SCHOOL OF ENGINEERING

DEPARTMENT OF ECE

B.Tech Electronics Engineering (VLSI Design and Technology)

THIRD SEMESTER

VDT2104 Data Structures and Algorithms [3 0 0 3]

Syllabus:

Introduction to C++/Python: An overview of C++/Python programming language, basic terms and operations. Linked List: Representing the linked list in memory with traversing and searching a linked list. Stack, Queues and Recursion: Array/ Linked representation of stack and queues with its applications. Trees: Tree Definitions, Type of Trees, Traversal Algorithms, Heaps and Priority Queues: Heaps, the Natural Mapping, Insertion into a Heap, Removal from a Heap, Path length: Huffman's algorithm. Sorting and Searching: Various sorting algorithms, Searching and data modification, Hashing. Graphs: Types of Graphs, Adjacency and Incidence Matrix for a Graph, Adjacency List for a Graph, Dijkstra's Algorithm, Graph Traversal Algorithms. Analysis of algorithm: Synergy between data structures and algorithm, Factors to be considered in the choice of data structures and algorithms.

References:

1. Yashavant Kanetkar, *Data Structures Through C++,* BPB Publications, 2023.
2. Adam Drozdek, *Data Structures and Algorithms in C++,* Cengage Learning, 2012.
3. David M. Reed , John Zelle, *Data Structures and Algorithms using Python and C++,* 1e, illustrated Edition, Shroff/Franklin, Beedle & Associates, 2024.
4. Roberto Tamassia , Michael H. Goldwasser, Michael T. Goodrich, *Data Structures and Algorithms in Python*, Wiley, 1(e) 2013.
5. E. Balagurusamy, *Object Oriented Programming with C++,* McGraw Hill, 2020.
6. Mark Allen Weiss*, Data Structures and Algorithm Analysis in C++,* University Paperback, Pearson, 2014.

VDT2105 Digital Electronics [3 0 0 3]

Syllabus:

Introduction of Combinational logic design: Overview of Boolean Algebra and K-Map, Half and Full Adders, Subtractors, Serial and Parallel Adders, BCD Adder. MSI devices: Comparators, Multiplexers, Encoder, Decoder, Driver & Multiplexed Display, Barrel shifter and ALU. Sequential logic design: latch, Flip-flop, S-R FF, D FF, JK FF, T FF, and Master-Slave JK FF, Edge triggered FF, Ripple and Synchronous counters, Shift registers, Timing Analysis of sequential circuits. Designing of State Machines: Finite state machines, Design of synchronous FSM, State Reduction, Timing issues in synchronous circuits. Algorithmic State Machines, Designing synchronous circuits like Pulse train generator, Pseudorandom Binary Sequence generator, Clock generation. Design of asynchronous circuits. Logic Families and Semiconductor Memories: TTL NAND gate, Specifications, Noise margin, Propagation delay, fan-in, fan-out, Tristate TTL, ECL, CMOS families and their interfacing, Memory elements, Concept of Programmable logic devices, Logic implementation using Programmable Devices.

References:

1. A. Kumar, *Fundamentals Of Digital Circuits*, Prentice Hall India Pvt., Limited, (2e), 2016.
2. R. P. Jain, *Modern Digital Electronics*, McGraw-Hill Education (India) Pvt Limited, (4e), 2009.
3. W.H. Gothmann, *Digital Electronics- An introduction to theory and practice*, PHI, (2e), 2006.
4. S. Brown and Z. Vranesic, *Fundamentals of Digital logic with Verilog Design*, McGraw Hill, (3e) 2013.

VDT2106 Electronic Devices & Circuits [3 0 0 3]

Syllabus:

Semiconductor Diodes: Semiconductor materials, energy levels. PN diode: equivalent circuits, capacitance, reverse recovery time. Zener diode, Light Emitting diode, Tunnel diode. Diode Circuits: Load–line, rectifier, clippers, clampers, voltage regulators. BJT: Introduction, Common-base, common-collector and common-emitter configuration & characteristic, Transistor Amplifying action, Emitter follower configuration. BJT biasing: operating point, Voltage divider bias configuration, bias stabilization. AC analysis: BJT model at low and high frequency, gains and resistances. FET: JFET-construction, operation and characteristics. MOSFET: structure and operation, IV Characteristics, Biasing in MOS Amplifier Circuits, DC analysis of MOSFET Circuits, Small Signal Operation and Models, Common Source (CS) amplifier, CS amplifier with degenerate source, Depletion-Type MOSFET. MOSFET scaling, short channel effects. FinFET: construction, operation and characteristics, subthreshold conduction. Multi-stage amplifiers and Frequency Analysis: RC coupling, frequency analysis of amplifiers, Miller effect capacitance. Feedback: Types of feedback, amplifiers with feedback. Oscillators, Barkhausen criteria, RC Phase shift oscillators, Crystal oscillators.

References:

1. Millman & Halkias, *Integrated Electronics*, McGraw Hill Publications, 2008.
2. Boylestad & Nashlesky, *Electronic Devices & Circuit Theory*, PHI,10(e)
3. Albert Malvino & David J. Bates, *Electronic Principles,* Tata McGraw Hill, 7(e), 2007.
4. Floyd, Thomas L., and David Buchla. Electronics fundamentals: circuits, devices & *applications*. Prentice Hall Press, 2009.
5. Sedra & Smith, *Microelectronic Circuits*, Oxford University Press, 5(e), 2004.
6. Streetman, Ben G., and Sanjay Banerjee. *Solid state electronic devices*. Vol. 4. New Jersey: Prentice hall, 2000.
7.

VDT2107 Circuits & Systems [3 0 0 3]

Syllabus:

Basic Circuit Elements and Laws: Voltage, current, power, energy, Ohm’s law, KVL, KCL, Source transformation, Nodal and mesh analysis. Network Theorems: Superposition theorem, Thevenin’s and Norton’s theorems, Maximum power transfer theorem, Application to DC and AC circuits. Transient Analysis: First-order circuits (RL, RC): step, impulse, and sinusoidal inputs, Second-order circuits (RLC): underdamped, overdamped, critically damped response, Initial and final conditions. Sinusoidal Steady-State Analysis: Phasor representation, Power in AC circuits: instantaneous, average, and complex power, Resonance in series and parallel circuits. Laplace Transform and Its Applications: Laplace transform fundamentals, Inverse Laplace and partial fraction, Application to circuit analysis, Transfer function of circuits, System response using Laplace. Two-Port Networks: Z, Y, h, and T parameters, Interconnection of two-port networks.

References:

1. Charles K. Alexander, Matthew N. O. Sadiku, *Fundamentals of Electric Circuits*, 6(e), McGraw-Hill Education.
2. William H. Hayt Jr., Jack E. Kemmerly, Steven M. Durbin, *Engineering Circuit Analysis,* 8(e), McGraw-Hill Education
3. A. Chakraborty, *Circuit Theory: Analysis and Synthesis*, Latest Edition, Dhanpat Rai & Co.
4. D. Roy Choudhury, *Networks and Systems*, 2(e)] New Age International
5. Van Valkenburg, M.E., *Network Analysis*, 3(e) PHI Learning Pvt. Ltd.
6. Kuo, Franklin. Network analysis and synthesis. John Wiley & Sons, 2006.

