BMS COLLEGE OF ENGINEERING, BENGALURU-19

Autonomous Institute, Affiliated to VTU

Department of Electronics and Communication Engineering

Scheme and Syllabus: M.Tech (Electronics)

Batch 2020 onwards

INSTITUTE VISION

Promoting Prosperity of mankind by augmenting human resource capital through Quality Technical Education & Training

INSTITUTE MISSION

Accomplish excellence in the field of Technical Education through Education, Research and Service needs of society

DEPARTMENT VISION

To emerge as a Centre of Academic Excellence in Electronics, Communication and related domains through Knowledge acquisition, knowledgedissemination and Knowledge generation meeting the global needs and standards

DEPARTMENT MISSION

Imparting quality education through state of the art curriculum, conducive learning environment and Research with scope for continuous improvement leading to overall Professional Success

PROGRAM EDUCATIONAL OBJECTIVES

The department has defined the following PEOs for the PG programme in Electronics

PEO-1:
Graduates shall be capable of building their career in related industries, R&D establishments as well as in academia with their scholarly knowledge with respect to advanced topics in Applied Electronics and VLSI Engineering

PEO-2:
Graduates shall be capable of Conceptualizing and Analysing Engineering problems of societal importance related to embedded systems, VLSI and Signal Processing, conduct independent Research leading to technology solutions and communicate the outcomes through verbal and written mechanisms
Graduates shall be capable of conducting research leading to technology solutions of societal importance

PEO-3:
Graduates shall be able to Collaborate, Manage and Execute projects in diversified using appropriate tools/technologies and utmost professionalism and acceptable good practices.

PROGRAM OUTCOMES

Program Outcomes (POs) are attributes acquired by the student at the time of graduation. These attributes are measured at the time of graduation and hence computed every year for the outgoing batch. The POs are addressed and attained through the Course Outcomes (COs) of various courses of the curriculum.

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

PO2: An Ability to write and present a substantial technical report/document

PO3: 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

Distribution of Credits

Category	No. of credits
Program Core Course	26
Program Elective Course	15
All Program Core Course	02
Open Elective Course	04
Internship	09
Technical Seminar	4 Units
Project Work	28

Total Number of Credits (I Sem – IV Sem) = 88 Credits

Distribution ofMarks

For each subject CIE will be conducted for 50, SEE for 100 (will be reduced to 50) and hence total marks of 100 are allotted to each subject including CIE (50) and SEE (50)

M.Tech. (Electronics)

I Semester **CREDIT BASED**

Subject Code	Course Title	Credits			CREDITS
		L	T	P	
20ECELBSAM	Applied Mathematics	3	0	0	3
20ECELPCES	Advanced Embedded Systems	3	0	1	4
20ECELPCSD	Digital System Design	3	0	1	4
20ECELPCCN	Advanced Computer Networks	3	0	0	3
20ECELPEZZ	Elective -1	3	0	0	3
20ECELPEZZ	Elective -2	3	0	0	3
20ALLPICRM	Research Methodology	2	0	0	2
Total					22

Note: Two electives to be chosen from the table below. Elective shall be offered for a minimum strength of six candidates (out of 18) / eightcandidates (out of 24)

Choices for Elective -1 and Elective -2			
20ECELPEVD	CMOS VLSI Design	20ECELPESN	Wireless Sensor Network
20ECELPEAE	Automotive Electronics	20ECELPEME	MEMS
20ECELPECT	Advanced Control Theory	20ECELGEED	Estimation & Detection Techniques

Note1: The course code expansion:
Example: 20ECELBSAM
20: Year of introduction of the syllabus
EC: Department code
EL: Program name
BS: Basic Science
AM: Title of the course

PC/PE: Program Core / Program Elective
GC/GE: Group Core / Group Elective
OE: Open Elective

ZZ: To be replaced with the corresponding code for the title of the course

Exception:
20ALLPICRM be expanded as
20: Year of introduction of the syllabus
ALLP: All Programs
I: Institution
C: Core
RM: “Research Methodology” (Title of the course)

M.Tech. (Electronics)

II Semester **CREDIT BASED**

Subject Code	**Course Title**	**Credits**			**CREDITS**
		L	**T**	**P**	
20ECELPCVV	VLSI Verification & Testing	3	1	0	4
20ECELPCSO	Synthesis & Optimization of Digital Circuits	3	1	0	4
20ECELPCRT	Real Time Operating Systems	3	0	1	4
20ECELPEZZ	Elective -3	3	0	0	3
20ECELPEZZ	Elective -4	3	0	0	3
20ECELOEZZ	Open Elective	4	0	0	4
Total					22

Note: Two electives to be chosen from the table below. Elective shall be offered for a minimum strength of six candidates (out of 18) / eight candidates (out of 24)

Choices for Elective -3 and Elective -4			
20ECELGESP	Advanced DSP	20ECELPEPP	Programming in Python
20ECELPELP	Low Power VLSI	20ECELPENE	Nano Electronics
20ECELPEIT	Internet of Things	20ECELPENN	Artificial Neural Networks

Open Elective offered by the program	
20ECELOEOT	Optimization Techniques

Note: Students are also allowed to opt for open elective from other PG programs from other departments throughout the institute

M.Tech. (Electronics)

III Semester **CREDIT BASED**

Subject Code	Course Title	Credits			CREDITS
		L	T	P	
20ECELGEZZ/20ECELPEZZ	Elective 5	2	1	0	3
20ECELPWP1	Project work Phase 1	0	0	8	8
20ECELPCIN	Internship	0	0	9	9
20ECELSR01	Technical Seminar-1	0	0	2	2
20ECELNCA1	Audit Course-1	0	0	0	2Units*
Total					22

Note: One elective to be chosen from the table below. Elective shall be offered for a minimum strength of six candidates (out of 18) / eight candidates (out of 24)

Choices for Elective -5			
20ECELGEML/20ECVEGEML	Machine Learning & AI	20ECELPESC	System on Chip
20ECELPENS	Network Security & Cryptography	20ECVEGEUV/20ECELGEUV	UVM METHODOLOGY CONCEPTS

M.Tech. (Electronics)

IV Semester **CREDIT BASED**

Subject Code	Course Title	Credits			CREDITS
		L	T	P	
20ECELSR02	Technical Seminar-2	0	0	2	2
20ECELPWP2	Project Work-Phase 2	0	0	20	20
20ECELNCA2	Audit Course-2	0	0	0	2Units*
Total					22

M. Tech- ELECTRONICS

First Semester

Course Title	APPLIED MATHEMATICS				
Course Code	20ECELBSAM	Credits	3	L-T-P	3:0:0
CIE	50 Marks(100% weightage)	SEE		100 Marks (50% weightage)	

Prerequisites:
Basic calculus

Course Outcomes:

CO1	Demonstrate knowledge and understanding of the underlying concepts of random variables and stochastic processes (PO3)
CO2	Demonstrate knowledge of the mathematical concepts and computational aspects of linear algebra and graph theory (PO3)
CO3	Analyse domain related engineering problems and develop analytical problem solving approach making use of the theoretical concepts (PO1)

Unit-I **08hrs**

Review of basic probability theory. Definition of random variables and probability distributions, probability mass and density functions, expectation operator, illustrative examples

Unit-II

07hrs Moments, central moments, characteristic functions, probability generating functions – illustrationsPoisson, Gaussian and Erlang distribution examples. Pair of random variables – Joint PMF, PDF, CDF.

Unit-III

06hrs Random Processes - Classification. Stationary, WSS and ergodic random process. Auto-correlation function-properties, Gaussian random process, Engineering Applications of Random processes.

