PONDICHERRY UNIVERSITY
PUDUCHERRY 605 014

Department of Electronics Engineering

M. Tech Electronics

Scheme & Syllabus

2011-12 Onwards

M.Tech. Program in Electronics

Department of Physics will mentor the **M.Tech. Program in Electronics**, which is to be introduced from the academic year 2010-11.

Electronics plays important role in the development of the state of the art science and technology. Advancement of Electronics led to an all round development on human comfort, safety and furthers research on almost all scientific technology and engineering endeavours. M. Tech. (Electronics) program is envisaged as a science, engineering and technology.

M. Tech. program is designed to impart the necessary background knowledge of the state of art developments in all the areas of electronics – devices to systems. The modern physics courses in most of the universities at graduate and post - graduate level of science try to cover the fundamental aspects of electronics Viz., semi-conductor physics and circuit theory. The engineering graduates are specialized only in technological aspects of the application of theses devices and circuits in instrumentation and communication systems. The present M.Tech. program is aimed to bridge this gap between the science and technology students. The emphasis will be on understanding both the science and technological aspects of electronics. Further it will enable them to design new devices and systems.

The program is planned to cover the following aspects in detail.

1. Devices: Design, fabrication and Application
2. Communication: Microwave, digital and optical communication
3. System design: Analog, digital and mixed-mode.
4. Embedded Systems: Real time and Robotics applications

The students who pass out of this course will have good Industrial and research opportunities.

Details of the program

Program Duration:
Two years (Four Semesters); Total number of credits: 73

Eligibility criteria:
B.E /B.Tech in EEE, ECE and E&I , M.Sc. Electronic Science / Physics with Electronics/ Materials Science with Electronics / Solid State Technology with Electronics

Admission criteria:
Pondicherry University – All India Entrance Examination
Or valid GATE Score in relevant disciplines
Intake: 24 students

Teaching and Learning Methods:
Lectures, tutorials and seminars form the main methods of course delivery enhanced by individual and group project work, laboratory work, computing workshops and industrial visits.

Assessment Methods:
Assessment will be through Choice Based Credit System (CBCS) through session (laboratory reports, class tests, set assignments) or by continuous assessment (designing, computer practical, seminar papers, project reports etc.) and end semester examinations. The end semester question paper can be set by concerned course teacher

Scheme of Courses and Credits for M.Tech Electronics:

First year:	**Odd semester**	**Even Semester**
Compulsory subjects	4 (16)	3 (9)
Elective Subjects	2 (6)	5 (15)*
Practical – Laboratory	1 (3)	1 (3)

*Depending on Students choice & faculty availability all three or two Groups (A/B/C) will be offered

Second year		
Project work & Dissertation	1 (12)	1 (12)

Dr. V.V. Ravi Kanth Kumar
Centre Head
Department of Electronics Engineering
Pondicherry University

Scheme of Study

S.No	Course No.	Course Title.	L-T-P	Credits
SEMESTER- I				
1.	EEC7100	Embedded systems & Electronic Design Laboratory	0-1-5	3
2.	EEC7101	Quantum Mechanics Its applications to Tech. & Adv Engg. Maths	4-0-0	4
3.	EEC7102	Semiconductor Devices & Technology	4-0-0	4
4.	EEC7103	Digital Signal Processing & Applications	4-0-0	4
5.	EEC7104	Electromagnetic Theory, Interference & Compatibility	4-0-0	4
5.		Elective - I	3-0-0	3
6.		Elective – II	3-0-0	3
				25
List of Electives – I & II				
7.	EEC7105	MOS Device Modelling	3-0-0	
8.	EEC7106	Embedded systems	3-0-0	
9.	EEC7107	Micro-electromechanical systems design, MEMS	3-0-0	
SEMESTER – II				
11.	EEC7200	Advanced Embedded Systems & Specialisation laboratory	0-1-5	3
12.	EEC7201	Analog & Digital Design Techniques	4-0-0	4
13.	EEC7202	Research Seminar	2-0-0	2
14.		Elective – III*	3-0-0	3
15.		Elective – IV*	3-0-0	3
16.		Elective – V*	3-0-0	3
17.		Elective – VI*	3-0-0	3
18.		Elective – VI*	3-0-0	3
				24
*All Elective of Semester-II has to be chosen from the same Group i.e. Group A/B/C				
List of Electives – III, IV, V, VI & VII				
Group-A: VLSI Technology				
18.	EEC7203	VLSI Technology	3-0-0	
19.	EEC7204	VLSI Systems & Architecture	3-0-0	
20.	EEC7205	CAD Tools for VLSI Design	3-0-0	
21.	EEC7206	CMOS VLSI Design	3-0-0	
22.	EEC7207	ASIC Design	3-0-0	
23.	EEC7208	Low Power VLSI Design	3-0-0	
24.	EEC7209	Design Analog & Mixedmode VLSI Circuits	3-0-0	
25.	EEC7210	Alogarithm for VLSI	3-0-0	
26	EEC7211	VLSI Testing & Verification	3-0-0	
27.	EEC7212	Advanced Analog & Digital Circuit Design		

S.No	Course No.	Course Title.	L-T-P	Credits
Group B: Communication Electronics				
28.	EEC7213	Passive Microwave Devices & Circuits	3-0-0	
29.	EEC7214	Antenna Theory & Design	3-0-0	
30.	EEC7215	Optical Communication & Networking	3-0-0	
31.	EEC7216	Wireless communications	3-0-0	
32.	EEC7217	Advanced Digital Communications	3-0-0	
33.	EEC7218	Active RF & Microwave Circuits	3-0-0	
34.	EEC7219	CMOS RF Circuit Design	3-0-0	
35.	EEC7220	Modelling & Simulation of Networks	3-0-0	
36	EEC7221	Microwave Integrated Circuits	3-0-0	
37.	EEC7222	CAD of RF & Microwave Circuits	3-0-0	
38.	EEC7223	Fabrication & Measurement Techniques for RF & Microwaves	3-0-0	
39.	EEC7224	RF MEMS	3-0-0	
40.	EEC7225	Advanced Techniques in Wireless Networks	3-0-0	
41.	EEC7226	OFDM for Wireless Communication	3-0-0	
42.	EEC7227	Ultra Wideband Wireless Communication	3-0-0	
Group C: Nano Electronics				
43.	EEC7228	Silicon on Insulator MOS Devices & Multiple Gate Devices	3-0-0	
44.	EEC7229	Molecular Electronics	3-0-0	
45.	EEC7230	Reliability of Semiconductor Devices	3-0-0	
46.	EEC7231	High Speed Semiconductor Devices	3-0-0	
47.	EEC7232	Nano Electronics	3-0-0	
48.	EEC7233	Compound Semiconductor Devices	3-0-0	
49.	EEC7234	Semiconductor Power Devices	3-0-0	
50.	EEC7235	Material Science	3-0-0	
51.	EEC7236	Semiconductor Device Characterisation Techniques	3-0-0	
SEMESTER – III & IV				
52.	EEC7300	Phase I – Project, Mid- Project Report – Problem Definition, Literature Review, Preliminary results, if any & Viva voce		**12**
53.	EEC7400	Phase-II – Project, Comprehensive Project report with results & Viva Voce		**12**
TOTAL NUMBER OF CREDITS TO BE OBTAINED FOR THE COURSE				**73**

EEC7100 EMBEDDED SYSTEMS AND ELECTRONIC DESIGN LAB 0-1-5
Credits: 3

1. **Microcontroller (8 bit) based experiment**

    a. ADC/DAC .
    b. Stepper Motor controller
    c. Clock
    d. Serial Communication

2. **DSP (TMS320C50) based experiment**

    a. Linear Convolution
    b. ADC/DAC Interface
    c. LPF/HPF/BPF/BSF
    d. Waveform Generation

3. **Communication Experiment**
    a. Impedance measurement using Gunn diode
    b. Gain measurement of Parabolic dish antenna using Klystron oscillator
    c. Characteristics of Directional Couplers
    d. Analysis of sampling and noise spectral density
    e. Synthesis of different digital modulation schemes (PCM,DM,DPCM ADM)

4. **VLSI**
    a. Synthesis of Gates using VHDL/Verilog
    b. Synthesis of Counter using VHDL/Verilog
    c. Synthesis of Register using VHDL/Verilog

5. **Simulation**
    a. Simulation of analog circuits using PSPICE
    b. Simulation of digital circuits using PSPICE
    c. Simulation of communication circuits using PSPICE /MATLAB
    d. Simulation of MOS modelling circuits using modeling package

EEC7101 QUANTUM MECHANICS & ITS APPLICATIONS TO TECHNOLOGY &ADVANCED ENGINEERING MATHEMATICS 4-0-0 Credits:4

UNIT-I: **5 hours**
Failure of Classical Mechanics: Black body radiation, spectral lines, Young's double slit experiment, Heisenberg's uncertainty principle

UNIT-II: **10 hours**
Wave particle duality, Wave equation and Schrodinger's equation, Time dependent Schrodinger's wave equation, Eigen values, Eigen vectors, Eigen Energy, Solutions to Schordinger's wave equation,

UNIT-III: **10 hours**
Probability, Probability Density, Probability Current density, Electrons in potentials (infinite barrier, potential well), Triangular Potential wells, double barriers, double potential wells,

UNIT-IV: **5 hours**
Tunnelling phenomenon, , tunnelling Electrons in periodic lattices (KP Model), E-k diagrams

UNIT-V: **30 hours**
Advanced Mathematics: Linear differential equations and its solutions, non-linear differential equations and its solutions, complex integration, Linear algebra, Matrices and Tensors

TEXT BOOKS/REFERENCE BOOKS

1. Mathematical methods for physicists, George B Arfken, 4th ed. Academic Press
2. Advanced Engineering Mathematics, Erwin Kreyszig, 7th ed., John Wiley
3. Mathematics for Physicists, P. Dennery and A. Krzywicki, Dover Publications (1996)
4. Theory and Problems of Vector Analysis, McGraw Hill (1959), Spiegl. M. R
5. Differential equations with applications, G.F.Simmons, Tata-McGraw Hill, 1972.
6. Finite Dimensional Vector spaces, P Halmos, 2nd Ed., Van Nostrand.
7. Quantum Mechanics Fundamentals & Applications to Technology by Jasprit Singh, John Wiley & Sons INC.
8. Introduction to Quantum Mechanics, by David. J. Griffiths (2nd Ed.) Pearson Education (2005)
9. Modern Quantum Mechanics by J. J. Sakurai Addison Wesley, 1999
10. Principles of Quantum Mechanics, R. Shankar (II Ed.), Springer (1994)
11. Problems in Quantum Mechanics, Constantinescu and Magyari, Pergamon (1974)

EEC7102 SEMICONDUCTOR DEVICES & TECNOLOGY 4-0-0 Credits:4

UNIT – I : 12 hours

Semiconductor Physics: Review of crystal structure, Crystal structure of important semiconductors (Si, Ge & GaAs), Review of quantum mechanics, Electrons in periodic lattices, E-k diagrams, Quasiparticles in semiconductors, electrons, holes and phonons. Carrier concentration and carrier transport phenomenon. Excess carriers in semiconductors: Doping, Injection and recombination mechanisms; Carrier statistics; Continuity equation, Poisson's equation and their solution; Optical, Thermal and High field properties of semiconductors.

UNIT – II: 12 hours

Metal Semiconductor Structure: Homo and Hetero-Junctions (Schottky diode): structure, Band diagrams, operation, I-V and C-V characteristics (Analytical expressions); Heterojunctions. Transistors (BJT & JFET): structure, band diagrams, operation, I-V and C-V characteristics (Analytical expressions), small signal switching models, benefits of heterojunction transistors for high speed applications.

UNIT – III: 12 hours

MOS structures: Introduction, ideal and non-ideal MOS capacitor: band diagrams and C-V characteristics; Effects of oxide charges, defects and interface states; passivation of interface states; Characterization of MOS capacitors: HF and LF CVs, avalanche injection; High field effects and breakdown. MOSFET and CCD: Band diagrams, I-V and C-V characteristics (Analytical expressions); scaling down, alternate high k-dielectric materials, HF-MOSFETs, SOI MOSFET.

UNIT –IV: 12 hours

Advanced Devices: Crystal structure of III-V binary and tenary compound semiconductors (InP, InGaAs, SiGe), Electrical properties such as carrier mobility, velocity versus electric field characteristics and device processing techniques of these materials, band gap diagrams; InP based HBT device structure, SiGe based HBT devices, Single electron devices, High Frequency resonant -tunneling diodes, Resonant -tunneling hot electron transistors, Quantum well LASER, Spintronic devices, organic semiconductor devices.

UNIT –V: 12 hours

Fabrication and Characterization Techniques: Crystal growth and wafer preparation, Epitaxy, Diffusion, Ion Implantation, Thinfilm deposition and oxidization techniques, Planar technology: Masking and lithography techniques (UV,e-beam and other advanced lithography techniques) Metallisation. Bipolar and MOS integration techniques, interface passivation techniques, Characterization techniques: Four-probe and Hall measurement; I-V and CVs for dopant profile characterization; Capacitance transients and DLTS.

