M. Tech.

IN

VLSI SYSTEM ENGINEERING

CURRICULUM
(For students admitted in 2016-17)
CURRICULUM

The total minimum credits for completing the M.Tech. programme in VLSI System is 66.

SEMESTER I

<table>
<thead>
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<tr>
<td>1.</td>
<td>MA617</td>
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<tr>
<td>2.</td>
<td>EC651</td>
<td>Analog IC Design</td>
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<td>Basics of VLSI</td>
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SEMESTER II

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<tr>
<td>1.</td>
<td>EC652</td>
<td>VLSI System Testing</td>
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<td>EC654</td>
<td>Electronic Design Automation Tools</td>
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<td>Design of ASICs</td>
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<td>ASIC – CAD Laboratory</td>
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## SEMESTER IV

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## LIST OF ELECTIVES

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<td>EC661</td>
<td>Digital System Design</td>
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<td>2.</td>
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<td>Modeling and Synthesis with Verilog HDL</td>
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<td>Optimization of Digital Signal Processing structures for VLSI</td>
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<td>EC664</td>
<td>Cognitive Radio</td>
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<td>EC665</td>
<td>VLSI Process Technology</td>
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<td>EC666</td>
<td>Analysis and Design of Digital Systems using VHDL</td>
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<td>EC667</td>
<td>Advanced Computer Architecture</td>
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<td>Low Power VLSI circuits</td>
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<td>EC669</td>
<td>VLSI Digital Signal Processing Systems</td>
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<td>Asynchronous System Design</td>
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<td>Advanced Digital Design</td>
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<td>Physical Design Automation</td>
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<td>Mixed - Signal Circuit Design</td>
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<td>RF circuits</td>
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<td>Thermal Design of Electronic Equipment</td>
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<td>Functional Verification using Hardware Verification Languages</td>
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<td>Testability of Analog / Mixed-Signal Circuits &amp; High Speed Circuit Design</td>
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<td>High Speed Communication Networks</td>
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<td>Digital Image Processing</td>
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**LIST OF OPEN ELECTIVES**

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<tr>
<td>1.</td>
<td>EC653</td>
<td>Basics of VLSI</td>
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<tr>
<td>2.</td>
<td>EC662</td>
<td>Modeling and Synthesis with Verilog HDL</td>
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Course Code: MA617  
Course Title: Graph Theory and Discrete Optimization  
Number of Credits: 3  
Course Type: Core

Course Learning Objective
- To introduce the basics of graphs and combinatory required for VLSI design and Optimization.

Course Content

Text Books

Reference Book
2. Recent literature in Graph Theory and Discrete Optimization.

Course outcomes
At the end of the course student will be able
CO1: understand the various types of graph Algorithms and graph theory properties.
CO2: analyse the NP – complete problems.
CO3: distinguish the features of the various tree and matching algorithms
CO4: appreciate the applications of digraphs and graph flow.
CO5: understand the linear programming principles and its conversion.
Course Code : EC651
Course Title : Analog IC Design
Number of Credits : 3
Course Type : Core

Course Learning Objectives
- To develop the ability design and analyze MOS based Analog VLSI circuits to draw the equivalent circuits of MOS based Analog VLSI and analyze their performance.
- To develop the skills to design analog VLSI circuits for a given specification.

Course Content

Basic MOS Device Physics – General Considerations, MOS I/V Characteristics, Second Order effects, MOS Device models. Short Channel Effects and Device Models. Single Stage Amplifiers – Basic Concepts, Common Source Stage, Source Follower, Common Gate Stage, Cascode Stage.


Feedback Amplifiers – General Considerations, Feedback Topologies, Effect of Loading.


Bandgap References, Introduction to Switched Capacitor Circuits, Nonlinearity and Mismatch.

Text Books

Reference Books
4. Recent literature in Analog IC Design.
Course outcomes

At the end of the course student will be able

CO1: draw the equivalent circuits of MOS based Analog VLSI and analyze their performance.
CO2: design analog VLSI circuits for a given specification.
CO3: analyse the frequency response of the different configurations of a amplifier.
CO4: understand the feedback topologies involved in the amplifier design.
CO5: appreciate the design features of the differential amplifiers.
Course Code : EC653  
Course Title : Basics of VLSI  
Number of Credits : 3  
Course Type : Core  

Course Learning Objectives
- To provide rigorous foundation in MOS and CMOS digital circuits
- To train the students in transistor budgets, clock speeds and the growing challenges of power consumption and productivity

Course Content
Introduction to CMOS circuits: MOS transistors, CMOS combinational logic gates, multiplexers, latches and flip-flops, CMOS fabrication and layout, VLSI design flow.

MOS transistor theory: Ideal I-V and C-V characteristics, non ideal I-V effects, DC transfer characteristics, Switch level RC delay models.

CMOS technologies: Layout design rules, CMOS process enhancement, Technology related CAD issues.

