Course Structure of M.Tech

Specialization: Microelectronics and VLSI Design

Department of Electronics and Communication Engineering.
Triguna Sen School of Technology,
Assam University, Silchar

Academic Session: 2020-2021

Assam University, Silchar
Dept. of Electronics and Communication Engineering
Course Structure of M.Tech (Specialization: Microelectronics and VLSI Design)

Academic Session – 2020-2021

Semester	Credit	Total Marks
1	18	750
2	18	750
3	16	400
4	16	400
Total	**68**	**2300**

Semester – 1

Sl. No.	Paper Name	Paper Code	Credit	Marks *			Total **
				Internal	Mid Sem.	End Sem.	Marks
1	Semiconductor Device Physics	MECE-101	3	20 (10)	30 (15)	50 (25)	100 (50)
2	Digital VLSI Design	MECE-102	3	20 (10)	30 (15)	50 (25)	100 (50)
3	**Elective – I** A. Microelectronics Technology B. Low Power VLSI Design	MECE-103	3	20 (10)	30 (15)	50 (25)	100 (50)
4	**Elective – II** A. Digital Signal Processing B. Image Processing	MECE-104	3	20 (10)	30 (15)	50 (25)	100 (50)
5	Research Methodology and IPR	MECE-105	2	20 (10)	30 (15)	50 (25)	100 (50)
6	Front End VLSI Design Lab	MECE-106	2	30 (15)	NA	70 (35)	100 (50)
7	Back End VLSI Design Lab	MECE-107	2	30 (15)	NA	70 (35)	100 (50)
8	**Audit Course – I** A. English for Research Paper Writing B. Disaster Management C. Sanskrit for Technical Knowledge D. Value Education	MECE-108	0	NA	NA	50 (25)	50 (25)
	Total		**18**	**160**	**150**	**440**	**750**

Semester – 2

Sl. No.	Paper Name	Paper Code	Credit	Marks *			Total **
				Internal	Mid Sem.	End Sem.	Marks
1	Analog VLSI Design	MECE-201	3	20 (10)	30 (15)	50 (25)	100 (50)
2	VLSI Physical Design	MECE-202	3	20 (10)	30 (15)	50 (25)	100 (50)
3	**Elective – III** A. Verification and Testing B. Embedded System Design	MECE-203	3	20 (10)	30 (15)	50 (25)	100 (50)
4	**Elective – IV** A. MEMS and NEMS Technology B. Quantum and Nanoelectronics C. Timing Analysis	MECE-204	3	20 (10)	30 (15)	50 (25)	100 (50)
5	Advanced Analog VLSI Design Lab	MECE-205	2	30 (15)	NA	70 (35)	100 (50)
6	Advanced Digital VLSI Design Lab	MECE-206	2	30 (15)	NA	70 (35)	100 (50)
7	Mini Project	MECE-207	2	30 (15)	NA	70 (35)	100 (50)
8	**Audit Course – II** A. Constitution of India	MECE-208	0	NA	NA	50 (25)	50 (25)

	B. Pedagogy Studies C. Stress Management by Yoga D. Personality Development through Life Enlightenment Skills						
	Total		**18**	**170**	**120**	**460**	**750**

Semester - 3

Sl. No.	Paper Name	Paper Code	Credit	Marks *			Total **
				Internal	**Mid Sem.**	**End Sem.**	**Marks**
1	**Elective – V** A. Hardware Description Language B. CAD for VLSI Design C. Advanced Digital Architecture	MECE-301	3	20 (10)	30 (15)	50 (25)	100 (50)
2	**Open Elective** A. Microwave Integrated Circuits B. Biomedical Instrumentation C. Biomedical Signal Processing	MECE-302	3	20 (10)	30 (15)	50 (25)	100 (50)
3	Dissertation Phase – I	MECE-303	10	60 (30)	NA	140 (70)	200 (100)
	Total		**16**	**100**	**60**	**240**	**400**

Semester - 4

Sl. No.	Paper Name	Paper Code	Credit	Marks *			Total **
				Internal	**Mid Sem.**	**End Sem.**	**Marks**
1	Dissertation Phase – II	MECE-401	16	120 (60)	NA	280 (140)	400 (200)
	Total		**16**	**120**	**0**	**280**	**400**

* Marks in () indicates individual pass marks
** Marks in () indicates total pass marks

Program Outcomes:

1. An ability to independently carry out research/investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. An ability to demonstrate a degree of mastery in Microelectronics and VLSI Design.
4. An ability to apply appropriate techniques and modern engineering tools in the design and implementation in the area of VLSI Design.
5. An ability to apply VLSI engineering and technology principles in multi-disciplinary environment through their team playing and self-learning capabilities.

Detailed Syllabus of the M.Tech Courses offered by Dept. of Electronics and Communication Engineering Triguna Sen School of Technology Assam University, Silchar

Semester – 1

Course code: MECE-101
Course Name: SEMICONDUCTOR DEVICE PHYSICS

Course Objective:
1. Acquire the fundamental knowledge and expose to the field of semiconductor theory and devices and their Applications.
2. To understand the fundamentals of basic semiconductor physics which includes the Electronic materials, Semiconductors
3. To understand the basic materials and properties of semiconductors
4. To provide problem solving experience and learning of concepts through it in semiconductor physics, in both the classroom and the laboratory learning environment.

Unit I:
Crystal structure- Reciprocal lattice -Brillouin zone and rules for band (k - space) representation, Dynamics of electrons in periodic potential: Kronig -penny and nearly free electron models – Real methods for band structure calculations, Energy band diagrams of III- V semiconductors and metal-semiconductor interface, Block wave functions, concepts of effective mass, Density of states, wave vector, Direct and Indirect semiconductor, quantisation of vibrational energy, phonons, defect dislocation and impurity states

Unit II:
Free carrier in semiconductor, statistical distribution, Fermi energy in degenerate and non- degenerate semiconductors, of quasi-Fermi levels, Transport phenomena in Semiconductor – Bolzman transport equation, scattering mechanisms, mobility diffusion, physics of High- electron-mobility transistor. Ballistic transport mechanism, Macroscopic transport: Carrier transport by Diffusion – Continuity and Poisson equation, Carrier transport by Drift and diffusion: Low field, High field and very high field (Impact ionization) – Einstein relation.
Hall-effect and voltage, P-n Junctions: equilibrium conditions, forward and reverse-biased junctions, reverse-bias breakdown, transient and a-c conditions, recombination and generation in the transition, semiconductor heterojunctions, Metal-semiconductor junctions: Schottky barriers, rectifying and Ohmic contacts.

Unit III:
Optoelectronics Devices: Light emitting diodes, Lasers, Photoconductors, Junction Photodiodes, Avalanche Photodiodes, Solar Cells, Semiconductor based microwave devices: Tunnel diode, Gunn diode, IMPATT diode, TRAPATT diode, PIN diode, varactor diode

Unit IV:
Bipolar junction transistors: minority carrier distribution and terminal currents, generalized biasing, switching, secondary

effects, frequency limitations of transistors, early effect, punch-through, Ebers-Moll model of BJT, heterojunction bipolar transistors, Field-Effect Transistors: JFET- current-voltage characteristics, effects in real devices, high-frequency and high-speed issues, Metal Insulator Semiconductor FET, MOSFET- basic operation and fabrication; ideal MOS capacitor; effects of real surfaces; threshold voltages; output and transfer characteristics of MOSFET, short channel and Narrow width effects: Drain Induced barrier lowering (DIBL), Gate-Induced drain leakage (GIDL), hot carrier degradation, velocity saturation, MOSFET scaling, Physics of FinFET, Junction less Transistor, SPICE Models for Semiconductor Devices

Unit V:
High Power semiconductor device: Power diode, Power MOSFET, Thyristors: Gate Turn-Off thyristor (GTO), Silicon Controlled Rectifier (SCR), TRIAC, DIAC.

Course Outcomes:
At the end of the course, students will demonstrate the ability to:
1. Compute carrier electronic properties in semiconductor materials and devices under different operating conditions.
2. Draw band diagram of different semiconductor devices under different bias conditions
3. Apply suitable approximations and techniques to derive the model referred to above starting from drift-diffusion transport equations
4. Compute electrostatic variables and current-voltage characteristics of semiconductor devices under a variety of conditions.
5. To design a pn junction device and bi-polar devices as per requirements
6. Explain and compute figures of merit of bipolar device based on device parameters and dimensions
7. Explain various non-ideal effects in a bipolar transistor
8. To provide qualitative understanding of the physics of a new device and conversion of this understanding into equations

Text/Reference Books:
1. Kevin F Brennan, "The Physics of Semiconductors", Cambridge Univ. Press, 1999.
2. S. A. Neamen and D. Biswas, Semiconductor Physics and Devices, 4th Edition, TMH, 2012.
3. S. M. Sze and K. K. Ng, "Physics of Semiconductor Devices", 3rd Edition, Wiley India, 2010.
4. Kittel Charles, "Introduction to Solid State Physics", 6th Ed., Willey (1991).
5. P. Bhattacharya, Semiconductor Optoelectronics Devices, 2nd Edition, PHI, 2009.
6. Streetman, B.G. and Banerjee, S.K, "Solid State Electronic Devices", 7th Ed., Pearson Education, 2016

Paper Code: MECE-102
Paper Name: Digital VLSI Design

Course Objective:
The students of first year M.E. (VLSI Design) will be able to acquire knowledge on VLSI Design Process, MOS Circuits, CMOS logic structures, sequential logic structures, Timing issues and CMOS Subsystems.

