KUMARAGURU COLLEGE OF TECHNOLOGY

An autonomous Institution affiliated to Anna University, Chennai

COIMBATORE – 641049

M.E VLSI DESIGN

Curriculum and Syllabus

REGULATION 2024A

Department of

Electronics and Communication Engineering

M. Bharathi

Signature of BOS Chairperson, ECE

VISION

To be a centre of excellence in education and research by offering an internationally accredited curriculum, state-of-the-art infrastructure, and advanced laboratories that empower students to excel in globally competitive academic and industrial environments.

MISSION

The Department is committed to:

- Inspiring students to cultivate professional ethics, self-confidence, and leadership qualities.
- Enabling students to acquire knowledge and skills through innovative practices to address evolving global challenges and societal needs.
- Pursuing excellence in academics, core engineering domains, and research activities.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO 1: Graduates will excel as professionals in the fields of analog and digital VLSI design, semiconductor technology, and emerging domains of VLSI, contributing to innovation and the development of advanced electronic systems.

PEO 2: Graduates will continuously adapt to evolving technological advancements, leveraging their expertise to address challenges in academia, research, and industry while upholding ethical standards and contributing responsibly to society.

PROGRAM OUTCOMES (POs)

Graduates of VLSI Design Postgraduate Program should have the ability to:

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. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
4. Graduates will gain expertise in designing and optimizing analog, digital, and mixed-signal VLSI systems using advanced design tools.
5. Graduates will apply emerging semiconductor technologies to develop high-performance, power-efficient VLSI solutions.
6. Graduates will embrace lifelong learning, lead responsibly, and adapt to evolving technologies through research and collaboration, ensuring readiness for academia, industry and entrepreneurship.

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KUMARAGURU COLLEGE OF TECHNOLOGY

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
REGULATION 2024A
M.E. VLSI DESIGN - Curriculum

Semester I

S.No.	Course code	Course Title	Course Mode	Course Type	L	T	P	J	C
1	24MAT502	Graph Theory and Optimization Techniques	Theory	BS	3	1	0	0	4
2	24VLI501	Digital CMOS VLSI Design	Embedded	PC	3	0	2	0	4
3	24VLI502	High Level Digital Design	Embedded	PC	3	0	2	0	4
4	24VLI504	Scripting for VLSI	Embedded	PC	2	0	2	0	3
5	24VLT510	Semiconductor Devices and Modeling	Theory	PC	3	0	0	0	3
6	24INT501	Research Methodology and IPR	Theory	ES	3	0	0	0	3
								Total Credits	**21**
								Total Contact Hours/week	**24**

Semester II

S.No.	Course code	Course Title	Course Mode	Course Type	L	T	P	J	C
1	24VLI505	Analog Integrated Circuit Design	Embedded	PC	3	0	2	0	4
2	24VLI507	Verification and Testing of VLSI Circuits	Embedded	PC	3	0	2	0	4
3	24VLT508	Low Power VLSI Design	Theory	PC	3	0	0	0	3
4	24VLI511	VLSI Physical Design	Embedded	PC	3	0	2	0	4
5	24VLE0XX	Professional Elective I	Theory	PE	3	0	0	0	3
6	24VLE0XX	Professional Elective II	Theory	PE	3	0	0	0	3
7	24VLJ509	Mini Project	Project	PW	0	0	0	6	3
								Total Credits	**24**
								Total Contact Hours/week	**30**

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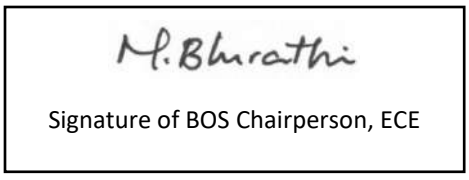
Semester III									
S.No.	**Course code**	**Course Title**	**Course Mode**	**Course Type**	**L**	**T**	**P**	**J**	**C**
1	24VLE0XX	Professional Elective III	Theory	PE	3	0	0	0	3
2	24VLE0XX	Professional Elective IV	Theory	PE	3	0	0	0	3
3	24VLE0XX	Professional Elective V	Theory	PE	3	0	0	0	3
4	24VLJ601	Project Phase - I	Project	PW	0	0	0	24	12
								Total Credits	**21**
								Total Contact Hours/week	**33**
Semester IV									
S.No.	**Course code**	**Course Title**	**Course Mode**	**Course Type**	**L**	**T**	**P**	**J**	**C**
1	24VLJ602	Project Phase - II	Project	PW	0	0	0	30	15
#Student can opt Project Phase - II as Internship in Industrial or Research Labs or inhouse									
								Total Credits	**15**
								Total Contact Hours/week	**30**