Circuit characterization and performance estimation: Delay estimation, Logical effort and transistor sizing, Power dissipation, Interconnect design margin, Reliability, Scaling.

Combinational circuit design: Static CMOS, Ratioed circuits, Cascode voltage switch logic, Dynamic circuits, Pass transistor circuits.

Text Books

Reference Book
2. Recent literature in Basics of VLSI.

Course outcomes
At the end of the course student will be able

CO1: implement the logic circuits using MOS and CMOS technology.
CO2: analyse various circuit configurations and their applications
CO3: analyse the merits of circuits according to the technology and applications change.
CO4: design low power CMOS VLSI circuits.
CO5: understand the rapid advances in CMOS Technology
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<td>Course Title</td>
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<td>Course Type</td>
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</table>

**List of Experiments**

1. Adder/ Subtractor
2. Multiplexer/ Demultiplexer
3. Encoder/ Priority Encoder
4. Code Converter
5. Flipflop
6. Shift Register/ Universal Shift Register
7. Comparator
8. Upcounter/ Downcounter
9. Udps
10. Memory – ROM, RAM
11. Array Multiplier/ Array Multiplier With Pipelining
12. Fir Filter/ Fir Filter With Pipelining
Course Code : EC652
Course Title : VLSI System Testing
Number of Credits : 3
Course Type : Core

Course Learning Objectives
- To expose the students, the basics of testing techniques for VLSI circuits and Test Economics.

Course Content
Universal test sets: Pseudo-exhaustive and iterative logic array testing. Clocking schemes for delay fault testing. Testability classifications for path delay faults. Test generation and fault simulation for path and gate delay faults.
Design for testability: Scan design, Partial scan, use of scan chains, boundary scan, DFT for other test objectives, Memory Testing.
Built-in self-test: Pattern Generators, Estimation of test length, Test points to improve testability, Analysis of aliasing in linear compression, BIST methodologies, BIST for delay fault testing.

Text Books

Reference Books
4. Recent literature in VLSI System Testing.

Course outcomes
At the end of the course student will be able
CO1: apply the concepts in testing which can help them design a better yield in IC design.
CO2: tackle the problems associated with testing of semiconductor circuits at earlier design levels so as to significantly reduce the testing costs.
CO3: analyse the various test generation methods for static & dynamic CMOS circuits.
CO4: identify the design for testability methods for combinational & sequential CMOS circuits.
CO5: recognize the BIST techniques for improving testability.
Course Code : EC654  
Course Title : Electronic Design Automation Tools  
Number of Credits : 3  
Course Type : Core

Course Learning Objectives
- To make the students exposed to Front end and Back end VLSI CAD tools.

Course Content
OS Architecture: System settings and configuration. Introduction to UNIX commands Handling directories, Filters and Piping, Wildcards and Regular expression, Power Filters and Files Redirection. Working on Vi editor, Basic Shell Programming, TCL Scripting language.
System Verilog- Introduction, Design hierarchy, Data types, Operators and language constructs. Functional coverage, Assertions, Interfaces and test bench structures.

Text Books

Reference Books
3. Recent literature in Electronic Design Automation Tools.

Course outcomes
At the end of the course student will be able
CO1: execute the special features of VLSI back end and front end CAD tools and UNIX shell script
CO2: explain the algorithms used for ASIC construction
CO3: design synthesizable Verilog and VHDL code.
CO4: explain the difference between Verilog and system Verilog and are able to write system Verilog code.
CO5: Model Analog and Mixed signal blocks using Verilog A and Verilog AMS
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<td>Course Title</td>
<td>Design of ASICs</td>
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<td>Number of Credits</td>
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<tr>
<td>Course Type</td>
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**Course Learning Objectives**

- To prepare the student to be an entry-level industrial standard ASIC or FPGA designer.
- To give the student an understanding of issues and tools related to ASIC/FPGA design and implementation.
- To give the student an understanding of basics of System on Chip and Platform based design.
- To give the student an understanding of High performance algorithms

**Course Content**

Introduction to Technology, Types of ASICs, VLSI Design flow, Design and Layout Rules, Programmable ASICs - Antifuse, SRAM, EPROM, EEPROM based ASICs. Programmable ASIC logic cells and I/O cells. Programmable interconnects. Advanced FPGAs and CPLDs and Soft-core processors.


Semicustom Approach: Synthesis (RTL to GATE netlist) - Introduction to Constraints (SDC), Introduction to Static Timing Analysis (STA). Place and Route (Logical to Physical Implementation): Floorplan and Power-Plan, Placement, Clock Tree Synthesis (clock planning), Routing, Timing Optimization, GDS generation.


System-On-Chip Design - SoC Design Flow, Platform-based and IP based SoC Designs, Basic Concepts of Bus-Based Communication Architectures. High performance algorithms for ASICs/ SoCs as case studies – Canonic Signed Digit Arithmetic, KCM, Distributed Arithmetic, High performance digital filters for sigma-delta ADC.