ECE2108 Computer Architecture & Processor [3 0 0 3]

Syllabus:

Computer Architecture: Introduction, computer types, functional units, Von Neumann and Harvard architectures, RISC and CISC Architectures. Register Transfer and Microoperations, microprogrammed control Design of Basic Computer, Design of Accumulator Logic, Control unit design, Parallel Processing, Pipelining, Input-Output Organization, Memory Organization. 8086 Microprocessor: 8086 Architecture, 8086 Instruction Set: types of instructions and addressing modes, assembler and assembler directives, assembly language programming. RISC V: Introduction to the Reduced Instruction Set Computer, RISC V architecture and features.

References:

1. M. Morris Mano, Computer System Architecture, 3 (e), Pearson, 2008.
2. K. M . Bhurchandi, and A K Ray, Advanced Microprocessors and Peripheral Devices, 3 (e), McGraw Hill, 2018.
3. David A. Patterson, and John L. Hennessy, Computer Organization and Design, The Hardware/Software Interface: RISC-V Edition, Morgan Kaufmann, 2018.
4. Sonal Yadav, Computer System Organization, 1 (e), All India Council for Technical Education, 2024.
5. V.C. Hamacher, Z. Vranesic and S. Zaky, Computer Organization, 5(e), McGraw Hill, 2002.

VDT2132 Data Structures and Algorithms Lab [0 0 2 1]

Syllabus:

This laboratory course is designed to provide students with hands-on experience in implementing core data structures and algorithms using the C++/python programming language. It reinforces the theoretical knowledge gained in lectures by allowing students to apply data structures in solving real-world computational problems. Through various experiments, students will develop the ability to choose and implement appropriate data structures and understand their internal mechanisms. The course also familiarizes students with advanced concepts such as trees, heaps, graphs, and algorithm analysis, thereby laying a strong foundation for software development and competitive programming.

VDT2133 Digital Electronics Lab [0 0 2 1]

Syllabus:

Experiments of this lab are implemented at Hardware as well as software level. List of experiments include study of implementation of combinational and arithmetic circuits using logic gates and MSI chips, designing of sequential circuits and implementation of FSMs for their applications.

VDT2134 Electronics Devices & Circuits Lab [0 0 2 1]

Syllabus:

Experiments are carried out on hardware and software to analyze the characteristics of semiconductor devices like diodes, transistors and MOSFET. Circuits based on these devices are studied for various device and circuit parameters on hardware as well as software.

FOURTH SEMESTER

VDT2203 Analog Integrated Circuits [3 0 0 3]

Syllabus:

Differential Amplifiers: Need of differential amplifiers, basic differential pair- qualitative and quantitative analysis, Current mirror. Operational Amplifiers: Introduction, voltage transfer characteristics, op-amp parameters, open loop configurations. Op-amp with negative feedback, Inverting & Non-inverting voltage amplifiers. Linear op-amp applications: Voltage follower, DC and AC amplifiers; summing, scaling and averaging amplifiers; integrator, Differentiator; Voltage to current converter. Non-linear applications: Filters, Precision Rectifiers, OTA, comparators, Schmitt trigger. Oscillator, triangular, sawtooth and square waveform generator. Digital-to-Analog Conversion: specifications, Weighted Resistor,R-2R Ladder, Monolithic DAC. Analog-to-Digital conversion: specifications, Ramp Type, Successive Approximation, Dual Slope, Flash Type, Monolithic ADC. Timer IC555: circuit and working, 555 as monostable and astable multivibrator. Voltage regulators: Linear Voltage Regulators, IC Regulators, Switching Regulators. Phase locked loop: Operation of basic PLL, Closed loop analysis of PLL, Voltage Controlled Oscillator, PLL applications, IC 565.

References:

1. Roy Choudhury and Shail Jain, *Linear Integrated Circuits,* 2 (e), New Age International Publishers, 2003.
2. S.Salivahanan and V.S. Kanchana Bhaaskaran, *Linear Integrated Circuits*, 6 (e), Tata McGraw-Hill, 2011.
3. Ramakant A.Gayakwad, *Op-Amps and Linear Integrated Circuits*, 4 (e), Prentice Hall, 2000.
4. Robert F. Coughlin, Frederick F. Driscoll, *Operational-Amplifiers and Linear Integrated Circuits*, 6 (e), Prentice Hall, 2001.
5. Sergio Franco, *Design with operational amplifier and analog integrated circuits*, McGraw Hill, 1997
6. Behzad Razavi, *Analog CMOS Integrated circuits*, McGraw-Hill, 2017.

VDT2204 System Design using HDL [3 0 0 3]

Syllabus:

Introduction to Verilog HDL, Hardware Simulation & Synthesis, Design Abstraction Levels: Switch-level, Gate-level, Dataflow, Behavioral modeling. Dataflow, Top-Down design with Verilog, Subprograms, Operators, Syntax and constraints, Delays. Characterization of HDL: Timing Analysis, concurrency, data types, nets, Verilog primitives. Modelling of Test Bench. Combinational and Sequential Design, task and functions. Usage of subprograms, parametrization and specifications, path delay specification. Modelling for State Machines. Interface design & Modelling.

References:

1. K. S. Kundert and O. Zinke, The Designer's Guide to Verilog-AMS. Springer, (1e) 2004.
2. S. Palnitkar, Verilog HDL, (2e), Pearson education, 2003.
3. J. Bhasker, A Verilog HDL Primer, Star Galaxy Pub., (3e), 2005.
4. S. Brown and Z. Vranesic, Fundamentals of Digital logic with Verilog Design, McGraw Hill, (3e) 2013.

5. M. Morris Mano, Michael D. Ciletti, Digital Design: With an introduction to Verilog HDL, Pearson, (6e), 2017.

VDT2205 Digital Signal Processing [3 0 0 3]

Syllabus:

Review of signals and systems: Time and frequency analysis. Transform Analysis of LTI Systems: The frequency Response of LTI systems, Inverse system, All- Pass system, Minimum Phase system, Linear systems with Generalized Linear Phase. Frequency domain sampling and reconstruction of discrete time signals: Discrete-Time Processing of continuous-time Signals, Continuous- Time Processing of Discrete-Time Signals, Changing the Sampling Rate Using Discrete-Time Processing. Discrete Fourier transform: Introduction, properties of the DFT, use of DFT in linear filtering, filtering of long data sequences, DFT as linear transformation, Computation of DFT, Decimation-in- Time and Decimation–in–frequency Algorithms. Implementation of discrete time systems: Structures for FIR systems – Direct form, cascade form, Frequency sampling and lattice structures. Structures for IIR systems – Direct form, cascade and parallel form. Design of IIR filters and digital FIR filters: Classical design by impulse invariance, bilinear transformation and matched Z- transform, characteristics and design of commonly used filters – Butterworth. Chebyshev, elliptical.

References:

1. A.V. Oppenheim & R.W. Schafer, *Discrete-Time Signal Processing,* (2e), Pearson education, 2001.
2. S. Salivahanan, C. Gnanpriya, *Digital Signal Processing*, (2e), Tata McGraw-Hill Education, 2011.
3. J.G. Proakis, D.G. Manolakis, D. Mimitris, *Introduction to Digital Signal Processing- Principles, Algorithms and Applications*, (3e), Prentice Hall, India 2007.
4. Sanjit K. Mitra, *Digital Signal Processing- A Computer Based Approach*, (4e), Mc Graw Hill Education, 2013.
5. L.R. Rabiner & D.J. Gold, *Theory and applications of digital signal processing*, (3e), Prentice Hall, India, 2007.

