

**ANNA UNIVERSITY, CHENNAI**

**AFFILIATED INSTITUTIONS**

**R - 2009**

**CURRICULUM I SEMESTER (FULL TIME)**

**M.E. VLSI DESIGN**

**SEMESTER I**

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
<b>THEORY</b>						
1	MA9217	<a href="#">Applied Mathematics for Electronics Engineers</a>	3	1	0	4
2	VL 9211	<a href="#">DSP Integrated Circuits</a>	3	0	0	3
3	AP9212	<a href="#">Advanced Digital System Design</a>	3	0	0	3
4	VL9212	<a href="#">VLSI Design Techniques</a>	3	0	0	3
5	VL9213	<a href="#">Solid State Device Modeling and Simulation</a>	3	0	0	3
6	E1	Elective I	3	0	0	3
<b>PRACTICAL</b>						
7	VL9217	<a href="#">VLSI Design Lab I</a>	0	0	4	2
<b>TOTAL</b>			<b>18</b>	<b>1</b>	<b>4</b>	<b>21</b>

**LIST OF ELECTIVES**

**M.E. VLSI DESIGN**

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
1	VL9251	<a href="#">Testing of VLSI Circuits</a>	3	0	0	3
2	VL9252	<a href="#">Low Power VLSI Design</a>	3	0	0	3
3	VL9253	<a href="#">VLSI Signal Processing</a>	3	0	0	3
4	VL9254	<a href="#">Analog VLSI Design</a>	3	0	0	3
5	VL9255	<a href="#">Design of Semiconductor Memories</a>	3	0	0	3
6	VL9256	<a href="#">VLSI Technology</a>	3	0	0	3
7	VL9257	<a href="#">Physical Design of VLSI Circuits</a>	3	0	0	3
8	VL9258	<a href="#">Genetic Algorithms and their Applications</a>	3	0	0	3
9	AP9213	<a href="#">Advanced Microprocessors and Microcontrollers</a>	3	0	0	3
10	AP9252	<a href="#">Neural Networks and Its Applications</a>	3	0	0	3
11	VL9261	<a href="#">ASIC Design</a>	3	0	0	3
12	NE9251	<a href="#">Reliability Engineering</a>	3	0	0	3
13	AP9256	<a href="#">Electromagnetic Interference and Compatibility in System Design</a>	3	0	0	3
14	VL9264	<a href="#">Digital Speech Signal Processing</a>	3	0	0	3
15	VL9265	<a href="#">DSP Processor Architecture and programming</a>	3	0	0	3
16	VL9266	<a href="#">Introduction to MEMS System Design</a>	3	0	0	3
17		Special Elective	3	0	0	3

**MA9217          APPLIED MATHEMATICS FOR ELECTRONICS ENGINEERS          LT P C**  
**3 1 0 4**

**UNIT I          FUZZY LOGIC          12**

Classical logic – Multivalued logics – Fuzzy propositions – Fuzzy quantifiers.

**UNIT II          MATRIX THEORY          12**

Some important matrix factorizations – The Cholesky decomposition – QR factorization – Least squares method – Singular value decomposition - Toeplitz matrices and some applications.

**UNIT III          ONE DIMENSIONAL RANDOM VARIABLES          12**

Random variables - Probability function – moments – moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a Random Variable.

**UNIT IV          DYNAMIC PROGRAMMING          12**

Dynamic programming – Principle of optimality – Forward and backward recursion – Applications of dynamic programming – Problem of dimensionality.

**UNIT V          QUEUEING MODELS          12**

Poisson Process – Markovian queues – Single and Multi-server Models – Little's formula - Machine Interference Model – Steady State analysis – Self Service queue.

**L = 45: T=15, TOTAL: 60 PERIODS**

#### **REFERENCES**

1. George J. Klir and Yuan, B., Fuzzy sets and fuzzy logic, Theory and applications, Prentice Hall of India Pvt. Ltd., 1997.
2. Moon, T.K., Sterling, W.C., Mathematical methods and algorithms for signal processing, Pearson Education, 2000.
3. Richard Johnson, Miller & Freund's Probability and Statistics for Engineers, 7<sup>th</sup> Edition, Prentice – Hall of India, Private Ltd., New Delhi (2007).
4. Taha, H.A., Operations Research, An introduction, 7<sup>th</sup> edition, Pearson education editions, Asia, New Delhi, 2002.
5. Donald Gross and Carl M. Harris, Fundamentals of Queueing theory, 2<sup>nd</sup> edition, John Wiley and Sons, New York (1985).

**VL 9211                                  DSP INTEGRATED CIRCUITS                                  LT P C**  
**3 0 0 3**

**UNIT I DSP INTEGRATED CIRCUITS AND VLSI CIRCUIT TECHNOLOGIES 9**

Standard digital signal processors, Application specific IC's for DSP, DSP systems, DSP system design, Integrated circuit design. MOS transistors, MOS logic, VLSI process technologies, Trends in CMOS technologies

**UNIT II          DIGITAL SIGNAL PROCESSING          9**

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

**UNIT III DIGITAL FILTERS AND FINITE WORD LENGTH EFFECTS 9**

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

**UNIT IV DSP ARCHITECTURES AND SYNTHESIS OF DSP ARCHITECTURES 9**

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

**UNIT V ARITHMETIC UNITS AND INTEGRATED CIRCUIT DESIGN 9**

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

**TOTAL: 45 PERIODS**

**REFERENCES**

1. Lars Wanhammer, "DSP Integrated Circuits", 1999 Academic press, New York
2. A.V.Oppenheim et.al, "Discrete-time Signal Processing", Pearson Education, 2000.
3. Emmanuel C. Ifeachor, Barrie W. Jervis, " Digital signal processing – A practical approach", Second Edition, Pearson Education, Asia.
4. Keshab K.Parhi, "VLSI Digital Signal Processing Systems design and Implementation", John Wiley & Sons, 1999.