TEXT BOOKS/ REFERENCE BOOKS

1. Nandita Das Gupta and Amitava Das Gupta, “Semiconductor Devices: Modelling and Technology”, Prentice-Hall of India Pvt. Ltd. 2004.
2. M.S. Tyagi, Introduction to Semiconductor Materials and Devices, John Wiley & Sons, 1991.
3. S. M. Sze, Physics of Semiconductor Devices, 2nd edition John Wiley, 1981.
4. J. P. McKelvey, Introduction to Solid State and Semiconductor Physics, Harper and Row and John Weathe Hill.
5. J. Singh, Semiconductor devices: Basic Principles, Wiley student edition 2004

EEC7103 DIGITAL SIGNAL PROCESSING AND APPLICATIONS 4-0-0 Credits:4

UNIT- I: Introduction **12 hours**
Discrete Time Signals: Sequences; representation of signals on orthogonal basis; Sampling and Reconstruction of signals. Discrete Time Systems: Discrete time systems, Definition, Classification of systems, Convolution sum and its properties, Discrete Time Fourier Transform, Implementation of discrete time systems

UNIT- II: Discrete Fourier Transform **12 hours**
Definition, DFT as a linear transformation, Properties of DFT, IDFT, Linear filtering using DFT, Relationship of DFT to other transforms, efficient computation of DFT, FFT Algorithms: Decimation-in-time radix-2 algorithm and Decimation-in-frequency radix-2 algorithm. IDFT calculation using fast algorithm.

UNIT- III: Digital Filter Design **12 hours**
Design of FIR Digital filters: Window methods, Park-McClellan's method. Design of IIR Digital Filters: Butterworth, Chebyshev and Elliptic Approximations; Low pass, Band pass, Band stop and High pass filters.

UNIT-IV: Architecture of a Fixed Point Processor **12 hours**
Difference between DSP and other microprocessor architectures, their comparison. TMS 320C54X processor architecture: Introduction, Central Processing Unit, Auxiliary Register Unit, Memory and Buses, Application specific units, Addressing modes, Instruction sets, Control operations, Interrupts, Pipeline operation.

UNIT V: DSP Tools and Applications **12 hours**
DSP tools: Simulator, Assembler, Compiler, Linker, Debugger, Code generation, DSP boards. Waveform generation, Implementation of MAC, Digital filters, DFT, Adaptive filter, Notch filter, echo cancellation, modems, voice synthesis and recognition.

TEXT BOOKS/ REFERENCE BOOKS

1. A.V. Oppenheim and Schafer, “Discrete Time Signal Processing”, Prentice Hall, 1989.
2. John G. Proakis and D.G. Manolakis, Digital Signal Processing: Principle, Algorithms and Applications, Prentice Hall, 1997.
3. B.Venkataramani and M.Bhaskar, “Digital Signal Processor, Architecture, Programming and Applications”, Tata McGraw- Hill, 2003
4. J.R. Johnson, Introduction to Digital Signal Processing, Prentice Hall, 1992.
5. S.K.Mitra, “ Digital Signal Processing”, (2/e), Tata Mcgraw Hill, 2001.
6. E.C.Ifeachor and B.W.Jervis, “Digital Signal Processing”, (2/e), Pearson Education, 2002.
7. Texas Instruments TMS 320C54X DSP CPU, Mnemonic and Peripheral User Guides, 1998
8. Texas Instruments TMS320C30 User Guide, 1994
9. S. Srinivasan and Avatar Singh, “Digital Signal Processing, Implementations using DSP Microprocessors with examples from TMS320C54X”, Thomson Brooks/ Coke, 2004.
10. Rulth Chassaing, “Digital Signal Processing with C and TMS320C30”, John Wiley and Sons,1992.
11. K.Slin, “DSP Applications with the TMS320 family”, Prentice-Hall, 1987.

EEC7104 EM THEORY, INTERFERENCE AND COMPATIBILITY 4-0-0 Credits:4

UNIT- I: Electromagnetic Waves **12 hours**
Introduction to electromagnetic fields: review of vector analysis, electric and magnetic potentials, boundary conditions, Maxwell's equations, diffusion equation, Poynting vector, wave equation, Plane electromagnetic waves, Reflection and refraction of electromagnetic waves at an interface between dielectric and vacuum, Waves in conducting medium, Wave propagation through conductor-dielectric interface, Numerical Problems.

UNIT- II: Transmission Lines **12 hours**
Transmission lines, Parallel plate transmission lines, Helmholtz equation, RLCG parameters, Smith chart and its applications, Propagation constant and characteristic impedance of a general, lossless and distortion less transmission line, Quarter wavelength and half wavelength lines, Skin effect and resistance, Derivation of skin depth, Numerical Problems.

UNIT- III: Microwaves **12 hours**
Introduction, Transferred Electron Devices (TEDs) - Gunn effect diode, Gunn diode as an oscillator. Avalanche Transit time devices: IMPATT, TRAPATT and BARITT, Microwave Transistors and FETs, Klystrons, Reflex Klystron, Magnetrons, Principle of operation.

UNIT- IV: EMI/EMC Concepts **12 hours**
EMI-EMC definitions and Units of parameters, Sources and victim of EMI, Conducted and Radiated EMI Emission and Susceptibility, Transient EMI, ESD, Radiation Hazards. EMI Coupling and controlling Techniques: 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. Shielding, Filtering, Grounding, and Bonding.

UNIT- V: EMI Measurements and Standards **12 hours**
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.

TEXT BOOKS/REFERENCE BOOKS

1. Mathew N Sadiku, “Elements of Electromagnetics,” Oxford University Press.
2. John D.Ryder, “Networks, Lines and Fields,” PHI, 2ed, 2005.
3. R.E. Collin, “Foundations for Microwave Engineering”, IEEE Press.
4. Bernhard Keiser, “Principles of Electromagnetic Compatibility”, Artech house, 3rd Edn, 1986.
5. Henry W. Ott, “Noise reduction Techniques in Electronics Systems”, John Wiley & Sons, 1988.
6. Jordan, E.C. and Balmain, K.G., “Electromagnetic Waves and Radiating Systems”, 2nd ed., Prentice-Hall of India, 1993.
7. David Jackson, “Classical Electrodynamics,” John Wiley.
8. T.C.Edwards, “Foundations for Microstrip circuits design”, (2/e), Wiley.
9. I. Bahl and P. Bartia, “Microwave Solid State Circuit Design”, Wiley Inter Science, 2003.
10. I Bahl, “Lumped Elements for RF and Microwave Circuits”, Artech House.
11. Paul C.R., “Introduction to Electromagnetic Compatibility,” John Wiley and Sons, Inc, 1992.
12. Don R.J.White Consultant Incorporate, “Handbook of EMI/EMC”, Vol I-V, 1988.

EEC7105 **MOS DEVICE MODELLING** **3-0-0 Credits:3**

UNIT- I: **15 hours**

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),

UNIT-II: **15 hours**

Three terminal MOS, effect on threshold voltage. MOSFET (Enhancement and Depletion MOSFETs), mobility, on current characteristics, off current characteristics, sub threshold 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.

UNIT-III: **15 hours**

MOS transistor in dynamic operation, Large signal Modeling, small signal model for low, medium and high frequencies. SOI concept, PD SOI, FD SOI and their characteristics, threshold voltage of a SOI MOSFET, Multi-gate SOI MOSFETs, Alternate MOS structures.

TEXT BOOKS/ REFERENCE BOOKS:

1. E.H. Nicollian, J. R. Brews, Metal Oxide Semiconductor - Physics and Technology, John Wiley and Sons.
2. Nandita Das Guptha, Amitava Das Guptha, Semiconductor Devices Modeling and Technology, Prentice Hall India
3. Jean- Pierrie Colinge, Silicon-on-insulator Technology: Materials to VLSI, Kluwer Academic publishers group.
4. Yannis Tsividis, Operation and Modeling of the MOS transistor, Oxford University Press.
5. M.S.Tyagi, Introduction to Semiconductor materials and Devices, John Wiley & Sons, ISBN: 9971-51-316-1.
6. Donald A Neamen, Semiconductor Physics and Devices Basic Principles, McGraw-Hill (1997) ISBN 0-256-24214-3.
7. S.M. Sze, Modern Semiconductor Device Physics, Wiley (1998) ISBN 0-471-15237-4.
8. Robert F. Pierret, Semiconductor Device Fundamentals, Addison-Wesley (1995), ISBN 020154393-1, (Indian edition available).
9. J.P.Colinge, C.A.Colinge, Physics of Semiconductor Devices, Kulwer Academic Publishers, ISBN 1-40207-018-7 (available online at NITC intranet, in Springer eBook library, status 15th March 2010).
10. Yuan Taur & Tak H Ning, Fundamentals of Modern VLSI Devices, Cambridge University Press, 1998.
11. BRENNAN, Kevin F, Introduction to semiconductor devices: for computing and telecommunications applications, Cambridge Press, London, 2005, ISBN 978-0-521-67036-4.
12. KANO, Kanaan, Semiconductor devices, Prentice hall: New Delhi, 1998, ISBN 8131705358.
13. Christaian C. Enz, Cric A. Vittoz, Charge-based MOS Transistor Modeling, John Wiley 2006, ISBN-0-479-85541-X
14. A.B.Bharracharya, Compact MOSFET Models for VLSI Design, John Wiley 2009, ISBN 978-0-470-82342-2.

EEC7106 EMBEDDED SYSTEMS 3-0-0 Credits: 3

UNIT I: Introduction to Embedded Processors 9 hours

Introduction to Embedded Computing, Issues and Challenges in Embedded system Design, Trends: SC, custom designed chips, configurable designed chips, configurable processors and multi-core processors.

Embedded processor architecture: General concepts, instruction sets, Levels in architecture, Functional description-hardware/software trade-off Introduction to RISC architecture, Pipelining, Instruction issue and execution, Instruction formats, Addressing modes, Data alignment and byte ordering, Introduction to VLIW and DSP processors.

UNIT II: Devices and Buses for Devices Network 9 hours

I/O Devices:- Types and Examples of I/O devices, Synchronous, Iso-synchronous and Asynchronous Communications from Serial Devices - Examples of Internal Serial-Communication Devices:- SPI, UART, Parallel Port Devices - Timer and Counting Devices – Serial Communication using: 'I2C', 'USB', 'CAN'- Advanced I/O Serial high speed buses: ISA, PCI, PCI-X, cPCI and advanced buses.

UNIT III: Programming Concepts and Embedded Programming in C, C++ 9 hours

Programming in assembly language (ALP) vs High Level Language - C Program Elements:- Macros and functions, Use of Date Types, Structure, Pointers, Function Calls - Concepts of Embedded Programming in C++:- Objected Oriented Programming, Embedded Programming in C++, 'C' Program compilers – Cross compiler – Optimization of memory needs.

UNIT IV: Real Time Operating Systems 9 hours

Definitions of process, tasks and threads – Inter Process Communication:- Shared data problem, Use of Semaphore(s), Priority Inversion Problem and Deadlock Situations, Message Queues, Mailboxes, Pipes, Virtual (Logical) Sockets, Remote Procedure Calls (RPCs) - Operating System Services:- Goals, Structures, Kernel, Process Management, Memory Management, Device Management - Real Time Operating System - RTOS Task scheduling models:- Co-operative Round Robin Scheduling, Cyclic Scheduling with Time Slicing.

UNIT V: System Design Techniques 9 hours

Design Methodologies, Requirement Analysis, Specification, System Analysis and Architecture Design. Design Examples: Telephone PBX- System Architecture, Ink jet printer - Hardware Design and Software Design, Personal Digital Assistants, Set-top Boxes.

TEXT BOOKS/REFERENCE BOOKS

1. Rajkamal, *Embedded Systems Architecture, Programming and Design*, TATA McGraw-Hill, First reprint Oct. 2003
2. Wayne Wolf, *Computers as Components: Principles of Embedded Computing System Design* – Harcourt India, Morgan Kaufman Publishers, First Indian Reprint 2001.
3. Steve Heath, *Embedded Systems Design*, Second Edition-2003, Newnes,
4. David E.Simon, *An Embedded Software Primer*, Pearson Education Asia, First Indian Reprint 2000.
5. Frank Vahid and Tony Givargis, *Embedded Systems Design* – A unified Hardware /Software Introduction, John Wiley, 2002.

EEC7107 MICRO-ELECTROMECHANICAL SYSTEMS DESIGN 3 -0-0 Credits:3

UNIT- I: Introduction 9 hours

History of Micro-Electro Mechanical Systems (MEMS), market for MEMS, Introduction and origin of MEMS, driving force for MEMS development, fabrication process, MEMS fabrication technologies: Conventional IC fabrication processes, bulk micro machining, surface micro machining, LIGA process, anodic and fusion bonding, packaging techniques for MEMS.