Unit-IV

08hrs Linear Algebra: Introduction to vector spaces and sub-spaces, definitions, illustrative example. Linearly independent and dependent vectors- Basis-definition and problems. Linear transformations-definitions, Matrix form of linear transformations - Illustrative examples, Computation of Eigen values and Eigen vectors of real symmetric matrices- Given's method. (8 hrs)

Unit-V

07hrs Computational Graph Theory: Graph enumerations and optimization: DFS-BFS algorithm, shortest path algorithm, min-spanning tree and max-spanning tree algorithm, basics of minimum cost spanning trees, optimal routing trees, optimal communication trees (7 hrs)

Text books:

1. S L Miller and D C Childers**, "Probability and random processes: application to signal processing and communication**", Academic Press / Elsevier 2004.
2. David C. Lay, "**Linear Algebra and its Applications**", 3rd Edition, Pearson Education, 2003.

3. GeirAgnarsson and Raymond Greenlaw "**Graph Theory- Modelling, Applications and Algorithms",** Pearson Education, 2007.

Reference books:

1 A. Papoulis and S U Pillai, **"Probability, Random variables and stochastic processes",** McGraw Hill 2002

2 Roy D. Yates and David J. Goodman, **Probability and Stochastic Processes: A friendly introduction for Electrical & Computer Engineers**/

3. MIT Open courseware**, Introduction to Linear Algebra, Course 18.06**

4 NarsingDeo, "**Graph Theory with applications to Engineering and Computer Science**", Prentice Hall of India, 1999.

MOOCs:

1. MIT Opencourseware:

https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-041-probabilistic-systems-analysis-and-applied-probability-fall-2010/

2. NPTEL course by IIT Delhi and IIT Madras:
    a. https://nptel.ac.in/courses/111/102/111102111/
    b. https://nptel.ac.in/courses/111/106/111106112/
    c. https://nptel.ac.in/courses/111/101/111101115/

Course Title	ADVANCED EMBEDDED SYSTEMS				
Course Code	20ECELPCES	Credits	4	L-T-P	3:0:1
CIE	50 Marks(100% weightage)	SEE		100 Marks (50% weightage)	

Prerequisites:

Introduction course on Embedded Systems, Microcontrollers (any)
Basic C Programming Skills

Course Outcomes:

CO1	Comprehend concepts in the field of Embedded Systems
CO2	Apply concepts to build and program Embedded Systems
CO3	Develop Cprograms for execution on microcontroller/SOC development board based on ARM architecture. Develop Python programs to interface with Embedded Systems.
CO4	Engage on market survey of various available Computer/Embedded architecture based on performance, power consumption and prizing criteria

Unit-I **08hrs**

Introduction to ARM architecture and Real Time Embedded Systems:

Introduction to ARM Architecture, Difference between Microcontroller, Application Processor and Realtime Processor architectures. Detail study of ARM Cortex-M processor. Introduction to peripheral interface scheme in ARM processors.Operating Modes and Exceptions.Time Management in Embedded Systems.ARM Instruction Set and its features.

Unit-II **08hrs**

Embedded C Programming:

Detail study of bitwise operators in C. Arrays, Structures and Unions. Pointers and Dynamic Memory allocation. Pre-processor Directives in C. Modular C programming approach. Relook into data types of C. Memory Map and Storage Classes of C. Storage Type Qualifiers.

Unit-III **07hrs**

Python Programming:

Introduction Python Programming, data types, lists, tuples, dictionaries, conditional statements, iterative statements, functions. File and I/O handling, serial device interfaced to external devices. Strings and data formatting, integer, bytes, hexadecimal representation.

Unit-IV **09hrs**

Firmware Architecture for Embedded Systems:

Super Loop, Interrupt driven, RTOS, CMSIS RTOS, Low Power Operations. Speed Power Product, Optimisation for time and space.

Unit-V **07hrs**

Debugging Techniques for Embedded Systems:

Introduction to GNU Debugger gdb.µVision IDE based debugging techniques. Single Stepping, Break Points, Watch Points, and Memory Probing. Simulation using uVision.

Lab Prerequisite:

Working knowledge of Kiel µ Vision MDK IDE on Windows-7

Schedule for laboratorywork: 2 hrs/week

List of Experiments:
Many more lab experiments based on each topic and peripheral. Study datasheet and technical reference manual of case-study Cortex-Mx microcontroller.

1. Install Keil MDK for ARM along with development board drivers. Interface development board to development PC. Download and test blinky code example.
2. Develop a super loop to transmit ADC data on UART to PC every one second.
3. Develop a interrupt routine to accept 100 bytes of data from PC over UART and send out on SPI or I2C bus. Consider buffering and non-buffering approaches.
4. Utilize CMSIS RTOS and develop a user interface console with keyboard, display and any serial interface protocol.
5. Transfer periodically sampled data from any analog peripheral to either PC or another analog peripheral using DMA process. Code could be standalone or CMSIS based.
6. Develop Python code to interface external peripherals connected to PC.
7. Send emails using Python program.
8. Post data on to any webpage using Python.
9. Read data from webpage Python program and transfer the same to microcontroller over UART.
10. Receive data from microcontroller on to PC using Python and either email that data or post it on to any webpage.

Reference books:
1. Joseph Yiu, “Definitive guide to the ARM Cortex-M3”, Latest available edition
2. Hennessy and Patterson, “Computer Architecture: A Quantitative Approach”, Latest available edition
3. Shibu K V, “Introduction to Embedded Systems”, Latest available edition
4. Michael J Pont, “Embedded C”, Latest available edition
5. Leonard Eddison, “Python Programming”, Latest available edition
6. Technical reference manual and datasheets of Cortex-M3 microcontroller and other components.
7. Relevant online tutorials and references.

Coursera courses:
1. Embedded Hardware and Operating Systems
2. Introduction to FPGA Design for Embedded Systems
3. Modeling and Debugging Embedded Systems
4. Introduction to FPGA Design for Embedded Systems

Udemy courses:
1. Embedded System Design with ARM
2. Mastering Microcontroller with Embedded Driver Development
3. Embedded Linux
4. Foundations of Embedded Systems with ARM Cortex and STM32
5. Embedded Systems Programming on ARM Cortex-M3/M4 Processor
6. Embedded Systems Bare-Metal Programming Ground Up™ (STM32)
7. Embedded Systems using the ARM Mbed Platform – Udemy

Online courses from ARM

1. Real-Time Operating Systems Design and Programming
2. Embedded Linux

Swayam course

1. Embedded System Design

Course Title	DIGITAL SYSTEM DESIGN				
Course Code	20ECELPCSD	Credits	4	L-T-P	3:0:1
CIE	50 Marks(100% weightage)	SEE		100 Marks (50% weightage)	

Prerequisites:
Digital Electronics, HDL (Verilog/ VHDL)

Course Outcomes:

CO1	Ability to demonstrate In-depth knowledge of Verilog / System Verilog for digital system design
CO2	Analyse and design different combinational and sequential digital circuits using Verilog / System Verilog
CO3	Engage in independent study to prepare a Technical document and oral presentation for a design of digital system using Verilog.
CO4	Engage in critical analysis to arrive at a valid conclusion through research to provide an optimal solution for a design and validation of digital system.

Unit-I **06hrs**

Introduction and Methodology: Design methodology and technology overview, Digital Systems and Embedded Systems, Real-World Circuits & Models**.** Modelling of Verilog Combinational and Sequential circuits.

Unit-II **08hrs**

Arithmetic circuit Design: Design of Unsigned and signed Integers circuits, Coding signed and unsigned integers, Design of arithmetic operation circuits using signed and unsigned integers, Design of Fixed and Floating point number systems, Coding Fixed and Floating point number systems.

