled filter. PLL and frequency synthesizers: Linearised Model, Noise properties, Phase detectors, Loop filters and Charge pumps, Integer- N frequency synthesizers, Direct Digital Frequency synthesizers

RF AMPLIFIERS, OSCILLATORS AND MIXERS 9

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, various mixers- working and implementation. Oscillators- Basic topologies VCO and definition of phase noise, Noise power and trade off. Radio frequency Synthesizers- PLLS, Various RF synthesizer architectures and frequency dividers, Design issues in integrated RF filters

Total: 45 Periods

TEXT BOOKS

1. R. Jacob Baker, H.W. Li, D.E. Boyce “CMOS Circuit Design, layout and Simulation”, PHI.
2. B.Razavi, “RF Microelectronics”, Pearson Education, 1997.

REFERENCES TEXT BOOKS

1. Thomas Lee, “Design of CMOS RF Integrated Circuits”, Cambridge university press, 2004.
2. Y.P. Tsividis, “Mixed Analog and Digital Devices and Technology”, TMH 1996.

VL955 RF SYSTEM DESIGN **L T P C**
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TRANSMISSION LINE THEORY
9

Review of Transmission Line Theory: Lumped element model, field Analysis of transmission lines, terminated lossless Lines, SWR, and Impedance Mismatches.Planar Transmission-Lines: Stripline, Microstrip, coplanar-line. Smith Chart: reflection coefficient, load impedance, impedance transformation, admittance transformation, parallel and series connection. Revision of S-parameters.

CMOS PHYSICS, TRANSCEIVER SPECIFICATIONS AND ARCHITECTURES

9

Introduction to MOSFET Physics, Noise: Thermal, shot, flicker, popcorn noise, Two port Noise theory, Noise Figure, THD, IP2, IP3, Sensitivity, SFDR, Phase noise -Specification distribution over a communication link, Homodyne Receiver, Heterodyne Receiver, Image reject, Low IF Receiver Architectures Direct up conversion Transmitter, Two step up conversion Transmitter

IMPEDANCE MATCHING NETWORKS
9

Impedance Matching using Discrete Components, Microstripline Matching Networks, Single Stub Matching Network , Double Stub Matching Network. Quarter-Wave Transformers, Multi-Section and Tapered Transformers.

RF FILTER DESIGN, PLL AND FREQUENCY SYNTHESIZERS
9

RF filter: Overview; Basic resonator and filter configuration, Special filter realizations, Filter implementations, Coupled filter. PLL and frequency synthesizers: Linearised Model, Noise properties, Phase detectors, Loop filters and Charge pumps, Integer- N frequency synthesizers, Direct Digital Frequency synthesizers

RF AMPLIFIERS, OSCILLATORS AND MIXERS 9

Characteristics; Amplifier Power Relations, Stability Considerations, Constant Gain circles, Noise figure circles, Constant VSWR Circles, Low Noise Circuits; broadband, high power and multistage amplifiers, Basic oscillator model, High frequency oscillator configurations, Basic characteristics of mixers.

Total: 45 Period

TEXT BOOKS

1. Reinhold Ludwig & Powel Bretchko, "RF Circuit Design – Theory and Applications", 1st Ed., Pearson Education Ltd., 2004.
2. B.Razavi, "RF Microelectronics", Pearson Education, 1997.
3. David M. Pozzar, "Microwave Engineering", 3rd edition, Wiley India, 2007.
4. Mathew M. Radmanesh, "Radio Frequency and Microwave Electronics", 2nd edition, Pearson Education Asia, 2006.

REFERENCE BOOKS

1. T.Lee, "Design of CMOS RF Integrated Circuits", Cambridge, 2004.
2. Jan Crols, MichielSteyaert, "CMOS Wireless Transceiver Design", Kluwer Academic Publishers, 1997.
3. B.Razavi, "Design of Analog CMOS Integrated Circuits", McGraw Hill, 2001.

4. Mathew M. Radmanesh, “Advanced RF & Microwave Circuit Design-The Ultimate Guide to System Design”, Pearson Education Asia, 2009.