VDT2206 Electromagnetic Field Theory [3 0 0 3]

Syllabus:

Coordinate systems and transformation, Vector fields–Gradient, Divergence, Curl–theorems and applications. Electrostatic Field: Coulomb’s Law, Electric field intensity, flux density. Electric field due to various charge configurations, Potential functions and displacement vectors, Gauss ‘s law, Laplace’s and Poisson’s equations, Uniqueness theorem, Continuity equation, Capacitances, Energy density in an electric field, Boundary conditions. Magnetostatic Field: Magnetic field intensity, flux density and magnetization, Biot- savart law, Ampere’s circuit law, Magnetic static and Vector potential, Energy stored in Magnetic field and boundary conditions. Electromagnetic fields: Analogy between electric and magnetic field, Field mapping and concept of field cells, Time varying fields, Displacement current, Maxwell’s equations. Electromagnetic Waves: Uniform Plane Wave in free space, dielectrics and conductors, skin depth, Plane wave reflection and refraction, Standing Wave ratio, Radiation, EMI and EMC.

References:

1. Mathew N.O. Sadiku, Elements of Electromagnetics, (4e), Oxford university press,2007 .
2. W. H. Hayt & J.A. Buck, *Engineering Electromagnetics*, (7e), TMH, 2005
3. J. D. Krause, *Electromagnetic with application,* (5e), TMH, 2010.
4. A.V.Bakshi, U.A.Bakshi, *Electromagnetic Field Theory*, (1e) , Technical Publications, 2020.
5. N.N. Rao, *Elements of Engineering Electromagnetic,* (6e), Pearson Education, 2006.
6. Edminister, *Theory and problems of Electromagnetic,* (2e), TMH, 2016

VDT2232 Integrated Circuits Lab [0 0 2 1]

Syllabus:

Experiments of this lab are implemented at hardware as well as software level based on op-amp 741 and timer IC 555. Opamp will be used for measurement of parameters and implementing circuits for linear and non-linear applications. Circuits will be implemented using Timer IC.

VDT2233 System Design using HDL Lab [0 0 2 1]

Syllabus:

The objective of this lab is to equip students with practical skills in designing, modelling, and verifying digital systems using Verilog Hardware Description Language (HDL). Through hands-on experiments, students will learn to implement combinational and sequential circuits employing various modelling styles such as gate-level, dataflow, and behavioural. The lab also aims to develop proficiency in creating modular, parameterized designs and writing effective testbenches for functional verification.

VDT2234 Digital Signal Processing Lab [0 0 2 1]

Syllabus:

Experiments of this lab are implemented using MATLAB software. The list of experiments includes : Time domain and Frequency Domain Analysis of signals and systems, Analysis in z-domain, Filter Design, Filter Implementation.

VDT2271 Project Based Learning - 1 [0 0 6 3]

Syllabus:

Based on identification of a research problem/latest innovation, literature review, planning and designing of the solution. Evaluation will be based on report/draft and presentation.

FIFTH SEMESTER

VDT3105 Semiconductor Device Fabrication [3 0 0 3]

Syllabus:

Introduction to semiconductor: Overview of semiconductors: intrinsic and extrinsic materials, Crystal structures and properties of silicon and compound semiconductors, defects in crystal, cleanroom substrates processing technology. Thermal oxidation, RTP and furnaces, laser and spike processing. Doping and implantation. Lithography: Fundamentals of lithography: masks, resist materials, and exposure techniques, contrast, process, photoresist, direct write, EBL, proximity, etc. Oxidation and diffusion: ion implantation. Basics of thin film deposition, PVD (sputtering, evaporation), Epitaxial growth, LPCVD, PECVD, crystallization/recrystallization. Wet etching, Dry etching, Metallization and wire bonding. Device isolation and packaging, Device technology (CMOS, GaAs FET, silicon photonics) Integrated circuit manufacturing (yield, DOE, SPC, etc). Electrical characterization of devices: I-V and C-V measurements, Techniques for analyzing device performance and defects, Reliability testing.

References:

1. S. M. Sze and Kwok K. Ng, *Physics of Semiconductor Devices*, 4 (e), Wiley,2021.
2. Stephen Campbell, *The Science and Engineering of Microelectronic Fabrication*, Oxford University Press , 2th Ed, Oxford University Press, USA (2001).
3. Sorab K. Ghandhi, *VLSI Fabrication Principles: Silicon and Gallium Arsenide*, 1 (e), Wiley, 1994.
4. Gary S. May and Simon M. Sze, *Fundamentals of Semiconductor Fabrication*, 1 (e)Wiley, 2012.

VDT3106 Analog and Digital Communication [3 0 0 3]

Syllabus:

Introduction: Historical perspective and standards, elements of communications systems, signals & spectra, transmission media. Analog Communication: Linear & exponential continuous wave modulation, transmitters and receivers, frequency conversion & demodulation. Digital Communication: Baseband digital transmission, sampling, quantization & pulse modulation, digitization techniques for analog messages, Bandpass digital transmission, concept and analysis of PCM, DPCM, DM and ADM, M-ary modulation. Noise: Review of probability theory, random variables, random processes. Random signals & noise, performance evaluation of communication systems corrupted by noise. Case study: FM radio broadcasting.

References:

1 Bruce Carlson, Paul B. Crilly, Janet C. Rutledge, *Communication Systems*, 4(e), Mc Graw Hill, 2002.
2 Behrouz A. Forouzan, *Data Communications and Networking*, 5(e), McGraw-Hill, 2013.
3 Simon Haykin and and Michael Moher, *Communication Systems*, (4e), John Wiley, 2009.
4 B. P. Lathi & Z. Ding, *Modern Digital and Analog Communication Systems*, Oxford, 2010.
5 Herbert Taub, Donald L. Schilling, and Goutam Saha, *Principles of Communication Systems*, (3e), McGraw Hill, 2008.

VDT3107 Digital VLSI Design [3 0 0 3]

Syllabus:

Introduction: VLSI technology trends, VLSI Design flow and Design Styles. MOS devices: MOS transistors-construction & operation, Threshold voltage. Scaling in MOS, second order effects in MOSFETs. CMOS Inverter: Static characteristics- VTC, noise margins, Dynamic behavior, Power dissipation. MOS Circuit design: Implementation of Boolean functions and combinational using CMOS logic family, Pass transistors and Transmission gates, dynamic and clocked CMOS. Clocking strategies. Design of sequential circuits. Circuit performance estimation: Estimation of delay in CMOS circuits, Logical effort. interconnects and delay models. Sizing and optimization. Fabrication and layout: MOS & CMOS fabrication, twin tub processes, Latch-up in CMOS, SOI process, VLSI Yield and economics. Stick diagram and Layout. Sub-system design: Adders, multipliers, and shifters. Static and dynamic RAM.

