M.Tech. (VLSI Technology)

Course Schedule:

Semester I:

Course No.	Title	Type	L- T- P	Credits
MTVT-101	MOS Circuit Design	PC	3- 3- 0	6
MTVT-102	Digital Systems Design	PC	3- 3- 0	6
MTVT-103	VLSI Fabrication Technology	PC	3- 3- 0	6
MTVT-104	Digital Signal Processing and Applications	PC	3- 3- 0	6
MTVT-105	Lab-I (HDL tools))	PC	0- 0- 6	6
MTVT-106	Lab-II (VLSI process technology)	OE	0- 0- 4	4
	Total Credits			**34**

Semester II:

Course No.	Title	Type	L- T- P	Credits
MTVT-201	Analog VLSI Circuits	PC	3- 3- 0	6
MTVT-202	CMOS RF Circuit Design	PC	3- 3- 0	6
MTVT-203	Designing with ASICs	PC	3- 3- 0	6
MTVT-204	Lab-III (Physical Design Lab)	PC	0- 0- 6	6
MTVT-205	Lab-IV (Semiconductor Processing Lab)	PC	0- 0- 6	6
MTVT-206	Major Project Part -I	OE		6
	Total Credits			**36**

Semester III:

Course No.	Title	Type	L- T- P	Credits
MTVT-301	Elective-I	OE	3- 3- 0	6
MTVT-302	**Major Project Part II**	OE		
	First Stage Evaluation		0- 0- 4	4
	Second Stage Evaluation		0- 0- 4	4
	Total Credits			**14**

Semester IV:

Course No.	Title	Type	L- T- P	Credits
MTVT-401	**Major Project Part II (Thesis)**	OE		10

	Third Stage Evaluation		0- 0- 6	6
	Total Credits:			**16**

(Distribution of total Credits)

Grading Scheme

Program Core Theory (PCT)	Program Core Lab (PCL)	Program Elective(PE)	Open Elective(OE)	Total Credits
36	18	06	40	100

Grades	Credits	CGPA (10 points)
AA	91-100	10
AB	81-90	09
BB	71-80	08
BC	61-70	07
CC	51-60	06
CD	41-50	05
DD	40	04

Open Electives (for MTVT-301)

1) Advanced Computer Architectures (OE1)
2) Embedded Systems (OE2)
3) Analog Signal Processing (OE3)
4) Modeling of Analog and Digital Systems (OE4)
5) Optical Integrated Circuits (OE5)
6) Neural networks and Artificial Intelligence (OE6)
7) Bluetooth Technology (OE7)
8) MEMS and IC Integration (OE8)
9) Compound Semiconductor Material and Devices (OE9)

Detailed Syllabus

MTVT-101: MOS Circuit Design

Introduction:
Basic principle of MOS transistor, Introduction to large signal MOS models (long channel) for digital design.

The MOS Inverter:
Inverter principle, Depletion and enhancement load inverters, the basic CMOS inverter, transfer characteristics, logic threshold, Noise margins, and Dynamic behavior, Propagation Delay, Power Consumption.

MOS Circuit Layout & Simulation:
MOS SPICE model, device characterization, Circuit characterization, interconnects simulation. MOS device layout: Transistor layout, Inverter layout, CMOS digital circuits layout & simulation

Combinational MOS Logic Design
Static MOS design: Complementary MOS, Ratioed logic, Pass Transistor logic, complex logic circuits.

Dynamic MOS design: Dynamic logic families and performances.

Sequential MOS Logic Design
Static latches, Flip flops & Registers, Dynamic Latches & Registers, CMOS Schmitt trigger, Monostable sequential Circuits, Astable Circuits. Memory Design: ROM & RAM cells design

Interconnect & Clock Distribution
Interconnect delays, Cross Talks, Clock Distribution. Introduction to low power design, Input and Output Interface circuits.