VL956 FPGA BASED SYSTEM DESIGN **L T P C**
3 0 0 3

MULTIRATE SIGNAL PROCESSING **9**

Decimation and Interpolation.Spectrum of decimated and interpolated signals, Polyphase decomposition of FIR filters and its applications to multirate DSP.Sampling rate converters, Sub-band encoder.

FILTER BANKS **9**

Uniform filter bank. direct and DFT approaches. Introduction to ADSL Modem.Discrete multitone modulation and its realization using DFT. QMF.Short time Fourier Transform Computation of DWT using filter banks.Implementation and verification on FPGAs.

CORDIC
9

DDFS- ROM LUT approach. Spurious signals, jitter. Computation of special functions using CORDIC.Vector and rotation mode of CORDIC.CORDIC architectures.Implementation and verification on FPGAs.

SOFTWARE RADIO
9

Block diagram of a software radio. Digital downconverters and demodulators.Universal modulator and demodulator using CORDIC. Incoherent demodulation - digital approach for I and Q generation, special sampling schemes. CIC filters. Residue number system and high speed filters using RNS. Down conversion using discrete Hilbert transform. Undersampling receivers, Coherent demodulation schemes.

SPEECH CODING
9

Speech apparatus.Models of vocal tract.Speech coding using linear prediction.CELP coder.An overview of waveform coding.Vocoders.Vocoder attributes. Block diagrams of encoders and decoders of G723.1, G726, G727, G728 and G729.

Total: 45 Period

TEXT BOOKS

1. J. H. Reed, “Software Radio”, Pearson, 2002.

2. U. Meyer – Baese , “Digital Signal Processing with FPGAs”, Springer, 2004

REFERENCE BOOKS

1. Tsui, “Digital Techniques for Wideband receivers”, Artech House, 2001.
2. S. K. Mitra, “Digital Signal processing”, McGrawHill, 1998

VL957 SOLAR CELLS, DEVICE PHYSICS AND MATERIALS TECHNOLOGY **L T P C**
3 0 0 3

SOLAR CELL FUNDAMENTALS
9

Fundamentals of solar cells: types of solar cells-semiconducting materials- band gap theory - absorption of photons - excitons and photoemission of electrons - band engineering - solar cell properties and design- p-n junction photodiodes- depletion region- electrostatic field across the depletion layer- electron and holes transports.

DEVICE PHYSICS
9

Charge carrier generation, recombination and other losses, I-V characteristics, output power- Single junction and triple-junction solar panels, metal-semiconductor heterojunctions, and semiconducting materials for solar cells.

CELL INTERCONNECTS AND EQUIVALENT CIRCUITS 9

PV cell interconnection- module structure and module fabrication -Equivalent circuits, load matching, efficiency- fill factor and optimization for maximum power;

PHOTOVOLTAIC SYSTEMS 9

Design of stand-alone PV systems - system sizing, device structures, device construction, installation, measurements – DC to AC conversion, inverters, on-site storage and grid connections - Solar cell manufacturing processes: material resources - chemistry, and environmental impacts - low cost manufacturing processes.

THIN FILM SOLAR CELLS 9

Single crystal - polycrystalline and amorphous silicon solar cells - cadmium telluride thin-film solar cells - conversion efficiency; Current trends in photovoltaic research and applications - nanotechnology applications, quantum dots, solution based processes solar cell production.

Total: 45 Periods

TEXT BOOKS

1. System on Chip design Martin A. Green, “Solar Cells: Operating Principles, Technology and system Applications”, Published by the University of New South Wales, 1998.
2. Jenny Nelson, “The Physics of Solar Cells”, Imperial College Press, 2003.
3. Stephen J. Fonash, “Solar Cell Device Physics”, Academic Press, 2nd edition, 2010.

REFERENCES TEXT BOOKS

1. D. Yogi Goswami, “Principles of Solar Engineering”, Taylor and Francis, 2000.
2. Applied Photovoltaics, Stuart Wenham, Martin Green, and Muriel Watt, Earthscan, 2007.
3. S. M.Sze,“Semiconductor Devices, Physics, and Technology”, Second Edition, New York, NY: Wiley, 2001.