References:

1. S. M. Kang & Y. Leblebici, *CMOS digital Integrated circuits design and analysis*, Tata McGraw Hill, 4 (e), 2018.
2. Jan. M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, *Digital Integrated Circuits*, (2e), Pearson, 2003.
3. Neil H. E. Weste & Kamran Eshraghian, *Principles of CMOS VLSI Design*, 4 (e), Addison Wesley, 2010.

VDT3108 Microcontroller and Applications [3 0 0 3]

Syllabus:

Microcontroller Overview and 8051Architecture: Features and selection factors for Microcontroller, Block diagram of 8051 Microcontroller, Comparison of Microcontroller and Microprocessor with examples. Architectures of 8051 Microcontroller: Architecture, Pin Configuration, Memory Organisation, Power saving options, Concept of pipelining. 8051 Programming: Software Development Cycle, Addressing Modes, Instruction set, Assembler Directives. 8051 Timers, Interrupts, Serial and Parallel Communication: Configuration and Programming of Timer/Counter, Interrupts, Serial Communication, and I/O Port using Special Function Registers [SFRs], Serial Communication, Modes of serial communication. 8051 Interfacing: I/O Interfacing, Interfacing ADC/DAC 0808/09 with 8051, Memory Interfacing. 8051 Applications: Square and Triangular waveform generation using DAC, Temperature sensor (LM35) interfacing using ADC to 8051, Water Level controller design using 8051, Stepper Motor Interfacing to 8051 to rotate in clockwise and anticlockwise direction.

References:

1. Mazidi Muhammad Ali, Mazidi Janice Gillispe, Mckinlay Rolin D, *The 8051 Microcontroller and Embedded Systems: Using Assembly and C*, 2 (e), Pearson Publication, 2017, ISBN: 9788131710265.
2. Ayala Kenneth J*, The 8051 Microcontroller,* 3 (e) Thomson Delmar Learning, 2005, ISBN: 9781401861582.
3. Deshmukh Ajay V, *Microcontroller: Theory and Application,* 2 (e), McGraw Hill, 2011, ISBN:9780070585959.
4. Pal Ajit, "*Microcontrollers: Principle and Application",* 1(e), PHI Learning, 2014, ISBN:978812034394.
5. Chattopadhyay Santanu, *"Microcontroller and Applications",* 1(e), All India Council for Technical Education, 2023.

VDT3132 Device Fabrication Lab [3 0 0 3]

Syllabus:

This course gives an overview on different fabrication process of semiconductor devices. In this course different steps are followed for fabrication and testing of Diode which includes Cleaning Process, Oxidation, Photolithography, Etching, Diffusion, Metallization and Characterization.

VDT3133 Analog & Digital Communication Lab [0 0 2 1]

Syllabus:

Experiments of this lab are to demonstrate & analyse the following in hardware: Analog communication: Modulation schemes, Transmission and Reception, Sampling Techniques and Time division multiplexing, Digital communication: Modulation schemes, Transmission and Reception, Advanced Modulation Formats, Data transmission using Line coding techniques.

VDT3134 VLSI Design Lab [0 0 2 1]

Syllabus:

The lab covers schematic design and simulation of CMOS circuits using EDA tools. It includes analysis of DC, transient, power, and delay characteristics under various load conditions. Students will design transistor-level layouts using lambda-based rules, perform DRC and LVS checks, and compare pre- and post-layout simulation results. The course also explores dynamic logic design and comparative analysis with CMOS logic.

VDT3171 Project Based Learning – 2 [0 0 6 3]

Syllabus:
Based on project implementation and execution. Evaluation will be based on report/draft and presentation. Based on application of the project. Evaluation will be based on the outcomes of the project in the form of research articles or draft, IPR, app/product development. A+ grade may be awarded for SCOPUS indexed publication or published patent or functional product/prototype/app development etc. A departmental PBL evaluation committee will evaluate the outcomes of the PBL courses and to award grades based on the merit of the project.

SIXTH SEMESTER

VDT3202 Embedded & RTOS [3 0 0 3]

Syllabus:

Introduction: Definition and classification of embedded systems, Characteristics: real-time operation, low power, size constraints, dedicated function, Embedded system components, Embedded system design process and development lifecycle. STM32 Hardware Architecture: Overview (ARM Cortex-M series), Internal architecture: ALU, registers, buses, stack, system clock, NVIC, Memory hierarchy, I/O peripherals: GPIOs, Timers, Counters, ADC, DAC, Watchdog, Communication interface protocols, Interrupts and NVIC configuration. Embedded Software for STM32: Embedded C programming, STM32CubeIDE: code generation using STM32CubeMX, Peripheral initialization and HAL libraries, programming for debugging and interrupts. RTOS Basics: Introduction to RTOS and Free-RTOS components: Inter-task communication: semaphores, queues, mutexes, Time management and task priorities, Debugging and analyzing RTOS behavior using STM32 tools, Interfacing and Application Development: Sensor and actuator interfacing with STM32, UART to PC, SPI sensors RTOS-based application.

References:

1. Raj Kamal,*Embedded Systems: Architecture, Programming and Design,* 1 (e), McGraw-Hill,2009.
2. James Peckol, *Embedded Systems: A Contemporary Design Tool,* 1 (e), John Wiley & sons,2019.
3. Qing Li, *"Real-Time Concepts for Embedded Systems,* 1 (e), CMP Books,2003.
4. Yifeng Zhu, *Embedded Systems with ARM Cortex-M Microcontrollers in Assembly and C,* 1 (e).
5. Elecia White, *Making Embedded Systems,* 2 (e), O'Reilly Media, 2024.
6. STM32CubeMX and STM32CubeIDE Official Documentation.

VDT3203 System Verilog for Verification [3 0 0 3]

Syllabus:

Introduction to System Verilog, System Verilog declaration Spaces, System Verilog Literal Values and Built in Data types: assignments, variables, models. System Verilog user defined data types and enumerated types, Arrays, Queues. Procedural Blocks, Tasks and Functions. System Verilog Procedural Statements. Modeling FSMs with System Verilog. Introduction to System Verilog assertion, Testbench Architecture and Basic UVM.

References:

1. Christian B. Spear, System Verilog for Verification: A Guide to Learning the Testbench Language Features, 1 (e), Springer 2012
2. Mark Glasser, Harry Foster, Tom Fitzpatrick, Adam Rose, Dave Rich, Open Verification Methodology Handbook: Creating Testbenches in System Verilog and System-C, Morgan Kaufmann, 2009
3. Faisal Haque, Jonathan Michelson, Khizar Khan, The Art of Verification with System Verilog Assertions, 1 (e), Verification Central, 2006.

VDT3204 Design for Testability [3 0 0 3]

Syllabus:

Introduction: Verification vs Testing, Need for testing, Level of testing, Cost of testing, Roles of testing. Fault modelling: Stuck at Faults, Bridging Faults; Fault collapsing; Transistor (switch) faults. Fault Simulation: Deductive, Parallel and Concurrent Fault Simulation, Critical Path Tracing. SCOAP Controllability and Observability: significance and calculation of SCOAP measures. ATPG for Combinational Circuits: D-Algorithm, PODEM, Random pattern generation, Boolean difference symbolic method, Path sensitization method. Scan chain: Concept of scan chains for serial testing. Sequential Circuit ATPG: Time frame expansion, Nine-valued logic, Drivability, Complexity of ATPG, Test generation system. Compaction Techniques: General Aspects of Compaction Techniques; Ones-Count, Transition Count and Parity Check Compression; Syndrome Testing; Signature Analysis. Memory Testing: Fault models, March tests. Built-In Self-Test (BIST) concept: BIST pattern generation, BIST response compaction, Aliasing definition. BIST Architecture.