BiCMOS Logic Circuits
Introduction, BJT Structure & operation, Basic BiCMOS Circuit behavior, Switching Delay in BiCMOS Logic circuits, BiCMOS Applications

Text:

1. Kang & Leblebigi "CMOS Digital IC Circuit Analysis & Design"- McGraw Hill, 2003
2. Rabey, "Digital Integrated Circuits Design", Pearson Education, Second Edition, 2003

Reference:

1. Weste and Eshraghian, "Principles of CMOS VLSI design" Addison-Wesley, 2002

MTVT-102: Digital System Design

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.

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 systems, 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, 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.

Text:

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

References:

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

MTVT-103: VLSI Fabrication Technology

Crystal growth & wafer preparation. Processing considerations: Chemical cleaning, getting the thermal Stress factors etc.

Epitaxy

Vapors phase Epitaxy Basic Transport processes & reaction kinetics, doping & auto doping, equipments, & safety considerations, buried layers, epitaxial defects, molecular beam epitaxy, equipment used, film characteristics, SOI structure.

Oxidation

Growth mechanism & kinetics, Silicon oxidation model, interface considerations, orientation dependence of oxidation rates thin oxides. Oxides. Oxidation technique & systems dry & wet oxidation. Masking properties of SiO2.

Diffusion

Diffusion from a chemical source in vapor form at high temperature, diffusion from doped oxide source, diffusion from an ion implanted layer.

Lithography

Optical Lithography: optical resists, contact & proximity printing, projection printing, electron lithography: resists, mask generation. Electron optics: roster scans & vector scans, variable beam shape. X-ray lithography: resists & printing, X ray sources & masks. Ion lithography.

Etching

Reactive plasma etching, AC & DC plasma excitation, plasma properties, chemistry & surface interactions, feature size control & apostrophic etching, ion enhanced & induced etching,

properties of etch processing. Reactive Ion Beam etching, Specific etches processes: poly/polycide. Trench etching,

Physical Characterization:

Thin Film Thickness- Measurements-ellipsometry, surface profiling, spectrophotometry, FTIR Critical Dimension Measurements: Optical microscope, Scanning Electron Microscope, Transmission Electron Microscope Material and Impurity Characterization: SIMS, XRD, EDAX Electrical Characterization: Four-probe technique, Hall effect, sheet resistance measurement. differential sheet resistivity, spreading resistance and impurity profiling C-V measurements, DLTS, Carrier lifetime, impurity profiling, I-V measurements and Process and SPICE model parameter Extraction

Text:

1. Sze, " Modern Semiconductor Device Physics", John Wiley & Sons, 2000.

References:

1. B.G. Streetman, "Solid State Electronics Devices", Prentice Hall, 2002.
2. Chen, "VLSI Technology" Wiley, March 2003.

MTVT-104 Digital Signal Processing and applications

Discrete Time Signals: Sequences; representation of signals on orthogonal basis; Sampling and Reconstruction of signals;

Discrete systems: attributes, Z-Transform, Analysis of LSI systems, Frequency analysis, Inverse systems, Discrete Fourier Transform (DFT), Fast Fourier Transform algorithm, Implementation of Discrete time systems.

Design of FIR Digital filters: Window method, Park-McClellan's method.

Design of IIR digital Filters: Butterworth Chebyshev and Elliptic Approximations lowpass, Bandpass, Bandstop and High pass filters.Effect of finite register length in FIR filter design Parametric and non-parametric spectra estimation. Introduction to multirate signal processing. Application of DSP to Speech and Radar signal processing.

Analog Interfacing using Digital Signal Processing: Block diagram of real time system, Sampling of low pass & band pass signals, Uniform & non-uniform quantization and encoding , over sampling in A/D conversion, D/A conversion process, Anti imaging filtering, over sampling in D/ A conversion, limitations of real time signal processing with analog input/output signals application.

Digital Signal Processing Applications: Digital audio Mixing, Speech synthesis and recognition, Compact Disk Audio system, Digital Cellular Mobile Telephone, Set-top Box for Digital Television Reception, Fetal EGC monitoring, DSP base closed loop controlled anesthesia.