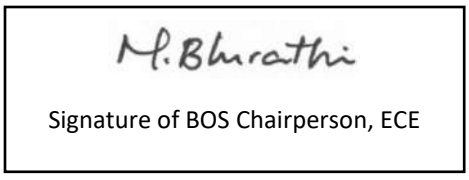
LIST OF ELECTIVES									
S.No.	**Course code**	**Course Title**	**Course Mode**	**Course Type**	**L**	**T**	**P**	**J**	**C**
PROFESSIONAL ELECTIVES									
1	24VLE001	Data Structures	Theory	PE	3	0	0	0	3
2	24VLE002	Nano devices and Circuit Design	Theory	PE	3	0	0	0	3
3	24VLE003	Process Technology	Theory	PE	3	0	0	0	3
4	24VLE004	Semiconductor Memories	Theory	PE	3	0	0	0	3
5	24VLE005	System-on-Chip	Theory	PE	3	0	0	0	3
6	24VLE007	MEMS & NEMS	Theory	PE	3	0	0	0	3
7	24VLE008	CAD for VLSI	Theory	PE	3	0	0	0	3
8	24VLE010	Reconfigurable Architectures	Theory	PE	3	0	0	0	3
9	24VLE011	Modern Transistor Architectures and Circuit Performance	Theory	PE	3	0	0	0	3
10	24VLE012	VLSI for Wireless Communications	Theory	PE	3	0	0	0	3
11	24VLE013	Machine learning for VLSI	Theory	PE	3	0	0	0	3
12	24VLE014	Universal Verification Methodology	Theory	PE	3	0	0	0	3



13	24VLE015	Advanced VLSI Interconnects	Theory	PE	3	0	0	0	3
14	24VLE016	Mixed Signal Circuit Design	Theory	PE	3	0	0	0	3
15	24VLE017	Introduction to Wearable Electronics	Theory	PE	3	0	0	0	3
16	24VLE018	Basics of Electronics & Semiconductor Packaging	Theory	PE	3	0	0	0	3
17	24VLE019	VLSI Signal Processing	Theory	PE	3	0	0	0	3
18	24VLE020	Advanced Processor Architecture	Theory	PE	3	0	0	0	3

Semester-wise Credits	
Semester – I	21
Semester – II	24
Semester – III	21
Semester – IV	15
Total Credits	**81**

Course types	**Credits**
Basic Science	4
Engineering Science	3
Professional Core	29
Professional Electives	15
Project/Internship	30
Total Credits	**81**



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24MAT502	Graph Theory and Optimization Techniques	L	T	P	J	C
		3	1	0	0	4
BS		SDG	4,9			

Pre-requisite courses	-	Data Book / Codes / Standards (If any)	-

Course Objectives:	
The purpose of taking this course is to:	
1	Introduce the principles of graph theory and demonstrate how they can be used to model and solve connectivity-related problems in real-world systems
2	Enable students' to understand and utilize fundamental graph algorithms and their practical applications
3	Build students' skill to model real-life problems using linear programming
4	Equip students with conceptual and practical knowledge of non-linear programming techniques for addressing complex engineering and business problems
5	Foster competence in using simulation modeling approaches for analyzing and solving engineering problems under varying conditions.

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO1	Apply graph as mathematical model to solve connectivity related problems	Ap
CO2	Implement fundamental graph algorithms to address real-world problem situations and interpret the obtained solutions	Ap
CO3	Formulate and construct mathematical models for real-life decision-making problems using the principles of linear programming	Ap
CO4	Analyze engineering and business problems with limited resources by utilizing non-linear programming techniques to determine feasible outcomes	An
CO5	Utilize simulation modeling techniques to investigate and solve engineering problems under various operating conditions	Ap

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Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independently carry out research /investigation and work	Write and present a substantial technical report/document	Demonstrate a degree of mastery over the area	Designing and Optimizing analog, digital, and mixed-signal VLSI systems using advanced design tools.	Apply emerging Semiconductor technologies to develop high-performance VLSI Circuits	Lifelong learning, lead responsibly, and adapt to evolving technologies for academia, industry and entrepreneurship.
1		2	2	2		2
2			2	2		2
3				2		2
4	2			2		2
5	2		2	2		2
6						2

Course Content	
GRAPHS Graphs and graph models – Graph terminology and special types of graphs – Matrix representation of graphs and graph isomorphism – Connectivity – Euler and Hamilton paths.	**12 Hours**
GRAPH ALGORITHM Graph Algorithms – Directed graphs – Some basic algorithms – Shortest path algorithms (Dijikstra's Algorithm) – Depth – First search on a graph – Theoretic algorithms (Maximum Flow Algorithms, Graph Partitioning Algorithms – Performance of graph theoretic algorithms– Graph theoretic computer languages.	**12 Hours**
LINEAR PROGRAMMING Formulation – Graphical solution – Simplex method – Two-phase method – Transportation and Assignment Models.	**12 Hours**
NON-LINEAR PROGRAMMING Constrained Problems – Equality constraints – Lagrangian Method – Inequality constraints – Karush – Kuhn-Tucker (KKT) conditions – Quadratic Programming-Wolfe's method.	**12 Hours**
SIMULATION MODELLING Monte Carlo Simulation – Types of Simulation – Elements of Discrete Event Simulation – Generation of Random Numbers – Applications to Queuing systems.	**12 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**15**	**Practical Hours:**	**0**	**Project Hours:**	**0**	**Total Hours:**	**60**

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Learning Resources
Textbooks:
1. Taha H.A, “Operation Research: An Introduction”, Ninth Edition, Pearson Education, New Delhi, 2010. 2. Gupta P. K, and Hira D.S., “Operation Research”, Revise Edition, S. Chand and Company Ltd., 2012. 3. Sharma J.K., “Operation Research”, 3rd Edition, Macmillan Publishers India Ltd., 2009. 4. Douglas B. West, “Introduction to Graph Theory”, Pearson Education, New Delhi, 2015. 5. Balakrishna R., Ranganathan. K., “ A text book of Graph Theory”, Springer Science and Business Media, New Delhi, 2012. 6. Narasingh Deo, “Graph Theory with Applications to Engineering and Computer Science”, Prentice Hall India,1997.