Unit – 1
Review of MOSFET characteristics, Scaling and small-geometry effects, Band Diagram, MOSFET capacitances, MOS Inverter, CMOS Inverters. Introduction MOSFET, threshold voltage, current, Channel length modulation, body bias effect and short channel effects, MOS switch, MOSFET models for calculation-Transistors and Layout, CMOS layout elements, Lambda Rule vs Micron rule, parasitic, Euler path Algorithm, legging, wires and vias-design rules-layout design SPICE simulation of MOSFET I-V characteristics and parameter extraction . Moore's Law, Scale of Integration (SSI, MSI, LSI, VLSI, ULSI, GSI), Technology growth and process Node.

Unit – 2
Combinational MOS Logic Circuits (including CMOS logic domino logic, Pseudo-NMOS), CMOS inverter, static characteristics, noise margin, effect of process variation, supply scaling, dynamic characteristics, inverter design for a given VTC and speed, effect of input rise time and fall time, static and dynamic power dissipation, energy & power delay product, sizing chain of inverters, latch up effect-Simulation of static and dynamic characteristics, layout, post layout simulation.

Unit – 3
Sequential MOS Logic Circuits, Dynamic Logic Circuits, Static CMOS design, Complementary CMOS, static properties, propagation delay, Elmore delay model, power consumption, low power design techniques, 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 –Course project

Unit – 4
Low-Power CMOS Logic Circuits, BiCMOS Logic Circuits, Circuit design considerations of Arithmetic circuits, shifter, CMOS memory design – SRAM and DRAM, BiCMOS logic - static and dynamic behavior -Delay and power consumption in BiCMOS Logic

Unit – 5
Why HDL? Frontend Design Flow using HDL (Behavioral, RTL and Gate Level), VHDL/Verilog Modeling: Behavioral, Data-Flow, Structural and Mixed, FSM Example: Mealy Machine and Moore Machine, FPGA logic element and interconnect architecture, Logic synthesis for FPGA ,Physical design for FPGA, Input Output Circuits, ESD protection circuit.

Course Outcome:
Upon the completion of this course, students will be able to demonstrate an ability to
1. Acquire the knowledge about various CMOS fabrication process and its modeling.
2. Infer about the second order effects of MOS transistor characteristics.
3. Analyze and implement various CMOS static logic circuits.
4. Learn the design of various CMOS dynamic logic circuits.
5. Learn the design techniques low voltage and low power CMOS circuits for various applications.
6. Learn the different types of memory circuits and their design.
7. Design and implementation of various structures for low power applications

Text Books:
1. Sung-Mo Kang & Yusuf Leblebici, CMOS Digital Integrated Circuits - Analysis & Design, MGH, Third Ed., 2003
2. Jan M Rabaey, Digital Integrated Circuits - A Design Perspective, Prentice Hall, Second Edition, 2005.

Reference Books:
3. David A. Hodges, Horace G. Jackson, and Resve A. Saleh, Analysis and Design of Digital Integrated Circuits, Third Edition, McGraw-Hill, 2004
4. R. J. Baker, H. W. Li, and D. E. Boyce, CMOS circuit design, layout, and simulation,Wiley-IEEE Press, 2007
5. Christopher Saint and Judy Saint, IC layout basics: A practical guide, McGraw- Hill6Professional, 2001

Course code: MECE-103A
Course Name: MICROELECTRONICS TECHNOLOGY

Course Objectives:
1) To teach the fundamentals of micromachining and micro fabrication techniques.
2) To train the students on the design of micro sensors and actuators and fabrication flow process.
3) To bring both circuits and system views on design together.
4) To give introduction about MEMS devices.

Unit 1:
Crystal growth: Source of silicon, Single crystalline and Poly crystalline, Requirement of purity for electronics industry, Electronics grade silicon production, Crystal growth techniques: Bridgeman method, float zone method, Czocharalski method, Wafer Preparation & Crystal Defects.
Epitaxial Process: Need of epitaxial layer, vapors phase epitaxy -reactor design, chemistry of epitaxial process, transport mechanism doping & auto doping, selective epitaxy, epitaxial process induced defects, molecular beam epitaxy, merits and demerits among epitaxial processes.

Unit 2:
Oxidation: Importance of oxidation, types of oxidation techniques, growth mechanism & kinetics, factors affecting the growth mechanisms, silicon oxidation model, dry & wet oxidation, oxidation induced faults, Lithography: Basic steps in lithography, lithography techniques-optical lithography, electron beam lithography, x-ray lithography, ion beam lithography, resists and mask preparation of respective lithographies, printing techniques- contact, proximity printing and projection printing, merits and demerits of lithographies.

Unit 3:
Etching: Performance metrics of etching, types of etching- wet and dry etching, dry etching techniques-ion beam or ion-milling, sputter ion plasma etching and reactive ion etching (RIE), merits and demerits of etching, etching induced defects. Diffusion and Ion Implantation: Diffusion mechanisms, diffusion reactor, diffusion profile, diffusion kinetics, parameters affecting diffusion profile, Dopants and their behavior, choice of dopants, Ion Implantation- reactor design, impurity distribution profile, properties of ion Implantation, low energy and high energy ion implantation.

Unit 4:
Metallization: Desired properties of metallization for VLSI, metallization choices, metallization techniques –vacuum evaporation, sputtering. Introduction to packaging, packaging process, package design considerations, various package types

Unit 5:
Fundamentals of MEMS/NEMS Design & Fabrication Needs for MEMS, MEMS material, MEMS Features, MEMS design limits and safety factors, Basic MEMS operating principles.

Course Outcomes:
1) Identify and demonstrate operating principles and typical applications Microelectronics and their applications in modern society.
2) To understand the fabrication techniques and wafer preparation.
3) To be aware about the trends in semiconductor technology, and how it impacts scaling and performance.
4) Expertise the knowledge in design of micro sensors and actuators fabrication.
5) Know the basic concepts of micro systems and advantages of miniaturization.

Text Books/ References:
1. S.M. Sze, “VLSI Technology”, TMH
2. S.K. Gandhi, “VLSI Fabrication Principles”, John Willey & Sons
3. S.D Senturia, “Microsystems design”. Kluwer Academic Publishers,2001
4. N.P. Mahalik, “ MEMS”, Tata McGraw Hills Publishers.
5. G.T.A. Kovacs, “Micromachined transducer”, McGraw Hill, 1998.
6. Botkar, “Integrated Circuits”, Khanna Publishers
7. D. Nagchoudhuri, “Principles of Microelectronics Technology” PHI

Course code: MECE-103B
Course name: LOW POWER VLSI DESIGN

Course Objectives:
To learn the sources of power dissipation in CMOS circuits. To learn SPICE simulations and power analysis. To learn design of low power circuits at the circuit and system level.

Unit-1
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. Dynamic dissipation in CMOS, Transistor sizing & gate oxide thickness, Impact of technology Scaling, Technology & Device innovation.

Unit-2
SPICE circuit simulators, gate level logic simulation, capacitive power estimation, static state power, gate level capacitance estimation.

Unit-3
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

Unit-4
Power & performance management, switching activity reduction, parallel architecture with voltage reduction, flow graph transformation, low power arithmetic components, low power memory design.

Unit-5
Introduction, design flow, algorithmic level analysis and optimization, Architectural level estimation and synthesis.

Text Books:
1. Gary K. Yeap, Farid N. Najm, "Low power VLSI design and technology", World Scientific Publishing Ltd., 1996.

REFERENCES:
2. Dimitrios Soudris, Christian Piguet, Costas Goutis," Designing CMOS circuits for low power", Kluwer Academic Publishers, 2002
3. Kaushik Roy and Sharat C. Prasad,"Low-Power CMOS VLSI Circuit Design", Wiley- Interscience, 2000.
4. Chandrakasan, R. Brodersen , "CMOS Low Power Digital Design", Kluwer Academic Publications. 1995.
5. Rabaey, M. Pedram, "Low Power Design Methodologies", Kluwer Academic Publications. 1996.
6. Christian Piguet, "Low-power CMOS circuits: technology, logic design and CAD tools", CRC Press, Taylor & Francis Group, 2006.

Course Outcomes:
At the end of the course, students will be able to:
1. Identify the sources of power dissipation in digital IC systems & understand the impact of power on system performance and reliability.
2. Characterize and model power consumption & understand the basic analysis methods.
3. Understand leakage sources and reduction techniques.
4. Design low power circuits and systems.

Course Code: MECE 104A
Course Name: Digital Signal Processing

Course objective:
To make students aware about the meaning and implications of the properties of systems and signals. Also, to make students familiar with the most important methods in DSP, including digital filter design, structures and effects in digital filters.

Unit I
Review of discrete time signals, systems and transforms: Discrete time signals, systems and their classification, analysis of discrete time LTI systems: impulse response, difference equation, frequency response, Transfer function, DTFT, DTFS and Z-transform.