UNIT-II : MEMS Sensor and Actuators 9 hours

Sensors, Classification and terminology of sensors, evolution of semiconductor sensors, sensor characterization basic concept of acoustic, mechanical, magnetic, radiation, thermal sensors and integrated sensors. Actuation in MEMS devices, electrostatic actuation, parallel plate capacitor-cantilever beam based movement, comb-drive structures.

UNIT- III: MEMS Switch 9 hours

MEM switch; Cantilever based MEM switch, Membrane based switch design microwave material and mechanical considerations. The MEMS switch; cantilever based MEMS switch, membrane based switch design.

UNIT- IV: RF MEMS 9 hours

Introduction to RF MEMS technologies: Need for RF MEMS components in communications, space and defense applications, Materials and fabrication technologies, Actuation methods in MEMS, Special considerations in RF MEMS design.

UNIT-V: MEMS Applications 9 hours

Examples of RF MEMS components and case studies: Micro-switches, Planar, on-chip components, Transmission lines and other components, Micromachined and reconfigurable antennas, Micromachined phase shifters.

TEXT BOOK/ REFERENCE BOOKS

1. M. Madou, “Fundamentals of Microfabrication”, 2nd ed., CRC Press, 2002
2. V.K. Varadan, K.J. Vinoy and K.A. Jose, “RF MEMS and their Applications”, John Wiley, 2002
3. Senturia, “Microsystem Design”, Kluwer, 2001.
4. J.W. Gardner , V.K. Varadan , O.O. Awadelkarim, “Microsensors, MEMS & Smart Devices”, John Wiley, 2001.
5. S. Campbell, “The Science and Engineering of Microelectronic Fabrication”, Oxford Univ. Press, 2001
6. N Maluf , “An Introduction to Microelectromechanical Systems Engineering”, Artech House
7. M Elwenspoek R. Wiegerink, “Mechanical Microsensensors”, Springer 2001
8. G.T. Kovacs, Micromachined Transducers Sourcebook, McGraw Hill Science, 1998
9. M. Gad El Hak The MEMS Handbook, CRC Press 2001.
10. H.J. De Los Santos, “Introduction to Microelectromechanical (MEM) Microwave Systems”, Artech house, 1999.

EEC7200 ADVANCED EMBEDDED SYSTEMS AND SPECIALISATION LAB

0-1-5 Credits: 3

A. **General experiments for VLSI & Communication**
   i) Microcontroller (16 bit) based experiment
      a) ADC/DAC
      b) Stepper Motor controller
      c) Clock
      d) Serial Communication
   ii) DSP (5416 processor) based experiment
      a) Circular Convolution
      b) FFT
      c) FIR
      d) IIR
      e) Speech processing

B. **Communication Specialized Laboratory**
   a. Synthesis of QAM modulation
   b. Synthesis of GMSK Modulation
   c. Spectral density of modulator circuits using Spectrum Analyser
   d. Response of filters using Network Analyser
   e. Response of MIC components using Network Analyzer
   f. Transmission line parameter measurement using Network Analyser
   g. Design, implementation and testing of CDMA system
   h. Gain measurement of Microstrip antenna
   i. Design and testing of Microstrip coupler
   j. Characteristics of MIC components
   k. Simulation and performance analysis of wireless communication system (OFDM MC - CDMA) using MATLAB
   l. Simulation and performance analysis of Phase Shifter, Directional Coupler, Impedance, Matching network, Branch line Coupler and Microstrip antenna using ADS software
   m. Simulation and performance analysis of error control coders using MATLAB
   n. Simulation of routing protocols of wireless networks (Wi-Fi/Ad hoc/WSN) using NS 2/OPNET
   o. Performance evaluation of digital data transmission through fibre optic link.

C. **VLSI Specialized Laboratory**
   a. Design and implementation of multiplexers using FPGA
   b. Design and implementation of Decoders using FPGA
   c. Design and implementation of PLA using FPGA
   d. Design and implementation of error control coders using FPGA
   e. Design and implementation TDM using FPGA
   f. Design and implementation of Spread Spectrum using FPGA
   g. Design and Implementation of filters using FPGA
   h. Circuit design experiments based on Design Compiler which do some circuit to layout related simulations. Should go in congruence with circuit design courses.

D. **Nanoelectronics Specialized Laboratory**
   a. Process simulations of pn junction diode, BJT & MOSFET
   b. Device Simulations of pn junction, BJT and MOSFET
   c. Nano electronic devices simulation (like tunnel FET, SOI devices, Molecular electronic devices, CNT based devices etc.).

EEC7201 ANALOG & DIGITAL DESIGN TECHNIQUES 3 -0-0 Credits:3

UNIT-I: ANALOG CIRCUIT DESIGN 9 hours

MOS differential amplifiers-common mode response-differential pair with MOS loads-Noise in differential pair-CMOS operational amplifiers-one stage op-amps and two stage op-amps –gain boosting-Miller, Nulling resistor compensation, CMOS oscillators-ring oscillators-LC oscillators-colpitts and one-port oscillators-voltage controlled oscillators-tuning in oscillators

UNIT II: 9 hours

Designing with Read only Memories-Programmable logic Array-Programmable Array Logic-Sequential Programmable Logic Devices

State transition table-State Machine Charts-Derivation of SM Charts-Realization of SM charts-Design example-Adder-Multiplier- Binary Divider-PLA-PAL

UNIT-III: FAULT MODELING AND TEST PATTERN GENERATION IN COMBINATIONAL CIRCUITS 9 hours

Hazards in combinational and sequential circuits, Logical Fault model, Fault diagnosis in Combinational Circuits- Fault Table method, Boolean Differences, Fault Detection by Path Sensitizing, Detection of Multiple Faults, Fault Tolerant Design and Redundancy Techniques

UNIT-IV: FAULT DIAGNOSIS IN SEQUENTIAL CIRCUITS 9 hours

State—Identifications and Fault-Detection Experiments: Homing Experiments, Distinguishing Experiments, Machine Identification, Design of Diagnosable Machines, Second Algorithm for the Design of Fault Detection Experiments, Fault-Detection Experiments for Machines which have no Distinguishing Sequences.

UNIT-V: CAPABILITIES, MINIMIZATION, AND TRANSFORMATION OF SEQUENTIAL MACHINES: 9 hours

The Finite- State Model, Further Definitions, Capabilities and Limitations of Finite – State Machines, State Equivalence and Machine Minimization, Simplification of Incompletely Specified Machines.

PLA minimization, Fault model in PLA, test generation and Testable PLA design

TEXT BOOKS/ REFRENCE BOOKS

1. Zvi Kohavi, “Switching and Finite Automata Theory”, 2nd Edition. Tata McGraw Hill Edition
2. Charles Roth Jr., “Digital Circuits and logic Design”,
3. Parag K Lala, “Fault Tolerant and Fault Testable Hardware Design”, Prentice Hall Inc. 1985
4. E. V. Krishnamurthy, “Introductory Theory of Computer”, Macmillan Press Ltd, 1983
5. Mishra & Chandrasekaran, “Theory of Computer Science – Automata, Languages and Computation”, 2nd Edition, PHI,2004

EEC7203 VLSI TECHNOLOGY 3-0-0 Credits: 3

UNIT-I: 5 hours

Material properties, crystal structure, lattice, basis, planes, directions, angle between different planes, characterization of material based on band diagram and bonding, conductivity, resistivity, sheet resistance, phase diagram and solid solubility, Crystal growth techniques, wafer cleaning, Epitaxy, Clean room and safety requirements.

UNIT-II: 5 hours

Oxidation: Kinetics of Silicon dioxide growth both for thick, thin and ultra-thin films, Deal-Grove model and Improvements in Deal-Grove method for thin and ultra-thin oxide layers, thickness characterization methods, multi dimension oxidation modelling.

UNIT-III: 5 hours

Diffusion and Ion Implantation: Diffusion process, Solid state diffusion modelling, various doping techniques, Ion implantation, modelling of Ion implantation, statistics of ion implantation, damage annealing, thermal budget, rapid thermal annealing, spike anneal, advanced annealing methods, Implant characterization SIMS, spreading resistance method.

UNIT-IV: 5 hours

Deposition & Growth: Various deposition techniques CVD, PVD, evaporation, sputtering, spin coating, LPCVD, epitaxy, MBE, ALCVD, Growth of High k and low k dielectrics

UNIT-V: 5 hours

Etch and Cleaning: materials used in cleaning, various cleaning methods, Wet etch, Dry etch, Plasma etching, RIE etching, etch selectivity/selective etch.

UNIT-VI: 12 hours

Photolithography: Positive photo resist, negative photo resist, comparison of photo resists, components of a resist, light sources, exposure, Resolution, Depth of Focus, Numerical Aperture (NA), sensitivity, contrast, need for different light sources, masks, Contact, proximity and projection lithography, step and scan, optical proximity correction, develop(development of resist), Next generation technologies: Immersion lithography, Phase shift mask, EUV lithography, X-ray lithography, e-beam lithography, ion lithography, SCALPEL.

UNIT-VII: 8 hours

Planarization Techniques: Need for planarization, Chemical Mechanical Polishing,

Interconnect Technologies: Copper damascene process, Metal interconnects; Multi-level metallization schemes, Process integration: NMOS, CMOS and Bipolar process.

TEXT BOOK/ REFERENCE BOOKS

1. James Plummer, M. Deal and P.Griffin, Silicon VLSI Technology, Prentice Hall Electronics
2. Stephen Campbell, The Science and Engineering of Microelectronics, Oxford University Press, 1996
3. S.M. Sze (Ed), VLSI Technology, 2nd Edition, McGraw Hill, 1988
4. S.K. Ghandhi, VLSI Fabrication Principles, John Wiley Inc., New York, 1983.
5. C.Y. Chang and S.M.Sze (Ed), ULSI Technology, McGraw Hill Companies Inc, 1996.

EEC7204 VLSI SYSTEM AND ARCHITECTURE 3-0-0 Credits 3

UNIT-I **9 hours**

Behavior and Architecture: Dedicated and Programmable VLSI architectures, Instruction sets and through enhancement techniques (Parallelism. pipelining. cache, etc.)

UNIT-II **12 hours**

CISC Architecture Concepts: Typical CISC instruction set and its VLSI implementation, RT-level optimization through hardware flow charting, Design of the execution unit, Design of the control part (micro programmed and hardwired), handling exceptions: Instruction boundary interrupts, immediate interrupts and traps.

UNIT-III **12 hours**

RISC Architecture Concepts: Typical RISC instruction set and its VLSI implementation, Execution pipeline, Benefits and problems of pipelined execution, Hazards of various types of pipeline stalling, concepts of scheduling (Static and dynamic) and forwarding to reduce / minimize pipeline stalls Exceptions in pipelined processors

UNIT-IV **12 hours**

DSP Architecture Concepts: Typical DSP instruction set and its VLSI implementation

Dedicated Hardware Architecture Concepts: Example and Case studies.
Dedicated DSP architecture Concepts: Synthesis, Scheduling and Resource allocation, Conventional Residue number, distributed arithmetic architecture

TEXT BOOK/ REFERENCE BOOKS

1. D A Patterson and I L Hennessy, "Computer Architecture: A Quantitative approach", Second edition, Margon Kaufmann, 1996
2. Lars Wanhammar, "DSP Integrated Circuits", Academic Press 1999.
3. D A Patterson and J L Hennessy, "Computer organization and Design: Hardware/Software interface" Second Edition, Margan Kaufmann, 1998
4. Avtar Sing and Srinivas S, "DSP: Architecture, Programming and Applications", Thomson Learning, 2004.
5. B. Venkataramani and M. Baskar, "DSP: Architecture, Programming and Applications", TMH, 2002.