References:

1. M. Bushnell and V. Agrawal, *Essentials of Electronic Testing for Digital, Memory, and Mixed-Signal VLSI Circuits*, 1 (e), Kluwer Academic Publishers, 2000.
2. M. Abramovichi, M. Breuer and A. Friedman, *Digital Systems Testing and Testable Design*, 1 (e), IEEE Press, 1999.
3. L. T. Wang, C. W. Wu and X. Wen, *VLSI Test Principles and Architectures,* 1 (e), Elsevier, 2006

VDT3232 Embedded & RTOS Lab [0 0 2 1]

Syllabus:

Experiments of this lab are related to embedded system design using Keil/Arduino software and its implementation on Hardware Kit. Experiments embedded C/Arduino programming for hardware interfacing to various sensors and actuators and implementation of communication protocols like RS-232 communication, SPI, I2C, etc. for embedded systems. Lab also introduces to Linux commands, Shell programming, etc. with introduction to basic concepts of Real Time Operating Systems like Process, Thread, Semaphores, Mutex, IPC, scheduling, etc.

VDT3233 System Verification Lab [3 0 0 3]

Syllabus:

The System Verilog course will cover essential concepts of hardware description and verification. Participants will learn RTL design, synthesis, and simulation, along with advanced features like interfaces. The course will also delve into building testbenches using object-oriented programming and constrained random verification. Hands-on lab sessions will provide practical experience with industry-standard EDA tools. By the end, students will have a strong foundation to excel in chip design and verification.

PROGRAM ELECTIVES-VDAT

PROGRAM ELECTIVE-I

VDT3146 FPGA based System Design [3 0 0 3]

Syllabus:

Introduction: Digital systems implementation using MSI/LSI circuits: PLDs, PLAs, and PALs. Overview of full-custom, semi-custom, and standard-cell-based design approaches. Introduction to programmable ASICs—CPLDs, MPGAs, and FPGAs. Overview of FPGA design flow. FPGA Architecture: Architecture of FPGAs including logic blocks, interconnects, and I/O. Classification into SRAM, antifuse, and flash-based types. Basics of multi-FPGA systems, on-chip buses. Synchronous Sequential Circuit Design: Design of circuits: BCD decoders, adders, and array multipliers. FSM-based systems: sequence detectors, vending machines, and serial adders. ASM charts-based designs: vending machines and traffic light controllers. Design examples using HDL. FSM design and optimization. Digital System Design Approaches:Top-down and bottom-up methods. Integration of datapath and control units. Behavioral modeling, timing analysis, pipelining, resource sharing. HDL-based implementation on FPGA platforms.

References:

1. Zvi Kohavi, *Switching and Finite Automata Theory*, (2e), Tata McGraw-Hill, 2008.
2. Navabi, *Analysis and modeling of digital systems*, (2e) McGraw Hill, 1998.
3. Douglas Perry, *Modeling with VHDL*, (3e), McGraw Hill, 1994.
4. Navabi, *Verilog Digital Design*, (2e), McGraw Hill, 2007.

VDT3147 Machine Learning [3 0 0 3]

Syllabus:

Introduction: Informed and Uninformed Searching solutions and strategies, Alpha - Beta pruning. Knowledge Representation & Reasoning, Utility theory, Hidden Markov Models (HMM), Bayesian Networks. Machine Learning: Supervised and unsupervised learning, Decision trees, Statistical learning models, Learning with complete data - Naive Bayes models, Learning with hidden data - EM algorithm, Reinforcement learning. Pattern Recognition: Introduction, Design principles of pattern recognition system, Statistical Pattern recognition, Parameter estimation methods - Principle Component Analysis (PCA) and Linear Discriminant Analysis (LDA), Classification Techniques – Nearest Neighbor (NN) Rule, Bayes Classifier, Support Vector Machine (SVM), K – means clustering.

References:

1. Stuart Russell, Peter Norvig, *Artificial Intelligence – A Modern Approach*, (3e), Pearson Education, 2009.
2. Elaine Rich and Kevin Knight, *Artificial Intelligence*, (1e), McGraw-Hill,1990.
3. E Charniak and D McDermott, *Introduction to Artificial Intelligence*, (1e), Pearson Education, 2016.
4. Dan W. Patterson, *Artificial Intelligence and Expert Systems*, (1e), Prentice Hall of India, 1990.

VDT3148 Introduction to Electronics Packaging [3 0 0 3]

Syllabus:

Introduction to IC Packaging Technologies: Overview of IC packaging and its significance. Historical context and evolution of packaging technologies. Introduction to packaging types: through-hole, surface-mount, ball grid array. Packaging Materials and Interconnection Techniques: Study of materials used in semiconductor packaging. Interconnection techniques: wire bonding, flip-chip, and solder bump technologies. Thermal Management in IC Packaging Principles of thermal management in IC packaging. Techniques for heat dissipation and cooling. Signal and Power Integrity Considerations: Signal integrity challenges in IC packaging. Power integrity considerations and solutions. Packaging Types and Trade-offs: In-depth study of through-hole, surface-mount, and ball grid array packaging. Trade-offs involved in selecting packaging types. Reliability in IC Packaging Factors affecting reliability in IC packaging. Testing and validation techniques for packaged ICs. Advanced Topics in IC Packaging Emerging trends in IC packaging technologies. Advanced materials and techniques.

References:

1. John H. Lau. Semiconductor Advanced Packaging. Springer, 2021.
2. King-Ning Tu, Chih Chen, Hung-Ming Chen. Electronic Packaging Science and Technology, 1e, John Wiley and Sons Inc., 2022

PROGRAM ELECTIVE-II

VDT3249 Display Technologies [3 0 0 3]

Syllabus:

Introduction to Display Technologies: Overview of display technologies, with a focus on OLEDs and LCDs. Historical development and evolution of OLED and LCD technologies. Principles of OLEDs: Working principles of OLEDs, Types of OLEDs: small molecule vs. polymer-based, Emissive layer materials and device structure. OLED Fabrication and Design: Thin film deposition techniques for OLEDs, Patterning methods and post-processing steps, Design considerations for OLED-based display systems. Principles of LCDs: Working principles of Liquid Crystal Displays. Types of LCDs: Twisted Nematic (TN), In-Plane Switching (IPS), and Vertical Alignment (VA) Liquid crystal alignment and color filters. LCD Fabrication and Design: Fabrication processes for LCDs. Backlighting techniques and advancements. Design considerations for LCD-based display systems. Electrical and Optical Characterization: Measurement techniques for OLED and LCD parameters, Evaluating luminance, color accuracy, contrast ratio, and response times. Comparative analysis of OLED and LCD performance. Applications and Emerging Trends: Diverse applications of OLEDs and LCDs in electronic devices, Exploration of emerging trends in display technologies.