**Text Book**


**Reference Books**


6. Recent literature in Design of ASICs.

Course outcomes

At the end of the course student will be able

CO1: demonstrate VLSI tool-flow and appreciate FPGA and CPLD architectures
CO2: understand the issues involved in ASIC design, including technology choice, design management and tool-flow.
CO3: understand the algorithms used for ASIC construction.
CO4: understand Full Custom Design Flow and Tool used
CO5: understand Semicustom Design Flow and Tool used - from RTL to GDS and Logical to Physical Implementation
CO6: understand about STA, LEC, DRC, LVS, DFM
CO7: understand the basics of System on Chip and on chip communication architectures appreciate high performance algorithms for ASICs
**Course Code**: EC658  
**Course Title**: Analog IC Design Laboratory  
**Number of Credits**: 2  
**Course Type**: Laboratory

**List of Experiments**

1. Characteristics of NMOS & PMOS Transistor  
2. Design of Common Source Amplifier with different Loads  
3. Design of Common Gate Amplifier  
4. Design of Common Drain Amplifier  
5. Design of Single stage Cascode Amplifiers  
6. Design of Current Mirrors  
7. Design of Differential Amplifiers with Different Loads  
8. Design of Two stage Opamp  
9. Design of Telescopic Cascode Opamp  
10. Design of Folded Cascode Opamp
Course Code : EC 660
Course Title : ASIC – CAD Laboratory
Number of Credits : 2
Course Type : Laboratory

List of Experiments

1. Adder/ Subtractor
2. Multiplexer/ Demultiplexer
3. 8-bit Counter
4. Signed Pipelined Multiplier
5. Accumulator
6. MAC
7. Memory

The above experiments are carried out using the following tools:

1. Model SIM
2. Cadence
3. Synopsis
4. Mentor Graphics
5. Xilinx Planahead
Course Code : EC661
Course Title : Digital System Design
Number of Credits : 3
Course Type : Elective

Course Learning Objectives
- To get an idea about designing complex, high speed digital systems and how to implement such design.

Course Content
Mapping algorithms into Architectures: Data path synthesis, control structures, critical path and worst case timing analysis. FSM and Hazards.


Data path and array subsystems: Addition / Subtraction, Comparators, counters, coding, multiplication and division. SRAM, DRAM, ROM, serial access memory, context addressable memory.

Reconfigurable Computing- Fine grain and Coarse grain architectures, Configuration architectures-Single context, Multi context, partially reconfigurable, Pipeline reconfigurable, Block Configurable, Parallel processing.

Text Books

Reference Books
6. Recent literature in Digital System Design.
Course outcomes

At the end of the course student will be able

CO1: identify mapping algorithms into architectures.
CO2: summarize various delays in combinational circuit and its optimization methods.
CO3: summarize circuit design of latches and flip-flops.
CO4: construct combinational and sequential circuits of medium complexity that is based on VLSIs, and programmable logic devices.
CO5: summarize the advanced topics such as reconfigurable computing, partially reconfigurable, Pipeline reconfigurable architectures and block configurable.
Course Code : EC662  
Course Title : Modeling and Synthesis with Verilog HDL  
Number of Credits : 3  
Course Type : Elective

**Course Learning Objectives**
- To design combinational, sequential circuits using Verilog HDL.
- To understand behavioral and RTL modeling of digital circuits.
- To verify that a design meets its timing constraints, both manually and through the use of computer aided design tools.
- To simulate, synthesize, and program their designs on a development board.
- To verify and design the digital circuit by means of Computer Aided Engineering tools which involves in programming with the help of Verilog HDL.

**Course Content**
Hardware modeling with the verilog HDL. Encapsulation, modeling primitives, different types of description.
Logic system, data types and operators for modeling in verilog HDL. Verilog Models of propagation delay and net delay path delays and simulation, inertial delay effects and pulse rejection.
Behavioral descriptions in verilog HDL. Synthesis of combinational logic.
HDL-based synthesis - technology-independent design, styles for synthesis of combinational and sequential logic, synthesis of finite state machines, synthesis of gated clocks, design partitions and hierarchical structures.
Synthesis of language constructs, nets, register variables, expressions and operators, assignments and compiler directives. Switch-level models in verilog. Design examples in verilog.

**Text Books**

**Reference Books**
3. Recent literature in Modeling and Synthesis with Verilog HDL.

**Course outcomes**
At the end of the course student will be able
- CO1: understand the basic concepts of verilog HDL
- CO2: model digital systems in verilog HDL at different levels of abstraction
- CO3: know the simulation techniques and test bench creation.
- CO4: understand the design flow from simulation to synthesizable version
- CO5: get an idea of the process of synthesis and post-synthesis
**Course Code**: EC663  
**Course Title**: Optimizations of Digital Signal Processing Structures for VLSI  
**Number of Credits**: 3  
**Course Type**: Elective

### Course Learning Objectives

- To understand the various VLSI architectures for digital signal processing.
- To know the techniques of critical path and algorithmic strength reduction in the filter structures.
- To enable students to design VLSI system with high speed and low power.
- To encourage students to develop a working knowledge of the central ideas of implementation of DSP algorithm with optimized hardware.