EEC7205 CAD TOOLS FOR VLSI DESIGN 3-0-0 Credits:3

UNIT-I **10 hours**

High level Synthesis, CDFG representation, Partitioning algorithms, Scheduling algorithms, allocation algorithms

Logic synthesis & verification: Introduction to combinational logic synthesis, Binary Decision Diagram, Cube representation, Kernels & co-Kernals, two level synthesis, PLA PLA folding, ROBDD, ITE graphs, Sequential synthesis

UNIT-II **14 hours**

VLSI automation Algorithms: Partitioning: problem formulation, classification of partitioning algorithms, Group migration algorithms, simulated annealing & evolution, other partitioning algorithms

Placement, floor planning & pin assignment: problem formulation, simulation base placement algorithms, other placement algorithms, constraint based floor planning, floor planning algorithms for mixed block & cell design. General & channel pin assignment

UNIT-III **14 hours**

Global Routing: Problem formulation, classification of global routing algorithms, Maze routing algorithm, line probe algorithm, Steiner Tree based algorithms, ILP based approaches

Detailed routing: problem formulation, classification of routing algorithms, single layer routing algorithms, two layer channel routing algorithms, three layer channel routing algorithms, and switchbox routing algorithms

Over the cell routing & via minimization: two layers over the cell routers, constrained & unconstrained via minimization

UNIT-IV **7 hours**

Compaction: problem formulation, one-dimensional compaction, two dimension based compaction, hierarchical compaction

TEXT BOOK/ REFERENCE BOOKS

1. Naveed Shervani, “Algorithms for VLSI Physical Design Automation”, Kluwer Academic Publisher, Second edition.
2. Deniel Gajski, Nikil Dutt and Allen Wu “High Level Synthesis”, Kluwer Academic
3. Christophn Meinel & Thorsten Theobold, “Algorithm and Data Structures for VLSI Design”, KAP, 2002.
4. Rolf Drechsheler : “Evolutionary Algorithm for VLSI”, Second edition
5. Trimburger, “Introduction to CAD for VLSI”, Kluwer Academic Publisher, 2002

EEC7206 **CMOS VLSI DESIGN** **3-0-0 Credits:3**

UNIT-I **10 hours**

MOS Transistor Theory: n MOS / p MOS transistor, threshold voltage equation, body effect, MOS device design equation, sub threshold region, Channel length modulation. Mobility variation, tunneling, punch through, hot electron effect MOS models, small signal AC Characteristics, CMOS inverter, βn / βp ratio, noise margin, static load MOS inverters, differential inverter, transmission gate, tristate inverter, BiCMOS inverter

UNIT-II **10 hours**

CMOS Process Technology: Lambda Based Design rules, scaling factor, semiconductor Technology overview, basic CMOS technology, p well / n well / twin well process. Current CMOS enhancement (oxide isolation, LDD. refractory gate, multilayer inter connect) , Circuit elements, resistor , capacitor, interconnects, sheet resistance & standard unit capacitance concepts delay unit time, inverter delays , driving capacitive loads, propagate delays, MOS mask layer, stick diagram, design rules and layout, symbolic diagram, mask feints, scaling of MOS circuits.

UNIT-III **10 hours**

Basics of Digital CMOS Design: Combinational MOS Logic circuits-Introduction, CMOS logic circuits with a MOS load, CMOS logic circuits, complex logic circuits, Transmission Gate. Sequential MOS logic Circuits - Introduction, Behavior of hi stable elements, SR latch Circuit, clocked latch and Flip Flop Circuits, CMOS D latch and triggered Flip Flop. Dynamic Logic Circuits - Introduction , principles of pass transistor circuits, Voltage boot strapping synchronous dynamic circuits techniques, Dynamic CMOS circuit techniques

UNIT-IV **5 hours**

CMOS Analog Design: Introduction, Single Amplifier. Differential Amplifier, Current mirrors, Band gap references, basis of cross operational amplifier.

UNIT-V **10 hours**

Dynamic CMOS and Clocking: Introduction, advantages of CMOS over NMOS, CMOS\SOS technology, CMOS\bulk technology, latch up in bulk CMOS., static CMOS design, Domino CMOS structure and design, Charge sharing, Clocking- clock generation, clock distribution, clocked storage elements

TEXT BOOK/ REFERENCE BOOKS

1. Neil Weste and K. Eshragian, "**Principles of CMOS VLSI Design: A System Perspective**," 2nd edition, Pearson Education (Asia) Pte. Ltd., 2000.
2. Wayne, Wolf, "**Modern VLSI design: System on Silicon**" Pearson Education, Second Edition
3. Douglas A Pucknell & Kamran Eshragian , "**Basic VLSI Design**" PHI 3rd Edition (original Edition – 1994)
4. Sung Mo Kang & Yosuf Lederabic Law, "**CMOS Digital Integrated Circuits: Analysis and Design**", McGraw-Hill (Third Edition)

EEC7207 ASIC DESIGN 3-0-0 Credits:3

UNIT-I **15 hours**

Introduction: Full Custom with ASIC, Semi custom ASICS, Standard Cell based ASIC, Gate array based ASIC, Channeled gate array, Channel less gate array, structured get array, Programmable logic device, FPGA design flow, ASIC cell libraries

Data Logic Cells: Data Path Elements, Adders, Multiplier, Arithmetic Operator, I/O cell, Cell Compilers

UNIT-I **15 hours**

ASIC Library Design: Logical effort: practicing delay, logical area and logical efficiency logical paths, multi stage cells, optimum delay, optimum no. of stages, library cell design.

Low-Level Design Entry: Schematic Entry: Hierarchical design. The cell library, Names, Schematic, Icons & Symbols, Nets, schematic entry for ASIC'S, connections, vectored instances and buses, Edit in place attributes, Netlist, screener, Back annotation

Programmable ASIC: programmable ASIC logic cell, ASIC I/O cell

UNIT-III **15 hours**

A Brief Introduction to Low Level Design Language: an introduction to EDIF, PLA Tools, an introduction to CFI designs representation. Half gate ASIC. Introduction to Synthesis and Simulation;

ASIC Construction Floor Planning and Placement And Routing: Physical Design, CAD Tools, System Partitioning, Estimating ASIC size, partitioning methods. Floor planning tools, I/O and power planning, clock planning, placement algorithms, iterative placement improvement, Time driven placement methods. Physical Design flow global Routing, Local Routing, Detail Routing, Special Routing, Circuit Extraction and DRC.

**Note All Designs Will Be Based On VHDL

TEXT BOOK/ REFERENCE BOOKS

1. M.J.S .Smith, - "Application – Specific Integrated Circuits" – Pearson Education, 2003.
2. Jose E.France, Yannis Tsividis, "Design of Analog-Digital VLSI Circuits for Telecommunication and signal processing", Prentice Hall, 1994.

EEC7208 LOW POWER VLSI DESIGN 3-0-0 Credits 3

UNIT-I **12 hours**

Introduction : Need for low power VLSI chips, Sources of power dissipation on Digital Integrated circuits. Emerging Low power approaches, Physics of power dissipation in CMOS devices.

Device & Technology Impact on Low Power: Dynamic dissipation in CMOS, Transistor sizing & gate oxide thickness, Impact of technology Scaling, Technology & Device innovation

UNIT-II **10 hours**

Power estimation, Simulation Power analysis: SPICE circuit simulators, gate level logic simulation, capacitive power 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, probabilistic power analysis techniques, signal entropy.

UNIT-III **18 hours**

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: Power & performance management, switching activity reduction, parallel architecture with voltage reduction, flow graph transformation, low power arithmetic components, low power memory design.

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

UNIT-IV **5 hours**

Algorithm & Architectural Level Methodologies: Introduction, design flow, Algorithmic level analysis & optimization, Architectural level estimation & synthesis.

TEXT BOOK/ REFERENCE BOOKS

1. Kaushik Roy, Sharat Prasad, "Low-Power CMOS VLSI Circuit Design" Wiley, 2000
2. Gary K. Yeap, "Practical Low Power Digital VLSI Design", KAP, 2002
3. Rabaey, Pedram, "Low Power Design Methodologies" Kluwer Academic, 1997

EEC7209 DESIGN OF ANALOG & MIXED MODE VLSI CIRCUITS 3-0-0 Credits 3

UNIT-I **8 hours**

Introduction to CMOS Analog Circuits : MOS transistor DC and AC small signal parameters from large signal model,

UNIT-II **15 hours**

Common Source Amplifier : with resistive load, diode load and current source load, Source follower, Common gate amplifier, Cascode amplifier, Folded Cascode, Frequency response of amplifiers, Current source/sink/mirror, Matching, Wilson current source and Regulated Cascode current source, Band gap reference,

UNIT-III **15 hours**

Differential Amplifier, Gilbert cell, Op-Amp, Design of 2 stage Op-Amp, DC and AC response, Frequency compensation, slew rate, Offset effects, PSRR, Noise, Comparator,

UNIT-IV **9 hours**

Sense Amplifier, Sample and Hold, Sampled data circuits, Switched capacitor filters, DAC, ADC, RF amplifier, Oscillator, PLL, Mixer.

TEXT BOOK/ REFERENCE BOOKS

1. Razavi B., “Design of Analog CMOS Integrated Circuits”, McGraw Hill, 2001
2. R. Jacob Baker,”CMOS: Mixed-Signal Circuit Dedsign”,John Wiley, 2008
3. Baker, Li, Boyce, “CMOS: Circuit Design, Layout and Simulation”, Prentice Hall of India, 2000
4. E. Allen, Douglas R. Holberg, “CMOS Analog circuit Design”

EEC7210 ALGORITHMS FOR VLSI DESIGN 3-0-0 Credits: 3

UNIT-I **8 hours**

Logic Synthesis & Verification: Introduction to combinational logic synthesis, Binary Decision Diagram, Hardware models for High-level synthesis.

UNIT-II **15 hours**

VLSI Automation Algorithms:
Partitioning: problem formulation, classification of partitioning algorithms, Group migration algorithms, simulated annealing & evolution, other partitioning algorithms

Placement, Floor Planning & Pin Assignment: problem formulation, simulation base placement algorithms, other placement algorithms, constraint based floor planning, floor planning algorithms for mixed block & cell design. General & channel pin assignment

UNIT-III **15 hours**

Global Routing: Problem formulation, classification of global routing algorithms, Maze routing algorithm, line probe algorithm, Steiner Tree based algorithms, ILP based approaches

Detailed Routing: problem formulation, classification of routing algorithms, single layer routing algorithms, two layer channel routing algorithms, three layer channel routing algorithms, and switchbox routing algorithms

Over The Cell Routing & Via Minimization: two layers over the cell routers, constrained & unconstrained via minimization

UNIT-IV **7 hours**

Compaction: problem formulation, one-dimensional compaction, two dimension based compaction, hierarchical compaction

TEXT BOOK/ REFERENCE BOOKS

1. Naveed Shervani, “Algorithms for VLSI physical design Automation”, Kluwer Academic Publisher, Second edition.
2. Christophn Meinel & Thorsten Theobold, “Algorithm and Data Structures for VLSI Design”, KAP, 2002.
3. Rolf Drechsheler : “Evolutionary Algorithm for VLSI”, Second edition
4. Trimburger, “Introduction to CAD for VLSI”, Kluwer Academic publisher, 2002

EEC7211 VLSI TESTING AND VERIFICATION 3-0-0 Credits 3

UNIT-I **10 hours**

Introduction: Scope of testing and verification in VLSI design process; Issues in test and verification of complex chips; embedded cores and SOCs

UNIT-II **10 hours**

Fundamentals of VLSI testing, Fault models. Automatic test pattern generation, Design for testability, Scan design, Test interface and boundary scan.

UNIT-III **10 hours**

System Testing and test for SOCs, Iddq testing, Delay fault testing, BIST for testing of logic and memories, Test automation.

UNIT-IV **15 hours**

Design Verification Techniques based on simulation, analytical and formal approaches, Functional verification, Timing verification, Formal verification, Basics of equivalence checking and model checking,

TEXT BOOK/ REFERENCE BOOKS

1. M. Abramovici, M. A. Breuer, A. D. Friedman, “Digital Systems Testing and Testable Design” Piscataway, New Jersey: IEEE Press, 1994

2. M. Bushnell and V. D. Agarwal, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwer Academic Publishers, 2000

3. T.Kropf, "Introduction to Formal Hardware Verification", Springer Verlag, 2000.

4. P. Rashinkar, Paterson and L. Singh, "System-on-a-Chip Verification-Methodology and Techniques", Kluwer Academic Publishers, 2001.

5. Samiha Mourad and Yervant Zorian, “Principles of Testing Electronic Systems”, Wiley (2000).

EEC7212 Advanced Digital and Analog Circuit Design 3-0-0 Credits 3

UNIT-I **12 hours**

Static CMOS design, Complementary CMOS, static and dynamic power dissipation, energy & power delay product, sizing chain of inverters, latch up effect, static properties, propagation delay, Elmore delay model, power consumption,

UNIT-II **12 hours**

Logical effort for transistor sizing, pseudo NMOS inverter, DCVSL, PTL, DPTL & Transmission gate logic, dynamic CMOS design, speed and power considerations, Domino logic and its derivatives, C2MOS, TSPC registers, NORA CMOS, Memory Design concepts, SRAM, DRAM

UNIT-III **12 hours**

MOS differential amplifiers – common mode response – differential pair with MOS loads – Noise in differential pair-

CMOS operational amplifiers - One-stage op-amps and two stage op-amps –gain boosting – Miller, Nulling resistor compensation.

UNIT-III **9 hours**

CMOS oscillators - ring oscillators – LC oscillators – colpitts and one-port oscillators – voltage controlled oscillators – tuning in oscillators.