Unit-III **08 hrs**

System Design: Design of Arithmetic circuits, Memories, Design of Error Detection and Correction**,** Design of memories, Sequential Data paths and Control, Finite state Machines, Clocked Synchronous Timing Methodology, System design using FSM,

Unit-IV **08hrs**

System Verilog Building blocks- Overview of System Verilog, Built in Data types, type conversion, Enumerated types, constants and string, Modules, programs, subroutines, package, and interface with example code. Procedural statements, Tasks, Functions and void functions.

Unit-V **06hrs**

System Verilog Classes & Arrays: Language evolution, Classes and objects, Class Variables and Methods, Class instantiation, Inheritance, and encapsulation, Polymorphism. Packed and unpacked arrays, fixed and dynamic arrays, Queues, associative arrays,

Text books:

1. Peter J. Ashenden, "Digital Design: An Embedded Systems Approach Using VERILOG", Elesvier, 2010.
2. Chris Spear, "SystemVerilog for Verification"A guide to learning the Test bench language features', Springer Publications, 2nd Edition, 2010

REFERENCE BOOKS:

1. Digital Design using Verilog, Elsevier, 2007 W. Wolf
2. Stuart S, Simon David & Peter Flake "System Verilog for Design"A guide to using system Verilog for Hardware design and modelling Springer publication 2nd Edition, 2006.

E Books:

1. https://freevideolectures.com/course/2319/digital-systems-design
2. http://www.asicguru.com/system-verilog/tutorial/introduction/1/
3. **https://www.chipverify.com/systemverilog/systemverilog-tutorial**
4. http://www.testbench.in

MOOCs:

1. **https://nptel.ac.in/courses/106/108/106108099/**
2. https://nptel.ac.in/courses/117/106/117106092/
3. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-111-introductory-digital-systems-laboratory-spring-2006/index.htm

LABORATORY EXPERIMENT LIST

1) Design an 8-Register 16-bit each RegisterFile (Multi port memory) with two read ports and one write port. Write Verilog model for the same.

2) Design a digital circuit to reliably transfer a pulse signal from a fast clk domain to slow clk domain. Write Verilog model for the same. (Hint: generate the pulse in fast clk domain and then transfer it to slow clk domain)

3) Design and develop a Verilog model for a 4-bit maximal length LFSR using two different architectures as given by the polynomials:

polynomial : x^4 + x^3 + 1 -- Fibonacci architecture LFSR
polynomial : x^4 + x + 1 -- Galois architecture LFSR

4) Design and develop a Verilog model for an Electronic Dice which produces numbers from 1-to-6 randomly when user pushes the button. The design should meet the following requirements:

- One push button input (Assume the signal is already debounced). When the user pushes and releases the button, output should be displayed.
- One-digit BCD output: should give out values from 1-to-6 randomly.
- Assume the clock frequency in the order of MHz.

5) Design and develop a Verilog model for an accumulator that calculates the sum of sequence of a fixed point numbers. Each input number is signed with 6 pre-binary-point and 12 post-binary-point bits. The accumulated sum has 8 pre-binary-point and 12 post-binary-point bits. A new number arrives at the input during a clock cycle when data_en control input is '1'. The accumulated sum is cleared to '0' when reset control input is '1'. Both control inputs are synchronous.

6) Design and develop a Verilog model for a one digit BCD adder with support for cascading to form multi-digit adder. Means, it should have carry-in input and should have carry-out output bits along with sum output.

7) Design and develop a Verilog model for detecting 4-bit sequence (1011) with overlapping detection using Moore State Machine.

8) Design and develop a Verilog model for detecting 4-bit sequence (1010) without overlapping detection using Mealy State Machine

Course Title	ADVANCED COMPUTER NETWORKS				
Course Code	20ECELPCCN	Credits	3	L-T-P	3:0:0
CIE	50 Marks(100% weightage)	SEE		100 Marks (50% weightage)	

Prerequisites:
Computer Networks

Course outcomes:

At the end of the course, the student will have the ability

CO-1	To understand the state-of-the-art in network protocols, architectures and applications.
CO-2	Design and critically analyze networking protocols for a range of technologies and scenarios
CO-3	To investigate novel ideas in the area of Networking via term-long research projects.

Unit-I **07hrs**

The internet architecture, Access Networks, The network Core, Peer-to-Peer Networks, Content Distribution Networks, Delay Tolerant Networks, Circuit Switching vs. Packet switching, Packet switching Delays and congestion, Client/Server and Peer-to-Peer Architectures, MAC and LLC, Virtual LAN, Asynchronous Transfer Mode (ATM)

Unit-II **08hrs**

Network Address Translator, Internet Control Message Protocol, SNMP, CIDR, IPv6, Routing Protocol Basics in advanced networks, Routing Information Protocol (RIP), Interior Gateway Routing Protocol (IGRP), Switching Services, Spanning Tree Protocol (STP), Standard Network Management Protocol.

Unit-III **08Hrs**

End to end protocols: Simple Demultiplexer (UDP), Reliable Byte Stream (TCP)-End-to-end issues, segment format, connection Establishment and Termination, sliding window revisited, triggering transmission, adaptive retransmission, record boundaries, TCP extensions, Transport for Real-Time Applications-requirements, RTP details, control protocol

Unit-IV **08hrs**

Introduction to traffic Engineering, Requirement Definition for Traffic Engineering, Traffic Sizing, Traffic Characteristics, Delay Analysis, Connectivity and Availability, Introduction to Multimedia Services, Explaining Transmission of Multimedia over the Internet

Unit-V **08hrs**

Congestion Control and Resource Allocation: Issues in resource allocation – network model, taxonomy, evaluation criteria; Queuing discipline – FIFO, Fair Queuing; TCP congestion control – additive increase/multiplicative decrease, slow start, fast retransmit and fast Recovery, Congestion avoidance mechanisms – DECbit, Random Early Detection (RED), Source-based congestion control. The Domain Name System(DNS),Electronic Mail(SMTP,POP,IMAP,MIME),World Wide Web(HTTP),Network Management(SNMP)

Text books:

1. Computer Networking: A Top-Down Approach, 6/e, James F. Kurose and Keith W. Ross, Pearson Education, 2012.

2. Larry Peterson and Bruce S Davis "Computer Networks: A System Approach" 5th Edition, Elsevier -2014.

REFERENCE BOOKS:

1. Douglas E Comer, "Internetworking with TCP/IP, Principles, Protocols and Architecture" 6th Edition, PHI – 2014

E Books:

1. Computer Networks And Internets 6th Edition by Douglas Comer, PEARSON INDIA ISBN 9789352869152
2. https://www.springer.com/gp/book/9781461421030

MOOCs:

1. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-829-computer-networks-fall-2002/readings/
2. https://nptel.ac.in/courses/106/105/106105183/

Course Title	CMOS VLSI DESIGN				
Course Code	20ECELPEVD	Credits	3	L-T-P	3:0:0
CIE	50 Marks(100% weightage)	SEE		100 Marks (50% weightage)	

Prerequisites:

Course Outcomes:

CO1	Apply the concepts of MOS system in digital VLSI design
CO2	Analyse the electrical and physical properties, Switching characteristics and interconnect effect of a MOS system in digital VLSI design
CO3	Design dynamic logic circuits, Semiconductors Memory circuits, and different CMOS logic circuits
CO4	Use modern tools to simulate Schematic and Layout of Digital circuits individually/ in group (s) and Make an effective oral presentation and documentation on advanced topics related to the course by referring IEEE

Unit-I **07hrs**

MOS Transistor: The Metal Oxide Semiconductor (MOS) Structure, MOS System under External Bias, Structure and Operation of MOS Transistor, MOSFET Current-Voltage Characteristics, MOSFET Scaling and Small-Geometry Effects.