VL958 NANOELECTRONICS: DEVICES AND MATERIALS **L T P C**
3 0 0 3

OVERVIEW 9

Nano devices, Nano materials, Nano characterization. Definition of Technology node, Basic CMOS Process flow.MOS Scaling theory, Issues in scaling MOS transistors : Short channel effects, Description of a typical 65 nm CMOS technology.Requirements for Non classical MOS transistor.

MOS CAPACITOR 9

MOS capacitor, Role of interface quality and related process techniques, Gate oxide thickness scaling trend, SiO_2vs High-k gate dielectrics. Integration issues of high-k. Interface states, bulk charge, band offset, stability, reliability - Qbd high field, possible candidates, CV and IV techniques. Metal gate transistor: Motivation, requirements, Integration Issues.

MOSFET STRUCTURE 9

Transport in Nano MOSFET, velocity saturation, ballistic transport, injection velocity, velocity overshoot. Metal source/drain junctions - Properties of Schottky junctions on Silicon, Germanium and compound semiconductors –Work function pinning. Germanium Nano MOSFETs: strain, quantization, Advantages of Germanium over Silicon, PMOS versus NMOS. Compound semiconductors - material properties,

MESFETs Compound semiconductors MOSFETs in the context of channel quantization and strain, Hetero structure MOSFETs exploiting novel materials, strain and quantization.SOI - PDSOI and FDSOI. Ultrathin body SOI - double gate transistors, integration issues, Vertical transistors – Fin FET and Surround gate FET.

SYNTHESIS AND CHARACTERIZATIONS OF NANOMATERIALS 9

CVD, Nucleation and Growth, ALD, Epitaxy, MBE. Compound semiconductor hetero-structure growth and characterization: Quantum wells and Thickness measurement techniques: Contact - step height, Optical - reflectance and ellipsometry.AFM. Characterization techniques for nanomaterials: FTIR, XRD, AFM, SEM, TEM, EDAX etc.

APPLICATIONS 9

Applications in emerging nano materials: Nanotubes, nanorods and other nano structures, LB technique, Soft lithography etc. Microwave assisted synthesis, Self assembly etc.

Total: 45 Periods

TEXT BOOKS

1. Mark Lundstrom and Jing Guo: Nanoscale Transistors: Device Physics, Modeling and Simulation, Springer, 2005
2. Karl Goser: Nanoelectronics and Nanosystems: From Transistors to Molecular and Quantum Devices, Springer 2005

REFERENCE BOOKS

1. Fundamentals of Modern VLSI Devices, Y. Taur and T. Ning, Cambridge University Press.
2. Silicon VLSI Technology, Plummer, Deal , Griffin , Pearson Education India.
3. Encyclopedia of Materials Characterization, Edited by: Brundle, C.Richard; Evans, Charles A. Jr.; Wilson, Shaun ; Elsevier.

VL959 INFORMATION THEORY AND CODING **L T P C**
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MEASURES OF INFORMATION AND CHANNEL CAPACITY
9

Entropy, Relative Entropy and Mutual Information, Basic inequalities :Jensen Inequality and its Physical application, Log-Sum inequality and its Physical application, Fano inequality and its physical application, Data Processing theorem and its Physical application, Consequences of the inequalities in the field ofInformation Theory

DESIGN OF LINEAR BLOCK CODES
9

Introduction to Coding Theory, Linear Block Codes, Generator Matrices,Linear Block Codes, Parity check matrices, Vector space view of codes, Dual codes,Dual Codes, Self-orthogonal and Self-Dual codes, Examples of dual codes, Relation between parity-check matrix and dual code Minimum Distance Decoder, Hamming Distance, Error Correcting Capability of codes, Geometric View of Decoding, Syndrome Decoder, Relationship between Minimum distance and Parity-Check Matrix