**AP9212 ADVANCED DIGITAL SYSTEM DESIGN LT P C  
3 0 0 3**

**UNIT I SEQUENTIAL CIRCUIT DESIGN 9**

Analysis of clocked synchronous sequential circuits and modeling- State diagram, state table, state table assignment and reduction-Design of synchronous sequential circuits-design of iterative circuits-ASM chart and realization using ASM

**UNIT II ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN 9**

Analysis of asynchronous sequential circuit – flow table reduction-races-state assignment-transition table and problems in transition table- design of asynchronous sequential circuit-Static, dynamic and essential hazards – data synchronizers – mixed operating mode asynchronous circuits – designing vending machine controller

**UNIT III FAULT DIAGNOSIS AND TESTABILITY ALGORITHMS 9**

Fault table method-path sensitization method – Boolean difference method-D algorithm - Tolerance techniques – The compact algorithm – Fault in PLA – Test generation-DFT schemes – Built in self test

**UNIT IV          SYNCHRONOUS DESIGN USING PROGRAMMABLE DEVICES          9**  
 Programming logic device families – Designing a synchronous sequential circuit using PLA/PAL – Realization of finite state machine using PLD – FPGA – Xilinx FPGA-Xilinx 4000

**UNIT V          SYSTEM DESIGN USING VHDL          9**  
 VHDL operators – Arrays – concurrent and sequential statements – packages- Data flow – Behavioral – structural modeling – compilation and simulation of VHDL code –Test bench - Realization of combinational and sequential circuits using HDL – Registers – counters – sequential machine – serial adder – Multiplier- Divider – Design of simple microprocessor

**TOTAL: 45 PERIODS**

**REFERENCES**

- 1 Charles H.Roth Jr “Fundamentals of Logic Design” Thomson Learning 2004
- 2 Nripendra N Biswas “Logic Design Theory” Prentice Hall of India,2001
- 3 Parag K.Lala “Fault Tolerant and Fault Testable Hardware Design” B S Publications,2002
- 4 Parag K.Lala “Digital system Design using PLD” B S Publications,2003
- 5 Charles H Roth Jr.”Digital System Design using VHDL” Thomson learning, 2004
- 6 Douglas L.Perry “VHDL programming by Example” Tata McGraw.Hill - 2006

**VL9212**

**VLSI DESIGN TECHNIQUES**

**LT P C  
3 0 0 3**

**UNIT I          MOS TRANSISTOR THEORY AND PROCESS TECHNOLOGY          9**  
 NMOS and PMOS transistors, Threshold voltage- Body effect- Design equations- Second order effects. MOS models and small signal AC characteristics. Basic CMOS technology.

**UNIT II          INVERTERS AND LOGIC GATES          9**  
 NMOS and CMOS Inverters, Stick diagram, Inverter ratio, DC and transient characteristics , switching times, Super buffers, Driving large capacitance loads, CMOS logic structures , Transmission gates, Static CMOS design, dynamic CMOS design.

**UNIT III          CIRCUIT CHARACTERISATION AND PERFORMANCE ESTIMATION          9**  
 Resistance estimation, Capacitance estimation, Inductance, switching characteristics, transistor sizing, power dissipation and design margining. Charge sharing .Scaling.

**UNIT IV          VLSI SYSTEM COMPONENTS CIRCUITS AND SYSTEM LEVEL PHYSICAL DESIGN          9**  
 Multiplexers, Decoders, comparators, priority encoders, Shift registers. Arithmetic circuits – Ripple carry adders, Carry look ahead adders, High-speed adders, Multipliers.

Physical design – Delay modelling ,cross talk, floor planning, power distribution. Clock distribution. Basics of CMOS testing.

**UNIT V VERILOG HARDWARE DESCRIPTION LANGUAGE 9**

Overview of digital design with Verilog HDL, hierarchical modelling concepts, modules and port definitions, gate level modelling, data flow modelling, behavioral modelling, task & functions, Test Bench.

**TOTAL: 45 PERIODS**

**REFERENCES**

1. Neil H.E. Weste and Kamran Eshraghian, Principles of CMOS VLSI Design, Pearson Education ASIA, 2<sup>nd</sup> edition, 2000.
2. John P.Uyemura “Introduction to VLSI Circuits and Systems”, John Wiley & Sons, Inc., 2002.
3. Samir Palnitkar, “Verilog HDL”, Pearson Education, 2<sup>nd</sup> Edition, 2004.
4. Eugene D.Fabricius, Introduction to VLSI Design McGraw Hill International Editions, 1990.
5. J.Bhasker, B.S.Publications, “A Verilog HDL Primer”, 2<sup>nd</sup> Edition, 2001.
6. Pucknell, “Basic VLSI Design”, Prentice Hall of India Publication, 1995.
7. Wayne Wolf “Modern VLSI Design System on chip. Pearson Education.2002.

**VL9213 SOLID STATE DEVICE MODELING AND SIMULATION LT P C  
3 0 0 3**

**UNIT I MOSFET DEVICE PHYSICS 9**

MOSFET capacitor, Basic operation, Basic modeling,Advanced MOSFET modeling, RF modeling of MOS transistors, Equivalent circuit representation of MOS transistor, High frequency behavior of MOS transistor and A.C small signal modeling, model parameter extraction, modeling parasitic BJT, Resistors, Capacitors, Inductors.

**UNIT II NOISE MODELING 9**

Noise sources in MOSFET, Flicker noise modeling, Thermal noise modeling, model for accurate distortion analysis, nonlinearities in CMOS devices and modeling, calculation of distortion in analog CMOS circuit

**UNIT III BSIM4 MOSFET MODELING 9**

Gate dielectric model, Enhanced model for effective DC and AC channel length and width, Threshold voltage model, Channel charge model, mobility model, Source/drain resistance model, I-V model, gate tunneling current model, substrate current models, Capacitance models, High speed model, RF model, noise model, junction diode models, Layout-dependent parasitics model.

**UNIT IV OTHER MOSFET MODELS 9**  
The EKV model, model features, long channel drain current model, modeling second order effects of the drain current, modeling of charge storage effects, Non-quasi-static modeling, noise model temperature effects, MOS model 9, MOSAI model)

**UNIT V MODELLING OF PROCESS VARIATION AND QUALITY ASSURANCE 9**  
Influence of process variation, modeling of device mismatch for Analog/RF Applications, Benchmark circuits for quality assurance, Automation of the tests

**TOTAL: 45 PERIODS**

**REFERENCES**

1. Trond Ytterdal, Yuhua Cheng and Tor A. FjeldlyWayne Wolf, “Device Modeling for Analog and RF CMOS Circuit Design”, John Wiley & Sons Ltd.