Course Curated by			
Expert(s) from Industry	**Expert(s) from Higher Education Institution**		**Internal Expert(s)**
Mr. Ramesh V.S., STEPS Knowledge Services Private Limited, Coimbatore.	Dr. M. Sivakumar Assistant Professor Sr. Grade Vellore Institute of Technology, Vellore Dr. Ramesh Babu Assistant Professor (SG) Amrita University Coimbatore, Tamil Nadu.		Maheswari K Assistant Professor I School of Foundational Sciences
Recommended by BoS on	16/08/2024		
Academic Council Approval	No.28	**Date**	26.06.2025

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24VLI501	Digital CMOS VLSI Design	L	T	P	J	C
		3	0	2	0	4
PC		SDG	8,9,11			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:	
The purpose of taking this course is to:	
1	Understand the theory of MOS transistors, their ideal and non-ideal characteristics.
2	Develop knowledge in CMOS circuit design, including both combinational and sequential logic and various MOS logic styles.
3	Introduce circuit characterization techniques like resistance, capacitance estimation, delay analysis, and power optimization.
4	Explore CMOS subsystem design elements such as data path circuits and semiconductor memory structures.
5	Study CMOS fabrication technologies, layout design rules, and manufacturing challenges to ensure reliable VLSI system design.

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	Analyze and explain the ideal and non-ideal I-V and C-V characteristics of MOSFETs and evaluate CMOS inverter DC characteristics including noise margins.	U
CO 2	Design and implement CMOS combinational and sequential logic circuits with efficient physical layout structures.	An
CO 3	Analyze circuit parameters such as resistance, capacitance, switching delay applying sizing and optimization techniques.	An
CO 4	Design CMOS subsystems including data path components like adders, comparators, counters, and memory units.	Ap
CO 5	Demonstrate understanding of CMOS fabrication processes, apply layout design rules, and address manufacturing challenges such as antenna effects and density rules.	U
CO 6	Design, simulate, and analyze CMOS layouts and digital circuits such as logic gates, multiplexers, adders, comparators, and flip-flops using layout design software like Microwind, Virtuoso, and DSCH.	C

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Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independently carry out research /investigation and work	Write and present a substantial technical report/document	Demonstrate a degree of mastery over the area	Designing and Optimizing analog, digital, and mixed-signal VLSI systems using	Apply emerging Semiconductor technologies to develop high-performance VLSI Circuits	Lifelong learning, lead responsibly, and adapt to evolving technologies for academia, industry and entrepreneurshi
1		2	3	2	3	
2			2	2	3	
3				2	3	
4	2			2	3	
5	2		2	2	3	2
6					3	

Course Content	
MOS TRANSISTOR THEORY Enhancement and Depletion MOS structure, I-V Characteristics, C-V Characteristics. MOS Inverter- Resistive Load, n-Type MOSFET Load. CMOS inverter – DC Characteristics, Noise Margin, Transistor sizing. Dynamic Behavior – Capacitance, Propagation Delay. Power dissipation, MOSFET Models. **Practical Component:** • nMOS / pMOS transistor I-V characteristic • CMOS Inverter	**9 Hours** **6 Hours**
CMOS CIRCUIT DESIGN AND CIRCUIT CHARACTERIZATION Static CMOS Design – Ratioless, Ratioed, Pass transistor, Transmission gate. Dynamic CMOS Logic- NP Domino logic. Static Latches and Registers - The Bistability Principle, Multiplexer-Based Latches, Master-Slave Edge-Triggered Register, Dynamic Latches and Registers- C^2MOS, True Single-Phase Clocked Register. Scaling principles. **Practical Component:** • Modify the NAND gate schematic to implement an **AND gate** using minimum additional logic. Simulate and verify the functionality. Also perform its Parasitic Extraction • Create a design for EXNOR gate and perform **Parasitic Extraction**. Simulate the extracted netlist and compare delay with the schematic simulation.	**9 Hours** **6 Hours**
INTERCONNECT AND CLOCKING STRATEGIES Interconnect Parameters – Capacitance, Resistance, and Inductance, Electrical	**9 Hours**

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Wire Models, Timing classification of Digital Systems, Synchronous Design, Self-Timed Circuit Design. **Practical Component:** • Design a SR/D/T/JK flip flops and measure its setup and hold times. • Design a UP-Down counter and measure its setup and hold times.	**6 Hours**
CMOS SUBSYSTEM DESIGN Data path operations – Adder -Full adder,Ripple Carry adder, Carry look ahead adder, Comparator, Modulo N Counter, Semiconductor Memory elements - SRAM, DRAM. **Practical Component:** • Design and implement the full adder using CMOS logic and verify the correct operation of the Full Adder through transient simulation • Design and implement the 2- bit comparator using CMOS Logic. • Design and implement the 6T SRAM using CMOS Logic.	**9 Hours** **5 Hours**
CMOS FABRICATION TECHNOLOGIES Wafer Formation, Photolithography, Well and Channel Formation, Silicon Dioxide (SiO2), Oxidation, Isolation Gate Oxide, Gate and Source/Drain Formations, Contacts and Metallization, Passivation, Twin Tub and SOI fabrication process. **Layout Design Rules:** Design Rule Background, Micron and Lambda Design Rules. **Manufacturing Issues:** Antenna Rules, Layer Density Rules, Resolution Enhancement Rules. **Practical Component:** • Generate the **layout** for the 2:1 MUX gate, perform **DRC** (Design Rule Check) and **LVS** (Layout vs Schematic) verification. • Design and implement the CMOS layout of a Ring Oscillator using Cadence Virtuoso. Perform DRC and LVS checks and verify the oscillation frequency through transient simulation.	**9 Hours** **7 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**0**	**Practical Hours:**	**30**	**Project Hours:**	**0**	**Total Hours:**	**75**