BCH AND RS CODES OVER FINITE FIELDS 9

BCH codes, Construction of BCH codes for given minimum distance, Properties of BCH codes (cyclic), their representation as polynomials, Minimum polynomials, Minimum polynomials, their construction and properties, their connection with cyclic codes, Generator polynomial of a cyclic code, Dimension of BCH codes, Examples of BCH codes, Reed-Solomon (RS) Codes, Dimension, Definition of distance, Generator polynomial, Minimum distance and binary expansion of RS codes

CODING OVER AWGN CHANNELS 9

AWGN channels, Coding gain, Encoding and decoding in AWGN channels ,Bitwise MAP Decoder, Likelihood ratios, LLRs, ML and Map decoding for Repetition codes, Probability of decoding error, Channel Capacity, Capacity for various schemes, Eb/No, Coding Gain, Coding gain performances of previously studied codes, Proof of capacity and random codes, Low-Density Parity check (LDPC) codes, Regular LDPC codes, Gallagerconstruction of LDPC codes**.**

CONVOLUTIONAL CODES AND TURBO CODES 9

Convolutional codes- Feed forward Convolutional Encoder, Trellis Representation, Viterbi Decoder for convolutional codes, Recursive convolutional encoders, Puncturing, Turbo encoders), Turbo Decoders, Free distance of convolutional codes, Trellises for block codes, Code concatenation,Turbo codes in the WiMax/3GPP standards, permutation polynomial interleavers.

Total: 45 Periods

TEXT BOOKS

1. T.M. Cover and J.A. Thomas, Elements of Information Theory, John Wiley (1991).
2. Error Control Coding (2nd edition) by Shu Lin and Daniel Costello, Pearson.
3. Introduction to Coding Theory by Ron M. Roth, Cambridge University press, 2007.

REFERENCE BOOKS

1. Modern coding theory by RudigerUrbanke and Thomas Richardson, Cambridge.
2. R.G. Gallager, Information Theory and Reliable Communication, Wiley (1968) for Discrete Memoryless Systems, Academic Press (1981).

VL960 BIO-MEDICAL ELECTRONIC SYSTEMS **L T P C**

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BIOMEDICAL SIGNALS & PHYSIOLOGICAL TRANSDUCERS **9**

Source of biomedical signal - Origin of bioelectric signals - recording electrodes - Electrodes for ECG, EMG & EEG .Physiological transducers: Pressure, Temperature, photoelectric & ultrasound transducers.

RECORDING SYSTEMS **9**

Basic recording system - General considerations for signal conditioners – Preamplifiers - Main amplifiers - Signal processing techniques. Writing systems: Direct writing recorder - ink-jet recorder - potentiometric recorder - digital recorders. Biomedical recorders: ECG, EEG & EMG.

PATIENT MONITORING SYSTEMS & AUDIOMETERS 9

Cardiac monitor - bedside patient monitor-measurement of heart rate - blood pressure, temperature -respiration rate - Arrhythmia monitor - Methods of monitoring fetal heart rate - Monitoring labor activity. Audiometers: Audiometers, Blood cell counters- Oximeter- Blood flow meter- cardiac output measurement- Blood gas analyzers.

MODERN IMAGING SYSTEMS 9

Basic principle & Block diagram of x-ray machine- x- ray Computed Tomography (CT) - Magnetic resonance imaging system (NMR) - ultrasonic imaging system.

THERAPEUTIC EQUIPMENTS 9

Cardiac pacemakers - cardiac defibrillators - Hemodialysis machine - Surgical diathermy machine - Physiotherapy: Soft wave Diathermy - microwave Diathermy, Ultrasound therapy unit. Electrotherapy Equipments - Ventilators.