### Course Content

An overview of DSP concepts, Pipelining of FIR filters. Parallel processing of FIR filters. Pipelining and parallel processing for low power, Combining Pipelining and Parallel Processing.

Transformation Techniques: Iteration bound, Retiming, Folding and Unfolding

Pipeline interleaving in digital filters. Pipelining and parallel processing for IIR filters. Low power IIR filter design using pipelining and parallel processing, Pipelined adaptive digital filters.

Algorithms for fast convolution: Cook-Toom Algorithm, Cyclic Convolution. Algorithmic strength reduction in filters and transforms: Parallel FIR Filters, DCT and inverse DCT, Parallel Architectures for Rank-Order Filters.

Synchronous pipelining and clocking styles, clock skew and clock distribution in bit level pipelined VLSI designs. Wave pipelining, constraint space diagram and degree of wave pipelining, Implementation of wave-pipelined systems, Asynchronous pipelining.

### Text Book


### Reference Books

7. Recent literature in *Optimizations of Digital Signal Processing Structures for VLSI*.

**Course outcomes**

At the end of the course student will be able

CO1: understand the overview of DSP concepts and design architectures for DSP algorithms.
CO2: improve the overall performance of DSP system through various transformation and optimization techniques.
CO3: perform pipelining and parallel processing on FIR and IIR systems to achieve high speed and low power.
CO4: optimize design in terms of computation complexity and speed.
CO5: understand clock based issues and design asynchronous and wave pipelined systems.
Course Learning Objective
- This subject introduces the fundamentals of multi rate signal processing and cognitive radio.

Course Content


Text Books

Reference Books
5. T. DarcChiueh, P. Yun Tsai,” OFDM baseband receiver design for wireless communications”, Wiley, 2007
6. Recent literature in Cognitive Radio.
Course outcomes
At the end of the course student will be able

CO1: gain knowledge on multirate systems.
CO2: develop the ability to analyze, design, and implement any application using FPGA.
CO3: be aware of how signal processing concepts can be used for efficient FPGA based system design.
CO4: understand the rapid advances in Cognitive radio technologies.
CO5: explore DDFS, CORDIC and its application.
Course Code : EC665  
Course Title : VLSI Process Technology  
Number of Credits : 3  
Course Type : Elective

Course Learning Objectives
- To provide rigorous foundation in MOS and CMOS fabrication process.

Course Content

Optical, electron, X-ray and ion lithography methods. Plasma properties, size, control, etch mechanism, etch techniques and equipments.


Ion implantation and metallization. Process simulation of ion implementation, diffusion, oxidation, epitaxy, lithography, etching and deposition. NMOS, CMOS, MOS memory and bipolar IC technologies. IC fabrication.

Analytical and assembly techniques. Packaging of VLSI devices.

Text Books

Course outcomes
At the end of the course student will be able

CO1: appreciate the various techniques involved in the VLSI fabrication process.
CO2: understand the different lithography methods and etching process.
CO3: appreciate the deposition and diffusion mechanisms.
CO4: analyze the fabrication of NMOS, CMOS memory and bipolar devices
CO5: understand the nuances of assembly and packaging of VLSI devices.
Course Code : EC666  
Course Title : Analysis and Design of Digital Systems using VHDL  
Number of Credits : 3  
Course Type : Elective

Course Learning Objectives
- To prepare the student to understand the VHDL language feature to realize the complex digital systems.
- To design and simulate sequential and concurrent techniques in VHDL.
- To explain modeling of digital systems using VHDL and design methodology.
- To explain predefined attributes and configurations of VHDL.
- To understand behavioral, non-synthesizable VHDL and its role in modern design.

Course Content
An overview of design procedures for system design using CAD tools. Design verification tools. Examples using commercial PC based VLSI CAD tools. Design methodology based on VHDL. Basic concepts and structural descriptions in VHDL.

Characterizing hardware languages, objects and classes, signal assignments, concurrent and sequential assignments. Structural specification of hardware.

Design organization, parameterization and high level utilities, definition and usage of subprograms, packaging parts and utilities, design parameterization, design configuration, design libraries. Utilities for high-level descriptions.

Data flow and behavioral description in VHDL- multiplexing and data selection, state machine description, open collector gates, three state bussing, general dataflow circuit, updating basic utilities. Behavioral description of hardware.

CPU modeling for discrete design- Parwan CPU, behavioral description, bussing structure, data flow, test bench, a more realistic Parwan. Interface design and modeling. VHDL as a modeling language.