Unit II
Discrete Fourier Transform (DFT): Computational problem, DFT relations, DFT properties, fast Fourier transform (FFT) algorithms (radix-2, decimation-in-time, decimation-in- frequency), Goertzel algorithm, linear and circular convolution using DFT

Unit III
Filters design and their characteristics: Frequency selective filters: Ideal filter Characteristics, lowpass, highpass, bandpass and bandstop filters, notch filters, all-pass filters, Structures for discrete-time systems: Signal flow graph representation, basic structures for FIR and IIR systems (direct, parallel, cascade and polyphase forms), transposition theorem, ladder and lattice structures.

Unit IV
Design of FIR and IIR filters: Design of FIR filters using windows, frequency sampling, Design of IIR filters using impulse invariance, bilinear transformation and frequency transformations

Unit V
Finite word length effects in digital filters: Fixed and floating point representation of numbers, quantization noise in signal representations, finite wordlength effects in coefficient representation, roundoff noise, SQNR computation and limit cycle. Introduction to multirate signal processing: Decimation, interpolation, polyphase decomposition; digital filter banks: Nyquist filters, two channel quadrature mirror filter bank and perfect reconstruction filter banks, subband coding.

Course Outcomes:
At the end of this course students will
1. Be able to represent signals mathematically in discrete time and frequency domains.
2. Have better understanding of digital filters
3. Be able to correlate the course with the real world applications

Text/Reference books:
1. Digital Signal Processing – Principles, Algorithms and Applications by J. G. Proakis and D. G. Manolakis, Pearson. Latest Edition.
2. Digital signal Processing by Salivahanan, TMH, Latest Edition.

Course Code: MECE 104B
Course Name: Image Processing

Course Objective:
The primary objective of this course is to introduce students to basic principles of digital images, image data structures, and image processing algorithms.

Unit I
Digital Image processing, Need of DIP, Pixel, sampling and digitization, Relationship among pixels: Neighborhood, connectivity, adjacency, Distance measures: Euclidean distance, city block, chess board.

Unit II
Image transformation, Need of transformation, Fourier transforms, DCT, Walsh Transform, K L transforms.

Unit III
Arithmetic operations such as addition, subtraction, multiplication and division, Logical operations for binary images, Perspective transformation, Interpolation and decimation. Image enhancement: Spatial domain methods include point processing, histogram based techniques and mask operations and frequency domain operations.

Unit IV
Image restoration, Image registration, Image segmentation: discontinuity based approach (Point, line, and edge detection) and similarity based approach (Thresholding, region growing based, region splitting and merging), Color Image Processing.

Unit V
Applications of DIP: Pattern recognition, texture classification, Face detection, Face recognition, Gesture recognition, Biomedical Image analysis.

Course outcomes:
At the end of this course students will
1. Apply principles and techniques of digital image processing in applications related to digital imaging system design and analysis.
2. Analyze and implement image processing algorithms.

Text/Reference books:
1. Digital Image Processing by Rafael C Gonzalez and Richard Woods 3rd Edition, Pearson
2. Anil K. Jain, Fundamentals of Digital Image Processing, Pearson, 2002

Course Code: MECE-105
Course Name: Research Methodology and IPR

Course Objectives:
To learn basics of research and to define research problem. To learn the measurement in research and scales, sampling fundamentals. To understand IPR, learn kinds of IPR, and understand Geographical Indication.

Unit - 1
Introduction to research, objectives, motivation, types of research, significance of research, Research Methods versus Methodology, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India.

Unit - 2
Research problem, problem selection, definition, research design, types of research design, basic principles of experimental design, developing research plan.

Unit - 3
Measurement in research, scales, Sources of Error in Measurement, Tests of Sound Measurement, measurement tools, methods of data collection, Processing and Analysis of Data.

Unit - 4
Sampling Fundamentals, Testing of Hypotheses-I , Chi-square Test, Testing of Hypotheses-II, Interpretation and Report Writing, Computer and Its Role in Research.

Unit - 5
Introduction and the need for intellectual property right (IPR) - Kinds of Intellectual Property Rights: Patent, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and Layout Design – Genetic Resources and Traditional Knowledge – Trade Secret - IPR in India.
Text Books:

1. C R Kothari, Research Methodology: Methods and Techniques, NEW AGE; 2nd ed. 2014
2. Panneerselvam R, Research Methodology, Prentice Hall India Learning Private Limited; Second edition, 2013
3. E. T. Lokganathan, Intellectual Property Rights (Iprs): Trips Agreement and Indian Laws: TRIPS Agreement & Indian Laws, Ingram short title; 1st edition, 2012
4. G.B.Reddy, Intellectual Property Rights and The Law (Copyright Law, Patent Law, Designs Law, Trademarks Law, Farmers Rights Law, Biological Diversity Law, Information Technology Law Etc.) - Comprehensive Book, Gogia Law Agency, 2020.

Course outcomes:
At the end of this course, students will be able to
1. Understand research problem formulation.
2. Analyze research related information
3. Follow research ethics
4. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
5. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
6. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

Paper Code: MECE-106
Paper Name: Front End VLSI Design Lab

Course Objective:
The students of first year M.TECH (: Microelectronics and VLSI Design) will be able to acquire knowledge on front end and back end tools in the design of VLSI circuits, design and implement digital circuits using HDL , interface the peripheral boards with FPGAs and performing the RTL Synthesis of CMOS Circuits. Modeling and Functional Simulation of the following digital circuits (with Xilinx/ ModelSim/Cadence tools) using VHDL/Verilog Hardware Description Languages

Experiments:
1. Basic Logic Gates.
2. Multiplexer, Comparator, Adder/ Subs tractor, Multipliers, Decoders.
3. D-Latch, D-Flip Flop, JK-Flip Flop, Registers.
4. Combinational Logic: Address decoders, parity generator, ALU
5. Sequential Logic: Ripple Counters, Synchronous Counters, Shift Registers (serial-to- parallel, parallel-to serial), Cyclic Encoder / Decoder

Course Outcome:
Upon the completion of this course, students will be able to demonstrate an ability to
1. Design and simulate the CMOS digital and analog VLSI Circuits using Modern Tools (Cadence Environment), interface peripheral boards with FPGA, perform RTL synthesis using Cadence Tool.
2. Develop skills to communicate effectively

Paper Code: MECE-107
Paper Name: Back End VLSI Design Lab

Course Objective:
The students of first year M.TECH (Microelectronics and VLSI Design) will be able to acquire knowledge on
1. Back end tools in the design of VLSI circuits, design and implement digital circuits and analog circuits.
2. Introduction to Cadence virtuoso environment.
3. Concept of Layout and introduction to cadence Assura environment.

Session –I: Digital IC Design Laboratory
1. Introduction to SPICE (operating point Analysis, DC Sweep, Transient Analysis, Transfer Function Analysis)
2. An Overview of Cadence Environment/Tanner EDA Tool/Electric/Magic/ NG spice/LTspice.
3. I-V Curve of NMOS & PMOS Transistor (Parametric Analysis)
4. DC analysis of CMOS Inverter (VTC, Noise Margin), Dynamic Characteristics of CMOS Inverters (Propagation Delay, Power Dissipation).
5. Schematic Entry /Simulation of CMOS Combinational & Sequential Circuits. (Also Design High Speed low power circuits)

Session –II: Analog IC Design Laboratory
Introduction to basic layouts:
a. Layout of an inverter and verify with DRC, LVS.
b. Layout of a basic logic gates with DRC & LVS.
c. Layout of CMOS Combinational & Sequential Circuits.
d. Layout of standard cells: what to take care of (pitch, reduction of area)

Course Outcome:
Upon the completion of this course, students will be able to demonstrate an ability to
1. Design and simulate the CMOS digital and analog VLSI Circuits using Modern Tools (Cadence virtuoso Environment), perform RTL synthesis using Cadence Tool.
2. Layout Design with DRC and LVS technique .(Cadence Assura Environment)

Paper Code: MECE-108A
Paper Name: ENGLISH FOR RESEARCH PAPER WRITING

Course Objectives:
Students will be able to:
1. Understand that how to improve your writing skills and level of readability
2. Learn about what to write in each section
3. Understand the skills needed when writing a Title
4. Ensure the good quality of paper at very first-time submission

Unit 1:
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

Unit 2:
Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, and Introduction.

Unit 3:
Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

Unit 4:
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

Unit 5:
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

Unit 6:
Useful phrases, how to ensure paper is as good as it could possibly be the first time submission

Suggested Studies
1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book.
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

Course Outcomes:
After the completion of the course, students will be able:
1. To understand the important points while writing a research paper.
2. To write good quality research papers.

Paper Code: MECE-108C
Paper Name: SANSKRIT FOR TECHNICAL KNOWLEDGE

Course Objectives:
1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2. Learning of Sanskrit to improve brain functioning
3. Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
4. The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

Unit – 1
Alphabets in Sanskrit, Past/Present/Future Tense, Simple Sentences

Unit – 2
Order, Introduction of roots, Technical information about Sanskrit Literature

Unit - 3
Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

Suggested reading
1. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

Course Outcomes:
Students will be able to
1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood
3. Being a logical language will help to develop logic in students

Course Code: MECE 108
Course name: Value Education

Course Objectives:
To familiarize the students with the value of education and self- development, imbibe good values in students and to make them realize the importance of Ethics in civilized society.