**VL9217**

**VLSI DESIGN LAB I**

**L T P C  
0 0 4 2**

1. Modeling of Sequential Digital system using VHDL.
2. Modeling of Sequential Digital system using Verilog.
3. Design and Implementation of ALU using FPGA.
4. Simulation of NMOS and CMOS circuits using SPICE.
5. Modeling of MOSFET using C.
6. Implementation of FFT, Digital Filters in DSP Processor.
7. Implementation of DSP algorithms using software package.
8. Implementation of MAC Unit using FPGA.

**TOTAL: 60 PERIODS**

<b>UNIT I</b>	<b>BASICS OF TESTING AND FAULT MODELLING</b>	<b>9</b>
Introduction to testing – Faults in Digital Circuits – Modelling of faults – Logical Fault Models – Fault detection – Fault Location – Fault dominance – Logic simulation – Types of simulation – Delay models – Gate Level Event – driven simulation.		
<b>UNIT II</b>	<b>TEST GENERATION FOR COMBINATIONAL AND SEQUENTIAL CIRCUITS</b>	<b>9</b>
Test generation for combinational logic circuits – Testable combinational logic circuit design – Test generation for sequential circuits – design of testable sequential circuits.		
<b>UNIT III</b>	<b>DESIGN FOR TESTABILITY</b>	<b>9</b>
Design for Testability – Ad-hoc design – generic scan based design – classical scan based design – system level DFT approaches.		
<b>UNIT IV</b>	<b>SELF – TEST AND TEST ALGORITHMS</b>	<b>9</b>
Built-In self Test – test pattern generation for BIST – Circular BIST – BIST Architectures – Testable Memory Design – Test Algorithms – Test generation for Embedded RAMs.		
<b>UNIT V</b>	<b>FAULT DIAGNOSIS</b>	<b>9</b>
Logical Level Diagnosis – Diagnosis by UUT reduction – Fault Diagnosis for Combinational Circuits – Self-checking design – System Level Diagnosis.		

**TOTAL: 45 PERIODS**

#### REFERENCES

1. M.Abramovici, M.A.Breuer and A.D. Friedman, "Digital systems and Testable Design", Jaico Publishing House, 2002.
2. P.K. Lala, "Digital Circuit Testing and Testability", Academic Press, 2002.
3. M.L.Bushnell and V.D.Agrawal, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwer Academic Publishers, 2002.
4. A.L.Crouch, "Design Test for Digital IC's and Embedded Core Systems", Prentice Hall International, 2002.

<b>UNIT I</b>	<b>POWER DISSIPATION IN CMOS</b>	<b>9</b>
Hierarchy of limits of power – Sources of power consumption – Physics of power dissipation in CMOS FET devices – Basic principle of low power design.		

<b>UNIT II</b>	<b>POWER OPTIMIZATION</b>	<b>9</b>
Logic level power optimization – Circuit level low power design – circuit techniques for reducing power consumption in adders and multipliers.		
<b>UNIT III</b>	<b>DESIGN OF LOW POWER CMOS CIRCUITS</b>	<b>9</b>
Computer arithmetic techniques for low power system – reducing power consumption in memories – low power clock, Inter connect and layout design – Advanced techniques – Special techniques.		
<b>UNIT IV</b>	<b>POWER ESTIMATION</b>	<b>9</b>
Power Estimation technique – logic power estimation – Simulation power analysis – Probabilistic power analysis.		
<b>UNIT V</b>	<b>SYNTHESIS AND SOFTWARE DESIGN FOR LOW POWER</b>	<b>9</b>
Synthesis for low power – Behavioral level transform – software design for low power.		

**TOTAL: 45 PERIODS**

**REFERENCES**

1. Kaushik Roy and S.C.Prasad, “Low power CMOS VLSI circuit design”, Wiley, 2000.
2. Dimitrios Soudris, Chirstian Pignet, Costas Goutis, “Designing CMOS Circuits for Low Power”, Kluwer, 2002.
3. J.B.Kulo and J.H Lou, “Low voltage CMOS VLSI Circuits”, Wiley 1999.
4. A.P.Chandrasekaran and R.W.Broadersen, “Low power digital CMOS design”, Kluwer, 1995.
5. Gary Yeap, “Practical low power digital VLSI design”, Kluwer, 1998.
6. Abdelatif Belaouar, Mohamed.I.Elmasry, “Low power digital VLSI design”, Kluwer, 1995.
7. James B.Kulo, Shih-Chia Lin, “Low voltage SOI CMOS VLSI devices and Circuits”, John Wiley and sons, inc. 2001.

**VL9253**

**VLSI SIGNAL PROCESSING**

**LT P C**  
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<b>UNIT I</b>	<b>INTRODUCTION TO DSP SYSTEMS, PIPELINING AND PARALLEL PROCESSING OF FIR FILTERS</b>	<b>9</b>
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Introduction to DSP systems – Typical DSP algorithms, Data flow and Dependence graphs - critical path, Loop bound, iteration bound, Longest path matrix algorithm, Pipelining and Parallel processing of FIR filters, Pipelining and Parallel processing for low power.

<b>UNIT II</b>	<b>RETIMING, ALGORITHMIC STRENGTH REDUCTION</b>	<b>9</b>
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Retiming – definitions and properties, Unfolding – an 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 architecture, rank-order filters, Odd-Even merge-sort architecture, parallel rank-order filters.



**UNIT III FAST CONVOLUTION, PIPELINING AND PARALLEL PROCESSING OF IIR FILTERS 9**

Fast convolution – Cook-Toom algorithm, modified Cook-Toom algorithm, Pipelined and parallel recursive filters – Look-Ahead pipelining in first-order IIR filters, Look-Ahead pipelining with power-of-2 decomposition, Clustered look-ahead pipelining, Parallel processing of IIR filters, combined pipelining and parallel processing of IIR filters.