Text Books

Reference Books
4. Recent literature in Analysis and Design of Digital Systems using VHDL.
Course outcomes

At the end of the course student will be able

CO1: model, simulate, verify, and synthesize with hardware description languages.
CO2: understand and use major syntactic elements of VHDL - entities, architectures, processes, functions, common concurrent statements, and common sequential statements
CO3: design digital logic circuits in different types of modeling
CO4: demonstrate timing and resource usage associated with modeling approach.
CO5: use computer-aided design tools for design of complex digital logic circuits.
Course Code : EC667  
Course Title : Advanced Computer Architecture  
Number of Credits : 3  
Course Type : Elective

**Course Learning Objectives**
- To give an exposure on look ahead pipelining- parallelism, multiprocessor scheduling, multithreading and various memory organizations.

**Course Content**

**Text Books**

**Reference Book**
2. Recent literature in Advanced Computer Architecture.

**Course outcomes**
At the end of the course student will be able
- CO1: apply the basic knowledge of partitioning and scheduling in Multiprocessors.  
- CO2: analyze and design cache memory, virtual memory and shared memory Organizations.  
- CO3: distinguish and analyze the design properties of Linear and Non - Linear processors.  
- CO4: analyze the principles of multithreading in hybrid Architectures.  
- CO5: write any parallel programming models for various architectures and Applications.
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<td>Course Title</td>
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<td>Course Type</td>
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**Course Learning Objectives**
- To expose the students to the low voltage device modeling, low voltage, low power VLSI CMOS circuit design.

**Course Content**
Evolution of CMOS technology. 0.25 μm and 0.1 μm technologies. Shallow trench isolation. Lightly-doped drain. Buried channel. BiCMOS and SOI CMOS technologies. Second order effects and capacitance of MOS devices.

CMOS inverters, static logic circuits of CMOS, pass transistor, BiCMOS, SOI CMOS and low power CMOS techniques.

Basic concepts of dynamic logic circuits. Various problems associated with dynamic logic circuits. Differential, BiCMOS and low voltage dynamic logic circuits.

Different types of memory circuits.

Adder circuits, Multipliers and advanced structures – PLA, PLL, DLL and processing unit.

**Text Books**

**Reference Books**
2. Recent literature in Low Power VLSI Circuits.

**Course outcomes**
At the end of the course student will be able

CO1: acquire the knowledge about various CMOS fabrication process and its modeling.
CO2: infer about the second order effects of MOS transistor characteristics.
CO3: analyze and implement various CMOS static logic circuits.
CO4: learn the design of various CMOS dynamic logic circuits.
CO5: learn the design techniques low voltage and low power CMOS circuits for various applications.
CO6: learn the different types of memory circuits and their design.
CO7: design and implementation of various structures for low power applications.
Course Code : EC669
Course Title : VLSI Digital Signal Processing Systems
Number of Credits : 3
Course Type : Elective

Course Learning Objectives

- To enable students to design VLSI systems with high speed and low power.
- To encourage students to develop a working knowledge of the central ideas of implementation of DSP algorithm with optimized hardware.

Course Content


Bit level arithmetic Architectures- parallel multipliers, interleaved floor-plan and bit-plane-based digital filters, Bit serial multipliers, Bit serial filter design and implementation, Canonic signed digit arithmetic, Distributed arithmetic.

Redundant arithmetic -Redundant number representations, carry free radix-2 addition and subtraction, Hybrid radix-4 addition, Radix-2 hybrid redundant multiplication architectures, data format conversion, Redundant to Non-redundant converter.

Numerical Strength Reduction - Subexpression Elimination, Multiple Constant Multiplication, Subexpression Sharing in Digital Filters, Additive and Multiplicative Number Splitting.

Text Book


Reference Book


Course outcomes

At the end of the course student will be able

CO1: Acquire the knowledge of round off noise computation and numerical strength reduction.
CO2: Ability to design Bit level and redundant arithmetic Architectures.
Course Code : EC670
Course Title : Asynchronous System Design
Number of Credits : 3
Course Type : Elective

Course Learning Objectives
- This subject introduces the fundamentals and performance of Asynchronous system
- To familiarize the dependency graphical analysis of signal transmission graphs
- To learn software languages and its syntax and operations for implementing Asynchronous Designs

Course Content
Fundamentals: Handshake protocols, Muller C-element, Muller pipeline, Circuit implementation styles, theory. Static data-flow structures: Pipelines and rings, Building blocks, examples


High-level languages and tools: Concurrency and message passing in CSP, Tangram program examples, Tangram syntax-directed compilation, Martin’s translation process, Using VHDL for Asynchronous Design. An Introduction to Balsa: Basic concepts, Tool set and design flow, Ancillary Balsa Tools


Text Books

Reference Books
3. A Designer's Guide to Asynchronous VLSI, Peter A. Beerel, Recep O. Ozdag, Marcos Ferretti, 2010
4. Recent literature in Asynchronous System Design.