Texts/References

1) Discrete Time signal Processing, A.V. Oppenheim and Schafer, Prentice Hall, 1989
2) Digital Signal Processing : Principle, Algorithms and Applications, John G. Proakis and D.G. Manolakis, Prentice Hall, 1997
3) Theory and Application of Digital Signal Processing: L.R. Rabiner and B. Gold, Prentice Hall, 1992
4) Introduction to Digital Signal Processing: J.R. Johnson, Prentice Hall, 1992
5) Digital Signal Processing: D. J. DeFatta, J. G. Lucas and W. S. Hodgkiss, J Wile and sons, Singapore, 1988.

MTVT-201 : Analog VLSI Design

Small Signal & large signal Models of MOS & BJT transistor. Analog MOS Process (Double Poly Process)

MOS & BJT Transistor Amplifiers:

Single transistor Amplifiers stages: Common Emitter, Common base, Common Collector, Common Drain, Common Gate & Common Source Amplifiers

Multiple Transistor Amplifier stages: CC-CE, CC-CC, & Darlington configuration, Cascode configuration, Active Cascode. Differential Amplifiers: Differential pair & DC transfer characteristics.

Current Mirrors, Active Loads & References

Current Mirrors: Simple current mirror, Cascode current mirrors Widlar current mirror, Wilson Current mirror, etc. Active loads, Voltage & current references. Analysis of Differential Amplifier with active load, supply and temperature independent biasing techniques, Frequency Response,

Operational Amplifier:

Applications of operational Amplifier, theory and Design; Definition of Performance Characteristics; Design of two stage MOS Operational Amplifier, two stage MOS operational Amplifier with cascodes, MOS telescopic-cascode operational amplifiers, MOS Folded-cascode operational amplifiers, Bipolar operational amplifiers. Frequency response & compensation.

Nonlinear Analog Circuits:

Analysis of four quadrant and variable Tran conductance multiplier, Voltage controlled oscillator, Comparators, Analog Buffers, Source Follower and Other Structures. Phase Locked Techniques; Phase Locked Loops (PLL), closed loop analysis of PLL. Digital-to-Analog (D/A) and Analog-to-Digital (A/D) Converters

OTA & Switched Capacitor filters

OTA Amplifiers. Switched Capacitor Circuits and Switched Capacitor Filters.

Text:

1. Paul B Gray and Robert G Meyer, “Analysis and Design of Analog Integrated Circuits”.
2. Behzad Razavi, “Principles of data conversion system design”, S.Chand and company Ltd, 2000. John Wiley

References:

1. D. A. Johns and Martin, Analog Integrated Circuit Design, John Wiley, 1997.
2. R Gregorian and G C Temes, Analog MOS Integrated Circuits for Signal Processing, John Wiley, 1986.
3. R L Geiger, P E Allen and N R Strader, VLSI Design Techniques for Analog & Digital Circuits, McGraw Hill, 1990.
4. Gray and Meyer," Analysis and Design of Analog IC ", Wiley international,1996.
5. Gray, Wooley, Brodersen, "Analog MOS Integrated circuits", IEEE press, 1989.
6. Kenneth R. Laker, Willy M.C. Sensen, " Design of Analog Integrated circuits and systems", McGraw Hill, 1994.

MTVT-202 : CMOS RF Circuit Design

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.

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
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
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. 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:
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

MTVT-203: Designing With ASICS

Types of ASICs – Design flow – Economics of ASICs – ASIC cell libraries – CMOS logic cell data path logic cells – I/O cells – cell compilers.

ASIC Library design: Transistors as resistors – parasitic capacitance – logical effort programmable ASIC design software: Design system – logic synthesis – half gate ASIC.

Low level design entry: Schematic entry – low level design languages – PLA tools – EDIF – An overview of VHDL and verilog.
Logic synthesis in verilog and & VHDL simulation.