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Learning Resources

Textbooks:

1. Kang Sung Mo and Leblebici Yusuf, CMOS digital integrated circuits analysis and design, McGraw Hill, Revised 4th Edition, January 2019.
2. Jan Rabaey, Anantha Chandrakasan, B Nikolic, "Digital Integrated Circuits: A Design Perspective". Second Edition, Feb 2003, Prentice Hall of India.
3. Neil H. E. Weste, Kamran Eshraghian, Principles of CMOS VLSI Design: A systems perspective, Addison Wesley, 2nd Edition, 1999.
4. Jacob Baker "CMOS: Circuit Design, Layout, and Simulation, Third Edition", Wiley IEEE Press 2010 3rd Edition.
5. Peter Van Zant , Microchip Fabrication , McGraw-Hill, International Edition, 5th Edition, 2005.

References:

1. Seetharaman Ramachandran, ―Digital VLSI Systems design‖, 1st Edition, Springer, 2007.
2. Ming-Bo Lin, ―Introduction to VLSI Systems: A Logic, Circuit, and System Perspective‖ Indian Edition, CRC Press, 2011.
3. Neil H. E. Weste, David Harris, CMOS VLSI Design: A circuits & systems perspective, Addison Wesley, 4th Edition, 2010.

Online Educational Resources:

1. https://onlinecourses.nptel.ac.in/noc21_ee09/preview
2. https://onlinecourses.nptel.ac.in/noc25_ee21/preview

Assessment (Embedded course)

SA, Activity and Learning Strategy - Think-pair-share, MCQ, End Semester Examination (ESE) Lab Workbook, Experimental Cycle tests, Viva-voce

Course Curated by

Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)
Mr. S. Chella Kumar, CAD Principal Engineer, Enphase Solar Energy Pvt. Ltd., Bengaluru	Dr.M.Muruganandam, Senior Lecturer, Department of Engineering and Technology, University of Technology and Applied Science – Ibri, Sultanate of Oman.	Dr.K. Paramasivam Professor, ECE, Kumaraguru College of Technology

Recommended by BoS on	06.06.2026		
Academic Council Approval	No.31	**Date**	19.06.2026

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24VLI502	High Level Digital Design	L	T	P	J	C
		3	0	2	0	4
PC		SDG	9			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:	
The purpose of taking this course is to:	
1	Design synthesizable digital systems at the RTL level using SystemVerilog constructs
2	Provide knowledge of high-performance arithmetic architectures used in digital datapaths.
3	Understand synchronous sequential design, FSM architectures, timing constraints, and ASM techniques for designing digital control systems.
4	Explore FPGA architecture, configuration methods, resource mapping, and IP cores for digital system implementation.
5	Develop proficiency in FIFO design, clock domain crossing techniques, and AMBA-based on-chip interconnects for reliable digital system design.

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	Apply SystemVerilog constructs for designing and modeling digital systems at the RTL level.	Ap
CO 2	Analyze suitable architectures for adders, multipliers, dividers, and fixed-/floating-point datapaths based on design requirements.	An
CO 3	Analyze FSM-based control units using appropriate state encoding, timing considerations, and ASM-to-FSM conversion techniques.	An
CO 4	Describe FPGA resources, configuration methods, and IP cores used for implementing high-throughput digital systems.	U
CO 5	Explain FIFO, CDC techniques, and AMBA bus protocols used for reliable on-chip communication.	U
CO 6	Develop SystemVerilog-based digital systems using arithmetic datapath architectures, FSMs, FPGA resources, FIFO/CDC techniques, and AMBA-based interfaces.	C

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Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independently carry out research /investigation and work	Write and present a substantial technical report/document	Demonstrate a degree of mastery over the area	Designing and Optimizing analog, digital, and mixed-signal VLSI systems using	Apply emerging Semiconductor technologies to develop high-performance VLSI Circuits	Lifelong learning, lead responsibly, and adapt to evolving technologies for academia, industry and entrepreneurshi
CO 1	–	2	3	3	2	–
CO 2	–	2	3	3	2	–
CO 3	–	2	3	3	2	–
CO 4	–	–	2	3	3	–
CO 5	–	–	2	3	3	–
CO 6	2	3	3	3	3	2