Unit-II **08hrs**

MOS Inverters: Static Characteristics of CMOS Inverter. MOS Inverters,Layout and stick diagrams

Unit-III **08hrs**

Switching Characteristics and Interconnect Effects: Delay-Time Definition, Calculation, Inverter Design with Delay Constraints, Estimation of Interconnect Parasitic, Calculation of Interconnect Delay, Switching Power Dissipation of CMOS Inverters.

Unit-IV **08hrs**

Dynamic Logic Circuits: Introduction, Basic Principles of Pass Transistor Circuits, Voltage Bootstrapping, Synchronous Dynamic Circuit Techniques, Dynamic CMOS Circuit Techniques, High Performance Dynamic CMOS Circuits.

Unit-V **08hrs**

Semiconductor Memories: Introduction, Dynamic Random Access Memory (DRAM), Static Random Access Memory (SRAM).

Text books:

1. Sung Mo Kang &YosufLeblebici, "CMOS Digital Integrated Circuits: Analysis and Design", Tata McGraw-Hill, Third Edition.
2. Neil Weste and K. Eshragian, "Principles of CMOS VLSI Design: A System Perspective", Second Edition, Pearson Education (Asia) Pvt. Ltd. 2000.

Reference books:

1. Modern VLSI Design: Systems on Silicon" by W Wolf.

2. Digital Integrated Circuits: A Design Perspective" by J Rabaey

E Books:

1. http://www.digimat.in/nptel/courses/video/106105034/106105034.html
2. https://freevideolectures.com/course/3059/low-power-vlsi-circuits-and-systems

MOOCs:

1. https://swayam.gov.in/nd1_noc20_ee29/preview
2. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-374-analysis-and-design-of-digital-integrated-circuits-fall-2003/index.htm
3. https://nptel.ac.in/courses/106/105/106105034/

Course Title	AUTOMOTIVE ELECTRONICS				
Course Code	20ECELPEAE	Credits	3	L-T-P	3:0:0
CIE	50 Marks(100% weightage)	SEE		100 Marks (50% weightage)	

Prerequisites:

Course Outcomes:

CO1	Ability to carry out quantitative and qualitative assessment of performance of automotives in terms of the underlying system dynamics with emphasis on emission and fuel consumption
CO2	Ability to design and implement in-vehicle communication systems of varied capabilities and capacities as electronic embedded systems
CO3	Ability to architect (for new development) or migrate (in case of existing design) automotive ECUs and infrastructure requirements in compliance to state-of-the-art standards

Unit-I **07hrs**

Automotive Fundamentals Overview – Four Stroke Cycle, Engine Control, Ignition System, Spark plug, Spark pulse generation, IgnitionTiming, Drive Train, Transmission, Brakes, Steering System, Battery, Starting System

Electronic Engine Control – Engine parameters, variables, Engine Performance terms, Electronic Fuel Control System, Electronic IgnitionControl, Idle sped control, EGR Control

Air/Fuel Systems – Fuel Handling, Air Intake System, Air/ Fuel Management

Exhaust After-Treatment Systems – AIR, Catalytic Converter, Exhaust Gas Recirculation (EGR), Evaporative Emission Systems

Vehicle Motion Control – Cruise Control, Chassis, Power Brakes, Antilock Brake System (ABS), Electronic Steering Control, Power Steering, Traction Control, Electronically controlled suspension

Integrated Body – Climate Control Systems, Electronic HVAC Systems, Safety Systems – SIR, Interior Safety, Lighting, Entertainment Systems

Automotive Diagnostics – Timing Light, Engine Analyzer, On-board diagnostics, Off-board diagnostics

Unit-2 **08hrs**

Sensors and actuators – Oxygen (O2/EGO) Sensors, Throttle Position Sensor (TPS), Engine Crankshaft Angular Position (CKP) Sensor, Magnetic Reluctance Position Sensor, Engine Speed Sensor, Ignition Timing Sensor, Hall effect Position Sensor, Shielded Field Sensor, Optical Crankshaft Position Sensor, Manifold Absolute Pressure (MAP) Sensor - Strain gauge and Capacitor capsule, Engine Coolant Temperature (ECT) Sensor, Intake Air Temperature (IAT) Sensor, Knock Sensor, Airflow rate sensor, Throttle angle sensor – Fuel Metering Actuator, Fuel Injector, Ignition Actuator

Unit-3 **08hrs**

Automotive in-Vehicle communication systems: Characteristics and constraints, In-car embedded networks: CAN, FlexCAN, TTCAN, Flexray, LIN, MOST and IDB1394 protocols, Car-to-Car (C2C) and Car-to-infrastructure (C2I) communications –Programmers model of communication controllers – communication hardware and bus – case studies

Unit-4 **08hrs**

Standardization in Automotive ECU Development: Traditional approach and its shortcomings, Worldwide standards, AUTOSAR based automotive ECU development, AUTOSAR architecture, AUTOSAR methodology, AUTOSAR in practice, Conformance testing, Migration to AUTOSAR, AUTOSAR in OEM-supplier collaboration

Unit-5 **08hrs**

Working definition of ITS - Broad scope - Current status of ITS and State-of-the-Art - Fundamental issues in ITS - Principal characteristics of ITS - Scientific validation of ITS designs through modeling and simulation

Traffic flow basics: Traffic variables - Equilibrium representation - traffic model families - Fundamental diagram - Time-space diagram and input-output diagrams - Network level aggregated models- Macroscopic Fundamental Diagram - Network level traffic management - Detailed case study of Control of traffic signal

Reference Books:

1.William B. Ribbens, "Understanding Automotive Electronics", 6th Edition, SAMS/Elsevier Publishing

2.NicolasNavet, "Automotive Embedded Systems Handbook", Industrial Information Technology Series, CRC press.

3. Robert Bosch GmbH, "Automotive Electrics Automotive Electronics", 5th edition, Wiley publications.

4. Ronald K Jurgen, "Automotive Electronics Handbook", McGraw-Hill, Inc, 2nd edition.

5.SumitGhosh, Tony S Lee, "Intelligent Transportation System" – Smart and Green Infrastructure, 2nd Edition CRC Press

MOOC:

1. Intro to Traffic Flow Modeling and Intelligent Transport Systems – edx thro' classcentral.com
2. An Introduction to Intelligent Transportation Systems – MIT OCW
3. Intelligent transportation systems - https://www.engineeringonline.ncsu.edu/

Course Title	Advanced Control Theory				
Course Code	20ECELPEVD	Credits	3	L-T-P	3:0:0
CIE	50 Marks(100% weightage)	SEE		100 Marks (50% weightage)	

Prerequisites:
Foundation course in Mathematics including calculus, linear algebra

Course Outcomes:

CO1	Ability to conceptualize physical systems dynamics using relevant mathematical formulations
CO2	Ability to analyse physical systems mathematically alongside their physical interpretation.
CO3	Ability to design physical systems from a control theoretic perspective

Unit-I **07hrs**
Mathematical models of Physical systems, Performance specification, Root locus analysis and design, frequency domain analysis and design.