CMOS System case studies

Dynamic warp processor: Introduction, the problem, the algorithm, a functional overview, detailed functional specification, structural floor plan, physical design, fabrication **pixels-planes graphic engine:** introduction, raster scan graphic fundamental, pixels-planes system overview, chip electrical design, chip organization and layout, clock distribution, **Hierarchical layout and design of single chip 32 bit CPU:** Introduction ,design methodology, technology updatability and layout verification.
ASIC Construction – Floor planning & placement – Routing.

Practical Realities and Ground Rules

Further thoughts on floor plans / layout, Floor plan layout of the four bit processor, input / output (I/O) pads, "Real estate", further thoughts on system delays, Ground rules for successful design, Scaling of MOS circuits.

Text / References:

8. Basic VLSI Design :Systems and Circuits, Douglas A. Pucknell & Kamran Eshraghian, Prentice Hall of India Private Ltd. , New Delhi , 1989
9. Principles of CMOS VLSI Design : A System Perspective, N. Westle & K. Eshraghian , Addison – Wesley Pub.Co.1985
10. Introduction to VLSI System,C. Mead & L. Canway, Addison Wesley Pub Co.1990
11. The Design & Analysis of VLSI Circuits, L. A. Glassey & D. W. Dobbepahl, Addison Wesley Pub Co. 1985
12. Introduction to NMOS & VLSI System Design, A. Mukharjee, Prentice Hall, 1986
13. VLSI Design techniques for analog and digital circuits,R. L. Geiger, P. E. Allen & N. R. Streder, McGraw Hill Int, 1990
14. Digital Integrated Circuits: A Design Perspective,Jan A. Rabey, Prentice Hall of India Pvt Ltd 1997

8. Application specific Integrated Circuits", J.S. Smith, Addison Wesley, 1997.

OE-1: Advanced Computer Architecture

Parallel computer models:
The state of computing, Classification of parallel computers, Multiprocessors and multicomputers, Multivector and SIMD computers.
Program and network properties:

Conditions of parallelism, Data and resource Dependences, Hardware and software parallelism, Program partitioning and scheduling, Grain Size and latency, Program flow mechanisms, Control flow versus data flow, Data flow Architecture, Demand driven mechanisms, Comparisons of flow mechanisms

System Interconnect Architectures:

Network properties and routing, Static interconnection Networks, Dynamic interconnection Networks, Multiprocessor system Interconnects, Hierarchical bus systems, Crossbar switch and multiport memory, Multistage and combining network.

Advanced processors:

Advanced processor technology, Instruction-set Architectures, CISC Scalar Processors, RISC Scalar Processors, Superscalar Processors, VLIW Architectures, Vector and Symbolic processors

Pipelining:

Linear pipeline processor, nonlinear pipeline processor, Instruction pipeline Design, Mechanisms for instruction pipelining, Dynamic instruction scheduling, Branch Handling techniques, branch prediction, Arithmetic Pipeline Design, Computer arithmetic principles, Static Arithmetic pipeline, Multifunctional arithmetic pipelines

Memory Hierarchy Design:

Cache basics & cache performance, reducing miss rate and miss penalty, multilevel cache hierarchies, main memory organizations, design of memory hierarchies.

Multiprocessor architectures:

Symmetric shared memory architectures, distributed shared memory architectures, models of memory consistency, cache coherence protocols (MSI, MESI, MOESI), scalable cache coherence, overview of directory based approaches, design challenges of directory protocols, memory based directory protocols, cache based directory protocols, protocol design tradeoffs, synchronization,

Scalable point –point interfaces: Alpha364 and HT protocols, high performance signaling layer.

Enterprise Memory subsystem Architecture:

Enterprise RAS Feature set: Machine check, hot add/remove, domain partitioning, memory mirroring/migration, patrol scrubbing, fault tolerant system.

Text:

1. Kai Hwang, “Advanced computer architecture”; TMH.
2. D. A. Patterson and J. L. Hennessey, “Computer organization and design,” Morgan Kaufmann, 2nd Ed.