Course Content	
RTL DESIGN USING SYSTEMVERILOG Introduction, Declaration Spaces, Literal Values and Built-in Data Types, User-Defined and Enumerated Types, Arrays, Structures and Unions, Procedural Blocks, Tasks and Functions, Procedural Statements. **Practical Component:** • Introduction to SystemVerilog basics • Parameterized ALU using SystemVerilog • Priority Encoder using generate statements	**9 Hours** **6 Hours**
HIGH-PERFORMANCE DATAPATH OPERATIONS Arithmetic Units: Fast adders - Carry Look-Ahead, Carry Skip, and Carry Select Adders, Parallel Prefix adders-Brent Kung, Sklansky, Kogge Stone Adder. High-Speed Multipliers: Wallace Tree, Dadda, and Radix-4 Booth Multipliers. Hardware Division Algorithms: Restoring, Non-Restoring, Radix-4 Division. Fixed-Point vs. Floating-Point Hardware Architectures. **Practical Component:** • Parallel Prefix Adder • Wallace Tree Multiplier • Radix-4 Booth Multiplier	**9 Hours** **6 Hours**
ADVANCED FSMS & CONTROL DATA PATH Sequential Logic Design - Synchronous design, Finite State Machines, FSM State Encoding: Binary, one-hot, Gray encoding, Mealy and Moore machines. Timing of sequential logic - setup/hold time, Clock Skew, Clock Jitter, Timing Paths. Algorithmic State Machine - ASM Charts- ASM blocks, state boxes, decision boxes, conditional outputs, ASM-to-FSM conversion**.**	**9 Hours**

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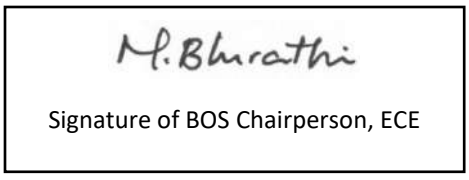
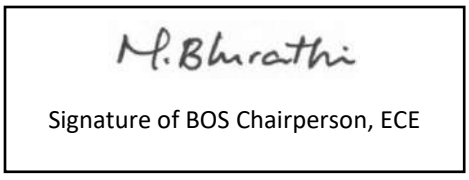
Practical Component: • Mealy and Moore Sequence Detector • ASM Chart to FSM Implementation • Traffic Light Controller using FSM, Tasks, and Functions	**6 Hours**
FPGA ARCHITECTURE & IP CORES LUTs, CLBs/logic blocks, flip-flops, routing resources, I/O blocks, SRAM-based FPGA architecture, bit streams, configuration modes, JTAG, SPI/QSPI, BRAM, DSP blocks, clocking, resource mapping, Hard vs. Soft IP, High-Throughput IP Cores: DMA architecture, SPI/I²C peripheral IP. **Practical Component:** • FPGA-Based Image Processing System	**9 Hours** **6 Hours**
FIFO, CLOCK DOMAIN CROSSING & ON-CHIP INTERCONNECTS Synchronous FIFO, Clock Domain Crossing (CDC) - Clock domains, metastability, synchronizer circuits, Asynchronous FIFOs, Gray-coded pointer transitions. AMBA Bus Protocols: AHB, APB and AXI, AXI-to-APB/AHB Bridge Architecture **Practical Component:** • Synchronous FIFO • Asynchronous FIFO for Clock Domain Crossing • AXI-to-APB Bridge	**9 Hours** **6 Hours**
Theory Hours: 45 **Tutorial Hours:** **Practical Hours: 30** **Project Hours:** **Total Hours: 75**	

Learning Resources
Textbooks:
1. Sutherland, Stuart, "SystemVerilog for Design: A Guide to Using SystemVerilog for Hardware Design and Modeling", 2nd Edition, Springer, 2006. 2. David Money Harris, and Sarah L Harris, "Digital Design and Computer Architecture", 3rd Edition, Morgan Kaufmann, 2015. 3. Parhami, Behrooz, "Computer Arithmetic: Algorithms and Hardware Designs", 2nd Edition, Oxford University Press, 2010.
Reference books:
1. Mano, M. Morris, and Ciletti, Michael D., "Digital Design", 6th Edition, Pearson, 2017. 2. Chu, Pong P., "FPGA Prototyping by SystemVerilog Examples", 1st Edition, Wiley, 2018.
Online Educational Resources:
https://onlinecourses.nptel.ac.in/noc21_ee39/



Assessment (Embedded course)			
SA, Activity and Learning Task(s), Mini project, MCQ, End Semester Examination (ESE) Lab Workbook, Experimental Cycle tests, viva-voce, etc…			
Course Curated by			
Expert(s) from Industry	**Expert(s) from Higher Education Institution**		**Internal Expert(s)**
Mr. S. Chella Kumar, CAD Principal Engineer, Enphase Solar Energy Pvt. Ltd., Bengaluru	Dr.M.Muruganandam, Senior Lecturer, Department of Engineering and Technology, University of Technology and Applied Science - Ibri, Ibri, Sultanate of Oman.		Dr. K. Ferents Koni Jiavana Associate Professor, ECE, Kumaraguru College of Technology
Recommended by BoS on	06.06.2026		
Academic Council Approval	No: 31	**Date**	19-06-2026



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24VLI504	Scripting for VLSI	L	T	P	J	C
		2	0	2	0	3
PC		SDG	4,8,9			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:	
The purpose of taking this course is to:	
1	Introduce the basics of Linux OS, commands, and text processing tools like sed, grep, and awk.
2	Develop skills in TCL scripting for file handling, regular expressions, and VLSI tool applications.
3	Build proficiency in Perl scripting, covering file operations, data structures, regular expressions, and object-oriented concepts.
4	Learn Python programming for handling data files, automation scripts, and developing VLSI verification workflows.
5	Enable writing efficient Make files to automate tasks and manage regression flows in VLSI projects.