Course outcomes

At the end of the course student will be able

CO1: understand the fundamentals of Asynchronous protocols
CO2: analyse the performance of Asynchronous System and implement handshake circuits
CO3: understand the various control circuits and Asynchronous system modules
CO4: gain the experience in using high level languages and tools for Asynchronous Design
CO5: learn commands and control flow of Balsa language for implementing Asynchronous Designs
Course Code : EC671
Course Title : Advanced Digital Design
Number of Credits : 3
Course Type : Elective

Course Learning Objectives

- To make the students learn about graphical models and state diagram in designing optimized digital circuits.
- To provide the students a detailed knowledge of scheduling algorithm, synthesis of pipelined circuits and scheduling pipelined circuits
- To enable the students to design digital design with advanced technique like Sequential logic optimization and test the designed circuit Testability considerations.

Course Content


Scheduling algorithms-Scheduling with and without constraints. Scheduling algorithms for extended sequencing models. Scheduling pipelined circuits.


Text Books


Reference Books

5. Recent literature in Advanced Digital Design.

Course outcomes

At the end of the course student will be able
CO1: understand advanced state of art techniques of digital design.
CO2: synthesis the circuits and evaluate its performance in terms of area, power and speed.
CO3: understand the use of scheduling algorithm.
CO4: gain in-depth knowledge of sequential digital circuits designed using resource sharing.
CO5: understand synchronization across clock domains, timing analysis, and Testability considerations
Course Learning Objectives

- Understand the concepts of Physical Design Process such as partitioning, Floorplanning, Placement and Routing.
- Discuss the concepts of design optimization algorithms and their application to physical design automation.
- Understand the concepts of simulation and synthesis in VLSI Design Automation
- Formulate CAD design problems using algorithmic methods

Course Content

VLSI design automation tools- algorithms and system design. Structural and logic design. Transistor level design. Layout design. Verification methods. Design management tools.


Floor planning and routing- floor planning concepts. Shape functions and floor planning sizing. Local routing. Area routing. Channel routing, global routing and its algorithms.

Simulation and logic synthesis- gate level and switch level modeling and simulation. Introduction to combinational logic synthesis. ROBDD principles, implementation, construction and manipulation. Two level logic synthesis.


Text Books


Reference Books

3. Recent literature in Physical Design Automation.
Course outcomes

At the end of the course student will be able

CO1: Students are able to know how to place the blocks and how to partition the blocks while for designing the layout for IC.
CO2: Students are able to solve the performance issues in circuit layout.
CO3: Students are able to analyze physical design problems and Employ appropriate automation algorithms for partitioning, floor planning, placement and routing
CO4: Students are able to decompose large mapping problem into pieces, including logic optimization with partitioning, placement and routing
CO5: Students are able to analyze circuits using both analytical and CAD tools
Course Code : EC673  
Course Title : Mixed - Signal Circuit Design  
Number of Credits : 3  
Course Type : Elective

Course Learning Objectives

- To make the students to understand the design and performance measures concept of mixed signal circuit.

Course Content


Design methodology for mixed signal IC design using gm/Id concept.


CMOS Digital Circuits Design: Design of MOSFET Switches and Switched-Capacitor Circuits, Layout Considerations.

Design of frequency and Q tunable continuous time filters.

Text Books


Course outcomes

At the end of the course student will be able

CO1: appreciate the fundamentals of data converters and also optimized their performances.
CO2: understand the design methodology for mixed signal IC design using gm/Id concept.
CO3: analyze the design of current mirrors and operational amplifiers
CO4: design the CMOS digital circuits and implement its layout.
CO5: design the frequency and Q tunable time domain filters.
Course Code : EC674  
Course Title : Electronic Packaging  
Number of Credits : 3  
Course Type : Elective

Course Learning Objectives
- To expose the students to all aspects of electronic packaging including electrical, thermal, mechanical and reliability issues.

Course Content
Functions of an Electronic Package, Packaging Hierarchy, IC packaging: MEMS packaging, consumer electronics packaging, medical electronics packaging, Trends, Challenges, Driving Forces on Packaging Technology, Materials for Microelectronic packaging, Packaging Material Properties, Ceramics, Polymers, and Metals in Packaging, Material for high density interconnect substrates


Text Book


Reference Books

6. Recent literature in *Electronic Packaging*.

**Course outcomes**

At the end of the course student will be able

CO1: Design of PCBs which minimize the EMI and operate at higher frequency.
CO2: Enable design of packages which can withstand higher temperature, vibrations and shock.
Course Code : EC675
Course Title : RF Circuits
Number of Credits : 3
Course Type : Elective

Course Learning Objectives
- To impart knowledge on basics of IC design at RF frequencies.