References:

1. J.P.Hayes, “computer Architecture and organization”; MGH.
2. Harvey G.Cragon,”Memory System and Pipelined processors”; Narosa Publication.
3. V.Rajaranam & C.S.R.Murthy, “Parallel computer”; PHI.
4. R.K.Ghose, Rajan Moona & Phalguni Gupta, “Foundation of Parallel Processing”; Narosa Publications.
5. Kai Hwang and Zu, “Scalable Parallel Computers Architecture”; MGH.
6. Stalling W, “Computer Organisation & Architecture”;PHI.
7. D.Sima, T.Fountain, P.Kasuk, “Advanced Computer Architecture-A Design space Approach,”Addison Wesley,1997.
8. M.J Flynn, “Computer Architecture, Pipelined and Parallel Processor Design”; Narosa Publishing.

9. D.A.Patterson, J.L.Hennessy, "Computer Architecture :A quantitative approach";Morgan Kauffmann feb,2002.
10. Hwan and Briggs, " Computer Architecture and Parallel Processing"; MGH.VLSI

OE2: Embedded System Design

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.

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.

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

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.

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

References:
1. An Embedded Software Primer by David E. Simon, Pearson Education
2. Designing Embedded Hardware by John Catsoulis, O'reilly
3. Embedded System Design by Frank Vahid, Tony Givargis,", John Wiley & Sons, Inc
4. Building Embedded Linux Systems by Karim Yaghmour, O'reilly
5. Programming Embedded Systems by Michael Barr, O'reilly
6. Real-time systems & software by Alan C. Shaw, John Wiley & sons, Inc.
7. Computers as Components by Wayne Wolf, Harcourt India Pvt. Ltd.

8. Embedded System Design by Peter Marwedel, Kluwer Acadeemic Pub.
9. Programming and Customizing the AVR Microcontroller by Dhananjay Gadre, MGH
10. Fundamental of Embedded software by Daniel W. Lewis, PHI
11. Bluetooth Technology by CSR Prabhu & A.P. Reddi, PHI
12. John B Peat man " Design with Microcontroller ", Pearson education Asia, 1998
13. Burns, Alan and Wellings, Andy, " Real-Time Systems and Programming Languages", Second Edition. Harlow: Addison-Wesley-Longman, 1997
14. Raymond J.A. Bhur and Donald L.Bialey, " An Introduction to real time systems: Design to networking with C/C++ ", Prentice Hall Inc. New Jersey, 1999
15. Grehan Moore, and Cyliax, " Real time Programming: A guide to 32 Bit Embedded Development. Reading " Addison-Wesley-Longman, 1998
16. Heath, Steve, " Embedded Systems Design ", Newnes 1997

OE-3 Modeling and Simulation Techniques

Chapter 1: Introduction Models and their applications, Common types of mathematical models used for engineering systems, Derivation of models from physical relations, Model determination from input- output observation, Basic principle of simulation, Analog and digital simulation techniques, Models: Structural, Process, Continuous, Discrete, Deterministic, Random, input/output, static, dynamic, multilevel.

Chapter 2: Classical and Semi-classical models:

Boltzmann transport equation, classical semiconductor equations- drift diffusion approximation, generation and recombinations, different generation and recombination mechanisms, limitations of drift-diffusions, energy transport, semiclassical and hot electron models, hydrodynamic and semi-classical semiconductor equations, modeling of semiconductor laser diode, general aspects, static models and dynamic models, model verification and validation.