Unit-2 **08hrs**
Sampled data control systems – Introduction to control systems , Sampling process; Sample and Hold circuit; Types of signals ; Mathematical operation on discrete time signals; Z-transform; Properties of Z-transforms; Inverse Z-transform; Solving the differential equations using Ztransform; and its Applications

Unit-3 **08hrs**
State space analysis- concepts of states; State space formulation; State model of linear system; State diagram and signal flow graph; State-space representation using physical variables-Electrical systems and mechanical translational system; State-space model of Mechanical translational systems and Rotational systems

Unit-4 **08hrs**
Stability, Controllability and Observability- Linear discrete-time systems(LDS); Transfer function of LDS systems; Stability analysis of sampled data control systems using Jury's stability test, Bilinear transformation and Root locus technique; Similarity transformation; Eigen values and Eigen vectors; Canonical form of state model; Controllability test and Observability test

Unit-5 **08hrs**
Nonlinear systems- Introduction to Nonlinear systems; common physical nonlinearities; Describing function; Derivation of describing function of dead-zone and saturation nonlinearity; Derivation of describing function of saturation nonlinearity; Derivation of describing function of dead-zone nonlinearity and Backlash nonlinearity; Derivation of describing function of relay with dead-zone and hysteresis; Phase plane and phase trajectories; Singular points; Stability analysis of nonlinear systems using phase trajectories; Liapunov's stability criterion; Popov's stability criterion.

Text Books:

1. Nagarath I. J. and Gopal M., Control System Engineering, Wiley Eastern, 2008.
2. Ogata K., Modern Control Engineering, Prentice Hall of India, New Delhi, 2010.
3. Gopal M, "Modern Control System Theory", New Age International, 2003
4. Benjamin C Kuo, "Automatic Control Systems", Prentice Hall of India, 2003.

5. M. Gopal, Digital Control and State Variable Methods, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997

Reference Books:

1. Nise N. S., Control Systems Engineering, 6/e, Wiley Eastern, 2010.
2. Chen CT, “Linear System Theory and Design”, Oxford University Press, 1999.
3. William L Brogan, “Modern Control Theory”, Dorling Kindersley (India) Pvt. Ltd., 2011.
4. R.C. Dorf, and R. T. Bishop, Modern Control Systems, Addison Wesley Longman Inc., 1999.
5. Eronini, Umez- Eronini, System Dynamics and Control, Thomson Asia Pt Ltd., Singapore, ISBN: 981-243-113-6, 2002.

MOOC:

1. Advanced Control Systems - Video course
   https://nptel.ac.in/content/syllabus_pdf/108103007.pdf

Course Title	WIRELESS SENSOR NETWORKS				
Course Code	20ECELPESN	Credits	3	L-T-P	3:0:0
CIE	50 Marks(100% weightage)	SEE		100 Marks (50% weightage)	

Prerequisites:

Computer Communication Networks

Course outcomes:

At the end of the course, the student will have the ability

CO-1	To demonstrate In-depth understanding of the fundamental problems, design issues that arise in sensor network,
CO-2	Identify and critically evaluate sensor network technologies.
CO-3	Analyse and Design Energy Efficient MAC protocols for a given specification.
CO-3	To conduct experiments to demonstrate the knowledge of design and analysis in the area of sensor networks by simulator/hardware

Unit-I **07hrs**

Introduction, Overview and Applications of Wireless Sensor Networks: Introduction, Basic overview of the Technology, Sensor Mote Platforms, WSN Architecture and Protocol Stack Applications of Wireless Sensor Networks: Introduction, Background, Range of Applications, Examples of Category 2 WSN Applications, Examples of Category 1WSN Applications, Another Taxonomy of WSN Technology

Unit-II **08hrs**

Factors Influencing WSN Design: Hardware Constraints Fault Tolerance Scalability Production Costs WSN Topology, Transmission Media, Power Consumption

Physical Layer: Physical Layer Technologies, Overview of RF Wireless Communication, Channel Coding (Error Control Coding), Modulation, Wireless Channel Effects, PHY Layer Standards,

.

Unit-III **08 Hrs**

MAC and Routing Protocols for Wireless Sensor Networks: Introduction, Background, Fundamentals of MAC Protocols, MAC Protocols for WSNs, Sensor-MAC case Study, IEEE 802.15.4 LR-WPANs Standard Case Study. Routing Protocols for Wireless Sensor Networks: Introduction, Background, Data Dissemination and Gathering, Routing Challenges and Design Issues in WSNs, Routing Strategies in WSNs, Physical Layer and Transceiver Design Considerations,

Unit-IV **08hrs**

Transport Control and Middleware for Wireless Sensor Networks: Traditional Transport Control Protocols, Transport Protocol Design Issues, Examples of Existing Transport

Control Protocols, Performance of Transport Control Protocols. Middleware for Wireless Sensor Networks: Introduction, WSN Middleware Principles, Middleware Architecture, Existing Middleware

Unit-V **08hrs**

Time Synchronization: Challenges for Time Synchronization, Network Time Protocol, Timing-Sync Protocol for Sensor Networks(TPSN), Reference-Broadcast Synchronization (RBS), Adaptive Clock Synchronization (ACS)
Localization; Challenges in Localization, Ranging Techniques, Range-Based Localization Protocols, Range-Free Localization Protocols.

Text books:

1. Ian F. Akyildiz and Mehmet Can Vuran "Wireless Sensor Networks",John Wiley & Sons Ltd. ISBN 978-0-470-03601-3 (H/B), 2010
2. Kazem Sohraby, Daniel Minoli, & Taieb Znati, "Wireless Sensor Networks- Technology, Protocols, And Applications", John Wiley, 2007.

REFERENCE BOOKS:

1. Christian Poellabauer, Waltenegus Dargie, "Fundamentals of wireless sensor networks: Theory Practice", John Wiley & Sons, Ltd
2. Holger Karl & Andreas Willig, "Protocols And Architectures for Wireless Sensor Networks", John Wiley, 2005

E Books:

1. Wireless Sensor Networks-Concepts, Applications, Experimentation and Analysis, Fahmy, Hossam Mahmoud Ahmad , ISBN 978-981-10-0412-4, https://www.springer.com/gp/book/9789811004117
2. nesC 1.1 Language Reference Manual by David Gay, Philip Levis, David Culler, Eric Brewer (http://nescc.sourceforge.net/papers/nesc-ref.pdf)

MOOCs:

3. https://nptel.ac.in/courses/106/105/106105160/
4. https://ocw.mit.edu/courses/...and...36.../MIT16_36s09_lec21_22.pdf

Note: Students will have hands on exposure to a practical experience of designing, deploying and implementing wireless sensor networks

Course Title	MEMS				
Course Code	20ECELPEME	Credits	3	L-T-P	3:0:0
CIE	50 Marks(100% weightage)	SEE		100 Marks (50% weightage)	

Prerequisites:

Course Outcomes:

CO1	Gain a fundamental understanding of standard microfabrication techniques and the issues surrounding them
CO2	Critically analyse microsystems technology for technical feasibility as well as practicality
CO3	Apply knowledge of microfabrication techniques and applications to the design and manufacturing of an MEMS device or a microsystem
CO4	Understand the unique requirements, environments, and applications of MEMS

Unit-I **07hrs**

Overview of MEMS and Microsystems: MEMs and Microsystems, Evolution of micro fabrication, Microsystems and miniaturization, Application of Microsystems, Markets for Microsystems

Working Principles of Microsystems:Introduction, MEMS and Micro actuators, Microfluidics, Micro actuators with Mechanical inertia

Unit-2 **08hrs**

Engineering Science For Microsystems Design: Introduction, Molecular theory of matter and intermolecular forces, Doping of semiconductor, Plasma physics, Electrochemistry

Unit-3 **08hrs**

Thermo fluid Engineering and Microsystems Design: Introduction, Clock Skew and Sequential Circuit Performance, Clock Generation and Synchronization

Unit-4 **08hrs**

Designing Arithmetic Building Blocks: Introduction, Basic equation in continuum fluid dynamics, laminar fluid flow in circular conduits, Computational fluid dynamics and incompressible fluid flow in micro-conduits

Unit-5 **08hrs**

Microsystems Fabrication Processes: Introduction, Photolithography, Diffusion, Oxidation, Chemical vapour deposition.