**UNIT IV SCALING, ROUND-OFF NOISE, BIT-LEVEL ARITHMETIC ARCHITECTURES 9**

Scaling and round-off noise – scaling operation, round-off noise, state variable description of digital filters, scaling and round-off noise computation, round-off noise in pipelined IIR filters, Bit-level arithmetic architectures – parallel multipliers with sign extension, parallel carry-ripple and carry-save multipliers, 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, Distributed Arithmetic fundamentals and FIR filters

**UNIT V NUMERICAL STRENGTH REDUCTION, SYNCHRONOUS, WAVE AND ASYNCHRONOUS PIPELINING 9**

Numerical strength reduction – subexpression elimination, multiple constant multiplication, iterative matching, 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.

**TOTAL: 45 PERIODS**

**REFERENCES**

1. Keshab K. Parhi, “ VLSI Digital Signal Processing Systems, Design and implementation “, Wiley, Interscience, 2007.
2. U. Meyer – Baese, “ Digital Signal Processing with Field Programmable Gate Arrays”, Springer, Second Edition, 2004

**VL9254**

**ANALOG VLSI DESIGN**

**LT P C  
3 0 0 3**

**UNIT I BASIC CMOS CIRCUIT TECHNIQUES, CONTINUOUS TIME AND LOW- VOLTAGESIGNAL PROCESSING 9**

Mixed-Signal VLSI Chips-Basic CMOS Circuits-Basic Gain Stage-Gain Boosting Techniques-Super MOSTransistor- Primitive Analog Cells-Linear Voltage-Current Converters-MOS Multipliers and Resistors-CMOS,Bipolar and Low-Voltage BiCMOS Op-Amp Design-Instrumentation Amplifier Design-Low Voltage Filters.

**UNIT II            BASIC BICMOS CIRCUIT TECHNIQUES, CURRENT -MODE SIGNAL  
PROCESSING AND NEURAL INFORMATION PROCESSING            9**

Continuous-Time Signal Processing-Sampled-Data Signal Processing-Switched-Current Data Converters-Practical Considerations in SI Circuits Biologically-Inspired Neural Networks - Floating - Gate, Low-Power Neural Networks-CMOS Technology and Models-Design Methodology-Networks-Contrast Sensitive Silicon Retina.

**UNIT III            SAMPLED-DATA ANALOG FILTERS, OVER SAMPLED A/D  
CONVERTERS AND ANALOG INTEGRATED SENSORS            9**

First-order and Second SC Circuits-Bilinear Transformation - Cascade Design-Switched-Capacitor Ladder Filter-Synthesis of Switched-Current Filter- Nyquist rate A/D Converters-Modulators for Over sampled A/D Conversion-First and Second Order and Multibit Sigma-Delta Modulators-Interpolative Modulators –Cascaded Architecture-Decimation Filters-mechanical, Thermal, Humidity and Magnetic Sensors-Sensor Interfaces.

**UNIT IV            DESIGN FOR TESTABILITY AND ANALOG VLSI INTERCONNECTS 9**

Fault modelling and Simulation - Testability-Analysis Technique-Ad Hoc Methods and General Guidelines-Scan Techniques-Boundary Scan-Built-in Self Test-Analog Test Buses-Design for Electron -Beam Testability-Physics of Interconnects in VLSI-Scaling of Interconnects-A Model for Estimating Wiring Density-A Configurable Architecture for Prototyping Analog Circuits.

**UNIT V            STATISTICAL MODELING AND SIMULATION, ANALOG            9  
COMPUTER- AIDED DESIGN AND ANALOG AND MIXED ANALOG  
DIGITAL LAYOUT**

Review of Statistical Concepts - Statistical Device Modeling- Statistical Circuit Simulation-Automation Analog Circuit Design-automatic Analog Layout-CMOS Transistor Layout-Resistor Layout-Capacitor Layout-Analog Cell Layout-Mixed Analog - Digital Layout.

**TOTAL: 45 PERIODS**

**REFERENCES**

1. Mohammed Ismail, Terri Fiez, "Analog VLSI signal and Information Processing ", McGraw-Hill International Editons, 1994.
2. Malcom R.Haskard, Lan C.May, "Analog VLSI Design - NMOS and CMOS ", Prentice Hall, 1998.
3. Randall L Geiger, Phillip E. Allen, " Noel K.Strader, VLSI Design Techniques for Analog and Digital Circuits ", Mc Graw Hill International Company, 1990.
4. Jose E.France, Yannis Tsvividis, "Design of Analog-Digital VLSI Circuits for Telecommunication and signal Processing ", Prentice Hall, 1994

**UNIT I            RANDOM ACCESS MEMORY TECHNOLOGIES            9**

Static Random Access Memories (SRAMs): SRAM Cell Structures-MOS SRAM Architecture-MOS SRAM Cell and Peripheral Circuit Operation-Bipolar SRAM Technologies-Silicon On Insulator (SOI) Technology-Advanced SRAM Architectures and Technologies-Application Specific SRAMs.

Dynamic Random Access Memories (DRAMs): DRAM Technology Development-CMOS DRAMs-DRAMs Cell Theory and Advanced Cell Structures-BiCMOS, DRAMs-Soft Error Failures in DRAMs-Advanced DRAM Designs and Architecture-Application, Specific DRAMs.

**UNIT II            NONVOLATILE MEMORIES            9**

Masked Read-Only Memories (ROMs)-High Density ROMs-Programmable Read-Only Memories (PROMs)-Bipolar PROMs-CMOS PROMs-Erasable (UV) - Programmable Read-Only Memories (EPROMs)-Floating-Gate EPROM Cell-One-Time Programmable (OTP) EPROMs-Electrically Erasable PROMs (EEPROMs)-EEPROM Technology And Architecture-Nonvolatile SRAM-Flash Memories (EPROMs or EEPROM)-Advanced Flash Memory Architecture.