Total: 45 Periods

TEXT BOOKS

1. NandiniK.Jog, “Electronics in medicine & Biomedical instrumentation”, Prentice-Hall of India Pvt.Ltd, 2006

2. K.N.Scott&A.K.Mathur, “Textbook of Biomedical instrumentation”.

3. S .N.Sarbadhikari, “Biomedical Engineering”.

REFERENCE BOOKS

1. R.S.Khandpur , “Hand book of Biomedical instrumentation”, TMH

2. Walter Welko- Witiz and Sid Doutsch, “Biomedical Instruments: Theory and Design”.

3. Lesile Cromwell, Fred J.Weibell& Erich A. Pfeiffer, “ Biomedical Instrumentation & Measurements” , PHI

VL961 ADVANCEDWIRELESS MOBILE COMMUNICATION **L T P C**
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WIRELESS COMMUNICATIONS
9

AND BROADBAND CHANNEL MODELLING

Fast Fading Wireless Channel Modeling ,Rayleigh/Ricean Fading Channels ,Bit Error Rate Performance in Fading Channels ,Diversity modeling for Wireless Communications ,Bit Error Rate Performance Improvement with diversity , Frequency Diversity, Time Diversity, Space Diversity,WSSUS Channel Modeling, RMS Delay Spread, Doppler Fading, Jakes Model, Autocorrelation, Jakes Spectrum,Impact of Doppler Fading

CELLULAR COMMUNICATIONS AND
9

MULTIPLE ACCESS TECHNIQUES

Introduction to Cellular Communications ,Frequency reuse ,Code Division Multiple Access, Time Division Multiple Access,Frequency Division Multiple Access (FDMA – Wideband and narrow band), Spread Spectrum Multiple Access – Frequency Hopped multiple Access (FHMA), Space Division Multiple Access (SDMA), Spectral efficiency of different access technologies, Packet ratio protocols – ALOHA, carrier sense Multiple Access (CSMA/CD, CSMA/CA), Packet reservation Multiple Access (PRMA)

OFDM AND MIMO **9**

Introduction to OFDM ,Multicarrier Modulation and Cyclic Prefix ,Channel model and SNR performance ,OFDM Issues – PAPR ,Frequency and Timing Offset Issues**,**Introduction to MIMO, MIMO Channel Capacity SVD and Eigenmodes of the MIMO Channel,MIMO Spatial Multiplexing – BLAST ,MIMO Diversity – Alamouti, OSTBC, MRT,MIMO - OFDM

MODERN WIRELESS MOBILE COMMUNICATION SYSTEM **9**

WPAN, IEEE 802.15, DECT, PACS, brief survey of: 1G wireless networks, 2G wireless cellular networks, GSM (radio subsystem, operation subsystem), GSM multiple access scheme, GSM channel organization, 2.5G networks, GPRS network architecture, classes of GPRS equipment, IS-95 systems, 3G (UMTS) of network architecture, WCDMA, LTE, Wi Max.

ROAMING IN WIRELESS AND MOBILE NETWORKS **9**

National and International Roaming, Interstandard Roaming, Prepaid and Postpaid Subscriber Roaming, Basic Structure of Roaming, Roaming Services.Inter-PLMN Signaling Network, Communication between a VPLMN VLR and HPLMN HLR ,Roaming Procedures, Roaming call scenarios, Short Message Services(SMS).

Total: 45Periods

TEXT BOOKS

1. Theodore Rappaport, "Wireless Communications: Principles and Practice", Prentice Hall.
2. William Stallings, "Wireless Communications & Networks".
3. Shahid K. Siddiqui, "Roaming in Wireless Networks".
4. EzioBiglieri ,"MIMO Wireless Communications", Cambridge University Press.

REFERENCE BOOKS

1. J. Schiller, "Mobile Communications", Pearson Education
2. W. C. Y. Lee, "Mobile cellular Telecommunications", 2nd Edition, McGraw Hill
3. Itisaha Mishra, "Wireless Communications & Network 3G and beyond",TataMc-Graw Hill Education Pvt. Ltd
4. KamiloFeher, "Wireless Digital Communication", PHI
5. David Tse and PramodViswanath, "Fundamentals of Wireless Communications", Cambridge University Press

VL 962 VLSI SIGNAL PROCESSING **L T P C**

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INTRODUCTION TO DSP SYSTEMS
9

Introduction To DSP Systems -Typical DSP algorithms; Iteration Bound – data flow graph representations, loop bound and iteration bound, Longest path Matrix algorithm; Pipelining and parallel processing – Pipelining of FIR digital filters, parallel processing, pipelining and parallel processing for low power.