References:

1. Lee, Jiun-Haw. *Introduction to Flat Panel Displays*. John Wiley & Sons, 2020.
2. Linliu, Kung. *Micro-Led Display*. 2018.
3. Tsujimura, Takatoshi. *OLED Display Fundamentals and Applications*. John Wiley & Sons, 2017.
4. Linliu, Kung. *A Perfect Display! Micro-LED, OLED, LCD and CRT*. 2018

VDT3150 Principles of Nanomaterials & Quantum dots [3 0 0 3]

Syllabus:

Introduction to nanomaterials: Scaling Laws, Properties of materials & nanomaterials, Three-, two-, one- and zero-dimensional nanomaterials, role of size in nanomaterials, nanoparticles, semiconducting nanoparticles, nanowires, nanoclusters, quantum wells, conductivity and enhanced catalytic activity compared to the same materials in the macroscopic state. Synthesis of metal nanoparticles: Top down and bottom-up approaches for nanomaterial synthesis. Synthesis of nanoparticles by physical, chemical and biological methods, Anisotropic nanoparticles. Metal nanoclusters, Bimetallic nanoparticles, Metallic nanoparticles: Surface plasmon resonance. Quantum Dots: Quantum confinement, Band gap tuning and properties of quantum dots. Surface defects and Doping in Quantum dots. Carbon nanomaterials: Preparation and properties of graphene oxide, graphene, fullerenes, carbon nanotubes and carbon dots. Composites of carbon nanomaterials. Characterization of nanomaterials by various analytical methods, optical characterization, spectroscopy, structural characterization and imaging techniques. Applications of nanomaterials: health and disease diagnostics, biomedical, delivery vehicles, sensors and biosensors, cosmetics, agriculture, environment, food, energy and defense.

References:

1. *Nanoscience & Nanotechnology: Fundamentals of Frontiers*; M. S. Ramachandra Rao, S. Singh.John Wiley & Sons, 2017.
2. Schmid, Günter, *Nanoparticles: from theory to application*. John Wiley & Sons, 2011.
3. Kumar, Challa SSR,*Nanomaterials for medical diagnosis and therapy*. John Wiley & Sons, 2007.
4. *Nanostructures and Nanomaterials: Synthesis, Properties, and Application*; G. Cao, Y. Wang.
5. L. Rogach, *Semiconductor nanocrystal quantum dots synthesis, assembly, spectroscopy and applications* (Springer, Wien; London, 2008).
6. E. Gazit, *Plenty of room for biology at the bottom: an introduction to bionanotechnology* (Imperial College Press ; Distributed by World Scientific Pub. in the USA, London : Hackensack, NJ, 2007.

VDT3151 Semiconductor Device Modeling [3 0 0 3]

Syllabus:

Diode Modeling: Reverse-bias breakdown and avalanche effects, High-frequency diode behavior, Modeling temperature-dependent characteristics, Advanced Semiconductor Physics Carrier statistics in semiconductors. Quantum effects and their impact on device behavior. Bipolar Junction Transistor (BJT) Modeling: Non-ideal effects in BJT operation, High-frequency and low-frequency BJT models, Impact of temperature and process variations on BJT characteristics. Metal-Oxide-Semiconductor Field-Effect Transistor (MOSFET) Modeling: Advanced MOSFET models for nanoscale technologies, Quantum effects in MOSFETs, Compact modeling for variability analysis. Advanced Transistor Structures: FinFET and nanowire transistor modelling, Tunnel FETs and other emerging transistor technologies, Trade-offs and advantages of advanced transistor structures. Simulation Challenges and Solutions: Simulation challenges in advanced semiconductor devices. Monte Carlo simulations for statistical variability.

References:

1. Wu, Yung-Chun. *3D TCAD Simulation for CMOS Nanoeletronic Devices*. Springer, 2017.
2. Chauhan, Yogesh. *FinFET Modeling for IC Simulation and Design*, 1 (e), Academic Press, 2015.
3. Snowden, Christopher. *Semiconductor Device Modelling*, 1 (e), Springer Science & Business Media, 2012.
4. Massabrio, Giuseppe. *Semiconductor Device Modeling with Spice,* 1 (e), McGraw Hill Professional, 1998.

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PROGRAM ELECTIVE-III

VDT3249 Analog VLSI [3 0 0 3]

Syllabus:

Review of MOS: Transistor operation models and equivalent circuits for low and high frequency. Single-Stage Amplifiers: CS, CG, CD, Cascode amplifiers. Differential Amplifiers: Common mode, differential mode response analysis and gain calculation. Passive and Active Current Mirrors: Cascode current mirror, current mirror as an active device. Miller effect. Frequency response of amplifiers. Feedback amplifiers. Theory and design of MOS Operational Amplifier, Stability and Frequency compensation of operational amplifiers. Comparators and Voltage Reference Sources. Switched Capacitor Circuits: Principles of operation of Switched Capacitor Circuits, Switched Capacitor Filters. Mixed signal circuits.

References:

1. Behzad, Razavi, Design of Analog CMOS Integrated Circuits, (2e), McGraw Hill, 2001.
2. Allen Holberg, CMOS Analog Integrated Circuit Design, (3e), Oxford University Press, 2012.
3. P. R.Gray, Hurst, Lewis and R. G. Meyer, Analysis and Design of Analog Integrated Circuits, (4e), John Wiley, 2001.

VDT3250 High Speed Circuits [3 0 0 3]

Syllabus:

Introduction to High-Speed circuit design: Sources of delay in CMOS circuits, High-speed design challenges in deep sub-micron technologies, Importance of interconnect modeling, Technology scaling and performance limits. Timing and Delay Optimization: Logical effort, Elmore delay, Advanced transistor sizing techniques, Pipelining and retiming, Design trade-offs in high-speed paths. Interconnects and Signal Integrity: Interconnect modeling (RC, RLC models), Crosstalk and coupling capacitance, Ground bounce and IR drop, Shielding and repeater insertion techniques. Clocking Strategies and Skew Reduction: Clock distribution techniques (H-tree, spine, mesh), Skew, jitter, duty cycle distortion, On-chip PLLs and DLLs, Clock gating and power-aware clocking. High-Speed I/O Circuit Design: I/O driver circuits, Transmission line effects, termination, ESD protection in high-speed design, Standards: LVDS, SSTL, HSTL. Mixed-Signal Interfaces and Layout Considerations: Design of comparators, sense amplifiers, High-speed ADC/DAC interface, Substrate noise and isolation techniques, Parasitic extraction and post-layout simulation.

References:

1. Howard Johnson, Martin Graham, *High-Speed Digital Design: A Handbook of Black Magic*,1 (e), Prentice-Hall, 1993.
2. Jan Rabaey et al., *Digital Integrated Circuits: A Design Perspective*, 2 (e), Pearson Education, 2003.
3. Baker, Li, Boyce, *CMOS: Circuit Design, Layout, and Simulation*, 2 (e), John Wiley & Sons,1993
4. David A. Johns, Ken Martin, *Analog Integrated Circuit Design,* 3 (e), John Wiley & Sons,2012
5. Razavi, *Design of Analog CMOS Integrated Circuits,* 1 (e), Graw Hill, d, 2017.
6. *EDA Tool Manuals and Application Notes* (Cadence, Synopsys, Keysight)

VDT3251 Optoelectronics [3 0 0 3]

Syllabus:

Light propagation through anisotropic media, Electro optic effect and electro optic modulators and switches, Liquid crystal devices and spatial light modulators, Acousto optic effect, acousto optic tunable filter, acousto optic deflector, scanner and spectrum analyser, Basics of nonlinear optical effects, Second harmonic generation, phase matching, quasi phase matching, Sum and difference frequency generation, parametric amplification and parametric oscillation, Third order nonlinear optical effects, Self phase modulation and soliton formation, Cross phase modulation and four wave mixing, Stimulated Raman and Brillouin scattering

Polymer waveguides, Surface Plasmon Devices, Optical integrated circuits, hybrid & monolithic systems, optical interconnects, materials and processing for OEIC.