**UNIT III            MEMORY FAULT MODELING, TESTING, AND MEMORY DESIGN FOR TESTABILITY AND FAULT TOLERANCE            9**

RAM Fault Modeling, Electrical Testing, Pseudo Random Testing-Megabit DRAM Testing-Nonvolatile Memory Modeling and Testing-IDDQ Fault Modeling and Testing-Application Specific Memory Testing

**UNIT IV            RELIABILITY AND RADIATION EFFECTS            9**

General Reliability Issues-RAM Failure Modes and Mechanism-Nonvolatile Memory Reliability-Reliability Modeling and Failure Rate Prediction-Design for Reliability-Reliability Test Structures-Reliability Screening and Qualification. RAM Fault Modeling, Electrical Testing, Pseudo Random Testing-Megabit DRAM Testing-Nonvolatile Memory Modeling and Testing-IDDQ Fault Modeling and Testing-Application Specific Memory Testing.

**UNIT V            PACKAGING TECHNOLOGIES            9**

Radiation Effects-Single Event Phenomenon (SEP)-Radiation Hardening Techniques-Radiation Hardening Process and Design Issues-Radiation Hardened Memory Characteristics-Radiation Hardness Assurance and Testing - Radiation Dosimetry-Water Level Radiation Testing and Test Structures. Ferroelectric Random Access Memories (FRAMs)-Gallium Arsenide (GaAs) FRAMs-Analog Memories-Magnetoresistive. Random Access Memories (MRAMs)-Experimental Memory Devices. Memory Hybrids and MCMs (2D)-Memory Stacks and MCMs (3D)-Memory MCM Testing and Reliability Issues-Memory Cards-High Density Memory Packaging Future Directions.

**TOTAL: 45 PERIODS****REFERENCES**

1. Ashok K.Sharma, " Semiconductor Memories Technology, Testing and Reliability ",Prentice-Hall of India Private Limited, New Delhi, 1997.
2. Tegze P.Haraszti, "CMOS Memory Circuits", Kluwer Academic publishers, 2001.
3. Betty Prince, " Emerging Memories: Technologies and Trends", Kluwer Academic publishers, 2002.

**UNIT I            CRYSTAL GROWTH, WAFER PREPARATION, EPITAXY AND OXIDATION            9**

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

**UNIT II            LITHOGRAPHY AND RELATIVE PLASMA ETCHING            9**

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

**UNIT III            DEPOSITION, DIFFUSION, ION IMPLEMENTATION AND METALISATION            9**

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

**UNIT IV            PROCESS SIMULATION AND VLSI PROCESS INTEGRATION            9**

Ion implantation – Diffusion and oxidation – Epitaxy – Lithography – Etching and Deposition- NMOS IC Technology – CMOS IC Technology – MOS Memory IC technology - Bipolar IC Technology – IC Fabrication.

**UNIT V            ASSEMBLY TECHNIQUES AND PACKAGING OF VLSI DEVICES            9**

Analytical Beams – Beams Specimen interactions - Chemical methods – Package types – banking design consideration – VLSI assembly technology – Package fabrication technology.

**TOTAL: 45 PERIODS****REFERENCES**

1. S.M.Sze, "VLSI Technology", Mc.Graw.Hill Second Edition. 2002.
2. Douglas A. Pucknell and Kamran Eshraghian, " Basic VLSI Design", Prentice Hall India. 2003.
3. Amar Mukherjee, "Introduction to NMOS and CMOS VLSI System design Prentice Hall India.2000.
4. Wayne Wolf ,"Modern VLSI Design", Prentice Hall India.1998.

**UNIT I INTRODUCTION TO VLSI TECHNOLOGY 9**

Layout Rules-Circuit abstraction Cell generation using programmable logic array transistor chaining, Wein Berger arrays and gate matrices-layout of standard cells gate arrays and sea of gates,field programmable gate array(FPGA)-layout methodologies-Packaging-Computational Complexity-Algorithmic Paradigms

**UNIT II PLACEMENT USING TOP-DOWN APPROACH 9**

Partitioning: Approximation of Hyper Graphs with Graphs, Kernighan-Lin Heuristic-RatioCut- partition with capacity and i/o constraints.

Floor planning: Rectangular dual floor planning- hierarchial approach- simulated annealing- Floor plan sizing-

Placement: Cost function- force directed method- placement by simulated annealing-partitioning placement- module placement on a resistive network – regular placement-linear placement.

**UNIT III ROUTING USING TOP DOWN APPROACH 9**

Fundamentals: Maze Running- line searching- Steiner trees

Global Routing: Sequential Approaches- hierarchial approaches- multicommodity flow based techniques- Randomised Routing- One Step approach- Integer Linear Programming

Detailed Routing: Channel Routing- Switch box routing.

Routing in FPGA: Array based FPGA- Row based FPGAs

**UNIT IV PERFORMANCE ISSUES IN CIRCUIT LAYOUT 9**

Delay Models: Gate Delay Models- Models for interconnected Delay- Delay in RC trees.

Timing – Driven Placement: Zero Stack Algorithm- Weight based placement- Linear Programming Approach Timing Driving Routing: Delay Minimization- Clock Skew Problem- Buffered Clock Trees. Minimization: constrained via Minimization-unconstrained via Minimization- Other issues in minimization

**UNIT V SINGLE LAYER ROUTING,CELL GENERATION AND COMPACTION 9**

Planar subset problem(PSP)- Single Layer Global Routing- Single Layer detailed Routing- Wire length and bend minimization technique – Over The Cell (OTC) Routing-Multiple chip modules(MCM)- Programmable Logic Arrays- Transistor chaining- Wein Burger Arrays- Gate matrix layout- 1D compaction- 2D compaction.

**TOTAL: 45 PERIODS****REFERENCES**

1. Sarafzadeh, C.K. Wong, "An Introduction to VLSI Physical Design", Mc Graw Hill International Edition 1995
2. Preas M. Lorenzatti, " Physical Design and Automation of VLSI systems", The Benjamin Cummins Publishers, 1998.

**VL9258 GENETIC ALGORITHMS AND THEIR APPLICATIONS LT P C  
3 0 0 3**

**UNIT I 9**

Introduction,GA Technology-Steady State Algorithm-Fitness Scaling-Inversion

**UNIT II 9**

GA for VLSI Design, Layout and Test automation- partitioning-automatic placement,routing technology,Mapping for FPGA- Automatic test generation-Partitioning algorithm Taxonomy-Multiway Partitioning

**UNIT III 9**

Hybrid genetic – genetic encoding-local improvement-WDFR-Comparison of Cas-Standard cell placement-GASP algorithm-unified algorithm.