Chapter 3: Numerical Techniques: Finite difference methods, first order and second order derivatives and discrimination, finite element method, solution of poison's equation, solution of steady state continuity equation for electrons and holes, advantages and disadvantages of finite element method, Monte Carlo simulation techniques, basic concepts, Random variables, random number generation and testing, analysis of simulation results, confidence intervals, variance reduction techniques. Case studies of analytical and simulation studies

Chapter 4: Modeling of Semiconductor Devices p-n junction, p-n junction C-V characteristics, breakdown, Schottky diodes, Hetero-structure diodes, Simulation of above device characteristics in graphical format, Simulation of simple laser diode and plot its characteristics by considering appropriate materials and parameters, PIN diode, Avalanche Photodiode, Quantum transport modeling, 1D models, discretized Schrodinger equation, Transmission matrix formation, I-V characteristics.

Chapter 5: Universal FET modeling

sub threshold regime, unified charge control model, short channel effects, I-V modeling. Capacitance modeling (Ward Dutton and Meyer models) Universal models for MOSFET, MESFET, HFET and TFT.

Tutorials:

Modeling of different types of diodes e.g. LED

References:

3. Modeling of CMOS

G.Gordon, 'System Simulation', 2nd ed., Prentice Hall
7. Narsing Deo, 'System Simulation with Digital Computers', Prentice Hall
8. R. Leigh, 'Modelling and Simulation', Peter Peregrims Ltd.,. 1983.
9. M.Law, W.D.Kelton, 'Simulation Modelling and Analysis, Mcgraw Hill, 1982.
10. Raj Jain, The Art of Computer Systems Performance Analysis, John Wiley and Sons, New York, USA, 1991
6. Trivedi, K.S, Probability and Statistics with Reliability, Queueing and computer science Applications, Prentice Hall of India, Reprinted in 1990.

OE-5: Neural Networks

Introduction & Motivation; Biological Neural Networks and simple models; The Artificial Neuron Model; Hopfield Nets; Energy Functions and Optimization; Perceptrons & Threshold Logic Machines; Multilayer Networks - their variants and Applications; Capacity of Multilayer Networks; Backpropagation; Recurrent Nets; Tree Structured Networks; Unsupervised Learning; Hebbian Learning, Principal Component Analysis; Competitive Learning, Feature Mapping, Self Organizing Maps, Adaptive Resonance Theory. Hardware Realization of ANNs. Recent Trends and Future Directions

OE-6 : Bluetooth Technology

Introduction to wireless technologies: WAP services, Serial and Parallel Communication, Asynchronous and synchronous Communication, FDM,TDM, TFM, Spread spectrum technology

Introduction to Bluetooth: Specification, Core protocols, Cable replacement protocol

Bluetooth Radio: Type of Antenna, Antenna Parameters, Frequency hoping

Bluetooth Networking: Wireless networking, wireless network types, devices roles and states, adhoc network, scatter net Connection establishement procedure, notable aspects of connection establishement, Mode of connection, Bluetooth security, Security architecture, Security level of services, Profile and usage model: Generic access profile (GAP), SDA, Serial port profile, Secondary bluetooth profile

Hardware: Bluetooth Implementation, Baseband overview, packet format, Transmission buffers, Protocol Implementation: Link Manager Protocol, Logical Link Control Adaptation Protocol, Host control Interface, Protocol Interaction with layers

Programming with Java: Java Programming, J2ME architecture, Javax.bluetooth package Interface, classes, exceptions, Javax.obex Package: interfaces, classes

Bluetooth services registration and search application, bluetooth client and server application. Overview of IrDA, HomeRF, Wireless LANs, JINI

Text:

1. Bluetooth Technology by C.S.R. Prabhu and A.P. Reddi; PHI

OE-7 : MEMS and IC Integration

Overview of CMOS process in IC fabrication, MEMS system-level design methodology, Equivalent Circuit representation of MEMS, signal-conditioning circuits, and sensor noise calculation.

Pressure sensors with embedded electronics(Analog/Mixed signal): Accelerometer with transducer,Gyroscope,RF MEMS switch with electronics,Bolo meter design.