Text Books:

1. Tai-Ran Hsu, MEMS and Microsystems, 2nd Edition, Wiley, 2008
2. Mohamad Gad El Hak, MEMS Design and Fabrication, 2nd Edition, CRC Press, 2006.

Course Title	Estimation and Detection Techniques				
Course Code	20ECELGEED	Credits	3	L-T-P	3:0:0
CIE	50 Marks(100% weightage)	SEE		100 Marks (50% weightage)	

Prerequisites: Fourier transform, signals and systems, probabilities and random processes.

COURSE OUTCOMES

CO1	Acquire the concepts of detection theory, estimation theory and binary/composite hypothesis testing	PO3
CO2	Apply different techniques to perform detection of deterministic / random signals in the presence of noise	PO3
CO4	Ability to independently reproduce the results of the research paper in the domain	PO1

Unit-I **07hrs**

Introduction: The mathematical detection problem, Binary hypothesis testing, Bayesian test, Minimax test, MAP criteria, Bayes' risk, Neyman-Pearson theorem

Unit-II **08hrs**

Detection of deterministic and random signals: Detection of known signals in noise, Matched filter, Performance evaluations, Estimator Correlator for random signals

Unit-III **08hrs**

Composite Hypothesis Testing: Bayesian approach, GLRT. Sinusoidal detection with unknown phase/ amplitude/ frequency

Unit-IV **08hrs**

Sequential Detection of Multiple Hypotheses, Signal detection with unknown noise parameters – white Gaussian noise case

Unit-V **08hrs**

Fundamentals of estimation theory: Formulation of the General Parameter Estimation Problem, Relationship between Detection and Estimation, Types of Estimation, Minimum variance unbiased estimation.

TEXT BOOKS:

1. Harry L. Van Trees, "Detection, Estimation, and Modulation Theory, Part I," John Wiley & Sons, 2004.
2. Steven M.kay, "Fundamentals of Statistical signal processing, volume-1: Estimation theory". Prentice Hall 1993.
3. Steven M.kay, "Fundamentals of Statistical signal processing, volume-2: Detection theory". Prentice Hall 1993
4. A.Papolis and S.Unnikrishna Pillai, "Probability, Random Variables and stochastic processes, 4e". The McGraw-Hill 2002.

EBooks:

1. An Introduction to Signal Detection and Estimation, Poor, H. Vincent

Course Title	Research Methodology				
Course Code	20ALLPICRM	Credits	2	L-T-P	2:0:0
CIE	50 Marks(100% weightage)	SEE		100 Marks (50% weightage)	

Prerequisites: Basic VLSI Design, Embedded system design

Course outcomes:

At the end of the course, the student will have the ability

CO-1	Ability to write and present a substantial technical report/document
CO-2	Able to demonstrate a degree of mastery over the area of specialization

Unit-I **05hrs**

Meaning and sources of research problem, , Objectives and Characteristics of research – Errors in selecting research problem, Research methods Vs Methodology - Types of research-Criteria of good research – Developing a research plan.

Unit-II **06hrs**

Investigations of a research problem - Selecting the problem - Necessity of defining the problem – Data collections-analysis- Importance of literature review in defining a problem - Survey of literature -Necessary instrumentations

Unit-III **05hrs**

How to write paper-conference articles-poster preparation, thesis report writing, inclusion of references, journal reviewing process, journal selection process, filling about journal template, developing effective research proposal-plagiarism-research ethics

Unit-IV **06hrs**

Nature of Intellectual property, IPRs- Invention and Creativity - Importance and Protection of Intellectual Property Rights (IPRs) – procedure for grant of patents and patenting under PCT-types of patents-technological research and innovation- international cooperation on IP.

Unit-V **04rs**

A brief summary of : Patents-Copyrights-Trademarks, patent rights-licensing and transfer of technology-patent databases-case studies on IPR-Geographical indications-new developments in IPR-protection of IPR rights

REFERENCE BOOKS:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Anderson, T. W., An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi
4. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications. 2

5. Subbarau NR-Handbook of Intellectual property law and practise- S Viswanathan Printers and Publishing Private Limited 1998.

M. Tech- ELECTRONICS

Second Semester

Course Title	VLSI VERIFICATION& TESTING				
Course Code	20ECELPCVV	Credits	4	L-T-P	3:1:0
CIE	50 Marks(100% weightage)	SEE		100 Marks (50% weightage)	

Prerequisites: Digital system design, C/ C++, System Verilog

Course outcomes:

At the end of the course, the student will have the ability

CO-1	Ability to acquire knowledge on verification & testing apply for VLSI designs
CO-2	Analyse on verification methodologies and different types of simulators
CO-3	Design a solution to obtain 100% code coverage & functional coverage by determining the set of input constraints and assertions in test benches.
CO-4	Simulate the test bench architecture using system Verilog and analyse coverage reports
CO-5	Make an effective oral presentation and documentation on advanced topics related to the course by referring IEEE Journals.

Unit-I **07 hrs**

Importance of Verification: Concepts of verification, importance of verification, Reconvergence model, Formal verification, Equivalence checking, Model checking, Functional verification.

Functional verification approaches: Black box verification, white box verification, grey box verification. Testing versus verification. Verification reuse. The cost of verification.

Unit-II **08 hrs**

The verification plan& Simulators: The role of verification plan: specifying the verification plan, defining the first success. Levels of verification: unit level verification, reusable components verification, ASIC and FPGA verification, system level verification, board level verification.

Stimulus and response, Event based simulation, cycle based simulation, Co-simulators, verification intellectual property: hardware modellers, waveform viewers.

Unit-III **08 hrs**

Code &Functional Coverage: statement coverage, path coverage, expression coverage, FSM coverage, what does 100%coverage mean? Item Coverage, cross coverage, Transition coverage, Cover Group, Cover Point, what does 100% functional mean? Issue tracking & Metrics. Randomization: Directed Vs Random Testing. Randomization: Constraint Driven Randomization. Assertions, Introduction to Assertion based verification, Immediate and concurrent assertions.

Unit-IV **06 hrs**

Verification Methodology: Introduction to Universal Verification Methodology, Overview of UVM Base Classes and simulation phases in UVM and UVM macros. Unified messaging in UVM, UVM environment structure.

Unit-V **07 hrs**

VLSI Testing: Faults in Logic Circuits, Stuck-at Fault, Bridging Faults, Delay Fault Breaks , Faults in CMOS, Stuck-on and Stuck-Open Faults, Basic Concepts of Fault Detection, Controllability and Observability, Undetectable Faults, Equivalent Faults, Temporary Faults. Built-In Self-Test**:** Test pattern generation for BIST, Output response analysis, BIST Architectures.

Text books:

1. Janick Bergeron, **"Writing test benches: functional verification of HDL models"**, 2nd edition ,Kluwer Academic Publishers
2. Lala Parag K., **Digital Circuit Testing and Testability**, New York, Academic Press, 1997.