RETIMING
9

Retiming - definitions and properties; Unfolding – algorithm for Unfolding, properties of unfolding, sample period reduction and parallel processing application; Algorithmic strength reduction in filters and transforms – 2-parallel FIR filter, 2-parallel fast FIR filter, DCT algorithm architecture transformation, parallel architectures for rank-order filters, Odd- Even Merge- Sort architecture, parallel rank-order filters.

FAST CONVOLUTION
9

Fast convolution – Cook-Toom algorithm, modified Cook-Took algorithm; Pipelined and parallel recursive and adaptive filters – inefficient/efficient single channel interleaving, Look- Ahead pipelining in first- order IIR filters, Look-Ahead pipelining with power-of-two decomposition, Clustered Look-Ahead pipelining, parallel processing of IIR filters, combined pipelining and parallel processing of IIR filters, pipelined adaptive digital filters, relaxed look-ahead, pipelined LMS adaptive filter.

BIT-LEVEL ARITHMETIC ARCHITECTURES
9

Scaling and roundoff noise- scaling operation, roundoff noise, state variable description of digital filters, scaling and roundoff noise computation, roundoff noise in pipelined first-order filters; Bit-Level Arithmetic Architectures- parallel multipliers with sign extension, parallel carry-ripple array multipliers, parallel carry-save multiplier, 4x 4 bit Baugh-Wooley carry-save multiplication tabular form and implementation, design of Lyon‟s bit-serial multipliers using Horner‟s rule, bit-serial FIR filter, CSD representation, CSD multiplication using Horner‟s rule for precision improvement.

PROGRAMMING DIGITAL SIGNAL PROCESSORS
9

Numerical Strength Reduction – subexpression elimination, multiple constant multiplications, iterative matching. Linear transformations; Synchronous, Wave and asynchronous pipelining-synchronous pipelining and clocking styles, clock skew in edge-triggered single-phase clocking, two-phase clocking, wave pipelining, asynchronous pipelining bundled data versus dual rail protocol; Programming Digital Signal Processors – general architecture with important features; Low power Design – needs for low power VLSI chips, charging and discharging capacitance, short-circuit current of an inverter, CMOS leakage current, basic principles of low power design.

Total: 45 Period

TEXT BOOKS

1. KeshabK.Parhi, "VLSI Digital Signal Processing systems, Design and implementation", Wiley, Inter Science, 1999.
2. Gary Yeap, “Practical Low Power Digital VLSI Design”, Kluwer Academic Publishers, 1998.
3. Mohammed Ismail and Terri Fiez, "Analog VLSI Signal and Information Processing", McGraw-Hill, 1994.

REFERENCES TEXT BOOKS

1. S.Y. Kung, H.J. White House, T. Kailath, "VLSI and Modern Signal Processing", Prentice Hall, 1985.
2. Jose E. France, YannisTsividis, "Design of Analog & Digital VLSI Circuits for Telecommunication and Signal Processing ", Prentice Hall, 1994. 18.

VL963 WAVELET TRANSFORMS AND APPLICATION

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INTRODUCTION 9

Introduction to Wavelet Transforms-Expansion of functions, Multi-resolution analysis, Scaling functions, MRA refinement equation, Wavelet series expansion, Discrete Wavelet Transform (DWT),Continuous Wavelet Transform, Fast Wavelet Transform, 2D wavelet Transform.

WAVELET FAMILIES
9

Orthogonal and Bi-OrthogonalWavelets, Daubechies' Family of Wavelets, Conjugate Quadrature Filter Banks (CQF) and their Design, Dyadic MRA, Fingerprint Compression Standards,JPEG-2000 Standards.

CONTINUOUS WAVELET TRANSFORM
9

Uncertainty Principle and Its Implications, Gaussian Function: GaborTransform and Its Generalization; Time, Frequency and Scale, Continuous Wavelet Transform (CWT),

Application of CWT in Wideband Correlation Processing.