**UNIT IV 9**

Global routing-FPGA technology mapping-circuit generation-test generation in a GA frame work-test generation procedures.

**UNIT V 9**

Power estimation-application of GA-Standard cell placement-GA for ATG-problem encoding- fitness function-GA vs Conventional algorithm.

**TOTAL: 45 PERIODS**

**REFERENCES**

1. Pinaki Mazumder,E.MRudnick,"Genetic Algorithm for VLSI Design,Layout and test Automation", Prentice Hall,1998.
2. Randy L. Haupt, Sue Ellen Haupt, "Practical Genetic Algorithms" Wiley – Interscience,1977.
3. Ricardo Sal Zebulum, Macro Aurelio Pacheco, Marley Maria B.R. Vellasco, Marley Maria Bernard Vellasco "Evolution Electronics: Automatic Design of electronic Circuits and Systems Genetic Algorithms", CRC press, 1<sup>st</sup> Edition Dec 2001.
4. John R.Koza, Forrest H.Bennett III, David Andre , Morgan Kufmann, "Genetic Programming Automatic programming and Automatic Circuit Synthesis", 1<sup>st</sup> Edition , May 1999.

**AP9213 ADVANCED MICROPROCESSORS AND MICROCONTROLLERS LT P C  
3 0 0 3**

**UNIT I MICROPROCESSOR ARCHITECTURE 9**

Instruction Set – Data formats –Addressing modes – Memory hierarchy –register file – Cache – Virtual memory and paging – Segmentation- pipelining –the instruction pipeline – pipeline hazards – instruction level parallelism – reduced instruction set –Computer principles – RISC versus CISC.

**UNIT II HIGH PERFORMANCE CISC ARCHITECTURE – PENTIUM 9**

CPU Architecture- Bus Operations – Pipelining – Branch predication – floating point unit- Operating Modes –Paging – Multitasking – Exception and Interrupts – Instruction set – addressing modes – Programming the Pentium processor.

**UNIT III HIGH PERFORMANCE RISC ARCHITECTURE – ARM 9**

Organization of CPU – Bus architecture –Memory management unit - ARM instruction set- Thumb Instruction set- addressing modes – Programming the ARM processor.

**UNIT IV MOTOROLA 68HC11 MICROCONTROLLERS 9**

Instruction set addressing modes – operating modes- Interruptsystem- RTC-Serial Communication Interface – A/D Converter PWM and UART.

**UNIT V PIC MICROCONTROLLER 9**

CPU Architecture – Instruction set – interrupts- Timers- I<sup>2</sup>C Interfacing –UART- A/D Converter –PWM and introduction to C-Compilers.

**TOTAL: 45 PERIODS**

**REFERENCES**

1. Daniel Tabak , “ Advanced Microprocessors” McGraw Hill.Inc., 1995
2. James L. Antonakos , “ The Pentium Microprocessor “ Pearson Education , 1997.
3. Steve Furber , “ ARM System –On –Chip architecture “Addision Wesley , 2000.
4. Gene .H.Miller .” Micro Computer Engineering ,” Pearson Education , 2003.
5. John .B.Peatman , “ Design with PIC Microcontroller , Prentice hall, 1997.
6. James L.Antonakos ,” An Introduction to the Intel family of Microprocessors “ Pearson Education 1999.
7. Barry.B.Breg,” The Intel Microprocessors Architecture , Programming and Interfacing “ , PHI,2002.
8. Valvano "Embedded Microcomputer Systems" Thomson Asia PVT LTD first reprint 2001.

**AP9252 NEURAL NETWORKS AND ITS APPLICATIONS LT P C  
3 0 0 3**

**UNIT I BASIC LEARNING ALGORITHMS 9**

Biological Neuron – Artificial Neural Model - Types of activation functions – Architecture: Feedforward and Feedback – Learning Process: Error Correction Learning –Memory Based Learning – Hebbian Learning – Competitive Learning - Boltzman Learning – Supervised and Unsupervised Learning – Learning Tasks: Pattern Space – Weight Space – Pattern Association – Pattern Recognition – Function Approximation – Control – Filtering - Beamforming – Memory – Adaptation - Statistical Learning Theory – Single Layer Perceptron – Perceptron Learning Algorithm – Perceptron Convergence Theorem – Least Mean Square Learning Algorithm – Multilayer Perceptron – Back Propagation Algorithm – XOR problem – Limitations of Back Propagation Algorithm.

**UNIT II            RADIAL-BASIS FUNCTION NETWORKS AND SUPPORT VECTOR MACHINES: RADIAL BASIS FUNCTION NETWORKS            9**

Cover's Theorem on the Separability of Patterns - Exact Interpolator – Regularization Theory – Generalized Radial Basis Function Networks - Learning in Radial Basis Function Networks - Applications: XOR Problem – Image Classification.

Support Vector Machines:

Optimal Hyperplane for Linearly Separable Patterns and Nonseparable Patterns – Support Vector Machine for Pattern Recognition – XOR Problem -  $\epsilon$ -insensitive Loss Function – Support Vector Machines for Nonlinear Regression

**UNIT III            COMMITTEE MACHINES            9**

Ensemble Averaging - Boosting – Associative Gaussian Mixture Model – Hierarchical Mixture of Experts Model(HME) – Model Selection using a Standard Decision Tree – A Priori and Postpriori Probabilities – Maximum Likelihood Estimation – Learning Strategies for the HME Model - EM Algorithm – Applications of EM Algorithm to HME Model

**NEURODYNAMICS SYSTEMS**

Dynamical Systems – Attractors and Stability – Non-linear Dynamical Systems- Lyapunov Stability – Neurodynamical Systems – The Cohen-Grossberg Theorem.