RF MEMS, and Optical MEMS

Text/References:

1. Gregory T.A. Kovacs, Micromachined Transducers Sourecbook, The McGraw-Hill, Inc. 1998
2. Stephen D. Senturia, Microsystem Design, Kluar Publishers, 2001
3. Nadim Maluf, An Introduction to Microelectromechanical Systems Engineering, Artech House, 2000.
4. M.H. Bao, Micro Mechanical Transducers, Volume 8, Handbook of Sensors and Actuators, Elsevier, 2000.
5. Masood Tabib-Azar, Microactuators, Kluwer, 1998.
6. Ljubisa Ristic, Editor, Sensor Technology and Devices, Artech House, 1994
7. D. S. Ballantine, et. al., Acoustic Wave Sensors, Academic Press, 1997
8. H. J. De Los Santos, Introduction to Microelectromechanical (MEM) Microwave Systems, Artech, 1999.
9. James M.Gere and Stephen P. Timoshenko, Mechanics of Materials, 2nd Edition, Brooks/Cole Engineering Division,

OE-8 : Microcontroller and Applications

Chapter 1: Introduction

Single Chip Controllers, Design and testing of software for Micro-controllers, Architectural features of different types of architectures used in Micro-controllers, like Van Neuman, Harward, CISC, RISC, SISC architectures. Special features like watchdog timer, digital signal processors, clock monitor, resident program, loader, monitor, General applications of Micro-controllers.

Chapter 2: Characteristics Features of MCS 96 Family:

Comparison of Intel MCS 51/251 and MCS 96 Microcontroller Families, Overview and features of MCS 96(HSIO) family, Intel 80C196 CHMOS 16 bit Microcontroller, Pin configuration, Architectural block diagram, Signal descriptions, memory and address space, registers, buses, and data transfers, different modes of operation.

Chapter 3: Intel 80C196 Instruction Set and Programming:

Instruction set : different types of instructions, instruction significance and execution, Addressing modes, effective address, simple programs, loop programs, subroutines and examples, Memory Management, Programming the Microcontroller for different applications,

Synchronous Serial Port, Serial port wave forms (shift register mode), Interrupts handling and priority, External Memory Interfacing.

Chapter 4: Input/Output Interfacing and interrupts:

Serial and parallel ports and software control of ports, port I/O registers, synchronization in data transfer and handshaking, interrupt management, interrupt service routines, and interrupt examples keeping time and parallel port transfers, A/D control and status registers and applications.

Chapter 5: **Interfacing Applications**

Interfacing of LEDs, Switches and 7- segment displays, keyboard interfacing, RS-232 interfacing, DC motor interfacing, Stepper motor interfacing, DAC, Data acquisition system, real world interfacing.

Tutorials

Study of Developments Tools for Microcontroller based system:

Simulators, resident debuggers, emulators, Java on embedded systems

References:

8. The 16 bit Intel 8096 Programming, Interfacing, applications by Ron Katz and Howard Boyet.
9. The 8051 Microcontroller, 3rd Ed., Scott MacKenzie,1999, Prentice Hall.
10. The 80251 Microcontroller, Kenneth Ayala, 2000 Prentice Hall.
11. The 8051 Microcontroller: Hardware, Software, and Interfacing, 2nd Ed, James Stewart and Kai Miao, 1999, Prentice Hall.
12. The art of programming embedded systems by Jack G. Ganssle.
13. Design with Microcontrollers by John B. Peatman.
14. Microcontroller: Architecture, implementation and Programming by Kenneth Hintz and Daniel Tabak, Tata McGraw Hill.

OE–9 Compound Semiconductor Materials and Devices

1) **Compound Semiconductor Materials: -**
   III-V and II-VI compound semiconductor materials and their applications in electronics and optoelectronic devices, crystal structures and their band structures, variation of band gap with the contents of compound metals, refractive index variation with respect to the contents of compound metals.

2) **Crystal Growth Techniques: -**
   Liquid Phase Epitaxy, Molecular Beam Epitaxy, and Metal Organic Chemical Vapor Deposition techniques for crystal growth.