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	Experiment with shell scripts programmatically using different features and debugging techniques.	An
CO 2	Experiment with TCL scripts for VLSI applications, focusing on the analysis of area, power, and time.	An
CO 3	Experiment with PERL scripts to create and manipulate scalar, array, and hash variables.	An
CO 4	Design and implement automation scripts using Python for VLSI tool integration and workflow management.	An
CO 5	Analyze the efficiency and performance of scripts through profiling tools and optimize them for large-scale VLSI design tasks.	An

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Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independently carry out research /investigation and work	Write and present a substantial technical report/document	Demonstrate a degree of mastery over the area	Designing and Optimizing analog, digital, and mixed-signal VLSI systems using advanced design tools.	Apply emerging Semiconductor technologies to develop high-performance VLSI Circuits	Lifelong learning, lead responsibly, and adapt to evolving technologies for academia, industry and entrepreneurship.
1	3			3	2	
2	3			3	2	
3						
4						
5	3			3	2	

Course Content

LINUX Introduction to Linux – Linux OS structure – Types of Kernels– Linux Commands - sed – grep – awk. **Practical Component:** • Basic Linux Commands and File Management	**6 Hours** **6 Hours**
TCL SCRIPTING Strings – Lists – Array – Procedures - Loop Statements - Decision statements – Dictionary - File Handling - Regular Expressions & Regular Substitutions. - Namespaces - File Manipulations -Error Handling – Examples – Application of TCL in VLSI Tools. **Practical Component:** • Introduction to Shell Scripting and Automation	**6 Hours** **6 Hours**
PERL SCRIPTING Introduction to PERL- Conditional Statements -Additional Control Statements- Loop Control Statements- Arithmetic Operators-Array Variables-File Handling-Subroutines- Introduction to References-Understanding Packages and Libraries- Process Management-Introduction to PERL OOPS . **Practical Component:** • Exploring TCL and TK Scripting for GUI Development • Perl Scripting: Fundamentals and Practical Applications	**6 Hours** **6 Hours**
PYTHON PROGRAMMING Introduction – Datatypes – Constructs – List – Tuples – Dictionary – Strings – Regular Expressions – Handling Text, CSV, XML, JSON files – Functions – Lambda functions - @ARGV array command line arguments - ARGV and	**6Hours**

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the Shift functions - Array Built-in Functions - Functions: grep, split, join, slice, pop, push - Functions: shift, unshift, reverse, sort, chop, chomp - Associative Array Functions **Object oriented Python:** Classes - my function - objects, methods – destructors – Inheritance -Derives classes. **Practical Component:** • Basic Python Programming: Functions and Arithmetic Operations	**6 Hours**
MAKEFILE Writing Makefile - Defining macros and variables. **Practical Component:** Makefile	**6 Hours** **6 Hours**

Theory Hours: 30	**Tutorial Hours:** 0	**Practical Hours:** 30	**Project Hours:** 0	**Total Hours:** 60

Learning Resources

Textbooks:

1. Programming Perl,Tom Christiansen, brian d foy, Larry Wall, Jon Orwant, 4th Edition, O'Reilly Media, Inc. February 2012,
2. Learning Linux Shell Scripting: Leverage the power of shell scripts to solve real-world problems, Ganesh Sanjiv Naik Ganesh Naik , 2nd Edition, Packtpub.

References:

1. Mastering Linux Shell Scripting : A practical guide to Linux command-line, Bash scripting, and Shell programming, Andrew Mallett, 2nd Edition, Packtpub.
2. Beginning Linux Programming, Neil Matthew , Richard Stones, 4th edition, Wrox, 2007.
3. Practical Programming in Tcl and Tk, Brent Welch, Ken Jones, Pearson; 4th edition, 2003.

Online Educational Resources:

1. https://github.com/UdayaShankarS/TCL-Scripting
2. . https://github.com/michaelfromyeg/makefiles
3. https://github.com/learnbyexample/Perl_intro

Assessment (Embedded course)

SA, Activity and Learning Task(s)* , Mini project, MCQ, End Semester Examination (ESE) Lab Workbook, Experimental Cycle tests, viva-voce, etc…

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Course Curated by			
Expert(s) from Industry	**Expert(s) from Higher Education Institution**		**Internal Expert(s)**
Dr. Chrisben Gladson, Sr RF/Wireless Engineer Axiro Semiconductor ·	Dr.D.Nirmal, Professor and Associate Dean of Engineering & Technology Karunya Institute of Technology and Sciences.		Dr. K. Gavaskar Assistant Professor III, ECE, Kumaraguru College of Technology
Recommended by BoS on	30/04/2025		
Academic Council Approval	No.28	**Date**	26/06/2025

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24VLT510	Semiconductor Devices and Modeling	L	T	P	J	C
		3	0	0	0	3
PC		SDG	9			

Pre-requisite courses	NIL	Data Book / Code book (If any)	NIL

Course Objectives:	
The purpose of taking this course is to:	
1	To understand the band structure and electronic properties of intrinsic and extrinsic semiconductors, including carrier statistics and recombination mechanisms.
2	To study the mathematical and numerical techniques used in semiconductor device simulations, including Poisson, continuity, drift-diffusion, and Schrödinger equations.
3	To analyze the operation and characteristics of semiconductor junction devices such as p-n junctions, tunnel diodes, and Schottky contacts.
4	To understand metal-semiconductor interfaces, heterojunction devices, and advanced semiconductor structures including HEMTs and TFTs.
5	To study the operating principles, characteristics, and short-channel effects of MOS capacitors and MOSFET devices.