Unit I
Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Value judgments. Moral and non- moral valuation. Standards and principles, Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline, Importance of cultivation of values, Sense of duty, Devotion, Self-reliance. Confidence, Concentration, Truthfulness, Cleanliness.

Unit II
Professional and Business Ethics. Ethical issues in Engineering practice. Codes of professional ethics. Conflicts between business demands and professional ideals: Case studies. Ethics in Corporate Sectors, Managerial Ethics
.
Unit III
Science, Technology and Human values, Environmental Ethics. Technological growth and its impact on Environment. Environmental degradation and pollution. Environmental Regulations. Concept of Sustainable Development. Eco-friendly technologies. Energy crisis and renewable energy resources. Ethics of the Eco-System. Human centered technology. Problems of Technology transfer. Ethics on IPR.

Unit IV
Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour, Universal brotherhood and religious tolerance, True friendship, Happiness Vs suffering, love for truth, Aware of self-destructive habits, Association and Cooperation, Doing best for saving nature.

Unit V
Character and Competence –Holy books vs Blind faith. Self-management and Good health, Science of reincarnation, Equality, Nonviolence, Humility, Role of Women, All religions and same message, Mind your Mind, Self-control, Honesty, Studying effectively.

Course Outcomes:
After studying the course, the student will be able to
1. Realize the knowledge of self-development

2. Learn the importance of moral character and human values
3. Learn about the environmental ethics.
4. Learn about the Professional and Business Ethics.
5. Develop the overall personality to live life with healthy and positive thoughts.

Text Books/Reference Books:

1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi
2. T. L. Beauchamp. Philosophical Ethics. An Introduction to Moral Philosophy. Georgetown University. McGraw Hill.
3. Peter Singer. Practical Ethics. Cambridge University Press.
4. Mike W. Martin. Ethics in Engineering. McGraw Hill.
5. Michael Bayles. Professional Ethics. Wadsworth.
6. Bruce O. Watkins and Meador Roy. Technology and Human Values: Collision and Solution. AnnArbor Science.
7. Dr. Subir Chowdhury. Blending the best of the East & West. EXCEL
8. Ghosh. Ethics & Mgmt. & Indian Ethos. VIKAS.
9. Pherwani. Business Ethics. EPH
10. Balachandran, Raja & Nair. Ethics, Indian Ethos & Mgmt., Shroff Publishers

Semester – 2

Paper Code: MECE-201
Paper Name: ANALOG VLSI DESIGN

Course Objectives:
1. To understand the construction, operation and mathematical models of MOSFETs
2. To analyze and design single stage and multistage amplifiers at low frequencies.
3. To study and analyze different current mirrors used to bias IC amplifiers.
4. To understand the frequency response of amplifier designed in integrated circuits.
5. To understand the principles of operation of Operational Amplifier.
6. To understand the principles of operation of Data Converter

UNIT I: Basic MOS Device Physics:
NMOS and PMOS transistors, CMOS logic, MOS transistor theory – Introduction, Band Diagram, Enhancement mode transistor action, Ideal I-V characteristics, DC transfer characteristics, Threshold voltage, Body effect- Design equations-Second order effects. MOS models and small signal AC characteristics, Simple MOS capacitance Models, Detailed MOS gate capacitance model, Detailed MOS Diffusion capacitance model.

UNIT II: CMOS TECHNOLOGY, DESIGN RULEAND CMOS SUB CIRCUITS(BIASING)
CMOS fabrication and Layout, CMOS technologies, P -Well process, N -Well process, MOS layers stick diagrams and Layout diagram, Layout design rules, Euler path technique in Layout.MOS switch - MOS diode and active resistor – Current Source , Current Sink, Basic Current mirrors – Cascode current mirrors-active current mirrors- voltage references-supply independent biasing.

UNIT III: SINGLE STAGE AMPLIFIERS , DIFFERENTIAL AMPLIFIERS & FREQUENCY RESPONSE
Basic concepts, common-source stage, common-source stage with resistive load, CS stage with diode-connected load, CS stage with current-source load, CS stage with triode load, CS stage with source degeneration, source follower, common-gate stage, cascade stage, folded cascode .Differential operation - Basic differential pair - Common mode response Differential pair with MOS loads, MOSFET Differential amplifier with Diode Connected Active load, Current Source as a load, Current Mirror as a load, frequency response, compensation techniques ,Miller effect.

UNIT IV: CMOS Operational Amplifier
CMOS Amplifiers & CMOS Operation Amplifiers : Basic concepts , Performance Parameters , Single Stage OPAMP, Two stage OPAMP, Stability and Phase compensation, Cascode OPAMP Comparators: Characterization, Two stage open loop comparators, Discrete time comparators , high speed comparator circuits , CMOS S/H circuits

UNIT V: Data Converter Fundamentals & Architecture:
Ideal D/A converters, Ideal A/D converter, Serial and Flash D/A converters and A/D converters, Medium and High Speed converters, Over-sampling converters, performance limitations, Design considerations. Special Circuits: Switched Capacitor circuits: General considerations, Resistor simulation using different Switched Capacitor topologies, Switched Capacitor integrators, First and second order switched capacitor filter circuits, ,cross talk, floor planning, power distribution, Clock distribution, Basics of CMOS testing. CMOS voltage controlled oscillators, Phase locked loops, Ring oscillators.

Course Outcomes:
At the end of the course student will be able -
1. Acquire knowledge of device physics related to MOSFET.
2. Acquire knowledge of amplifier design with the use of proper biasing techniques.
3. Identify appropriate circuit topology for given gain, input impedance, output impedance and bandwidth requirements.
4. Design single and multi-stage amplifiers for desired gain, bandwidth and terminal impedance specifications.
5. Acquire the knowledge of different op-amp topologies and to design op-amps for the given specifications
6. Acquire the knowledge of different Data Converter technique and architecture.

Text Books
B. Razavi, Design of Analog CMOS Integrated Circuits, McGraw Hill, 2011.
R. Jacob Baker, "CMOS Circuit Design, Layout, and Simulation", 3rd Edition, Wiley, 2010.

References
1. P. R. Gray & R. G. Meyer, Analysis and Design of Analog Integrated Circuits, 5/e, John Wiley, 2012.
2. P.E.Allen & D.R. Holberg, "CMOS Analog Circuit Design", 3rd Edition, Oxford University Press, 2011
3. K.Radhakrishna Rao," Electronics for Analog Signal Processing-I", NPTEL, Courseware, 2005.

Paper Code: MECE-202
Paper Name: VLSI Physical Design

Course Objectives:
To learn basics of VLSI physical design, fundamentals of IC fabrication, interconnect issues. To learn the floorplan, placement, and routing algorithms. To learn the physical design automation tools.

Unit -I
VLSI Physical Design Automation: VLSI Design Cycle, Physical Design Cycle, Design Styles, System Packaging Styles, Historical Perspectives.

Unit-II
Existing Design Tools Design and Fabrication of VLSI Devices: Fabrication Materials, Transistor Fundamentals, Fabrication of VLSI Circuits, Design Rules.

Unit-III
Layout of Basic Devices Fabrication Process and its Impact on Physical Design: Scaling Methods, Status of Fabrication Process, Issues Related to the Fabrication Process, Future of Fabrication Process, Solutions for Interconnect Issues, Tools for Process Development.

Unit – IV
Data Structure and Basic Algorithms: Basic Terminology, Complexity Issues and NP-hardness, Basic Algorithms, Basic Data Structures, Graph Algorithm for Physical Design Partitioning: Problem formulation, Classification of Partitioning Algorithms, Group Migration Algorithm, Simulated Annealing and Evolution, Other Partitioning Algorithms, Performance Driven Partitioning Floor Planning and Pin assignment: Floor Planning, Chip Planning, Pin Assignment, Integrated Approach

Unit -V
Placement: Problem Formulation, Classification of Placement Algorithms, Simulation Based Placement Algorithms, Partitioning Based Placement Algorithms, Other Placement Algorithms, Performance Driven Placement Over-the-Cell Routing and Via Minimisation, Clock and Power Routing: Over-the-Cell Routing, Via Minimisation, Clock Routing, Power and Ground Routing.

Text Books:
1. Naved A. Sherwani, Algorithms for VLSI Physical Design Automation, 3rd Edn., Springer (India) Pvt. Ltd., 2005, ISBN: 0792383931
Reference Books:
1. Gerez, Algorithms for VLSI Design Automation, Wiley India Pvt. Ltd., New Delhi, ISBN 10: – 8126508211, ISBN 13: – 9788126508211.

Course Outcomes:
At the end of the course, students will be able to:
1. Study automation process for VLSI design.
2. Understanding of fundamentals for various physical design CAD tools.
3. Develop and enhance the existing algorithms and computational techniques for physical design process of VLSI systems.

Paper Code: MECE-203A
Paper Name: Verification and Testing

Course Objectives:
To learn basics of VLSI testing, faults, fault models, different testing techniques, verification methodologies, different types of verifications processes and algorithms.

Unit 1
Scope of testing and verification in VLSI design process, Issues in test and verification of complex chips, embedded cores and SOCs.