TEXT BOOK/ REFERENCE BOOKS

1. David A Johns & Ken Martin, Analog Integrated Circuit Design, John Wiley and Sons, 2001.
2. Behzad Razavi, Design of Analog CMOS Integrated Circuit, Tata-Mc GrawHill, 2002.
3. Philip Allen & Douglas Holberg, CMOS Analog Circuit Design, Oxford University Press, 2002.
   Sung-Mo Kang & Yusuf Leblebici, CMOS Digital Integrated Circuits - Analysis & Design, , MGH, Third Ed., 2003
4. Jan M Rabaey, Digital Integrated Circuits - A Design Perspective,Prentice Hall, Second Edition, 2005
5. David A. Hodges, Horace G. Jackson, and Resve A. Saleh, Analysis and Design of Digital Integrated Circuits, Third Edition, McGraw-Hill, 2004
6. R. J. Baker, H. W. Li, and D. E. Boyce, CMOS circuit design, layout, and simulation, Wiley-IEEE Press, 2007
7. Christopher Saint and Judy Saint, IC layout basics: A practical guide, McGraw-Hill Professional, 2001

EEC7213 Passive Microwave Devices & Circuits 3-0-0 Credits:3

UNIT-I **10 hours**

The transmission line section as a basic component; Application of Thevenin's theorem to a transmission line; Transfer function of a transmission line section; T and PI representation of a transmission line section;

UNIT-II **10 hours**

Analysis of two ports and multiports network by using Z, Y and transmission matrix; S-parameter analysis of the microwave circuits; Conversion of Z, Y, transmission parameters and S-parameters;

UNIT-III **15 hours**

Inter valley Scattering, Gunn diodes, IMPATT diodes.

Matching networks: Reactive matching network using the lumped elements; Quarter wavelength transformer, multi section transformer matching section; Lumped planar components like capacitor, inductor and balun; Power divider, Branch line coupler, hybrid ring coupler, directional coupler; Analysis of these components using the S-parameters; Richard transformation and Kurda identities; Inverters, Design of microwave planar filters;

UNIT-IV **10 hours**

Planar Non reciprocal devices: Circulator, delay lines and phase shifters; MEMS technology based microwave components like switches, filters, phase shifters and delay lines.

TEXT BOOK/ REFERENCE BOOKS

1. B. Bhat & S. Koul , Stripline – Loke transmission lines for MICS, John Wiley.
2. T.K.Ishii, Hand book of Microwave Technology , VOL .**I,** Academic press.
3. Y. Konishi, Microwave integrated circuit , Marcel Dekker.
4. S.Y. Liao , Microwave Circuit Analysis and Amplifier Design , PH.
5. B. Razavi , RF Micro – Electronics, PH.
6. M.I.Skolink – Introduction to Radar System, McGraw Hill
7. B.Edde- Radar, Principles, Technology,Application- Prentice Hall
8. D.K.Batras- Modern Radar Systems Analysis – Artech House

EEC7214 ANTENNA THEORY & DESIGN 3-0-0 Credits 3

UNIT-I Antenna Fundamentals and Definitions 10 hours

Antennas: radiation concepts, diploes, monopoles, Antenna parameters: bandwidth, gain, efficiency, directivity, polarization, input impedance, return loss, radiation resistance - theory, comparison with simulators, and measured data for simple antennas. Analysis and synthesis of simple linear arrays.

UNIT-II Aperture Antennas 12 hours

Fields as sources of radiation, Field-equivalence principles, General formulation for the far fields, Waveguide coupling by aperture, Horn Antennas: Types of horns and their uses, The open-ended rectangular waveguide, The E-plane sectoral horn, Slot Antennas: Slot in a ground plane, Babinet's principle, Parabolic Reflector: Geometrical relations, aperture field and radiation pattern, Aperture efficiency and directivity, Feeding arrangements, Aperture blockage.

UNIT-III Microstrip Antennas 12 hours

Microstrip patch antennas, Patch arrays, Radiation characteristics, Design parameters, Applications, Advantages, Disadvantages, Feeding Techniques, Method of analysis: transmission line model, cavity model, FDTD, MOM, FEM. Review of Broadband techniques for Microstrip Antennas, log-periodic Microstrip configurations, broadband planar monopole antenna.

UNIT-IV Broadband Printed Antennas 12 hours

Radiation mechanism, parameters and applications of different shaped Microstrip Antennas, Planar multiresonator Microstrip antenna, Multilayer Microstrip antenna, Compact broadband MSA, printed dipole antenna, Microstrip – fed slot antenna, Coplanar Waveguide – fed Patches, Coplanar Waveguide – fed slot antennas.

TEXT BOOK/ REFERENCE BOOKS

1. C. A. Balanis: “Antenna Theory Analysis and Design”, John Wiley, 2nd Edition, 1997
2. Grish Kumar and K.P.Ray, “Broadband Microstrip Antenna”, Artech House, 2003.
3. Stutzman and Thiele, “Antenna Theory and Design”, 2nd Ed, John Wiley and Sons Inc.
4. Kraus “Antennas”, McGraw Hill, TMH, Third Edition, 2003.
5. P.Bhartia, J.J.Bahl, “Microstrip Antenna”,
6. Robert A.Sainati, “CAD of Microstrip Antennas for wireless applications”, Artech House.
7. R.E.Collin, “Antennas and Radio Wave Propagation”, McGraw Hill.
8. K.F.Lee, “Principles of Antenna Theory”, Wiley.
9. J.R. James et. Al, “Microstrip Antenna Theory and Design”, IEEE, 1981.

EEC7215 OPTICAL COMMUNICATION & NETWORKING 3-0-0 Credits 3

UNIT-I **12 hours**

Introduction: Propagation of signals in optical fiber, different losses, nonlinear effects, solitons, optical sources, detectors.

Optical Components: Couplers, isolators, circulators, multiplexers, filters, gratings, interferometers, amplifiers.

UNIT-II **8 hours**

Modulation — Demodulation: Formats, ideal receivers, Practical detection receivers, Optical preamplifier, Noise considerations, Bit error rates, Coherent detection.

UNIT-III **15 hours**

Transmission System Engineering: system model, power penalty, Transmitter, Receiver, Different optical amplifiers, Dispersion.

Optical Networks: Client layers of optical layer, SONET/SDH, multiplexing, layers, frame structure, ATM functions, adaptation layers, Quality of service and flow control, ESCON, HIPPI.

WDM Network Elements: Optical line terminal optical line amplifiers, optical cross connectors, WDM network design, cost trade offs, LTD and RWA problems, Routing and wavelength assignment, wavelength conversion, statistical dimensioning model.

UNIT-IV **10 hours**

Control and Management: network management functions, management frame work, Information model, management protocols, layers within optical layer performance and fault management, impact of transparency, BER measurement, optical trace, Alarm management, configuration management.

TEXT BOOK/ REFERENCE BOOKS

1. John M. Senior, “Optical Fiber Communications”, Pearson edition, 2000.
2. Rajiv Ramswami, N Sivaranjan, “Optical Networks”, M. Kauffman Publishers, 2000.
3. Gerd Keiser, “Optical Fiber Communication”, MGH, 1 991.
4. G. P. Agarawal, “Fiber Optics Communication Systems”, John Wiley NewYork, 1997
5. P.E. Green, “Optical Networks”, Prentice Hall, 1994

EEC7216 WIRELESS COMMUNICATIONS 3-0-0 Credits 3

UNIT-I: CELLULAR CONCEPT:

System Fundamentals: Frequency reuse, channel assignment strategies, handoff strategies; interference and system capacity, improving coverage and capacity in cellular systems.

Multiple Access Techniques: FDMA, TDMA, spread spectrum multiple access, SDMA, packet Radio

UNIT-II: RADIO PROPAGATION:

Free space propagation model, Basic propagation mechanisms, practical link budget design using path loss models, outdoor propagation models, indoor propagation models, Small scale multi-path propagation, Impulse response model of a multi-path channel, Small scale multi-path measurements, parameters of mobile multi-path channels, types of small scale fading, Rayleigh and Riccean distributions, statistical models for multi-path fading channels.

UNIT-III: Diversity techniques:

Concepts of Diversity branch and signal paths, Frequency Diversity, Time Diversity , Space Diversity-Combining and switching methods, polarization diversity ,MIMO diversity techniques

Signal reception: Signal model for wireless Channels, basic receiver signal processing for RAKE Receiver- multi-user detection, blind multi-user detection- space-time multi-user detection and turbo multi-user detection, performance of blind multi-user detector, subspace tracking algorithms, space-time multi-user detector and turbo multi-user detector in multi-path channel

UNIT-IV: Performance measurements

Capacity and Information rates of noisy, AWGN and fading channels - Capacity of MIMO channels - Capacity of non-coherent MIMO channels

C/N, C/I performance of fading channels, BER of BPSK, QPSK, MSK, GMSK M-ary PSK,M-ary QAM on fading channel, Average Probability of Error-combined outage

DIFFERENT GENERATION NETWORK STANDARDS

GSM architecture, radio aspects and functionality, IS-95 and IS-136 architecture radio aspects and services, CDMA 2000 architecture, radio aspects and services, W-CDMA System; Introduction to 4G networks- OFDMA and LTE.

TEXT BOOK/ REFERENCE BOOKS

1. Theodore S. Rappaport, "**Wireless Communications: Principles and Practice**", 2nd edition, Prentice Hall of India, 2005.
2. Andrea Goldsmith, "**Wireless Communication**", Pearson Education, 2003.
3. Xiaodong Wang and Vincent Poor, "**Wireless Communication Systems: Advanced Techniques for Signal Reception**", Pearson Education (Asia) Pte. Ltd, 2004.
4. Kamilo Feher, "**Wireless Digital Communications: Modulation and Spread Spectrum Techniques**", Prentice Hall of India, 2004.
5. Vijay K. Garg, "**IS-95 CDMA and cdma2000**," Pearson Education (Asia) P. Ltd, 2004.

EEC7217 ADVANCED DIGITAL COMMUNICATIONS 3-0-0 Credits 3

UNIT-I: Digital Modulation Techniques: Introduction to digital communication system**,** Communication channels –their mathematical model-their characteristics, coherent and non coherent detection -QPSK, DPSK, FQPSK, GMSK,QAM, M-QAM, OFDM, Performance of the Optimum Receiver for Memory-less Modulation-Optimum Receiver for CPM and CPFSK Signals -Optimum Receiver for Signals Corrupted by AWGN.

UNIT-II: Coding Techniques: Review of block codes**,** Convolutional Codes, Hamming Distance Measures for Convolutional Codes; Various Good Codes, Maximum Likelihood Decoding of Convolutional codes, Error Probability with Maximum Likelihood Decoding of Convolutional Codes, Sequential Decoding and Feedback Decoding, Trellis Coding with Expanded Signal Sets for Band-limited Channels, Viterbi decoding. **,** Turbo coding and space time coding

UNIT-III: Communication through band limited linear filter channels: Optimum Receiver for Signals with Random Phase in AWGN Channel., Optimum receiver for channels with ISI and AWGN, Linear equalization, Decision-feedback equalization, reduced complexity ML detectors, Iterative equalization and decoding-Turbo equalization.

Communication Through Fading Multi-Path Channels: Characterization of fading multi-path channels, the effect of signal characteristics on the choice of a channel model, frequency-Nonselective, slowly fading channel, diversity techniques for fading multi-path channels, Digital signal over a frequency-selective, slowly fading channel, coded wave forms for fading channels, multiple antenna systems.

UNIT-IV: Adaptive Equalization: Adaptive linear equalizer, adaptive decision feedback equalizer, adaptive equalization of Trellis- coded signals, Recursive least squares algorithms for adaptive equalization, self recovering (blind) equalization.

Synchronisation Signal parameter estimation-carrier phase estimation-symbol timing estimation-joint estimation of carrier phase and symbol timing –Performance characteristics of ML estimators

TEXT BOOK/ REFERENCE BOOKS

1. John G. Proakis and Masoud Salehi, "**Digital Communications**", 5th edition, McGraw Hill, 2008.
2. Stephen G. Wilson, "**Digital Modulation and Coding**," First Indian Reprint, Pearson Education (Asia), 2003.
3. Ian A.Glover and Peter M.Grant, "**Digital Communications**", 2nd edition, Pearson Education 2008
4. Marvin K.Simon M.Hinedi and William C.Lindsey, "**Digital Communication Techniques: Signal Design and Detection**", Prentice Hall of India, 2009.
5. Bernard Sklar, "**Digital Communications: Fundamentals and Applications**," 2nd edition, Pearson Education 2002.
6. Andrew J. Viterbi, "**CDMA: Principles of Spread Spectrum Communications,"** Prentice Hall, USA, 1995

EEC7218 ACTIVE RF AND MICROWAVE CIRCUIT DESIGN 3-0-0 Credits 3

UNIT-I **10 hours**

Wave Propagation in Networks: Introduction to RF/Microwave Concepts and applications; RF Electronics Concepts; Fundamental Concepts in Wave Propagation; Circuit Representations of two port RF/MW networks

UNIT-II **10 hours**

Passive Circuit Design: The Smith Chart, Application of the Smith Chart in Distributed and lumped element circuit applications, Design of Matching networks.