**UNIT IV            ATTRACTOR NEURAL NETWORKS            9**

Associative Learning – Attractor Neural Network Associative Memory – Linear Associative Memory – Hopfield Network – Content Addressable Memory – Strange Attractors and Chaos - Error Performance of Hopfield Networks - Applications of Hopfield Networks – Simulated Annealing – Boltzmann Machine – Bidirectional Associative Memory – BAM Stability Analysis – Error Correction in BAMs - Memory Annihilation of Structured Maps in BAMS – Continuous BAMs – Adaptive BAMs – Applications

**ADAPTIVE RESONANCE THEORY**

Noise-Saturation Dilemma - Solving Noise-Saturation Dilemma – Recurrent On-center – Off-surround Networks – Building Blocks of Adaptive Resonance – Substrate of Resonance Structural Details of Resonance Model – Adaptive Resonance Theory – Applications

**UNIT V            SELF ORGANISING MAPS            9**

Self-organizing Map – Maximal Eigenvector Filtering – Sanger's Rule – Generalized Learning Law – Competitive Learning - Vector Quantization – Mexican Hat Networks - Self-organizing Feature Maps – Applications



## **PULSED NEURON MODELS**

Spiking Neuron Model – Integrate-and-Fire Neurons – Conductance Based Models – Computing with Spiking Neurons.

**TOTAL: 45 PERIODS**

### **REFERENCES**

1. Satish Kumar, “Neural Networks: A Classroom Approach”, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2004.
2. Simon Haykin, “Neural Networks: A Comprehensive Foundation”, 2ed., Addison Wesley Longman (Singapore) Private Limited, Delhi, 2001.
3. Martin T.Hagan, Howard B. Demuth, and Mark Beale, “Neural Network Design”, Thomson Learning, New Delhi, 2003.
4. James A. Freeman and David M. Skapura, “Neural Networks Algorithms, Applications, and Programming Techniques, Pearson Education (Singapore) Private Limited, Delhi, 2003.

**VL9261**

**ASIC DESIGN**

**LT P C  
3 0 0 3**

### **UNIT I INTRODUCTION TO ASICs, CMOS LOGIC AND ASIC LIBRARY DESIGN**

**9**

Types of ASICs - Design flow - CMOS transistors CMOS Design rules - Combinational Logic Cell – Sequential logic cell - Data path logic cell - Transistors as Resistors - Transistor Parasitic Capacitance- Logical effort –Library cell design - Library architecture

### **UNIT II PROGRAMMABLE ASICs, PROGRAMMABLE ASIC LOGIC CELLS AND PROGRAMMABLE ASIC I/O CELLS**

**9**

Anti fuse - static RAM - EPROM and EEPROM technology - PREP benchmarks - Actel ACT - Xilinx LCA –Altera FLEX - Altera MAX DC & AC inputs and outputs - Clock & Power inputs - Xilinx I/O blocks.

### **UNIT III PROGRAMMABLE ASIC INTERCONNECT, PROGRAMMABLE ASIC DESIGN SOFTWARE AND LOW LEVEL DESIGN ENTRY**

**9**

Actel ACT -Xilinx LCA - Xilinx EPLD - Altera MAX 5000 and 7000 - Altera MAX 9000 - Altera FLEX –Design systems - Logic Synthesis - Half gate ASIC -Schematic entry - Low level design language - PLA tools -EDIF- CFI design representation.

### **UNIT IV LOGIC SYNTHESIS, SIMULATION AND TESTING**

**9**

Verilog and logic synthesis -VHDL and logic synthesis - types of simulation -boundary scan test - fault simulation - automatic test pattern generation.



**UNIT V MANUFACTURE AND RELIABILITY MAQNAGEMENT 9**

Control of production variability, Acceptance sampling, Quality control and stress screening, Production failure reporting; preventive maintenance strategy, Maintenance schedules, Design for maintainability, Integrated reliability programmes , reliability and costs, standard for reliability, quality and safety, specifying reliability, organization for reliability.

**TOTAL: 45 PERIODS**

**REFERENCES**

1. Patrick D.T. O'Connor, David Newton and Richard Bromley, Practical Reliability Engineering, Fourth edition, John Wiley & Sons, 2002
2. David J. Klinger, Yoshinao Nakada and Maria A. Menendez, Von Nostrand Reinhold, New York, "AT & T Reliability Manual", 5th Edition, 1998.
3. Gregg K. Hobbs, "Accelerated Reliability Engineering - HALT and HASS", John Wiley & Sons, New York, 2000.
4. Lewis, "Introduction to Reliability Engineering", 2nd Edition, Wiley International, 1996.

**AP9256**

**ELECTROMAGNETIC INTERFERENCE AND  
COMPATIBILITY IN SYSTEM DESIGN**

**LT P C  
3 0 0 3**

**UNIT I EMI/EMC CONCEPTS 9**

EMI-EMC definitions and Units of parameters; Sources and victim of EMI; Conducted and Radiated EMI Emission and Susceptibility; Transient EMI, ESD; Radiation Hazards.

**UNIT II EMI COUPLING PRINCIPLES 9**

Conducted, radiated and transient coupling; Common ground impedance coupling ; Common mode and ground loop coupling ; Differential mode coupling ; Near field cable to cable coupling, cross talk ; Field to cable coupling ; Power mains and Power supply coupling.

**UNIT III EMI CONTROL TECHNIQUES 9**

Shielding, Filtering, Grounding, Bonding, Isolation transformer, Transient suppressors, Cable routing, Signal control.

**UNIT IV EMC DESIGN OF PCBS 9**

Component selection and mounting; PCB trace impedance; Routing; Cross talk control; Power distribution decoupling; Zoning; Grounding; VIAs connection; Terminations.

**UNIT V EMI MEASUREMENTS AND STANDARDS 9**

Open area test site; TEM cell; EMI test shielded chamber and shielded ferrite lined anechoic chamber; Tx /Rx Antennas, Sensors, Injectors / Couplers, and coupling factors; EMI Rx and spectrum analyzer; Civilian standards-CISPR, FCC, IEC, EN; Military standards-MIL461E/462.

**TOTAL: 45 PERIODS**

## REFERENCES

1. V.P.Kodali, "Engineering EMC Principles, Measurements and Technologies", IEEE Press, Newyork, 1996.
2. Henry W.Ott., "Noise Reduction Techniques in Electronic Systems", A Wiley Inter Science Publications, John Wiley and Sons, Newyork, 1988.
3. Bemhard Keiser, "Principles of Electromagnetic Compatibility", 3<sup>rd</sup> Ed, Artech house, Norwood, 1986.
4. C.R.Paul, "Introduction to Electromagnetic Compatibility", John Wiley and Sons, Inc, 1992.
5. Don R.J.White Consultant Incorporate, "Handbook of EMI/EMC", Vol I-V, 1988.