Course Content
Characteristics of passive IC components at RF frequencies – interconnects, resistors, capacitors, inductors and transformers – Transmission lines. Noise – classical two-port noise theory, noise models for active and passive components
High frequency amplifier design – zeros as bandwidth enhancers, shunt-series amplifier, $f_T$ doublers, neutralization and unilateralization
Low noise amplifier design – LNA topologies, power constrained noise optimization, linearity and large signal performance
Mixers – multiplier-based mixers, subsampling mixers, diode-ring mixers
RF power amplifiers – Class A, AB, B, C, D, E and F amplifiers, modulation of power amplifiers, linearity considerations
Oscillators & synthesizers – describing functions, resonators, negative resistance oscillators, synthesis with static moduli, synthesis with dithering moduli, combination synthesizers – phase noise considerations.

Text Books

Reference Books
4. Recent literature in RF Circuits.

Course outcomes
At the end of the course student will be able
- CO1: understand the Noise models for passive components and noise theory
- CO2: analyse the design of a high frequency amplifier
- CO3: appreciate the different LNA topologies & design techniques
- CO4: distinguish between different types of mixers
- CO5: analyse the various types of synthesizers, oscillators and their characteristics.
Course Code   :   EC676
Course Title   :   Thermal Design of Electronic Equipment
Number of Credits  :   3
Course Type :   Elective

Course Learning Objectives
- To expose the students to all aspects of electronic equipment and components including electrical, thermal, fluid dynamics and reliability issues.

Course Content


Reference Books

4. Recent literature in Thermal Design of Electronic Equipment.

Course outcomes

At the end of the course student will be able

CO1: design of electronic equipment which minimizes the thermal failures and get the knowledge on cooling Techniques.
CO2: design a package which can withstand higher temperature, vibrations and shock.
CO3: understand the fluid dynamics of electronic cooling systems and heat transfer mechanisms
CO4: appreciate the principle behind heat transfer equipments.
CO5: analyse of thermal stress and strain and cooling techniques.
Course Code : EC677
Course Title : Functional Verification using Hardware Verification Languages
Number of Credits : 3
Course Type : Elective

Course Learning Objectives

Course Content

System Verilog (SV) - Data Types, Arrays, Structures, Unions, Procedural Blocks, Tasks & Functions, Procedural Statements, Interfaces, Basic OOPs, Randomization, Threads & Inter Process Communication, Advanced OOPs & Test bench guidelines, Advanced Interfaces,


System Verilog Assertions (SVA) – Introduction to SVA, Building blocks, Properties, Boolean expressions, Sequence, Single & Multiple Clock definitions, Implication operators (Overlapping & Non-overlapping), Repetition operators, Built-in System functions ($past, $stable, $onehot, $onehot0, $isunknown), Constructs (ended, and, intersect, or, first_match, throughout, within, disableiff, expect, matched, if –else), assertion directives, nested implication, formal arguments in property,

SVA using local variables, calling subroutines, SVA for functional coverage, Connecting SVA to the Design or Test bench, SVA for FSMs, Memories, Protocol checkers, SVA Simulation Methodology, Assertions: Practice & Methodology, Re-use of Assertions, Tracking coverage with Assertions, Using SVA with other languages.


Text Books


**Reference Books**


4. Recent literature in Functional Verification using Hardware Verification Languages.

**Course outcomes**

At the end of the course student will be able
Course Code: EC678
Course Title: Testability of Analog / Mixed-Signal Circuits & High Speed Circuit Design
Number of Credits: 3
Course Type: Elective

Course Learning Objectives

Course Content


ADC Testing: ADC testing versus DAC testing, DC tests and Transfer curve tests, Dynamic ADC tests, ADC Architectures. Sampling Theory. DSP based testing: Advantages of DSP based testing, DSP, Discrete-time transforms, The Inverse FFT.


High speed design techniques: High Speed Op-amps, High Speed op-amp applications, RF/IF Subsystems.

High Speed sampling and High Speed ADCs, High Speed DACs and DDS systems.

Text Books

1. An Introduction to Mixed-signal IC test & Measurement - Mark Burns, Gordon W. Roberts
2. High Speed Design Techniques - Walt Kester, Analog Devices

Reference Books

2. The Fundamentals of Mixed Signal Testing - Brian Lowe
3. Test and Design for Testability in Mixed Signal ICs - Jose L Huertas
5. Recent literature in Testability of Analog / Mixed-Signal Circuits & High Speed Circuit Design.
Course outcomes

At the end of the course student will be able
Course Code : EC679
Course Title : High Speed System Design
Number of Credits : 3
Course Type : Elective

Course Learning Objectives

Course Content

Functions of an Electronic Package, Packaging Hierarchy, IC packaging requirements and properties; materials and substrates; Interconnect Capacitance, Resistance and Inductance fundamentals; IC assembly: Wire bonding, Tape Automated Bonding, Flip Chip, wafer-level packaging; impact on reliability and testability

Overview of Transmission line theory, Clock Distribution, Noise Sources, power Distribution, signal distribution, EMI; crosstalk and nonideal effects; signal integrity: impact of packages, vias, traces, connectors; non-ideal return current paths, high frequency power delivery, simultaneous switching noise; system-level timing analysis and budgeting; methodologies for design of high speed buses; radiated emissions and minimizing system noise;

Practical aspects of measurement at high frequencies; high speed oscilloscopes and logic analyzers


Text Books


Reference Books

IEEE Press
5. Recent literature in High Speed System Design.