UNIT-I **10 hours**

Basic Considerations in Active Networks: Stability Consideration in Active networks, Gain Considerations in Amplifiers, Noise Considerations in Active Networks.

UNIT-I **15 hours**

Active Networks: Linear and Nonlinear Design: RF/MW Amplifiers Small Signal Design, Large Signal Design, RF/MW Oscillator Design, RF/MW Frequency Conversion Rectifier and Detector Design, Mixer Design, RF/MW Control Circuit Design, RF/MW Integrated circuit design.

TEXT BOOK/ REFERENCE BOOKS

1. Matthew M. Radmanesh, "**Radio Frequency and Microwave Electronics Illustrated"**, Pearson Education (Asia) Pte. Ltd., 2004.
2. Reinhold Ludwig and Pavel Bretchko, "**RF Circuit Design: "Theory and Applications**", Pearson Education (Asia) Pte. Ltd., 2004.
3. Malcolm R.Haskard; Lan. C. May, "Analog VLSI Design - NMOS and CMOS", Prentice Hall, 1998.
4. Mohammed Ismail and Terri Fiez, "Analog VLSI Signal and Information Processing", McGraw Hill, 1994.

EEC7219 CMOS RF CIRCUIT DESIGN 3-0-0 Credits 3

UNIT-I **10 hours**

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

UNIT-II **10 hours**

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

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

UNIT-III **10 hours**

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

UNIT-IV **15 hours**

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 BOOK/ REFERENCE BOOKS

1. B. Razavi, “RF Microelectronics” PHI 1998
2. R. Jacob Baker, H.W. Li, D.E. Boyce “CMOS Circuit Design, layout and Simulation”, PHI 1998.
3. Thomas H. Lee “Design of CMOS RF Integrated Circuits” Cambridge University press 1998.
4. Y.P. Tsividis, “Mixed Analog and Digital Devices and Technology”, TMH 1996

EEC7220 MODELING AND SIMULATION OF NETWORKS 3-0-0 Credits: 3

UNIT-I **10 hours**

Delay Models in Data Networks: Queuing Models, M/M/1, M/M/m, M/M/¥, M/M/m/m and other Markov System, M/G/1 System, Networks of Transmission Lines, Time Reversibility, Networks of Queues.

UNIT-I **10 hours**

Multi-access Communication: Slotted Multi-access and the Aloha System, Splitting Algorithms, Carrier Sensing, Multi-access Reservations, Packet Radio Networks.

UNIT-III **15 hours**

Routing in Data Networks: Introduction, Network Algorithms and Shortest Path Routing, Broadcasting Routing Information: Coping with Link Failures, Flow models, Optimal Routing, and Topological Design, Characterization of Optimal Routing, Feasible Direction Methods for Optimal Routing, Projection Methods for Optimum Routing, Routing in the Codex Network.

UNIT-IV **10 hours**

Flow Control: Introduction, Window Flow Control, Rate Control Schemes, Overview of Flow Control in Practice, Rate Adjustment Algorithms.

TEXT BOOK/ REFERENCE BOOKS

1. Dimitri Bertsekas and Robert Gallager, “Data Networks," 2nd edition, Prentice Hall of India, 2003.
2. William Stallings, “High-Speed Networks and Internets,” Pearson Education (Asia) Pte. Ltd, 2004.
3. J. Walrand and P. Varaya, “High Performance Communication Networks,” 2nd edition, Harcourt India Pte. Ltd. & Morgan Kaufman, 2000.

EEC7221 MICROWAVE INTEGRATED CIRCUITS 3-0-0 Credits:3

UNIT-I Introduction **12 hours**

Planar transmission lines; microstripline, coplanar waveguide, coplanar strips, striplines and slot line characteristics, properties ; design parameters and its applications, Technology of MICs: Monolithic and hybrid substrates; thin and thick film technologies, advantages and applications, Active device technologies, design approaches, multichip module technology, substrates.

UNIT-II Planar Passive Components **12 hours**

Lumped elements in MICs: Planar Inductors, capacitors, resistors, Microstrip components, coplanar circuits, multilayer techniques, Micromachined passive components, switches, attenuators and filters design.

UNIT-III MIC Filters Design **12 hours**

Introduction, Low pass to High Pass, Band Pass, Band stop Transformations, (Butterworth and Chebyshev responses), Realization using Microstrip lines and strip lines. Development of Band Pass Filter.

UNIT-IV MIC Components – Design and Realization **9 hours**

3dB Hybrid Design, Directional Coupler, circulator, power divider, Realization using Microstriplines and striplines components.

TEXT BOOK/ REFERENCE BOOKS

1. B.Bhat and S.Koul, “Stripline Like transmission lines for MICS”, John Wiley, 1989.
2. Samuel. Y. Liao, “Microwave Circuit Analysis and Amplifier Design”, Prentice Hall. Inc.,1987.
3. Hoffman R.K., “Handbook of Microwave Integrated Circuits”, Artech House, Boston, 1987.
4. T.C.Edwards, “Foundations for Microstrip Circuit Design (2/e)”, Wiley, 1992.
5. T.K.Ishii, “Handbook of Microwave Technology”, vol. I, Academic Press, 1995.
6. Ravender Goyal, “Monolithic MIC; Technology & Design”, Artech House, 1989.
7. Gupta K.C. and Amarjit Singh, “Microwave Integrated Circuits”, John Wiley, New York, 1975.
8. Ulrich L. Rohde and David P.N., “RF/Microwave Circuit Design for Wireless Applications”, John Wiley, 2000.
9. Gentili.C, “Microwave Amplifiers and Oscillators”, North Oxford Academic, 1986.
10. R.N.Simons, “Coplanar Waveguide Circuits, Components, and Systems”, Wiley Interscience, 2001.
11. Mathew N.O. Sadiku, “Numerical techniques in Electromagnetics”, CRC Press, 2001.
12. G.Gonzalez, “Microwave Transistors and Amplifiers”, Prentice- Hall
13. C.Nguyen, “Analysis Methods for RF, Microwave and Planar Transmission Line Structures”, Wiley, 2000.
14. T.Itoh, “Numerical Techniques for Microwave and Millimeter Wave Passive Structures”, Wiley.
15. J.A. Seegar, “Microwave Theory, Components and Devices”, Prentice Hall.

EEC7222 CAD OF RF AND MICROWAVE CITCUITS 3-0-0 Credits: 3

UNIT-I Review of Basic Microwave Theory 12 hours

Transmission Lines and waveguides - Concepts of characteristic impedance, reflection coefficient, standing and propagating waves, Modes and evanescent waves.

UNIT-II Microwave Network Analysis 12 hours

Microwave Networks. :Impedance, Admittance, Hybrid, Transmission Matrix, Generalized S parameters, Reciprocal Networks, Loss less Networks, Signal Flow graphs and its Applications, Gain Consideration in Amplifiers, Impedance Matching and network selection: power gain concept, mismatch factor, return

loss, input/output VSWR, maximum gain, constant gain design, figure of merit, matching network design using lumped and distributed elements, Implementation in simulators.

UNIT-III Planar Transmission Lines 12 hours

Planar transmission lines: Quasi-static analysis, full wave analysis, and numerical techniques, Discontinuities, equivalent circuits, Simple printed couplers, filters, power dividers, Implementation in simulators.

UNIT-IV Lumped and Distributed Elements 9 hours

Passive components in RF technology, design of lumped elements, design of inductors, capacitors and resistors, MMICs.

TEXT BOOK/ REFERENCE BOOKS

1. D.M.Pozar, “Microwave Engineering”, John Wiley, 3ed., 2004.
2. K.C.Gupta, “CAD of Microwave Circuits”,
3. Rameh Garg, “ Microstrip Line and Slot Lines”, Artech House, 2000.
4. Lee T., “Design of CMOS RF Integrated Circuits”, Cambridge, 2004
5. Razavi B., “RF Microelectronics”, Pearson Education, 1997
6. Jan Crols, Michiel Steyaert, “CMOS Wireless Transceiver Design”, Kluwer Academic Publishers, 1997
7. Razavi B., “Design of Analog CMOS Integrated Circuits”, McGraw Hill, 2001

EEC7223 FABRICATION & MEASUREMENT TECHNIQUES FOR RF AND MICROWAVE DEVICES **3-0-0 Credits:3**

UNIT-I RF Electronics Concepts **12 hours**

Introduction, RF/Microwaves versus DC or low AC signals, EM spectrum, Wave length and frequency, Introduction to component basics, Resonant circuits, Analysis of a simple circuit in phasor domain, Impedance transformers, RF impedance matching, Three element matching.

UNIT -II RF Fabrication Process **12 hours**

Concept of process flow in IC fabrication, representative process flow for diode/ MOSFET, High temperature processes: oxidation, diffusion, and annealing, Use of "masks" in IC fabrication, mask design
and fabrication, Photolithography processes, Chemical etching processes: dry and wet etching. Thin films in IC processing, resistive evaporation, e – beam, RF and DC sputtering processes, Concept of test chip design and process parameter extraction.

UNIT-III Review of RF Measurements **9 hours**

Review of measurement and instrumentation basics, Principles and applications of various sensors used in
Characterization of RF materials, devices, circuits and system: acoustic, ultrasonic, magnetic, electrical, thermal, optical, radiation and smart sensors, Mechanical and thermal engineering issues for RF modules/instruments.

UNIT-IV Advances in RF Measurement Techniques **12 hours**

Instrumentation concepts and measurement techniques in: Oscilloscopes, Spectrum analyzers, Network analyzer, Lock-in-amplifiers, Waveform generators, Bit-error rate measurement, S/N measurement Telemetry, Data recording and display, Recent advances in RF and Microwave measurement Techniques.

TEXT BOOK/ REFERENCE BOOKS

1. Joseph Helszain "Microwave Engineering, Active and Non-reciprocal Circuits", McGraw Hill International Edition, 1992.
2. Matthew M. Radmanesh, "Radio Frequency and Microwave Electronics Illustrated", Pearson Education (Asia) Pte. Ltd., 2004.
3. Reinhold Ludwig and Pavel Bretchko, "RF Circuit Design: "Theory and Applications", Pearson Education (Asia) Pte. Ltd., 2004.

EEC7224 RF MEMS 3-0-0 Credits: 3

UNIT-I RF MEMS relays and switches 9 hours
Switch parameters, Actuation mechanisms, Bistable relays and micro actuators, Dynamics of switching operation.

UNIT-II MEMS inductors and capacitors 9 hours
Micromachined inductor, Effect of inductor layout, Modeling and design issues of planar inductor, Gap tuning and area tuning capacitors, Dielectric tunable capacitors.

UNIT-III Micromachined RF filters 9 hours
Modeling of mechanical filters, Electrostatic comb drive, Micromechanical filters using comb drives, Electrostatic coupled beam structures.

UNIT-IV MEMS Phase Shifters 9 hours
Types, Limitations, Switched delay lines, Micromachined transmission lines, Coplanar lines, Micromachined directional coupler and mixer.

UNIT-V Micromachined antennas 9 hours
Microstrip antennas, design parameters, Micromachining to improve performance, Reconfigurable antennas.

TEXT BOOK/ REFERENCE BOOKS

1.V.K.Varadan etal, “RFMEMS and their Applications”, Wiley, 2003.
2.G. Rebeiz, “RF MEMS: Theory, Design, and Technology”, Wiley/IEEE Press, 2003.
3.H.J. De Los Santos, “RF MEMS Circuit Design for Wireless Communications”, Artech House, 2003

EEC7225 ADVANCED TECHNIQUES IN WIRELESS NETWORKS 3-0-0 CREDITS:3

UNIT- I WIRELESS LANS, PANS AND MANS 12 hours

Fundamentals of WLAN –technical issues, network architecture, IEEE 802.11- physical layer, MAC layer mechanism, CSMA/CA, Bluetooth- specification, middleware protocol group, Application models, Radio Frequency Identification(RFID), WLL –generic WLL architecture, technologies, broadband wireless access, Wireless Broad band (WiMAX), IEEE 802.16 – Physical layer-MAC layer differences between IEEE 802.11 and 802.16.

UNIT- II WIRELESS INTERNET 12 hours

Introduction –wireless internet, co-located address, mobility, inefficiency of transport layer and application layer protocol, mobile IP – simultaneous binding, route optimization, mobile IP variations, handoffs, IPv6 advancements, IP for wireless domain, security in mobile IP, TCP in wireless domain – TCP over wireless , TCPs -traditional, snoop, indirect, mobile, transaction-oriented, impact of mobility.

UNIT- III AD-HOC AND WIRELESS SENSOR NETWORK 12 hours

Introduction, issues –medium access scheme, routing, multicasting, transport layer protocol, pricing scheme, QoS provisioning, self-organization, security, addressing, service discovery, energy management, deployment consideration, ad-hoc wireless internet.