References:

1. Ajoy Ghatak and K Thyagarajan, *Optical Electronics*, Cambridge University Press, 1989
2. A Yariv and P. Yeh, *Photonics*, Oxford Univ. Press, 2007.
3. BMA Saleh and MC Teich, *Fundamentals of Photonics*, John Wiley, NY, 2007
4. Robert W. Boyd, Nonlinear *Optics*, Academic Press is an imprint of Elsevier, 2008
5. G P Agarwal, *Nonlinear Fiber Optics*, Academic Press, Boston, 2013
6. A Ghatak and K Thyagarajan, *Introduction to fiber optics*, Cambridge Univ. Press, UK, 1998.

PROGRAM ELECTIVE-IV

VDT4148 Low Power VLSI Design [3 0 0 3]

Syllabus:

Introduction: Need for Low Power VLSI chips, Sources of power dissipation in Digital Integrated circuits. Overview of the importance of low-power circuit design in CMOS and FinFET technologies. Device & Technology Impact on Low Power: Physics of power dissipation in CMOS devices & FinFET Devices; Dynamic and static power dissipation, Transistor sizing & gate oxide thickness; Impact of technology Scaling and Device innovation. Power estimation, Simulation and Power analysis: SPICE circuit simulators, gate level logic simulation, capacitive power estimation, static state power, gate level capacitance estimation, architecture level analysis. Circuit level Power reduction techniques: Power consumption in circuits; Design of Flip Flops and Latches; Low Power Dynamic logic families & adiabatic logic families. Logic level Power reduction techniques: logic encoding, state machine encoding, reduction of power in address and data buses. Low power Architecture and Systems: Power and performance management, switching activity reduction, parallel architecture with voltage reduction, flow graph transformation, low power arithmetic components, low power memory design. Emerging trends in low-power circuit design with CMOS and FinFET, Optimization techniques for minimizing power consumption in advanced semiconductor designs

References:

1. G. K. Yeap, *Practical Low Power Digital VLSI Design*, KAP, 2002.
2. Rabaey, Pedram, *Low power design methodologies*, Kluwer Academic, 1997.
3. K. Roy, Sharat Prasad, *Low Power CMOS VLSI Circuit Design*, Wiley, 2000.
4. Samar K. Saha. FinFET Devices for VLSI Circuits and Systems, Taylor and Francis Group, 2020.

VDT4149 Semiconductor Memory Design [3 0 0 3]

Syllabus:

Introduction to Memory Design: Memory types and their applications. Basic principles of memory operation. Static Random-Access Memory (SRAM): SRAM cell design and optimization, Memory bit-cell stability and read/write operations, SRAM array architecture and peripheral circuitry. Dynamic Random-Access Memory (DRAM): DRAM cell design and refresh mechanisms, Memory array organization and addressing, Timing considerations in DRAM design. Flash Memory: NAND and NOR Flash architectures, Programming and erasing mechanisms Timing and Signal Integrity. Power Optimization in Memory Systems

References:

1. Itoh, Kiyoo. VLSI Memory Chip Design, 1e, Springer Science & Business Media, 2013.
2. Tanović, Sabina. Designing Memory, 1e, Cambridge University Press, 2019.
3. Campardo, Giovanni. VLSI-Design of Non-Volatile Memories, 1e, Springer Science & Business Media, 2005.
4. Yu, Shimeng. Resistive Random Access Memory (RRAM), 1e, Springer Nature, 2022.

VDT4150 Internet of Things [3 0 0 3]

Syllabus

Fundamentals of Internet of Things: Beginner's Idea for IoT, Definition of IoT, Evolution of IoT, Conceptual Framework of IoT, IoT elements, architecture of IoT, Sensing and Actuation in IoT. IoT Communications Protocols: Introduction to IoT Communications Protocols, IoT Communication Protocols, IoT Network Topologies. Arduino Programming: Introduction, Arduino Hardware, Arduino Software (IDE), Examples of Arduino Programming, Introduction to Sensors and Actuators. Implementation of IoT with advanced microcontroller: Introduction, Introduction to Python Programming, Data Collection and Storage, Data Processing and Analytics, Visualization and Reporting. IoT Applications with Case Studies: Smart Agriculture, Smart Healthcare, Activity Monitoring.

References:

1. R. Kamal, *Internet of Things – Architecture and Design Principles,* (1e), McGraw Hill, 2017.
2. R. Buyya A. V. Dastjerdi, *Internet of Things: Principles and Paradigms*, (1e), Morgan Kaufmann,2016.
3. Adrian McEwen, Hakim Cassimally, *Designing the Internet of Things*, , (1e) Wiley, 2015.
4. Samuel Greengard, *The Internet of Things,* (1e), The MIT Press, 2015.
5. Gaston C. Hillar Gaston C, *Internet of Things with Python, Ingram short title*, 2016.
6. Anita Gehlot, Rajesh Singh, Bhupendra Singh, Praveen Kumar Malik, Lovi Raj Gupta, *Internet of Things with 8051 and ESP8266*, 1 (e), CRC Press; 2020.

PROGRAM ELECTIVE-V

VDT4151 Static Timing Analysis [3 0 0 3]

Syllabus:

Introduction to STA: Importance & Classification. Timing Parameters: Timings paths, Arrival time, Required Time, Basics of hold time & set up time, Skews & Jitter. Static Timing analysis of combinational circuits: Delay modelling and calculation: gate, interconnect, cell delays, analysis of critical paths, Timing analysis in multi-path combinational logic. Static Timing Analysis of Sequential Circuits: Clocking strategies: single-phase, multi-phase, and derived clocks, Setup and Hold timing violations, Maximum operating frequency estimation, Impact and analysis of clock skew in sequential circuits, Setup and Hold analysis considering clock skew. Timing Checks: Setup Timing Checks, Hold Timing Checks, On-Chip Variation (OCV): sources, modelling, and impact, OCV-aware timing analysis: derating, pessimism removal

References:

1. S. S. Sapatnekar, *Timing,* Springer, 2004.
2. J. Bhasker, R. Chadha, *Static Timing Analysis for Nanometer Designs: A Practical Approach,* Springer, 2009.
3. K. Golshan, *Timing Verification of Application-Specific Integrated Circuits (ASICs),* Springer, 2003.