REFERENCE BOOKS:

1. https://en.wikipedia.org/wiki/**Universal_Verification_Methodology.**
2.The **Verification Methodology Cookbook**

E Books:

1. https://freevideolectures.com/course/4800/nptel-vlsi-design-verification-test - (introduction to verification methodology, formal design verification, model checking, Functional and structural testing, BIST)
2. http://www.testbench.in/TS_24_VERIFICATION_PLAN.html –(functional coverage, UVM,OVM)

MOOCs:

https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-884-complex-digital-systems-spring-2005/lecture-notes/l15_testing.pdf- (verification and testing)

Course Title	Synthesis And Optimization Of Digital Circuits				
Course Code	20ECELPCSO	Credits	4	L-T-P	3:0:1
CIE	50 Marks(100% weightage)	SEE		100 Marks (50% weightage)	

Prerequisites:
Digital Logic Circuits

Course outcomes:
At the end of the course, the student will have the ability

CO-1	Understand and apply the various algorithms and graphs to synthesis and optimization of different digital circuit
CO-2	Analyze and design combinational circuit
CO-3	Analyze the performance of standard algorithm used for synthesis and optimization of two level, multiple level logic circuits
CO-4	To work in teams to realize any current research in optimization /scheduling and present a report

Unit-I **08hrs**

Basic VLSI Design: Introduction, Design of Microelectronics circuits,Fabrication, Design Rules and Layout, Performance Parameters , Testing, Design Requirements, ASIC

Architectural Synthesis and Optimization: Fundamental Architectural Synthesis problems, Area and Performance Estimation, Strategies for Architectural Optimization, Datapath Synthesis, Control Path Synthesis

Unit-II **08hrs**

Graph theory for CAD for VLSI: Graphs, Combinatorial Optimization, Graph Optimization problems and Algorithms, Boolean Algebra and Applications.

Logic Synthesis: Computational Boolean Algebra , Boolean Representation via BDDs and SAT2-Level Logic Synthesis and Optimization

Unit-III **08hrs**

Two level Combinational Logic Optimization: Introduction, Logic Optimizations, Operations on Two level Logic Covers, Algorithms for Logic Minimization, Symbolic Minimization and Encoding Problems.

Multiple Level Combinational Logic Optimization: Introduction, Models and Transformations for Combinational Networks, The Algebraic Model, The Boolean Model

Unit-IV **08hrs**

Scheduling Algorithms: Introduction, A Model for Scheduling problems, Scheduling with Resource Constraints, Scheduling without Resource Constraints, Scheduling Algorithms for Extended Sequencing Models, Scheduling Pipelined Circuits

Unit-V **07hrs**

Physical Synthesis: Floor planning, Placement, Routing, Compaction. FPGA Origins and Architecture

Text books:

1. Giovanni De Micheli, “Synthesis and Optimization of Digital Circuits”, Tata McGraw-Hill, 2003.ISBN: 9780070582781.
2. John Paul Shen, Mikko H. Lipasti, “Modern processor Design”, Tata McGraw Hill, 2003

REFERENCE BOOKS:

1. Edwars M.D., Automatic Logic synthesis Techniques for Digital Systems, Macmillan New Electronic Series, 1992.
2. NeilWeste and K. Eshragian, “Principles of CMOS VLSI Design: A System Perspective”, 2nd edition, Pearson Education (Asia) Pte.Ltd., 2000

E Books:

1. https://freevideolectures.com/course/2319/digital-systems-design
2. https://nptel.ac.in/courses/106/102/106102181/

MOOCs:

1. https://swayam.gov.in/nd1_noc19_cs73/preview
2. https://nptel.ac.in/courses/106/105/106105160/
3. https://nptel.ac.in/courses/106/103/106103116/

Note: Students are expected to carry out a project using VHDL.

Course Title	Real Time Operating Systems				
Course Code	20ECELPCRT	Credits	4	L-T-P	3:0:1
CIE	50 Marks(100% weightage)	SEE		100 Marks (50% weightage)	

Prerequisites:

Course outcomes:

At the end of the course, the student will have the ability

CO-1	Design high performance software applications with real time deterministic response.
CO-2	Configure and Optimize Embedded RTOS to achieve desired High Performance Computing response.
CO-3	Make an effective oral presentation pertaining to RTOS and related high performance computing concepts.
CO-4	Engage on Literature survey about High Performance & Deterministic systems, both from hardware and software perspective and submit a report

Unit-I **08hrs**

Introduction to ARM SoC architecture: ARM Application Processor features, Virtualization extension of ARM. Memory Management Unit, Virtual Addressing, Cache controller.Advanced Microprocessor Bus Architecture (AMBA). Usability of FPGA modules interfaced to ARM-AP

Unit-II **08hrs**

RTOS: Introduction to OS, Defining RTOS, Services, Characteristics of RTOS, Tasks, tasks its States and Scheduling, Synchronization, Communication and Concurrency. Semaphores. File Management (open, read, write, close) and IO services, IOCTL. Case Study RTOS**:** RT-Linux. Process management and IPC: Parent-Child Process, Process Priority, Various types of Process. Exceptions, Interrupts, and Timers.Signals, Pipes, Message Ques, and FIFO.Memory management.

Unit-III **08hrs**

Network Programming: Machine to Machine Interface. Sockets, ports, UDP, TCP/IP, client server model, socket programming, 802.11 and Bluetooth.

Unit-IV **08hrs**

Developing a Hardware Module in FPGA part of SoC: VHDL/Verilog code development for case study peripheral module.

Unit-V **07hrs**

Device Drivers, Developing Interface Code for module developed in M4: C program-based application layer code and kernel level code to configure and access data in/out of hardware module developed in M4.

Reference books:

1. Steve Furber, “ARM System-on-Chip Architecture”
2. The Zynq Book, by Crockett, Elliot, Enderwitz& Stewart, University of Strathclyde Glasgow, 2014

3. Advanced UNIX Programming, Richard Stevens
4. Embedded Linux: Hardware, Software and Interfacing – Dr. Craig Hollabaugh

Lab Prerequisite:
Xilinx, ZyncSoC development board along with Raspberry-Pi-3B.Windows-7 or above OS platform.Optional GNU/Linux OS platform. All module will have integrated lab sessions.

List of Lab Experiments:
1. Raspberry Pi 3: Booting the Board with multiple OS,
2. Programming of GPIO, Programming of Serial Peripherals, Control of ADC.
3. Zynq Board: Implement Timers and GPIO modules in FPGA and control it with ARM SOC.
4. Implement a USB generic serial emulator device on FPGA, interface it with Raspberry Pi 3.
5. Develop a sample GNU/Linux Device Driver for modules developed in lab experiment

Course Title	INTERNET OF THINGS				
Course Code	20ECELPEIT	Credits	3	L-T-P	3:0:0
CIE	50 Marks(100% weightage)	SEE		100 Marks (50% weightage)	

Prerequisites:
Wireless sensor Networks, Embedded systems

Course outcomes:
At the end of the course, the student will have the ability

CO-1	Interpret the impact and challenges posed by IoT networks leading to new architectural models for various case studies
CO-2	Apply communications knowledge to facilitate transport of IOT data over various available communications media
CO-3	Design a use case for a typical application in real life ranging from sensing devices to analyzing the data available on a server to perform tasks on the device

Unit-I **07hrs**

Demystifying the IoT Paradigm: Why the IoT is Strategically Sound, Drivers behind new network Architectures, Comparing IOT Architectures, M2M architecture, IOT world forum standard, IOT Reference Model, Simplified IOT Architecture

Unit-II **08hrs**

IOT Network Architecture and Design :Core IOT Functional Stack, Layer1(Sensors and Actuators) , Layer 2(Communications Sublayer), Access network sublayer, Gateways and backhaul sublayer, Network transport sublayer, IOT Network management. Layer 3(Applications and Analytics) – Analytics vs Control, Data vs Network Analytics IOT Data Management and Compute Stack