Issues, design challenges and architecture of wireless sensor network- layered and clustered, data dissemination, data gathering, MAC protocols, Routing schemes, location discovery, security, quality of sensor network – coverage and exposure, zigbee standard, applications of sensor network, comparisons with MANET.

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UNIT- IV EMERGING TECHNOLOGIES 9 hours

UWB radio communication- fundamentals of UWB- major issues- operation of UWB systems-comparisons with other technologies, advantages and disadvantages, multimode 802.11 – IEEE 802.11a/b/g – software radio-based multimode system, meghadoot architecture -802.11 phone, Fundamentals of UMTS, Interoperability of Wi-Fi and UMTS.

TEXT BOOK/ REFERENCE BOOKS

1. C.Siva Ram Murthy and B.S. Manoj, “Ad-hoc wireless networks-architecture and protocols”, Pearson education, 2nd, 2005.
2. Kaveh Pahlavan and Prashant Krishnamurthy, “Principle of Wireless network- A unified approach”, Prentice Hall, 2006.
3. Jochen Schiller, “Mobile Communication”, Pearson education, 2nd edition 2005.
4. Wllliam Stallings, “Wireless Communication and Networks”, Prentice Hall, 2nd edition, 2005.
5. Clint Smith and Daniel Collins, “3G wireless networks”, Tata Mcgraw Hill, 2nd edition, 2007.

EEC7226 OFDM FOR WIRELESS COMMUNICATION 3-0-0 Credits:3

UNIT- 1 **12 hours**

OFDM Principles-System Model –Generation of sub carrier using IFFT, guard time and cyclic extensions-windowing –choice of OFDM parameters-OFDM signal processing

UNIT- II **12 hours**

FEC coding-Interleaving-QAM-Coded modulation-Synchronisation-Frequency offset estimation, carrier synchronization, sampling-frequency synchronization and ML estimation of timing and frequency offset synchronization; coherent detection-one and two dimensional channel estimation - special training symbols-Decision direct channel estimation-differential detection in the time and frequency domain

UNIT-III **9 hours**

MIMO in OFDM system-STBC in OFDM system-STTC in OFDM system-Performance analysis of MIMO-OFDM systems-channel capacity, diversity gain

UNIT- IV **12 hours**

Frequency hopping in OFDMA-OFDMA system description-Channel coding, modulation, synchronization, Combination of OFDM and CDMA – MC-CDMA,MT-CDMA and DS-CDMA systems –Difference and OFDMA and MC-CDMA.

TEXT BOOK/ REFERENCE BOOKS

1. Richard Van Nee and Ramjee Prasad, “OFDM for Wireless Multimedia Communication”, Artech House, 2007.
2. Lajas Hanzo, “OFDM and MC-CDMA for broadband Multiuser Communication”, 2003
3. Henrik Schulze,Christian Luders, “Theory and applications of OFDM and CDMA”,2005

EEC7227 ULTRA WIDEBAND WIRELESS COMMUNIATION 3-0-0 Credits:3

UNIT- I **11 hours**

Ultra wideband communication systems: UWB concepts, challenges, UWB signaling techniques-UWB spectral characteristics- advantages, single band versus multiband UWB , FCC emission limits and UWB applications.

UNIT- II **11 hours**

UWB sources, UWB pulse generation, -Optimal UWB single pulse design-Optimal UWB orthogonal Pulse Design; UWB modulation options- pulse modulation and detection techniques –Comparison with conventional pulse detection techniques-Modulation performances in practical conditions.

UNIT –III **11 hours**

Principles and background of UWB multipath propagation channel modeling-Channel Sounding Techniques-UWB statistical –based channel Modeling-Impact of UWB channel on system design- MIMO model for UWB-MIMO channel capacity and diversity gain in fading channels

UNIT- IV **12 hours**

UWB receiver related issues-UWB receiver options-Multiple access interference integration mitigation at the receiver side-Multiple access interference integration mitigation at the transmitter side; Effect of NBI in UWB systems –avoiding NBI-Cancelling NBI.

TEXT BOOK/ REFERENCE BOOKS

1. Huseyin Arslan,ZhiNing Chen and Maria-Gabriella Di Benedetto, "Ultra Wideband Wireless Communication", Wiley Publications,2006
2. K. Siwiak and D. McKeown, Ultra-Wideband Radio Technology, John Wiley and Sons Limited, 2004
3. Faranak Nekoogar, Ultra-Wideband Communications: Fundamentals and Applications, Prentice Hall, 2005.
4. Homayoun Nikookar and Ramjee Prasad, "Introduction to Ultra Wideband for Wireless communications",Springer 2009
5. Jeffrey H.Reed, " An Introduction to ultra wideband communication systems", Prentice Hall, 2005
6. S. Haykin and M. Moher, Modern Wireless Communication, Pearson Education, 2005.

EEC7228 Silicon On Insulator MOS Devices and Multiple Gate Devices 3-0-0 Credits: 3

UNIT-I **11 hours**

Review of MOS device: band diagrams, drain current and subthreshold characteristics, drain conductance, transconductance, substrate bias, mobility, low field mobility, high field mobility, mobility various models, scaling of MOSFET, short channel and narrow channel MOSFET, high-k gate dielectrics, ultra shallow junctions, source and drain resistance

UNIT-II **11 hours**

The SOI MOSFE: comparison of capacitances with bulk MOSFET, PD and FD SOI devices, short channel effects, current-voltage characteristics: Lim&Fossum model and C-∞ model, transconductance, impact ionization and high field effects: Kink effect and Hot-carrier degradation, Floating body and parasitic BJT effects, self-heating

UNIT-III **11 hours**

Multiple gate SOI MOSFETs: double gate, FINFET, triple gate, triple-plus gate, GAA, device characteristics, short channel effects, threshold effect, volume inversion, mobility, FINFET

UNIT-IV: **12 hours**

Physical view of nano scale MOSFET, Nator's theory of the ballistic MOSFET, role of quantum capacitance, scattering theory, MOSFET physics in terms of scattering, transmission coefficient under low and high drain biases, silicon nano wires, evaluation of the I-V characteristics, I-V characteristics of non-degenerate and degenerate carrier statistics

TEXT BOOK/ REFERENCE BOOKS

1. Jean-Pierre Colinge, Physics of Semiconductor Devices, Kluwer Academic Publishers, eBook ISBN: 0-306-47622-3, Print ISBN: 1-4020-7018-7.
2. 2Y. Taur and T.H. Ning, Fundamentals of Modern VLSI DevicesCambridge University Press, 1998, ISBN: 0-521-55959-6
3. Jean-Pierre Colinge, FinFETs and Other Multi-Gate Transistors Springer, 2008, ISBN 978-0-387-71751-7 e-ISBN 978-0-387-71752-4.
4. Amara Amara and Olivier Rozeau, Planar Double-Gate Transistor, From Technology to Circuit, Springer, 2009, ISBN 978-1-4020-9327-2,e-ISBN 978-1-4020-9341-8.
5. Jean- Pierrie Colinge, Silicon-on-insulator Technology: Materials to VLSI Kluwer Academic publishers group, 2004.

EEC7229 MOLECULAR ELECTRONICS 3-0-0 Credits:3

UNIT-I **15 hours**

Energy Level Diagram, What Makes Electrons Flow?, The Quantum of Conductance, Charging/CoulombBlockade, Summary/Towards Ohm's Law, Schrödinger Equation: Basic Concepts, Method of FiniteDifferences, Examples, Self Consistent Field: Basic Concept, Relation to the Multi-Electron Picture,

UNIT-II: **15 hours**

NEGF,Bonding, Basis Functions: As a Computatinal Tool, As a Conceptual Tool, Density Matrix I, Density Matrix II, Band Structure: Toy Examples, Beyond 1-D, 3-D Solids, Prelude to Sub-Bands, Subbands: Quantum Wells, Wires, Dots and Nano-Tubes, Density of States, Minimum Resistance of a Wire, Capacitance: Model Hamiltonian, Electron Density, Quantum vs. Electrostatic Capacitance, Level Broadening: Open Systems and Local Density of States, Self Energy, Lifetime, Irreversibility, Coherent

UNIT-III: **15 hours**

Transport: Overview, Transmission and Examples, Non-Equilibrium Density Matrix, Inflow/Outflow, Non-Coherent Transport: Why does an Atom Emit Light?, Radiative Lifetime, Radiative Transitions Phonons, Emission and Absorption, Inflow/Outflow, Atom to Transistor: Physics of Ohm's Law, Self Consistent Field Method and Its Limitations, Coulomb Blockade, Spin

TEXT BOOKS/REFERENCE BOOKS

1. Quantum Transport: Atom to Transistor, S. Datta, Cambridge University Press.
2. Electronic Transport in Mesoscopic Systems, S. Datta, Cambridge University Press, 1995, Paperback Edition 1997.

EEC7230 RELIABILITY OF SEMICONDUCTOR DEVICES 3-0-0 Credits:3

UNIT-I: **10 hours**

Introduction to Reliability Physics, Reliability definition, dielectrics, critical field in a dielectric, generation and recombination of carriers, life time of carriers, diffusion length, Types of Defects in a Semiconductor, Avalanche break down, Zener break down, MOSFET scaling, Hot electron effect, velocity saturation, GIDL, Mathematics of Reliability: Weibull statistics, PDF

UNIT-II: **10 hours**

Kinetics of Negative Bias Temperature Instability: Stress Phase, NBTI: Relaxation, Freq. Independence, and Duty Cycle Dependence, Field Acceleration of Negative Bias Temperature Instability, Dispersive vs. Arrhenius Diffusion, Circuit Implications of NBTI

Scaling Theory of Hot Carrier Degradation, Voltage Dependence of Trap Generation: Lucky Electron Model, On-State Hot Carrier Degradation, Off-State Hot Carrier Degradation , Characterization of Interface Traps, Subthreshold and linear drain current Measurements, Charge-pumping, DC-IV, and GIDL Techniques for Interface Traps, Spin-Dependent Recombination

UNIT-III: **10 hours**

Breakdown mechanisms of thick dielectrics and thin dielectrics, Time-Dependent Dielectric Breakdown, Kinetics of Trap Generation, Field-dependence of TDDB, Statistics of Oxide Breakdown: Cell percolation model, Theory of Soft and Hard Breakdown, Statistics of Soft-breakdown by Markov Chain.

UNIT-IV: **10 hours**

Measurement Techniques: VT, SILC, QY, and Floating Probe, TDDB and Circuits, Theory of Thick dielectrics, Spatial and Temporal Characteristics of dielectric breakdown, Theory of Radiation Damage, Sources of radiation flux and its characteristics, Soft error due to radiation effects, Radiation and hard errors, Radiation, error correction, Stress migration, Electro migration

UNIT-V **5 hours**

Introduction to Electro static discharge (ESB), human body model, machine model, methods to contain ESD

TEXT BOOKS/REFERENCE BOOKS

1. Y. Taur and T.H. Ning, Fundamentals of Modern VLSI DevicesCambridge University Press, 1998, ISBN: 0-521-55959-6
2. R.F. Pierret, Semiconductor Device Fundamentals, Addison-Wesley, 1996, ISBN: ISBN 0-201-54393-1
3. D. K. Schroder, Semiconductor Material and Device Characterization, John Wiley and Sons, 1996, ISBN: 0-471-73906-5
4. Steven H. Voldman, ESD: Physics and Devices 2004, John Wiley & Sons, Ltd ISBN: 0-470-84753-0
5. Jean-Pierre Colinge, Physics of Semiconductor Devices, Kluwer Academic Publishers, 2002, eBook ISBN: 0-306-47622-3, Print ISBN: 1-4020-7018-7

EEC7231 HIGH SPEED SEMICONDUCTOR DEVICES 3-0-0 Credits:3

Unit-I: Important parameters governing the high speed performance of devices and circuits: Transit time of charge carriers, junction capacitances, ON-resistances and their dependence on the device geometry and size, carrier mobility, doping concentration and temperature; important parameters governing the high power performance of devices and circuits: Break down voltage, resistances, device geometries, doping concentration and temperature

Unit-II: Materials properties: Merits of III –V binary and ternary compound semiconductors (GaAs, InP, InGaAs, AlGaAs, SiC, GaN etc.), different SiC structures, silicon-germanium alloys and silicon carbide for high speed devices, as compared to silicon based devices, outline of the crystal structure, dopants and electrical properties such as carrier mobility, velocity versus electric field characteristics of these materials, electric field characteristics of materials and device processing techniques, Band diagrams, homo and hetro junctions, electrostatic calculations, Band gap engineering, doping, Material and device process technique with these III-V and IV – IV semiconductors,

Unit-III: Metal semiconductor contacts and Metal Insulator Semiconductor and MOS devices: Native oxides of Compound semiconductors for MOS devices and the interface state density related issues. Metal semiconductor contacts, Schottky barrier diode, Metal semiconductor Field Effect Transistors (MESFETs): Pinch off voltage and threshold voltage of MESFETs. D.C. characteristics and analysis of drain current. Velocity overshoot effects and the related advantages of GaAs, InP and GaN based devices for high speed operation. Sub threshold characteristics, short channel effects and the performance of scaled down devices.