VDT4152 VLSI Physical Design [3 0 0 3]

Syllabus:

VLSI Physical Design Introduction: VLSI Design Process, difficulties in Physical design, Graph theory; Circuit Partitioning: Problem definition, cost functions and constraints, Partitioning algorithms; Floorplanning: Problem definition, cost functions and constraints, Floorplanning algorithms; Placement: Problem definition, cost functions and constraints, Placement algorithms; Routing: Problem definition, cost functions and constraints, Global routing algorithms, Channel routing algorithms, switchbox routing, Clock Tree Synthesis and Routing; Layout generation and Compaction: Layout generation, layout compaction. Physical design verification and tape-out: Methods for physical design verification, Overview of tape-out process, Introduction to Design for Testability (DFT) and Design for Manufacturability (DFM) principles.

References:

1. Naveed Sherwani, "*Algorithms for VLSI Physical Design Automation*" (3e) Kluwer Academic Publishers. 2002
2. S.H. Gerez, "*Algorithms for VLSI Design Automation*", (1e), John Wiley & Sons, 2008
3. C. J. Alpert, D. P. Mehta, S. S. Sapatnekar, "*Hand Book of Algorithms of Physical design Automation*", (1e), CRC press, 2009
4. S. M .Sait, H. Youssef, "*VLSI Physical design automation theory and Practice*", (1e), World Scientific Publishing, 1999

VDT4153 Thin Film Transistors [3 0 0 3]

Syllabus:

Introduction to Thin Film Transistors: Overview of Thin Film Transistors and their significance in electronics. Historical perspective and evolution of TFT technology. Principles of Operation: Understanding the working principles of Thin Film Transistors. Types of TFTs: amorphous, polysilicon, and organic TFTs. Thin Film Deposition Techniques: Overview of thin film deposition methods: PVD, CVD, and atomic layer deposition (ALD). Material selection and considerations in thin film deposition for TFTs. TFT Fabrication Processes: Semiconductor layer deposition and patterning. Gate dielectric and electrode fabrication. Source and drain electrode deposition and contact formation. Electrical Characterization of TFTs: Measurement techniques for electrical parameters: mobility, threshold voltage, and on/off ratio Role of thin film properties in electrical performance. Optical Properties and Applications Optical transparency and its significance in TFT applications. Applications of TFTs in flat-panel displays and sensors. Emerging trends in flexible electronics using TFT technology.

References:

1. Kagan, Cherie. Thin-Film Transistors, 1 (e), CRC Press, 2003.
2. Brotherton, S. D. Introduction to Thin Film Transistors, 1 (e), Springer Science & Business Media, 2013.
3. Zhou, Ye. Semiconducting Metal Oxide Thin-Film Transistors, 1 (e), IOP Publishing Limited, 2020.
4. Facchetti, Antonio. Transparent Electronics , 1 (e), John Wiley & Sons, 2010.

PROGRAM ELECTIVE-VI

VDT4154 Scripting Language for VLSI [3 0 0 3]

Syllabus:

Introduction to Scripting Languages: Overview of scripting in the context of system administration and EDA, Introduction to Linux shell environment, Common Linux Commands and Kernel Usage. PERL Programming: PERL DATA TYPES, syntax and control structures, Regular expressions and pattern matching, Regular expressions in Perl, Debugging Perl Scripts. Shell Scripting (BASH): Shell basics: variables, loops, conditionals, functions, File handling, process control, and automation, Writing scripts for tool invocation and batch processing, Text processing tools: grep, sed, awk. TCL/TK Scripting: TCL basics: variables, loops, conditionals, procedures. File I/O and error handling, TK for GUI development (basics only), Application in EDA tools like Synopsys, Cadence, etc., TCL scripting in simulation and synthesis automation

References:

1. Randal L. Schwartz, Brian D Foy, Tom Phoenix *Learning Perl*, (7e), O'Reilly Media, 2016
2. Brent B. Welch, Ken Jones, Jeffrey Hobbs, *A Practical Guide to Linux Commands*, Editors, and Shell Programming, (4e), Pearson, 2017.
3. Mark G. Sobell, *Practical Programming in Tcl and Tk*, (4e), Prentice Hall, 2003.

VDT4155 Mixed Signal Design [3 0 0 3]

Syllabus:

Linearity, noise in mixed signal systems. Operational amplifier: block diagram, characteristics, circuit applications. Comparator design. Preamplifier design. Active analog filters. Switched capacitor circuits. Analog-to-Digital conversion (ADC) and Digital-to-Analog Conversion (DAC): Basics of data conversion systems, Sampling theory, Sample and hold circuits. ADC topologies. DAC architecture. Data Converter Signal to Noise Ratio. Phase Locked Loops: Simple PLL, Charge - Pump PLL, VCO : Ring Oscillator, LC Oscillator, Applications in PLL.

References:

1. R. Jacob Baker, *CMOS Mixed-Signal Circuit Design, (2e)*, Wiley, 2008.
2. Karl D. Stephan, *Analog and Mixed- Signal Electronics*, Wiley, 2015
3. R. Jacob Baker, *CMOS – Circuit Design, Layout and Simulation,* Wiley
4. Behzad Razavi, *Design of Analog CMOS Integrated Circuits,* McGraw Hill , *(2e),* 2017.

VDT4156 CAD for VLSI [3 0 0 3]

Syllabus:

Introduction to CAD tools: Evolution of Design Automation, Types of CAD tools. Algorithmic Graph Theory: Graphs, graph optimization, basic algorithms. Architectural Synthesis: Constraints and problem formulation, Datapath and control unit synthesis, Scheduling, resource sharing and binding, Area/latency/Cycletime optimization. Combinational Logic Synthesis: Binary Decision Diagrams, positional cube notation, Two Level Logic Synthesis, Unate Recursive Paradigm, logic minimization algorithms, Multiple-Level Combinational Logic Optimization. Sequential logic optimization: State minimization and encoding, retiming. Logical Effort and delay optimization: Logical Effort, Multistage Logic Networks, Logical Effort Optimizing performance. Cell-library Binding: problem formulation, covering algorithms.

References:

1. G. D. Micheli, *Synthesis and optimization of digital systems*, (1e), Mc Graw Hill, 2003.
2. S. Imam, M. Pedram, *Logic Synthesis for Low Power VLSI Designs*, (1e), Kluwer, 1997.
3. M. J. S. Smith, *Application Specific ICs*, (1e), Pearson, 1997.
4. Rabaey, J. M., Chandrakasan, A. P., & Nikolic, B., *Digital integrated circuits* (2e), Englewood Cliffs, Prentice Hall, 2002.

VDT4171 Internship (Industry/ Research/ Industry Certification) [0 0 4 2]

Syllabus:

Each student must undergo internship for a period of 4-6 weeks. This may be taken in a phased manner during the vacation period of the Semester IV/VI. The student must submit an internship report in the prescribed format to the department. The student also will present the outcomes of the internship followed a by viva voce. The report should include the certificates issued by the industry/institution. The evaluation will be done in the Semester VII in their concerned branch.

EIGHTH SEMESTER

VDT4271 Capstone Project [0 0 24 12]

Syllabus:

Project work should be carried out for a minimum duration of 16 weeks at the institution/ industry research laboratory or any other institution where facilities exist, with approval of the parent Department. The grade awarded to the student will be based on the total marks obtained by him/ her. There will be a mid-semester evaluation will be carried out at the parent department to assess the work done on the project after 8-10 weeks. In case of external projects, the qualitative feedback of the external guide shall be taken.The final evaluation and viva-voce will be conducted after the completion of the project work and submission of the project report, by a panel of examiners including the internal guide.