Course outcomes

At the end of the course student will be able
Course Code : EC612
Course Title : DSP Architecture
Number of Credits : 3
Course Type : Elective

Course Learning Objective
- To give an exposure to the various fixed point and floating point DSP architectures and to implement real time applications using these processors.

Course Content
Digital Media Processors. Video processing sub systems. Multi-core DSPs. OMAP. CORTEX, SHARC, SIMD, MIMD Architectures.

Text Books

Reference Books
4. Recent literature in DSP Architecture.

Course outcomes
At the end of the course student will be able
CO1: learn the architecture details fixed and floating point DSPs
CO2: infer about the control instructions, interrupts, and pipeline operations, memory and buses.
CO3: illustrate the features of on-chip peripheral devices and its interfacing with real time application devices.
CO4: learn to implement the signal processing algorithms and applications in DSPs.
CO5: learn the architecture of advanced DSPs.
Department of Electronics and Communication Engineering, National Institute of Technology:
Tiruchirappalli – 620 015

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<td>Course Title</td>
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<td>High Speed Communication Networks</td>
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**Course Learning Objectives**
- To impart the students a thorough exposure to the various high speed networking technologies and to analyse the methods adopted for performance modeling, traffic management and routing

**Course Content**

**Text Books**

**Reference Books**
3. Recent literature in High Speed Communication Networks.

**Course outcomes**
At the end of the course student will be able
Students are able to
- CO1: compare and analyse the fundamental principles of various high speed communication networks and their protocol architectures
- CO 2: analyse the methods adopted for performance modeling of traffic flow and estimation
- CO 3: examine the congestion control issues and traffic management in TCP/IP and ATM networks
- CO 4: compare, analyse and implement the various routing protocols in simulation software tools
- CO 5: examine the various services.

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Course Code : EC615
Course Title : Digital Image Processing
Number of Credits : 3
Course Type : Elective

Course Learning Objective
- To explore various techniques involved in Digital Image Processing.

Course Content


Feature Extraction from the Image: Boundary descriptors, Regional descriptors, Relational descriptors. Dimensionality reduction techniques, Discriminative approach and the Probabilistic approach for image pattern recognition.

Text Books

Reference Books
4. Recent literature in Digital Image Processing.

Course outcomes
At the end of the course student will be able
- CO1: understand the need for image transforms different types of image transforms and their properties.
- CO2: develop any image processing application.
- CO3: understand the rapid advances in Machine vision.
- CO4: learn different techniques employed for the enhancement of images.
- CO5: learn different causes for image degradation and overview of image restoration techniques.
CO6: understand the need for image compression and to learn the spatial and frequency domain techniques of image compression.

CO7: learn different feature extraction techniques for image analysis and recognition.
Course Learning Objective

- To impart knowledge on basics of MEMS and their applications in RF circuit design.

Course Content


Micro-machined transmission lines. Coplanar lines. Micro-machined directional coupler and mixer.


Text Books


Reference Books

3. Recent literature in RF MEMS.

Course outcomes

At the end of the course student will be able

CO1: learn the Micromachining Processes  
CO2: learn the design and applications of RF MEMS inductors and capacitors.  
CO3: learn about RF MEMS Filters and RF MEMS Phase Shifters.  
CO4: learn about the suitability of micro-machined transmission lines for RF MEMS  
CO5: learn about the Micro-machined Antennas and Reconfigurable Antennas.
Course Code : EC626  
Course Title : Bio MEMS  
Number of Credits : 3  
Course Type : Elective

Course Learning Objective:
- To train the students in the design aspects of Bio MEMS devices and Systems. To make the students aware of applications in various medical specialists especially the Comparison of conventions methods and Bio MEMS usage.

Course Content:
Introduction-The driving force behind Biomedical Applications – Biocompatibility
- Reliability Considerations-Regularity Considerations – Organizations - Education of Bio MEMS-Silicon Micro fabrication-Soft Fabrication techniques
SENSOR PRINCIPLES and MICRO SENSORS: Introduction-Fabrication-Basic Sensors-Optical fibers-Piezo electricity and SAW devices-Electrochemical detection-Applications in Medicine

Text Book:

Reference Books:
6. Recent literature in Bio MEMS.

Course outcomes:
At the end of the course student will be able

CO1: learn and realize the MEMS applications in Bio Medical Engineering
CO2: understand the Micro fluidic Principles and study its applications.
CO3: learn the applications of Sensors in Health Engineering.
CO4: learn the principles of Micro Actuators and Drug Delivery system
CO5: learn the principles and applications of Micro Total Analysis