Unit 2
Fundamentals of VLSI testing Fault models. Automatic test pattern generation, Design for testability, Scan design, Test interface and boundary scan. System testing and test for SOCs. Delay fault testing.

Unit 3
BIST for testing of logic and memories, Test automation, Design verification techniques based on simulation, analytical and formal approaches.

Unit 4
Functional verification, Timing verification, Formal verification, Basics of equivalence checking and model checking, Hardware emulation.

Unit 5
Test generation for combinational circuits –D-algorithm etc. Test pattern generation for sequential circuits-boundary scan (JTAG) Built in self-test techniques Non-intrusive automated testing Functional testing

Text Books:
1. M. Bushnell and V. D. Agrawal, Essentials of Electronic Testing for Digital, Memory and Mixed- Signal VLSI Circuits, Kluwer Academic Publishers, 2000.
2. M. Abramovici, M. A. Breuer and A. D. Friedman, Digital Systems Testing and Testable Design, IEEE Press, 1990.
3. T.Kropf, Introduction to Formal Hardware Verification, Springer Verlag, 2000.

References:
3. P. Rashinkar, Paterson and L. Singh, System-on-a-Chip Verification Methodology and Techniques, Kluwer Academic Publishers, 2001.
4. Neil H. E. Weste and Kamran Eshraghian, Principles of CMOS VLSI Design, Second Edition, Addison Wesley, 1993.
6. Neil H. E. Weste and David Harris, Principles of CMOS VLSI Design, Third Edition, Addison Wesley, 2004.

Course Outcomes:
At the end of this course, students will be able to
1. Familiarity of Front end design and verification techniques and create reusable test environments.
2. Verify increasingly complex designs more efficiently and effectively.
3. Use EDA tools like Cadence, Mentor Graphics.

Course code: MECE-203B
Course name: Embedded System Design

Course Objectives:
1. To understand the basics of Embedded Systems, peripherals, processors and operating systems associated with embedded systems.
2. To understand the Embedded system interfacing and issues in hardware software co- design.
3. To make the students to be able to understand the embedded firmware design and development.

4. To program embedded systems using modern embedded processors.

Unit-1
Introduction of Embedded Systems: Concept of Embedded System Design: Design challenge, Processor technology, IC technology, Design technology, Trade-offs. Introduction, basic architecture, operation, super-scalar and VLSIIW architecture, application specific instruction set processors (ASIPS), microcontrollers, digital signal processors, selecting a microprocessor, Memory.

Unit-2
Architecture and Programming in assembly and C, Interfacing Analog and digital blocks, Analog-to-Digital Converters (ADCs), Digital to-Analog, Converters (DACs), Communication basics and basic protocol concepts, Microprocessor interfacing: I/O addressing, Port and Bus based, I/O, Memory mapped I/O, Standard I/O interrupts, Direct memory access, Advanced communication principles parallel, serial and wireless, Serial protocols I2C, Parallel protocols PCI bus, Wireless protocol IrDA, blue tooth.

Unit-3
Different peripheral Devices: Buffers and latches, Crystal, Reset circuit, Chip select logic circuit, timers and counters and watch dog timers, Universal asynchronous receiver, transmitter (UART), Pulse width modulators, LCD controllers, Keypad controllers. Design tradeoffs .

Unit-4
Software aspects of embedded systems: Challenges and issues in embedded software development, Co-design Embedded software development environment: Real time operating systems, Kernel architecture: Hardware, Task/process control subsystem, Device drivers, File subsystem, system calls, Embedded operating systems, Task scheduling in embedded systems: task scheduler, first in first out, shortest job first, round robin, priority based scheduling, Context switch: Task synchronization.

Unit-5
Development for Embedded systems: Embedded system development process, requirements, designing the system architecture, choosing the operating system, processor, development platform, programming language, coding issues, code optimization, efficient input/output, Testing and debugging, Verify the software on the host system, Verify the software on the embedded system.

Course Outcomes:
At the end of the course, students will demonstrate the ability to:
1. Suggest design approach using advanced controllers to real-life situations.
2. Design interfacing of the systems with other data handling / processing systems.

Text Book:
1. Frankvahid/Tony Givargis, Embedded System Design- A unified Hardware/software Introduction.
2. David E Simon, An embedded software primer, Pearson education Asia, 2001.
3. Dreamteach Software team, Programming for Embedded Systems, AVR 8515 manual

Reference Book:
1. J.W. Valvano, Embedded Microcomputor System: Real Time Interfacing
2. Jack Ganssle, The Art of Designing Embedded Systems, Newnes, 1999.
3. Shibu K.V., Introduction to Embedded Systems, TMH Private Limited, New Delhi, 2009.
4. Wayne Wolf, Computers as Components, Morgan Kaufmann, 2001
5. G. De Micheli, Rolf Ernst and Wayne Wolf, eds, Readings in Hardware/Software Co- Design, Morgan Kaufmann, Systems-on-Silicon Series Embedded
6. Frank Vahid and Tony D. Givargis, System Design: A Unified Hardware/Software Introduction, Addison Wesley, 2002.

Course Code: MECE 204A
Course name: MEMS and NEMS Technology

Course Objectives:
To familiarize the student with the advancements of Micro-Electro- Mechanical-Systems (MEMS) and Nano-Electro-Mechanical-Systems (NEMS) technology, different materials used for MEMS/NEMS, design, simulation and fabrication of MEMS/NEMS devices, and their applications to versatile disciplines of engineering.

Unit 1
Introduction to Design of MEMS and NEMS, Overview and Applications, MEMS and NEMS Architectures , Modeling levels- Analytical and numerical, Commercialization of MEMS/NEMS.

Unit 2
Force and Pressure Sensors, Resonant sensor, Accelerometers- types and applications, Vibratory Gyroscopes, Silicon Nanowire Solar cells, ZnO Nanowire UV Photodetectors, ZnO Nanowire Nanogenerator , Electrostatic Actuators- Comb Drive Actuators , Parallel –Plate Actuator, Cantilever beam Actuator, RF MEMS/NEMS Switch, MEMS/NEMS resonators, Inkjet Nozzles , Introduction to Bio- MEMS/NEMS applications: Lab-on-chip, endoscopic pill camera. Drug Delivery Systems. Nanorobotics. Micro-thrusters in satellites.

Unit 3
Modeling Strategies : Lump Parameter Modeling, Distributed Parameter Modeling, Equivalent Circuit Modeling, Introduction to MEMS simulators: COMSOL Multiphysics, CoventorWare, ANSYS, Intellisuite.

Unit 4
Silicon: Semiconductors, Metals, Metal Alloys, thin metal films, Polymers, Glass and Quartz substrates, diamond, piezoelectric and magnetic compounds, Fundamentals of Metal-oxide Nanowires: ZnO Microfabrication and Micromachining of Microdevices, Bulk Micromachining, Surface Micromachining, High-Aspect-Ratio (LIGA and LIGA-Like) Technology, Photolithography, Etching, Molecular Beam Epitaxy Growth of Nanowires, Metal-oxide Nanowires by Thermal Oxidation Reaction Technique.

Unit 5
Packaging: Types of packaging, Ceramic, Metal, Molded plastic, Hermetic packaging, Die- attach process, Interconnects.

Course Outcomes:
After studying the course, the student will be able to
1. Understand the underlying working principles of MEMS and NEMS devices.
2. Learn about MEMS/NEMS architectures
3. Design Nanowire devices.
4. Learn about applications of MEMS/NEMS technology in renewable energy engineering, automobile engineering, printing technology, biomedical instrumentation, and space technology.
5. Learn about the specific fabrication steps involved in micromachining of micro devices, and fabrication of nanowires by Thermal Oxidation Reaction Technique.
6. Understand the various fabrication and packaging technologies of MEMS/NEMS.

Text Books:
1. “Principles of Mocroelectromechanical Systems” – Lee,Ki Bang, John Wiley &Sons, 2011
2. “MEMS and NEMS: Systems, Devices, and structures” – Sergey Edward Lyshevski, CRC Press, 2002.

Reference Books:
1. “An Introduction to Microelectromechanical Systems Engineering” – Nadim Maluf, Kirt Williams, 2nd edition, Artech House, 2004.
2. “Analysis and Design Principles of MEMS Devices” – Minhang Bao, Elsevier, 2005.
3. “Microsystem Design” – Stephen D. Senturia, Kluwer Academic Publishers, 2002
4. “ Energy Harvesting Technologies” – Shashank Priya, Daniel J. Inman, Springer, 2009.

5. " Nanowires - Recent Advances" – Xihong Peng, InTech , 2012.
6. "Nanowires – Paola Prete, Intech, 2010.
7. "Piezotronics and Piezo-Phototronics" – Zhong Lin Wang , Springer, 2012.
8. "Nanowires and Nanobelts, Materials, Properties, and Devices, Volume 2: Nanowires and Nanobelts of Functional Materials" –Zhong Lin Wang, Springer, 2006.

Paper Code: MECE-204B
Paper Name: Quantum and Nanoelectronics

Course Objectives:
To learn nano-scale devices MOSFET, SON, SOI, FinFET, VMOS. To learn hetero structure based devices. To learn CNT/GNR device and interconnect structures, and quantum structures.