DISCRETE WAVELET TRANSFORM
9

Discretization steps, Discretization of Scale - Generalized Filter Bank, Discretization of Translation - Generalized Output Sampling, Discretization of Time/ Space (Independent Variable) -Sampled Inputs, Spline Wavelets.

APPLICATIONS OF WAVELET
9

Transient Analysis, Singularity Detection, BiomedicalSignal Processing Applications, Geophysical Signal AnalysisApplications, Efficient Signal Design and Realization, WaveletBased Modulation And Demodulation, Applications in Computer Graphics andComputer Vision.

Total: 45 periods

TEXT BOOKS:

1. Howard L. Resnikoff, Raymond O. Wells, “Wavelet Analysis: The ScalableStructure of Information”, Springer, 1998: available in Indian Edition.

2. K. P. Soman, K. I. Ramachandran, "Insight Into Wavelets - From Theory toPractice", Prentice Hall of India, Eastern Economy Edition, Prentice Hall ofIndia Private Limited, M-97, Connaught Circus, New Delhi - 110 001,Copyright 2004, ISBN Number 81-203-2650-4.

REFERENCE BOOKS:

1. Michael W. Frazier, “An Introduction to Wavelets Through Linear Algebra”,Springer, ISBN 3-540-780-75-0, c 1999, Reprint for sale in India, Pakistan,Bangladesh, Nepal, Sri Lanka only, at a reasonable price.

2. P. P. Vaidyanathan, “Multirate Systems and Filter Banks”, PearsonEducation, Low Price Edition, ISBN 81 – 7758 – 942 – 3.

VL964 INTEGRATED OPTOELECTRONIC DEVICES AND CIRCUITS L T P C

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MATERIALS GROWTH & FABRICATION

GROWTH OF OPTOELECTRONIC MATERIALS 9

Materials Growth&FabricationGrowthofoptoelectronicmaterialsby MBE,MOCVD,PlasmaCVD,photochemicaldeposition.Epitaxy,interfacesandjunctions(advantages/disadvan

tagesofgrowthmethodsoninterfacequality,interdiffusionanddoping)Quantumwells and bandgapengineering

OPTICALPROCESSESINSEMICONDUCTORS 9

Electron hole pair formation and recombination, Absorption in semiconductor, Effect of electric field on Absorption, Franz-Keldysh and starkeffects,AbsorptioninQuantumwellsandQuantumconfinedstarkeffect,relationbetweenAbsorptionandemissionspectra,Stokesshiftinopticaltransition,deepleveltransitions,MeasurementofabsorptionandluminescenceSpectra,TimeresolvedPhotoluminescence

LIGHT EMITTING DIODES AND LASERS 9

Optoelectronic devices, Optical modulators, modulation methods and modulators, transmitters,optical transmitter circuits, LED and laser drive circuits, LED-Power and efficiency, doubleheterostructure LED, LED structures, LED characteristics. Laser operating principles.

OPTOELECTRONIC MODULATION AND SWITCHING DEVICES 9

Modulation of light, birefringence, electro optic effect, EO materials, Kerr modulators, scanningand switching, self electro optic devices, MO devices, AO devices, AO modulators.

DISPLAY DEVICES, PHOTODIODES AND SOLAR CELLS 9

Photoluminescence, cathodo luminescence, EL display, LED display, drivecircuitary, plasma panel display, liquid crystals, properties, LCD displays, numeric displays. Photo detectors, thermal detectors, photoconductors, detectors, photon devices, PMT, photodiodes,photo transistors, noise

characteristics of photo-detectors, PIN diode, APD characteristics, APDDesign of detector arrays, CCD, Solar cells.

Total: 45 Periods

TEXT BOOKS

1. Pallab Bhattacharya "Semiconductor optoelectronic devices" Prentice Hall of India, 1995
2. Jasprit Singh"Electronic & Optoelectronic properties of Semi conductor" Cambridge University Press

REFERENCES TEXT BOOKS

1. J Wilson and J. F. B. Hawkers, "Opto electronics - An introduction" Prentice Hall of India, 1996.
2. J Palais"Introduction to optical electronics" Prentice Hall, 1988.