VL9264

DIGITAL SPEECH SIGNAL PROCESSING

L T P C  
3 0 0 3

### UNIT I MECHANICS OF SPEECH 8

Speech production mechanism – Nature of Speech signal – Discrete time modelling of Speech production – Representation of Speech signals – Classification of Speech sounds – Phones – Phonemes – Phonetic and Phonemic alphabets – Articulatory features. Music production – Auditory perception – Anatomical pathways from the ear to the perception of sound – Peripheral auditory system – Psycho acoustics

### UNIT II TIME DOMAIN METHODS FOR SPEECH PROCESSING 8

Time domain parameters of Speech signal – Methods for extracting the parameters Energy, Average Magnitude – Zero crossing Rate – Silence Discrimination using ZCR and energy – Short Time Auto Correlation Function – Pitch period estimation using Auto Correlation Function

### UNIT III FREQUENCY DOMAIN METHOD FOR SPEECH PROCESSING 9

Short Time Fourier analysis – Filter bank analysis – Formant extraction – Pitch Extraction – Analysis by Synthesis- Analysis synthesis systems- Phase vocoder— Channel Vocoder.

### HOMOMORPHIC SPEECH ANALYSIS

Cepstral analysis of Speech – Formant and Pitch Estimation – Homomorphic Vocoders.

### UNIT IV LINEAR PREDICTIVE ANALYSIS OF SPEECH 10

Formulation of Linear Prediction problem in Time Domain – Basic Principle – Auto correlation method – Covariance method – Solution of LPC equations – Cholesky method – Durbin's Recursive algorithm – lattice formation and solutions – Comparison of different methods – Application of LPC parameters – Pitch detection using LPC parameters – Formant analysis – VELP – CELP.

**UNIT V APPLICATION OF SPEECH SIGNAL PROCESSING 10**

Algorithms: Spectral Estimation, dynamic time warping, hidden Markov model – Music analysis – Pitch Detection – Feature analysis for recognition –Automatic Speech Recognition – Feature Extraction for ASR – Deterministic sequence recognition – Statistical Sequence recognition – ASR systems – Speaker identification and verification – Voice response system – Speech Synthesis: Text to speech, voice over IP.

**TOTAL: 45 PERIODS**

**REFERENCES**

1. Ben Gold and Nelson Morgan, Speech and Audio Signal Processing, John Wiley and Sons Inc. , Singapore, 2004
2. L.R.Rabiner and R.W.Schaffer – Digital Processing of Speech signals – Prentice Hall -1978
3. Quatieri – Discrete-time Speech Signal Processing – Prentice Hall – 2001.
4. J.L.Flanagan – Speech analysis: Synthesis and Perception – 2<sup>nd</sup> edition – Berlin – 1972
5. I.H.Witten – – Principles of Computer Speech – Academic Press – 1982

**VL9265 DSP PROCESSOR ARCHITECTURE AND PROGRAMMING LT P C  
3 0 0 3**

**UNIT I FUNDAMENTALS OF PROGRAMMABLE DSPs 9**

Multiplier and Multiplier accumulator – Modified Bus Structures and Memory access in P-DSPs – Multiple access memory – Multi-port memory – VLIW architecture- Pipelining – Special Addressing modes in P-DSPs – On chip Peripherals.

**UNIT II TMS320C5X PROCESSOR 9**

Architecture – Assembly language syntax - Addressing modes – Assembly language Instructions - Pipeline structure, Operation – Block Diagram of DSP starter kit – Application Programs for processing real time signals.

**UNIT III TMS320C3X PROCESSOR 9**

Architecture – Data formats - Addressing modes – Groups of addressing modes- Instruction sets - Operation – Block Diagram of DSP starter kit – Application Programs for processing real time signals – Generating and finding the sum of series, Convolution of two sequences, Filter design

**UNIT IV ADSP PROCESSORS 9**

Architecture of ADSP-21XX and ADSP-210XX series of DSP processors- Addressing modes and assembly language instructions – Application programs –Filter design, FFT calculation.

**UNIT V    ADVANCED PROCESSORS****9**

Architecture of TMS320C54X: Pipe line operation, Code Composer studio - Architecture of TMS320C6X - Architecture of Motorola DSP563XX – Comparison of the features of DSP family processors.

**TOTAL: 45 PERIODS****REFERENCES**

1. B.Venkataramani and M.Bhaskar, “Digital Signal Processors – Architecture, Programming and Applications” – Tata McGraw – Hill Publishing Company Limited. New Delhi, 2003.
2. User guides Texas Instrumentation, Analog Devices, Motorola.

**VL9266****INTRODUCTION TO MEMS SYSTEM DESIGN****LT P C  
3 0 0 3****UNIT I            INTRODUCTION TO MEMS****9**

MEMS and Microsystems, Miniaturization, Typical products, Micro sensors, Micro actuation, MEMS with micro actuators, Microaccelerometers and Micro fluidics, MEMS materials, Micro fabrication

**UNIT II            MECHANICS FOR MEMS DESIGN****9**

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

**UNIT III            ELECTRO STATIC DESIGN****9**

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

**UNIT IV            CIRCUIT AND SYSTEM ISSUES****9**

Electronic Interfaces, Feed back systems, Noise , Circuit and system issues, Case studies – Capacitive accelerometer, Peizo electric pressure sensor, Modelling of MEMS systems, CAD for MEMS.

**UNIT V            INTRODUCTION TO OPTICAL AND RF MEMS****9**

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

**TOTAL: 45 PERIODS****REFERENCES**

1. Stephen Santuria, " Microsystems Design", Kluwer publishers, 2000.
2. Nadim Maluf, " An introduction to Micro electro mechanical system design", Artech House, 2000
3. Mohamed Gad-el-Hak, editor, " The MEMS Handbook", CRC press Baco Raton,2000.
4. Tai Ran Hsu, " MEMS & Micro systems Design and Manufacture" Tata McGraw Hill, New Delhi, 2002.