Unit 1
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 2
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 3
Hetero structure based devices – Type I, II and III Hetero-junction, Si-Ge hetero-structure, hetero structures of III-V and II-VI compounds - resonant tunneling devices, MODFET/HEMT

Unit 4
Carbon nanotubes based devices – CNFET, characteristics, Spin-based devices – spinFET, characteristics

Unit 5
Quantum structures – quantum wells, quantum wires and quantum dots, Single electron devices – charge quantization, energy quantization, Coulomb blockade, Coulomb staircase, Bloch oscillations

Text 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.
References:
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 , (Available on NITC intranet in Springer eBook section)
8. B.R. Nag, Physics of Quantum Well Devices, Springer 2002, ISBN 978-0-7923-6576-1, (Available on NITC intranet in Springer eBook section).
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, (Available on NITC intranet in Springer eBook section).

Course Outcomes:
The students will be able to:
1. Know basics of nanoelectronics and its fabrication.

2. Understand fundamentals of nano-scale MOSFET and design of circuits
3. Understand the concept quantum mechanics in electronics
4. Learn molecular devices and its synthesis techniques

Paper Code: MECE-204C
Paper Name: Timing Analysis

Course Objectives:
To learn basics of timing analysis, different timing related terms, setup and hold time analysis. To learn techniques to perform timing analysis in digital circuits and systems. To learn On-chip variations, sources. To understand and develop timing models.

Unit 1
Introduction to timing path and arrival time, Introduction to required time and slack, Introduction to basic categories of setup and hold analysis, Introduction to data check and latch timing, Introduction to slew, load and clock checks.

Unit 2
Convert logic gates into nodes, Compute actual arrival time (AAT), Compute required arrival time (RAT), Compute slack and introduction to GBA-PBA analysis, Convert pins to nodes and compute AAT, RAT and slack.

Unit 3
Introduction to transistor level circuit for flops, Negative and positive latch transistor level operation, Library setup time calculation, Clk-q delay calculation, Steps to create eye diagram for jitter analysis, Jitter extraction and accounting in setup timing analysis.

Unit 4
Setup analysis - graphical to textual representation, Hold analysis with real clocks, Hold analysis - graphical to textual representation, crosstalk.

Unit 5
On chip variation (OCV), Sources of variation – etching, Sources of variation - oxide thickness, Relationship between resistance, drain current and delay, OCV based setup timing analysis, Setup timing analysis after pessimism removal, OCV based hold timing analysis, Hold timing analysis after pessimism removal.

Text Books:
1. Michae John Sebastian Smith, "Application-Specific Integrated Circuits", Addison-Wesley, 2000

Reference Books:
2. Sung-Mo Kang & Yusuf Leblebici, CMOS Digital Integrated Circuits - Analysis &Design, , MGH, Third Ed., 2003
3. Jan M Rabaey, Digital Integrated Circuits - A Design Perspective, Prentice Hall, Second Edition, 2005.

Course Outcomes:
The students will be able to:
1. Perform timing analysis in digital circuits.
2. Develop timing models.
3. Optimize timing by employing circuit design techniques.
4. Perform crosstalk delay analysis.

Paper Code: MECE-205
Paper Name: Advanced Analog VLSI Design Lab

Course Objective:
The students of first year M.TECH (Microelectronics and VLSI Design) will be able to acquire knowledge on
1. Back end tools in the advanced design of VLSI circuits, design and implement digital circuits and analog circuits.

2. Complete knowledge on Cadence virtuoso environment
3. Details technique of Layout design and post layout simulation.
4. Details knowledge on Back annotation technique.

1. ASIC Design Experiments (shall be carried out using Mentor Graphics/Cadence Tools)

Backend Design Schematic Entry/ Simulation / Layout/ DRC/LVS/Post Layout Simulation of CMOS Inverter, NAND Gate, OR Gate, Flip Flops, Register Cell, Half Adder, Full Adder Circuits

2. Design and simulation of other analog amplifier circuits with complete layout (pre – post validation)
Common Source Amplifier with different Loads
A. Common Drain Amplifier
B. Single stage Cascode Amplifiers
C. Current Mirrors, Current Source and sink.
D. Differential Amplifiers with Different Loads
E. Design of Two stage Opamp

3. Mini Project:
A. Band gap Reference Voltage.
B. Level Shifter.

Course Outcomes:
The aim of this course student should be able to:
1. Describe the MOS devices and types of Single Stage Amplifiers.
2. Describe the types of Differential Amplifiers.
3. Describe the types of Current mirrors and Current sources.
4. Describe the working of Operational Amplifiers.

5. Demonstrate how to use the Differential Amplifiers in the different modes.
6. Describe the different types of Feedback circuits.
7. Describe the Frequency compensation Techniques.
8. Describe the A/D and D/A circuits by using the Operational Amplifiers.

Paper Name: Advanced Digital VLSI Design Lab Paper Code:MECE206

Course Objective:

The students of first year M.TECH (Microelectronics and VLSI Design) will be able to acquire knowledge on
• Advanced front end tools in the design of VLSI circuits and implement digital circuits and analog circuits.
• RTL synthesis and verification using Cadence Incisive environment
• Design a complete chip using full innovus/encounter implementation and floor planning.

Design, simulate and RTL analysis (Full flow) using Cadence Incisive, innovus/encounter environment of following design:
1. Combinational Logic: Address decoders, parity generator, ALU
2. Sequential Logic: Ripple Counters, Synchronous Counters, Shift Registers (serial-to-parallel, parallel-to-serial), Cyclic Encoder / Decoder.
3. Memories and State Machines: Read Only Memory (ROM), Random Access Memory (RAM), Mealy State Machine, Moore State Machine, Arithmetic Multipliers using FSMs

Course Outcome:
After completion of course Student should be able to:
• Describe the different VLSI Technologies
• Design the Digital circuits using Combinational and Sequential elements.

• Draw the Layouts of Logical Cells and other logics.
• Describe the different methodologies in System Design.
• Design the different types of Adders and Simple ALU.
• Describe and Design the different types of Memories like SRAM, DRAM etc..

Course Code: MECE-207
Course Name: Mini Project

Course Objectives:
To design a circuit, system, program for solving a practical problem. To learn literature survey. To write technical reports and learn technical presentation.

Syllabus Contents:
Mini Project will have mid semester presentation and end semester presentation. Mid semester presentation will include identification of the problem based on the literature review on the topic referring to latest literature available.
End semester presentation should be done along with the report on identification of topic for the work and the methodology adopted involving scientific research, collection and analysis of data, determining solutions highlighting individuals' contribution.
Continuous assessment of Mini Project at Mid Sem and End Sem will be monitored by the departmental committee.

Students can take up small problems in the field of circuit design as mini project. It can be related to solution to an engineering problem, verification and analysis of experimental data available, conducting experiments on various engineering subjects, material characterization, studying a software tool for the solution of an engineering problem etc.

Course Outcomes:
At the end of the course, the student will be able to:
1. Solve a live problem using software/analytical/computational tools.
3. Write technical reports.
4. Develop skills to present and defend their work in front of technically qualified audience.

Course Code: MECE 208A
Course Name: Constitution of India

Course Objectives:
To familiarize the students with the history, structure and salient features of the Constitution of India, and the basic structure, hierarchy of the Indian governance and administration.

Unit 1
History of Making of the Indian Constitution: History Drafting Committee, (Composition Working), Preamble, Salient Features.

Unit 2
Contours of Constitutional Rights & Duties: Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.
.
Unit 3
Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary,

Appointment and Transfer of Judges, Qualifications, Powers and Functions,

Unit 4
Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and

role of Elected Representative CEO of Municipal Corporation, Pachayati raj: Introduction, PRI: Zila Pachayat, Elected officials and their roles, CEO Zila Pachayat: Position and role, Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy

Unit 5
Election Commission: Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners, State Election Commission: Role and Functioning, Institute and Bodies for the welfare of SC/ST/OBC and women.

Course Outcomes:
After studying the course, the student will be able to
1. Learn about the growth of the demand for civil rights in India for the bulk of Indians in Indian politics.
2. Learn about the basic structure of the Constitution of India.
3. Learn about the Contours of Constitutional Rights & Duties.
4. Learn about the different Organs and Hierarchy of Governance and Local administration.

Text/Reference Books:
1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Course Code: MECE 208B
Course Name: Pedagogy Studies

Course objective:
Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers. To identify critical evidence gaps to guide the development

Unit I: Introduction and Methodology:
Aims and rationale, Policy background, Conceptual framework and terminology Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions. Overview of methodology and Searching.

Unit II: Thematic overview:
Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education

Unit III: Evidence on the effectiveness of pedagogical practices
Methodology for the in depth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change, Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.

Unit IV: Professional development: alignment with classroom practices and follows up support
Peer support, Support from the head teacher and the community, Curriculum and assessment, Barriers to learning: limited resources and large class sizes

Unit V: Research gaps and future directions
Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact

Course outcomes:
At the end of this course students will be able to understand

1. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

Text/Reference books:

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.