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	Understand the band structure, carrier transport, density of states, and recombination mechanisms in semiconductors.	U
CO 2	Apply semiconductor equations and numerical techniques for analyzing semiconductor device behavior and simulations.	Ap
CO 3	Analyze the electrostatics and current-voltage characteristics of p-n junctions, tunnel diodes, and semiconductor interfaces.	An
CO 4	Evaluate the characteristics and energy band behavior of Schottky barriers, heterojunctions, and advanced semiconductor devices.	E
CO 5	Analyze the operation, performance limitations, and scaling challenges of MOSFETs and evaluate the characteristics of emerging transistor devices such as HEMTs, FinFETs, Tunnel FETs, and TFTs.	An

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Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independently carry out research /investigation and work	Write and present a substantial technical report/document	Demonstrate a degree of mastery over the area	Designing and Optimizing analog, digital, and mixed-signal VLSI systems using advanced design tools.	Apply emerging Semiconductor technologies to develop high-performance VLSI Circuits	Lifelong learning, lead responsibly, and adapt to evolving technologies for academia, industry and entrepreneurship
1	2	1	3	2	1	2
2	2	2	3	3	2	2
3	3	2	3	3	3	2
4	3	1	3	3	3	3
5	3	3	3	3	3	3

Course Content	
BAND STRUCTURE AND ELECTRONIC PROPERTIES OF SEMICONDUCTORS Concept of band gap: Direct and indirect bands in semiconductor, Band structure of selected Semiconductors: Si,Ge, GaAs, GaN, ZnO. Semiconductor alloys, Lattice-mismatched and pseudomorphic materials, variation of Energy bands with alloy composition, Amorphous Semiconductors. Energy distribution functions, Density of states, Density of carriers in Intrinsic and Extrinsic semiconductors, Compensation in semiconductors, Heavy doping – Band tail states, Effective mass, Hall Effect. Carrier Generation and Recombination, Characteristics of Excess Carriers: continuity equations, time dependent diffusion equations. Excess - carrier lifetime: Effect of traps and defects, Surface effects.	**9 Hours**
MATHEMATICAL TECHNIQUES FOR DEVICE SIMULATIONS Poisson equation, continuity equation, drift-diffusion equation, Principles of Quantum Mechanics – energy quanta, wave-particle duality, the uncertainty principle, Schrodinger equation – the wave equation, physical meaning of the wave equation, boundary conditions, Applications of Schrodinger equation – electron in free space, the infinite potential wall, step potential function, the potential barrier	**9 Hours**
P-N JUNCTIONS p-n junction formation, Electrostatics of the p-n junction: Contact potential and Space Charge. Current - Voltage relationship, Quasi- Fermi levels and High- level injection, Graded Junctions, Junction Breakdown, Tunnel Diode	**9 Hours**

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METAL-SEMICONDUCTOR AND SEMICONDUCTOR HETEROJUNCTIONS Schottky Barriers: Ideal junction properties, Non-ideal Effects on the Barrier Height, Current-Voltage Relationship, Capacitance-Voltage. Ohmic Contacts: Ideal Nonrectifying Barriers, Tunneling Barrier, Specific contact resistance: Multiple -Contact Two-Terminal Methods. Heterojunctions: Heterojunction Materials, EnergyBand Diagrams, Two-Dimensional Electron Gas, Current-Voltage Characteristics, Band Offsets, Heterojunction Band Lineups - Types.	**9 Hours**
MOSFETs AND BEYOND MOSFET DEVICES MOSFET basics, Challenges in Real MOSFETS- Second order effects, Subthreshold Conduction, Mobility Variation with Gate Bias, Important Effects in Short-Channel MOSFETs. Heterojunction FET: High electron mobility transistors (HEMT), FinFET, Tunnel FET, Thin film transistors (TFT).	**9 Hours**

Theory Hours: 45	**Tutorial Hours:**	**Practical Hours:**	**Project Hours:**	**Total Hours:** 45

Learning Resources

Textbooks:

6. Donald Neamen and Dhrubes Biswas, "Semiconductor Physics and Devices", 4th edition, McGraw Hill Education, 2017.
7. Yuan Taur and Tak H.Ning, "Fundamentals of Modern VLSI Devices", Cambridge University, Press, 2016.
8. A.B. Bhattacharyya "Compact MOSFET Models for VLSI Design", John Wiley & Sons Ltd, 2009.

References:

4. Ansgar Jungel, "Transport Equations for Semiconductors", Springer, 2009
5. Trond Ytterdal, Yuhua Cheng and Tor A. Fjeldly Wayne Wolf, "Device Modeling for Analog and RF CMOS Circuit Design", John Wiley & Sons Ltd, 2004
6. Selberherr, S., "Analysis and Simulation of Semiconductor Devices", Springer-Verlag., 1984
7. Behzad Razavi, "Fundamentals of Microelectronics" Wiley Student Edition, 2nd Edition, 2014.