3) **Devices: -**
   HBT, DHBT, Heterostructure laser, waveguides and optical modulators and switches, SLAPDS, and other Heterostructure p-i-n diodes.

4) **Characterization Techniques for the compound semiconductors: -**
   Photoluminescence Techniques, X-Ray diffraction, SIMS, SEM, TEM, measurement of waveguides, modulator and optical detector.

Text/References: -

1) Stephen A. Campell. "The science and engineering of microelectronics fabrication". Oxford University Press. 1996.
2) Donald L. Smith. "Thin Film Deposition". McGraw Hill. 1995.
3) H. C. Cassey and M. B. Panish. "Heterostructure Laser". Academic Press
4) M. J. Kelly. "Low Dimensional Semiconductor Materials, Physics Technology, Devices". Oxford Science Publication. 1995.
5) John L. Vossen and Werner Kern. "Thin Film Processes II". Academic Press Inc. 1991.
6) Nishihara. Optical Integrated Circuit

Core Laboratory

Laboratory I : Computer Aided VLSI Design / Digital Systems Design

Exposure to high-level design tools including high-level synthesis, logic synthesis and simulation. Hardware Description Languages; Verifying behaviour prior to system construction - simulation and logic verification; Logic Synthesis - PLA based synthesis and multilevel logic synthesis; Logic optimization; Logic Simulation - Compiled and event simulators; Relative advantages and disadvantages; Modelling and design using VHDL. FPGA based design. Layout Algorithms - Circuit partitioning, placement, and routing algorithms; Design rule verification; Circuit compaction; Circuit extraction and post-layout simulation; Automatic Test Program Generation; Combinational testing - D Algorithm and PODEM algorithm; Scan-based testing of sequential circuits; Testability measures for circuits

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Laboratory II: VLSI process technology

(A) Metallization:-

1(a) To measure the pumping speed of the vacuum pump
2(b) To deposit the metallic layers by vacuum evaporation

(B) Chemical Vapor Deposition:-

3(a) To deposit the oxide films by thermal CVD
4(b) To deposit the oxide films by PECVD
5(c) To deposit the natural gate oxide by thermal CVD

(C) Impurity Diffusion:-

6(a) To diffuse the n type impurity in the given semiconductor
7(b) To diffuse the p type impurity in the given semiconductor

(D) Photo Lithography:-

8(a) Transfer the pattern of the given mask by photo lithography techniques
9(b) Perform the photo lithography for list of method

(E) Etching:-

10(a) Perform the selective wet etching using photolithography
11(b) Perform the selective dry etching using photolithography
Note: Student are required to perform minimum 10 experiments and minimum one from each section.

Laboratory III: Characterization Techniques:-
1. To measure the resistivty using four probe method
2. To measure the sheet resistance of a given sample
3. To measure the IV characteristics of the given diode
4. To measure the C-V characteristics of the given diode
5. To measure the IV characteristics of the transistor
6. To measure the carrier concentration at the surface by C-V measurement
7. To measure the carrier concentration by Hall Effect
8. To measure the physical parameters of the layout of the chip
9. To measure the sub threshold voltage of the given transistor
10. To measure the short channel effect of the MOS device

Laboratory IV : VLSI Physical Design Lab
Introduction to CAD Tools. Circuit simulation using SPICE. Layout Design. Design Rules and Design Rule Checking. Design of a static CMOS inverter. Effects of W/L ratio on performance. Pseudo-NMOS inverters. Latchup and Layout considerations for its prevention. Transmission Gates. Circuit Characterization. Resistance and Capacitance Estimation. Gate Design. Static two-input NAND and NOR gates. Gate Transistor Sizing. Effects of and Fan-Out. Power dissipation and its Estimation using SPICE. Layout of complex gates. Dynamic, C2MOS, Pass-Transistor Logic. Domino, NP-Domino styles. Design Margining; effects of variations in supply voltage and temperature. Design Corners. Sizing of Power and Clock Conductors. Clocking Strategies. One end-semester design project is also envisaged.