Course Code: MECE-208C
Course Name: Stress Management by Yoga

Course Objectives:
1. To achieve overall health of body and mind
2. To overcome stress

Unit - 1
Definitions of Eight parts of yog. (Ashtanga)

Unit – 2
Yam and Niyam.
Do's and Don't's in life.
i)Ahinsa, satya, astheya, bramhacharya and aparigraha
ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

Unit – 3
Asan and Pranayam
i)Various yog poses and their benefits for mind & body
ii) Regularization of breathing techniques and its effects-Types of pranayama

Course Outcomes:
Students will be able to:
1. Develop healthy mind in a healthy body thus improving social health also
2. Improve efficiency

Suggested reading
1. 'Yogic Asanas for Group Tarining-Part-I" : Janardan Swami Yogabhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

Course Code: MECE-208D
Course Name: Personality Development Through Life Enlightenment Skills

Course Objectives
- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

Syllabus Contents
Unit 1: Neetisatakam-Holistic development of personality

• Verses- 19,20,21,22 (wisdom)
• Verses- 29,31,32 (pride & heroism)
• Verses- 26,28,63,65 (virtue)
• Verses- 52,53,59 (dont's)
• Verses- 71,73,75,78 (do's)
Unit 2: Approach to day to day work and duties
• Shrimad Bhagwad Geeta : Chapter 2-Verses 41, 47,48,
• Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,
• Chapter 18-Verses 45, 46, 48.
Unit 3: Statements of basic knowledge
• Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68
• Chapter 12 -Verses 13, 14, 15, 16,17, 18
• Personality of Role model. Shrimad Bhagwad Geeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42,
• Chapter 4-Verses 18, 38,39
• Chapter18 – Verses 37, 38, 63
Course Outcomes
Students will be able to
- Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and mankind to peace and prosperity
- Study of Neetishatakam will help in developing versatile personality of students.

Suggested Readings
1. "Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata
2. "Bhartrihari's Three Satakam (Niti-sringar-vairagya)" by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.

Semester – 3

Course Code: MECE-301A
Course Name: Hardware Description Language Credit - 3

Course Objectives:
To learn basics of HDL, syntax of VHDL language. To learn different hardware modeling styles, to write VHDL codes. To design memory, hardware blocks, ALU, and microcontroller.

UNIT-I:
INTRODUCTION TO VHDL: VHDL description, combinational, networks, modeling flip flop using VHDL, VHDL model for multiplexer, compliance and simulation of VHDL, codes, modeling a sequential machine, variables, signals and constants, arrays VHDL operators, VHDL functions, VHDL procedures, packages and libraries, VHDL model for a counter.
ADVANCED VHDL: Attributes, transport and inertial delays, operator over loading, multi valued logic and signal resolution, IEEE-1164, standard logic, generic, generates statements, synthesis of VHDL codes, synthesis examples, file handling and TEXTIO.

UNIT-II:
DESIGN OF NETWORKS FOR ARITHMATIC OPERATIONS: Design of serial adder with accumulator, state graph for control networks design of binary multiplier, multiplication of signed binary numbers design of binary divider.
DIGITAL DESIGN WITH SM CHART: state machine charts, derivation of SM charts, realization of SM charts, implementation of dice game, alternative realization of SM charts using microprogramming, linked state machine.

UNIT-III:
FLOATING POINT ARITHMETIC: Representation of floating point numbers, floating point multiplication and other floating point operations.
DESIGNING WITH PROGRAMMABLE GATE ARRAYS AND COMPLEX PROGRAMMABLE LOGIC DEVICES: Xinx 3000 series FPGAs, Xinx 4000 series FPGAs, using one hot state assignment.

UNIT-IV:
MEMORY MODELS FOR MEMORIES AND BUSES: Static RAM, a simplified 486 bus model, interfacing memory to microprocessor bus.

UNIT-V:
DESIGN EXAMPLES: UART design, description of MC68HC05 microcontroller, and design of micro-controller CPU, complete microcontroller design.

TEXT BOOKS:
1. J. Bhaskar, “ A VHDL Primer”, Addison Wesley, 1999.
2. C. H. Roth, “Digital System Design using VHDL”, PWS Publishing, 2003.
REFERENCES BOOKS:
1. M. Ercegovac, T. Lang and L.J. Moreno, ”Introduction to Digital Systems”, Wiley,2000
2. J.F. Wakerly, “Digital Design-Principles and Practices”, PHL, 2000.
3. Douglas Perry, “VHDL”, MGH, 2000.
4. Michae John Sebastian Smith, “Application-Specific Integrated Circuits”, Addison-Wesley, 2000.
5. Z. Navabi, “ VHDL-Analysis and Modeling of Digital Systems”, MGH, 2000.
6. Peter J. Ashenden, Designers guide to VHDL, Morgan Kaufman Publishers.

Course Outcomes:
Students will be able to:
1. Write VHDL programs for digital logic circuits.
2. Design hardware blocks using different modeling styles.

3. Write testbench programs and simulate the codes.
4. Design memory and bus architecture.
5. Design ALU, MPU, and MC.

Course Code: MECE-301B
Course Code: CAD for VLSI Design

Course Objectives:
To learn the fundamentals of Computer-Aided Design (CAD) tools for the design, analysis, synthesis, test, verification, routing and placement of digital Very Large Scale Integration (VLSI) systems.

Unit 1
Introduction to VLSI Design methodologies - Review of Data structures and algorithms - Review of VLSI Design automation tools - Algorithmic Graph Theory and Computational Complexity - Tractable and Intractable problems - general purpose methods for combinatorial optimization.

Unit 2
DESIGN RULES Layout Compaction - Design rules - problem formulation - algorithms for constraint graph compaction.

Unit 3
Placement and partitioning - Circuit representation - Placement algorithms - partitioning FLOOR PLANNING Floor planning concepts - shape functions and floorplan sizing.

Unit 4
Routing, Types of local routing problems - Area routing - channel routing - global routing - algorithms for global routing.

Unit 5
Simulation - Gate-level modeling and simulation - Switch-level modeling and simulation - Combinational Logic Synthesis - Binary Decision Diagrams - Two Level Logic Synthesis. MODELING AND SYNTHESIS High level Synthesis - Hardware models - Internal representation - Allocation - assignment and scheduling - Simple scheduling algorithm - Assignment problem - High level transformations.

Text Books:
1. N.A. Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwer Academic Publishers, 2002
2.S.H. Gerez, "Algorithms for VLSI Design Automation", John Wiley & Sons, 2002.

Course Outcomes:
At the end of this course, students will be able to
1. Fundamentals of CAD tools for modelling, design, test and verification of VLSI systems.
2. Study of various phases of CAD, including simulation, physical design, test andverification.
3. Demonstrate knowledge of computational algorithms and tools for CAD.

Course code: MECE-301C
Course name: Advanced Digital Architecture

Course outcomes:
1. Provide the student with the fundamentals of digital system architecture.
2. To understand Digital Signal Processor properly and why it is preferred over other processor.
3. To understand the Datapath system design of any processor and array system design.

Unit-1
Fundamentals: Components of (an embedded) computer, Architecture organization, Von- Neumann vs Harvard, RISC and CISC architecture, basic structure, pipelining, pipeline hazards and solutions, comparison, merging RISC and CISC.

Unit-2
DSP Architecture: Basic processor structure, basic processor functions, DSP implementation, functional characteristics, operation, DSP Arithmetic logic unit, register structure, memory addressing, memory architecture for DSP (Harvard and Von Neumann), DSP Generations, DSP Application, General processor Vs DSP.

Unit-3
Digital system design: Structure Design, Strategy, Hierarchy, Regularity, Modularity, Locality. System on Chip Design options: Programmable logic and structures, Programmable interconnect, programmable gate arrays, Programmable Logic Design, Register, Counter.

Unit-4
Data Path Sub System Design : Introduction, Addition, Subtraction, Comparators, Counters, shifters, Multiplication, Parallel Prefix computations. Datapath logic, arithmetic-logic unit, datapath representation, control logic, control word, simple computer architecture, instruction formats, instruction decoder, basic operation cycle, operand addressing, addressing modes, instruction set architectures,.

Unit-5
Array Subsystem Design: SRAM, RAM arrays, DRAM, Read only memory(ROM), Content Addressable memory(CAM), Programmable logic arrays. Control Unit Design : Finite State Machine (FSM) Design, Control Logic Implementation: PLA control implementation, ROM control implementation, FPGA.

Course outcomes:
At the end of this course students will demonstrate the ability to
1. Design and analyze different digital system architecture.
2. Understand the FPGA architecture and FPGA Implementation of different circuits.

Textbook:
1. Morris Mano, Charles R. Kime, Tom Martin, “Logic and Computer Design Fundamentals”, Pearson.

References:
1. Stephen Brown &ZvonkVranesic, “Fundamentals of digital logic with VHDL design”, TMH.
2. Charles H. Roth Jr, “Fundamentals of logic design”, Thomson Learning.
3. Donald G. Givone, “Digital principles and design”, TMH.
4. Thomas L. Floyd, Digital fundamentals”, Prentice Hall.
5. Neil H.E. Weste, Davir Harris, “CMOS VLSI Design: A Circuits and system perspectives” Pearson Education 3rd Edition.

Course Code: MECE 302A
Course name: Microwave Integrate Circuits

Course Objectives:
To familiarize the students with the advanced topics of monolithic microwave integrated circuits, its applications and to equip them with comprehensive abilities to design and analyze various microstrip transmission lines, slot lines, and microwave integrated circuits.