Online Educational Resources:

3. https://onlinecourses.nptel.ac.in/noc23_ee35/preview

Assessment (Theory course)

SA, Activity and Learning Task(s)*, Mini project, MCQ, End Semester Examination (ESE)

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Course Curated by			
Expert(s) from Industry	**Expert(s) from Higher Education Institution**		**Internal Expert(s)**
Dr. Chrisben Gladson, Sr RF/Wireless Engineer Axiro Semiconductor ·	Dr.D.Nirmal, Professor and Associate Dean of Engineering & Technology Karunya Institute of Technology and Sciences.		Dr. Ananya Bhattacharya Assistant Professor I, ECE, Kumaraguru College of Technology
Recommended by BoS on	06.06.2026		
Academic Council Approval	No.31	**Date**	19.06.2026

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24INT501	RESEARCH METHODOLOGY AND IPR	L	T	P	J	C
		3	0	0	0	3
ES		SDG	9,12,13			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:	
The purpose of taking this course is to:	
1	Equip students with the knowledge and skills necessary to design, conduct and critically evaluate research
2	Draft research reports and present effective research findings
3	foster an understanding of intellectual property rights and ethical considerations essential for successful research and innovation

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	Apply the scientific method and research planning steps to formulate research problems and objectives	Ap
CO 2	Analyze different research designs and ethical considerations to classify research types and ensure ethical integrity	An
CO 3	Evaluate the structure and components of research reports to organize and present research findings effectively	E
CO 4	Interpret data collection tools and statistical methods to visualize and analyze biological research data	An
CO 5	Create a research proposal incorporating IPR principles to develop innovative and ethically sound research plans	C

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independently carry out research /investigation and work	Write and present a substantial technical report/document	Demonstrate a degree of mastery over the area	Analyze and solve complex structural engineering problems	Use modern/advanced techniques, tools and skills	Communicate with larger community, to design and document complex problems
1	3	3		3	3	
2	3	3		3		
3	3			3		3

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4	3	3		3		3
5	3	3		3		

Course Content

INTRODUCTION TO RESEARCH METHODS Definition and Objectives of Research, Scientific Method, Various Steps in Scientific Research, Research Planning, Selection of a Problem for Research, Formulation of Selected Problems, Purpose of the Research, Formulation of Research Objectives, Formulation of Research Questions, Hypotheses Generation and Evaluation, Literature Search and Review Process.	**9 Hours**
RESEARCH DESIGN AND ETHICS Types and Methods of Research, Classification of Research, Research Ethics: Informed Consent, Confidentiality, Data Protection, Sampling Techniques, Methods of Collecting Primary Data, Use of Secondary Data, Experimentation, Design of Experiments, Survey Research, Construction of Questionnaires, Pilot Studies, and Pre-tests, Data Collection Methods, Processing, Editing, Classification, and Coding Validity, Reliability, Ethical Dilemmas and Solutions.	**9 Hours**
RESEARCH REPORTS Components of Research Articles, Manuscripts, Thesis, and Review Papers, Preparation of Thesis Documents: Referencing, In-text Citations, Tools like Endnote, Mendeley, Writing Techniques: CARS Model, Organizing Literature Review, Materials, and Methods Critical Thinking for Writing the Discussion Section. **Case Study:** Comparison of Research Articles with and without Referencing Tools	**9 Hours**
DATA COLLECTION AND ANALYSIS FOR RESEARCH Tools for Data Collection: Clinical Trials, Surveys, Questionnaires, Observational Methods, Data Management and Preparation, Overview of Statistical Concepts, Descriptive Statistics: Mean, Median, Mode, Variance, Standard Deviation, Data Visualization Techniques. **Case Study:** Journal Club on Research Papers Published in Tier 1 Journals	**9 Hours**
INTELLECTUAL PROPERTY RIGHTS (IPR) AND RESEARCH GRANTS Introduction to Intellectual Property Rights: Patents, Trademarks, Copyrights, Trade Secrets, Importance of IPR in Research and Innovation, developing a Research Proposal: Components, Do's and Don'ts, Writing Winning Research Proposals, Peer Review, and Feedback, Finalizing Research Plans. **Case Study:** Evaluating Successful Research Proposals and Understanding the Role of IPR	**9 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**0**	**Practical Hours:**	**0**	**Project Hours:**	**0**	**Total Hours:**	**45**

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Learning Resources:

Textbooks:

1. Cooper, D. R., Schindler, P. S., & Sharma, J. K.. Business research methods (11th ed.). Tata McGraw Hill Education. (2012)
2. Hazari, A.. Research Methodology for Allied Health Professionals. Springer Nature Singapore. (2023)
3. Goh, K. M. Research Methodology in Bioscience and Biotechnology. Springer. (2023)
4. Ganguli, P. Intellectual property rights: Unleashing the knowledge economy. McGraw Hill Education. (2017)

References:

1. AJIET. (n.d.). Lecture Notes on Research Methodology & Intellectual Property Rights. Retrieved from https://www.ajiet.edu.in/img/basic-science/21RMI56%20notes.pdf
2. Oxford University Press. (n.d.). Handbook of Intellectual Property Research: Lenses, Methods, and Perspectives. Retrieved from https://academic.oup.com/book/41122
3. Goddard, W., & Melville, S.. Research Methodology: An Introduction for Science & Engineering Students. Juta and Company Ltd. (2004)
4. Kumar, R. Research Methodology: A Step by Step Guide for Beginners (4th ed.). SAGE Publications. (2014)

Online Educational Resources:

1. https://hrdc.ugc.ac.in/Web/Home/ViewCourseDetails/842/
2. https://onlinecourses.swayam2.ac.in/ntr24_ed08/preview

Assessment (Theory course)
SA, Activity and Learning Task(s), Mini project, MCQ, End Semester Examination (ESE)

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