Unit-IV: High Electron Mobility Transistors (HEMT): Hetero-junction devices. The generic Modulation Doped FET(MODFET) structure for high electron mobility realization. Principle of operation and the unique features of HEMT, InGaAs/InP HEMT structures: Hetero junction Bipolar transistors (HBTs): Principle of operation and the benefits of hetero junction BJT for high speed applications. GaAs and InP based HBT device structure and the surface passivation for stable high gain high frequency performance. SiGe HBTs and the concept of strained layer devices; High Frequency resonant – tunnelling devices, Resonant-tunnelling hot electron transistors

TEXT BOOKS/REFERENCE BOOKS

1. C.Y. Chang, F. Kai, GaAs High-Speed Devices: Physics, Technology and Circuit Applications, Wiley, 1994.
2. Cheng T. Wang, Ed., Introduction to Semiconductor Technology: GaAs and Related Compounds, John Wiley & Sons, 1990.
3. David K. Ferry, Ed., Gallium Arsenide Technology, Howard W. Sams & Co., 1985. Avishay Katz, Indium Phosphide and Related materials: Processing, Technology and Devices, Artech House, 1992.
4. S.M. Sze, High Speed Semiconductor Devices, Wiley (1990) ISBN 0-471-62307-5.
5. Ralph E. Williams, Modern GaAs Processing Methods, Artech (1990), ISBN 0-89006-343-5, 1990.
6. Sandip Tiwari, Compound Semiconductor Device Physics, Academic Press (1991), ISBN 0-12-691740-X.
7. G.A. Armstrong, C.K. Maiti, TCAD for Si, SiGe and GaAs Integrated Circuits, The Institution of Engineering and Technology, London, United Kingdom, 2007,ISBN 978-0-86341-743-6.
8. Ruediger Quay, Gallium Nitride Electronics, Springer 2008, ISBN 978-3-540-71890-1.

EEC7232 NANOELECTRONICS 3-0-0 Credits:3

UNIT-I: 10 hours

Challenges going to sub-100 nm MOSFETs – Oxide layer thickness, tunneling, power density, non-uniform dopant concentration, threshold voltage scaling, lithography, hot electron effects, sub-threshold current, velocity saturation, interconnect issues, fundamental limits for MOS operation. High-K gate dielectrics, effects of high-K gate dielectrics on MOSFET performance,

UNIT-II: 9 hours

Novel MOS-based devices – Multiple gate MOSFETs, Silicon-on-nothing, Silicon-on-insulator devices, FD SOI, PD SOI, FinFETs, vertical MOSFETs, strained Si devices

UNIT-III: 9 hours

Hetero structure based devices – Type I, II and III Heterojunction, Si-Ge heterostructure, hetero structures of III-V and II-VI compounds - resonant tunneling devices, MODFET/HEMT

UNIT-IV: 9 hours

Carbon nanotubes based devices – CNFET, characteristics, Spin-based devices – spinFET, characteristics

UNIT-V: 8 hours

Quantum structures – quantum wells, quantum wires and quantum dots, Single electron devices – charge quantization, energy quantization, Coulomb blockade, Coulomb staircase, Bloch oscillations

TEXT BOOKS/REFERENCE BOOKS

1. Mircea Dragoman and Daniela Dragoman, Nanoelectronics – Principles & devices, Artech House Publishers, 2005.
2. Karl Goser, Nanoelectronics and Nanosystems: From Transistors to Molecular and Quantum Devices, Springer 2005.
3. Mark Lundstrom and Jing Guo, Nanoscale Transistors: Device Physics, Modeling and Simulation, Springer, 2005.
4. Vladimir V Mitin, Viatcheslav A Kochelap and Michael A Stroscio, Quantum heterostructures, Cambridge University Press, 1999.
5. S.M. Sze (Ed), High speed semiconductor devices, Wiley, 1990.
6. Manijeh Razeghi, Technology of Quantum Devices, Springer, ISBN 978-1-4419-1055-4.
7. H.R. Huff and D.C. Gilmer, High Dielectric Constant Materials for VLSI MOSFET Applications, Springer 2005, ISBN 978-3-540-21081-8.
8. B.R. Nag, Physics of Quantum Well Devices, Springer 2002, ISBN 978-0-7923-6576-1.
9. E.Kasper, D.J. Paul, Silicon Quantum Integrated Circuits Silicon-Germanium Heterostructures Devices: Basics and Realisations, Springer 2005, ISBN 978-3-540-22050-3.

EEC7233 COMPOUND SEMICONDUCTOR DEVICES 3-0-0 Credits:3

UNIT-I: Important parameters governing the high speed performance of devices and circuits: Transit time of charge carriers, junction capacitances, ON-resistances and their dependence on the device geometry and size, carrier mobility, doping concentration and temperature; important parameters governing the high power performance of devices and circuits: Break down voltage, resistances, device geometries, doping concentration and temperature.

UNIT-II: Materials properties: Merits of III –V binary and ternary compound semiconductors (GaAs, InP, InGaAs, AlGaAs, SiC, GaN etc.), different SiC structures, silicon-germanium alloys and silicon carbide for high speed devices, as compared to silicon based devices, outline of the crystal structure, dopants and electrical properties such as carrier mobility, velocity versus electric field characteristics of these materials, electric field characteristics of materials and device processing techniques, Band diagrams, homo and hetro junctions, electrostatic calculations, Band gap engineering, doping, Material and device process technique with these III-V and IV – IV semiconductors.

UNIT-III: Metal semiconductor contacts and Metal Insulator Semiconductor and MOS devices: Native oxides of Compound semiconductors for MOS devices and the interface state density related issues. Metal semiconductor contacts, Schottky barrier diode, Metal semiconductor Field Effect Transistors (MESFETs): Pinch off voltage and threshold voltage of MESFETs. D.C. characteristics and analysis of drain current. Velocity overshoot effects and the related advantages of GaAs, InP and GaN based devices for high speed operation. Sub threshold characteristics, short channel effects and the performance of scaled down devices.

UNIT-IV: High Electron Mobility Transistors (HEMT): Hetero-junction devices. The generic Modulation Doped FET(MODFET) structure for high electron mobility realization. Principle of operation and the unique features of HEMT, InGaAs/InP HEMT structures: Hetero junction Bipolar transistors (HBTs): Principle of operation and the benefits of hetero junction BJT for high speed applications. GaAs and InP based HBT device structure and the surface passivation for stable high gain high frequency performance. SiGe HBTs and the concept of strained layer devices; High Frequency resonant – tunneling devices, Resonant-tunneling hot electron transistors

TEXT BOOKS/ REFERENCE BOOKS

1. C.Y. Chang, F. Kai, GaAs High-Speed Devices: Physics, Technology and Circuit Applications, Wiley & Sons.
2. Cheng T. Wang, Ed., Introduction to Semiconductor Technology: GaAs and Related Compounds, John Wiley & Sons.
3. David K. Ferry, Ed., Gallium Arsenide Technology, Howard W. Sams & Co., 1985
4. Avishay Katz, Indium Phosphide and Related materials: Processing, Technology and Devices, Artech House, 1992.
5. S.M. Sze, High Speed Semiconductor Devices, Wiley (1990) ISBN 0-471-62307-5
6. Ralph E. Williams, Modern GaAs Processing Methods, Artech (1990), ISBN 0-89006-343-5,
7. Sandip Tiwari, Compound Semiconductor Device Physics, Academic Press (1991), ISBN 0-12-691740-X.
8. G.A. Armstrong, C.K. Maiti, TCAD for Si, SiGe and GaAs Integrated Circuits, The Institution of Engineering and Technology, London, United Kingdom, 2007,ISBN 978-0-86341-743-6.
9. Ruediger Quay, Gallium Nitride Electronics, Springer 2008, ISBN 978-3-540-71890-1.
10. Prof. Dr. Alessandro Birolini, Reliability Engineering Theory and Practice, Springer 2007.

EEC7234 SEMICONDUCTOR POWER DEVICES 3-0-0 Credits:3

UNIT-I: **12 hours**

Avalanche Breakdown voltage of plane and planar pn junctions, Breakdown voltage improvement Techniques. High injection level effects in pn junctions. Forward voltage drop in high voltage PIN diodes , and its dependence on carrier lifetime. Bipolar Power Transistor structures and characteristics, Current-gain, Switching operation, second break down and safe operating area, overlay transistor.

UNIT-II: **12 hours**

Thyristor operation principles: Reverse and forward blocking voltage and forward conduction characteristics. Cathode shorted and Anode shorted Thyristor. di/dt and dv/dt ratings of thyristors, Triacs and GTO.

UNIT-III: **12 hours**

Power MOSFET structure, I-V characteristics, on resistance, Minimum size chip design for specific drain breakdown voltage, Switching characteristics, Safe operating area, Insulated Gate Transistor (IGT) – Structure, Operation principle, I-V characteristics and turn off transients, Latch up and its prevention.

UNIT-IV: **9 hours**

Power Integrated Circuit Problems and isolation techniques in HVIC's, Smart PIC's and HVIC's

TEXT BOOKS/ REFERENCE BOOKS

1. Baliga, B. Jayant, Power Semiconductor Devices, PWS Publishing Co., Boston, 1996
2. Benda, Vitezslav, John Gowar, and Duncan A. Grant, Chichester , Power semiconductor devices: theory and applications, New York Wiley, c 1999
3. Bose, Bimal K, Modern Power Electronics, Evolution, Technology, and Application, IEEE Press, 1992.
4. Ramshaw, Raymond S., Power Electronics Semiconductor Switches, 2nd ed., London: Chapman & Hall (Kluwer)
5. Rashid, Muhammad H., Upper Saddle River, Power Electronics, Circuits, Devices and Applications, 3rd ed., NJ: Pearson Education, 2003.

EEC7235 Material Science 3-0-0 Credits:3

UNIT-I: 8 hours

Classification of materials (by structure amorphous, poly crystalline and crystalline and by conductivity type), planes, directions, equivalence of planes, Bonding in solids, packing in crystals and important metallic, ionic and covalent structures , reciprocal lattice and Free electron theory, Brillouin zones, Energy bands, Boltzman Transport Equation, introduction to phase diagram and utility of phase diagrams

UNIT-II: 10 hours

Dielectric materials: Ploarization, dielectric constant, frequency dependence of dielectric constant, dielectric relaxation time, Dielectric properties of materials for electrical insulators and capacitors. Piezo electric and ferro electric materials, Electrostriction

UNIT-III: 12 hours

Electronic structure of magnetic materials (Properties: Dia-, para-, ferro, ferri-, and antiferromagnetism. Magnetic domains and hystereris loops) Localised and itinerant (band) models-Direct, Super and indirect (RKKY) exchange interactions, Molecular field theories, magnetic domains-influence of defects in, shape and size of samples on the magnetisation process. Soft and hard magnetic materials, Magnetic anisotropy, Magnetostriction, Ferromagnetic semiconductors, Ferrites, Garnets and their applications

UNIT-IV: 15 hours

Principles of measurement techniques: Optical Microscopy techniques-phase contrast, interferometric and polarization microscopes. Confocal scanning microscopy, Ellipsometry, Atomic Force Microscopy, Scanning Probe Microscopy, Scanning Tunneling Microscopy, SEM, TEM, Transmission electron microscopy, spectroscopic characterisation methods: x-ray, auger, electron, secondary ion and Rutherford backscattering

TEXT BOOKS/ REFERENCE BOOKS

1. Metals handbook, Vol. 9, Characterisation of Materials, 10th Ed., American Society of Metals, Metals Park, OH, USA, 1986.
2. H.H. Willard, L.L. Merrit, J.A. Dean and F.A. Settle, Instrumental Methods of Analysis, 6th Ed., CBS Publishers & Distributors, Delhi, 1986.
3. N. W. Ashcroft and N. D. Mermin: Solid State Physics
4. R. E. Hummel: Electronic Properties of Materials
5. Cullity, B.D., Elements of X-ray diffraction, Addison-Wesley, 1978
6. Williams, D.B. and Barry Carter, C., Transmission Electron Microscopy, Plenum Press, New York, 1996.
7. P. Haasen (Ed.), Phase Transformations in Materials, VCH Pub., New York, 1991.
8. A.G. Khachaturyan, Theory of Structural Transformations in Solids, Wiley Interscience, 1983.
9. A.M. Alper, Phase Diagrams: Material Science and Technology, Vol. 6, Academic Press, 1978.
10. C. Kittel, Introduction to Solid State Physics, 7th Ed., John Wiley & Sons, NY, 1996.
11. A.Goldman, Modern Ferrite Technology, Van Nostrand, New York, 1990

EEC7236 Semiconductor Device Characterization:
Theory and practice of Electrical characterization techniques, Physical characterization techniques