Unit 1
Introduction to Monolithic Microwave Integrated Circuits (MMICs), their advantages over discrete circuits, MMIC fabrication techniques, MIC applications, Thick and Thin film technologies and materials, encapsulation and mounting of active devices. Microstrips on semiconductor substrates.

Unit 2
Planar Transmission Lines and Lumped Elements for MICs: Fundamentals of the theory of transmission lines, Foundations of Microstrip lines, Striplines, Higher modes in microstrips and striplines, Slotlines, Coplanar waveguides, Coplanar strips; Launching Techniques: Coaxial line to microstrip transition, Rectangular waveguide to microstrip transition, microstrip to slot-line transition, microstrip to coplanar waveguide (CPW) transition; Discontinuities and Bends: T-junction, series gaps, Bends, 4-Port Network Design: Couplers

Unit 3
Low noise microwave amplifiers and oscillators – masers – stimulated emission, noise figure, parametric amplifiers – Manley Rowe relations, up, down and negative resistance parametric amplifier.

Unit 4
Nonlinear RF Circuits: Introduction; Power Gain Relations; Simultaneous conjugate Matching; Stability Considerations; Power gain for matched, unmatched, unilateral conditions; Noise characterization and design options; Switches: Pin Diode switches, FET switches, MEMS switches

Unit 5
MIC Measurement, Testing and Applications: MIC measurement system, measurement techniques – S parameter measurement, noise measurement.

Course Outcomes:
After studying the course, the student will be able to
1. Comprehend the monolithic microwave integrated circuits, its applications, advantages over discrete circuit.
2. Analyze the microstrip transmission lines and slot lines. .
3. Analyze the functionality of various microwave integrated circuits.
4. Design and analyze Low noise microwave amplifiers and oscillators.
5. Design and analyze non-linear RF circuits.
6. Evaluate the performance of microwave integrated circuits by using different measurements and testing techniques.

Text Books:
1. Microwave Integrated circuit, K. C. Gupta.
2. Microwave Devices & Circuits 3/e, Samuel Y. Liao.
3. Microstrip lines and Slot lines, K.C. Gupta, R. Garg. , I. Bahl, P. Bhartia, Artech House, Boston, 1996.
4. Microwave Integrated Circuits, By Ivan Kneppo, J. Fabian, P. Bezousek

Reference books:
1. Fooks, E.H. and Zakarevicius, R.A., “Microwave Engineering Using Microstrip Circuits,” Prentice-Hall, 1990.
2. Franco di Paolo, “Networks and Devices using Planar Transmission Lines,” CRC Press. 2000.
3. Pozar, D.M., “Microwave Engineering”, 3rd Ed., John Wiley & Sons, 2004..
4. Roberto Sorrentino and Giovanni Bianchi, “Mirowave and RF Engineering” John Wiley & Sons, 2010.
5. Ludwig, R. and Bretchko, P., “RF Circuit Design”, Pearson Education, 2000.
6. Misra, D.K., “Radio-frequency and Microwave Communication Circuits”, John Wiley & Sons, 2001.
7. Rajeshwari Chatterji: Microwave, Millimeter wave and sub-millimeter wave vacuum electron devices, Affiliated East - West Press, 1994
8. R E Collin: Foundations for Microwave Engineering, Second Ed, IEEE-Wiley, 2000
9. Stripline-like Transmission lines for Microwave Integrated circuits, B. Bhat, S. K. Koul, Wiley Eastern Ltd., New Delhi.

Course Code: MECE-302B
Course Name: BIOMEDICAL INSTRUMENTATION

Course Objective:
- To make the student understand biomedical signals and their importance in diagnosis of diseases
- To understand how electronic devices and circuits are used for acquisition and monitoring of biomedical signals
- To make the student aware of various electronic instruments used in medical field

Unit 1
Sources of Biomedical Signals, Basic medical Instrumentation system, Performance requirements of medical Instrumentation system, use of microprocessors in medical instruments, PC based medical Instruments, general constraints in design of medical Instrumentation system & Regulation of Medical devices.

Unit 2
Origin of Bioelectric Signals, Electrocardiogram, Electroencephalogram, Electromyogram, Electrode-Tissue Interface, Polarization, Skin Contact Impedance, Motion Artifacts.Electrodes for ECG, Electrodes for EEG, Electrodes for EMG.

Unit 3
Introduction to Transducers, Classification of Transducers, Performance characteristics of Transducers, Biosensors, Basic Recording systems, General considerations for Signal conditioners, Preamplifiers, Differential Amplifier, Isolation Amplifier, Electrostatic and Electromagnetic Coupling to AC Signals, Proper Grounding (Common Impedance Coupling)

Unit 4
Patient monitoring systems, arrhythmia and ambulatory monitoring instruments, biomedical telemetry, telemedicine technology, audiometers and hearing aids, patient safety. Modern imaging systems

Unit 5
Blood flow, and cardiac output measurement, blood gas analyzers, blood cell counters, foetal monitoring system, oximeters.

Course Outcome:
At the end of the course, students will demonstrate the ability to:
- Understand the application of the electronic systems in biological and medical applications.
- Understand the practical limitations on the electronic components while handling biosubstances.
- Understand and analyze the biological processes like other electronic processes.

References:
1. Handbook of biomedical instrumentation – MGH – R S Khandpur.
2. W.F. Ganong, Review of Medical Physiology, 8th Asian Ed, Medical Publishers, 1977.
3. J.G. Websster, ed., Medical Instrumentation, Houghton Mifflin, 1978.
4. A.M. Cook and J.G. Webster, eds., Therapeutic Medical Devices, Prentice-Hall, 1982.

Course Code: MECE-302C
Course Name: BIOMEDICAL SIGNAL PROCESSING

Course Objective:
- To familiarize student with the bio-signals and their importance in medical science.
- To make them understand how bio-signals are acquired and then processed.
- To make them understand how digital signal processing techniques are for processing of bio-signals.

Unit-1
Acquisition, Generation of Bio-signals, Origin of Bio-signals, Types of Bio-signals, Study of diagnostically significant Bio-signal parameters.

Unit-2
Electrodes for bio-physiological sensing and conditioning, Electrode-elctrolyte interface, Polarization, electrode-skin interface and motion artefacts, Biomaterial used for electrode, Types of electrodes, Practical aspects of using electrodes, Acquisition of bio-signals (signal conditioning) and Signal conversion (ADC & DAC) processing, Digital filtering.

Unit-3
Biomedical signal processing by Fourier analysis, Biomedical signal processing by wavelet (time-frequency) analysis, Analysis (Computation of signal parameters that are diagnostically significant)

Unit-4
Classification of signal and noise, Spectral analysis of deterministic, stationary random signals and non-stationary signals, Coherent treatment of various biomedical signal processing methods and appications.

Unit-5
Principal component analysis, Correlation and regression, Analysis of chaotic signals, Application areas of biosignals analysis, Multiresolution analysis (MRA) and wavelets, PCA, Independent component analysis (ICA)

Course Outcome:
At the end of this course, student will be able to
- Understand different types of biomedical signals
- Identify and analyse different biomedical signals
- Find application related to biomedical signal processing

References:

1. Biomedical signal processing – Academic Press, MetinAkay.
2. Advanced Methods of Biomedical SignalProcessing, Wiely, SergioCerutti, CarloMarchesi.
3. Biomedical signal processing- D. C. Reddy, McGraw Hill 2005
4. Biomedical Digital Signal Processing- W. J. Tompkins, Pentice Hall, 1993

Course Code: MECE-303
Course Name: DISSERTATION PHASE –I

Course Objective:
A dissertation allows students present their findings in response to a question or proposition that they choose themselves. The aim of the project is to test the independent research skills students have acquired during their time at university/college.

Content:
The project work will start in semester III and should preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution. The candidate has to be in regular contact with his guide from the department and the topic of dissertation must bemutually decided by the guide and student

Course Outcomes:
At the end of this course,
- Students will be exposed to self-learning various topics.
- Students will learn to survey the literature such as books, national/international refereedjournals and contact resource persons for the selected topic of research.
- Students will learn to write technical reports.
- Students will develop oral and written communication skills to present and defend theirwork in front of technically qualified audience.

Semester – 4

Course Code: MECE-401
Course Name: DISSERTATION PHASE -II

Course Objective:
A dissertation allows students present their findings in response to a question or proposition that they choose themselves. The aim of the project is to test the independent research skills students have acquired during their time at university/college.

Content:
It is a continuation of Project work started in semester III. He has to submit the report in prescribed format and also present a seminar. The dissertation should be presented in standard format as provided by the department. The candidate has to prepare a detailed project report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) of solution and results and discussion. The report must bring out the conclusions of the work and future scope for the study.

Course Outcomes
At the end of this course,
- Students will be able to use different experimental techniques.
- Students will be able to use different software/ computational/analytical tools.
- Students will be able to design and develop an experimental set up/ equipment/test rig.
- Students will be able to conduct tests on existing set ups/equipment and draw logical conclusions from the results after analyzing them.
- Students will be able to either work in a research environment or in an industrial environment.
- Students will be conversant with technical report writing.
- Students will be able to present and convince their topic of study to the engineering community.

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