Unit-III **08Hrs**

IOT Networks: Things in IOT – Sensors, Actuators, MEMS and smart objects. Sensor networks, WSN, Communication protocols for WSN Communications Criteria, Range Frequency bands, power consumption, Topology, Constrained Devices, Constrained Node Networks IOT Access Technologies, IEEE 802.15.4 Competitive Technologies – Overview only of IEEE 802.15.4g, 4e, IEEE 1901.2a Standard Alliances – LTE Cat0, Cat-M, NB-IOT

Unit-IV **08hrs**

Data and Analytics for IoT: An Introduction to Data Analytics for IoT, Machine Learning, Big Data Analytics Tools and Technology, Edge Streaming Analytics, Network Analytics, **Security in IoT**: Securing IoT, A Brief History of OT Security, Common Challenges in OT Security, How IT and OT Security Practices and Systems Vary, Formal Risk Analysis Structures: OCTAVE and FAIR,

Unit-V **08hrs**

IOT in Industry (Three Use cases): IOT Strategy for Connected manufacturing, Architecture for Connected Factory. Utilities – Power utility, IT/OT divide, Grid blocks

reference model, Reference Architecture, Primary substation grid block and automation, Smart and Connected cities –Strategy, Smart city network Architecture, Street layer, city layer, Data center layer, services layer, Smart city security architecture, Smart street lighting

Text books:

1. Pethuru Raj and Anupama C Raman, The Internet of Things – Enabling Technologies, Platforms, and use cases, CRC Press, Taylor and Francis, 2017.
2. Arshdeep Bahga and Vijay Madisetti, 'Internet of Things – A Hands on Approach', orient Blackswan Private Limited - New Delhi; First edition (2015), ISBN-10: 8173719543, ISBN-13: 978-8173719547,
3. Cisco, IOT Fundamentals – Networking Technologies, Protocols, Use Cases for IOT, Pearson Education; First edition (16 August 2017). ISBN-10: 9386873745, ISBN-13: 978-9386873743

.

REFERENCE BOOKS:

1. Yasuura, H., Kyung, C.-M., Liu, Y., Lin, Y.-L., Smart Sensors at the IoT Frontier, SpringerInternational Publishing

E Resources:

1. https://www.udemy.com/internet-of-things-iot-for-beginners-getting-started/
2. http://playground.arduino.cc/Projects/Ideas
3. http://runtimeprojects.com

MOOCs:

1. https://ocw.mit.edu/courses/...701.../MITCMS_701S15_BigData.pdf
2. https://ocw.mit.edu/courses/engineering-systems.../johnwilliams.pdf
3. https://nptel.ac.in/courses/106/105/106105183/
4. https://swayam.gov.in/nd1_noc20_cs66/preview

Course Title	Programming in Python				
Course Code	20ECELPEPP	Credits	3	L-T-P	3:0:0
CIE	50 Marks(100% weightage)	SEE		100 Marks (50% weightage)	

Prerequisites: Programming in C/ C++

Course outcomes:

At the end of the course, the student will have the ability

CO-1	Demonstrate proficiency in handling Python syntax and semantics and be fluent in the use of Python flow control and functions
CO-2	Create, run and manipulate Python Programs using core data structures like Lists, Dictionaries and use Regular Expressions
CO-3	Implement exemplary applications related to Network Programming, Web Services in Python and prepare a technical document

Unit-I **09hrs**

Introduction: Introduction to python, History, Features of Python, Coding guidelines in python. Variables, Types of Variables – strings, Boolean, Numeric types, Logical and Arithmetic Operators, Operations on Strings ,Variable Comparison ,Lists, Tuples, Regular Expressions and Dictionary

Unit-II **07hrs**

Control statements and Loops: Conditional Statements, If else statements, Nested if else, Pass statements, Loops in pythons, For loop, While loop, Nested looping, Range functions

Unit-III **07 hrs**

Functions: Creating functions, calling functions, Argument passing and return statements, Recursion, Variable –length Argument

Unit-IV **07hrs**

Modules and imports: Built in Modules, Usage of modules, Installing the modules, Making own modules.

Unit-V **09hrs**

Classes and objects: OOPS terminologies, Creating Class, Creating instance object Accessing Attributes, Creating instance objects, Built in class attributes, Inheritance, Overriding Methods, Overloading Operators, applications on Network Programming, Web Services. Case studies

Text books:

1. Charles R. Severance, "Python for Everybody: Exploring Data Using Python 3", 1st Edition, Create Space Independent Publishing Platform, 2016. (http://do1.drchuck.com/pythonlearn/EN_us/python learn.pdf))

2. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2ndEdition, Green Tea Press, 2015. http://greenteapress.com/thinkpython2/thinkpython2.pdf)

REFERENCE BOOKS:

1. Charles Dierbach, "Introduction to Computer Science Using Python", 1st Edition, Wiley India Pvt.ltd.ISBN-13:978-8126556014
2. Mark Lutz, “Programming Python”, 4th Edition, O’Reilly Media, 2011.ISBN-13: 978-9350232873
3. Wesley J Chun, “Core Python Applications Programming”, 3rd Edition,Pearson Education India,2015.ISBN-13:978-9332555365
4. Roberto Tamassia, Michael H Goldwasser, Michael T Goodrich, “Data Structures and Algorithms in Python”,1stEdition, Wiley India Pvt Ltd, 2016. ISBN-13: 978-8126562176.
5. Reema Thareja, “Python Programming using problem solving approach”, Oxford university press, 2017

E Books:

1. https://www.programiz.com/python-programming
2. https://www.tutorialspoint.com/python/index.htm
3. https://www.geeksforgeeks.org/python-programming-language/
4. https://www.w3schools.com/python/default.asp

MOOCs:

1. https://coursera.org/share/601b351745a4fc4fb6f63ee1e387b764
2. https://www.futurelearn.com/courses/programming-101?utm_source=RakutenMarketing&utm_medium=Affiliate&utm_campaign=3132850:MOOC+List&utm_content=10:1&utm_term=UKNetwork&ranMID=42801&ranEAID=*GqSdLGGurk&ranSiteID=.GqSdLGGurk-ny6fPUql6DXKaCqjKwdnEQ
3. https://nptel.ac.in/courses/106/106/106106212/
4. https://www.datacamp.com/courses/intro-to-python-for-data-science

Course Title	Advanced DSP				
Course Code	20ECELGEAD	Credits	3	L-T-P	3:0:0
CIE	50 Marks(100% weightage)	SEE		100 Marks (50% weightage)	

Prerequisites: Programming using Matlab

Course outcomes:

At the end of the course, the student will have the ability to

CO-1	acquire the theoretical knowledge of advanced DSP, including FIR/IIR filter design, multirate DSP and adaptive filters
CO-2	analyse and apply the theoretical concepts of DSP to real life problems of practical and numerical nature
CO-3	select an IEEE journal paper covering a contemporary application of DSP, conduct appropriate literature survey pertaining to the topic, and solve and assimilate the selected paper
CO-4	create a standard documentation and presentation of the study performed by their team

Unit-I **08hrs**

Introduction: Overview of signals and systems, The concept of frequency in continuous time and discrete time signals, Sampling of continuous time signals, Analog to digital and digital to analog conversion. Discrete Fourier transform: The DFT / IDFT pair, Properties of DFT, Linear filtering methods based on the DFT, applications in Communication engineering.

Unit-II **07hrs**

Design of digital filters: General considerations, design of FIR filters, windowing and frequency sampling methods, Design of IIR filters from analog filters, impulse invariance and bilinear transformation methods.

Unit-III **08 hrs**

Multirate digital signal processing: decimation by a factor D, Interpolation by a factor sampling rate conversion by a factor I/D, Engineering applications of multirate signalprocessing, digital filter banks, QMF filters.

Unit-IV **08hrs**

Filter Implementation techniques: Polyphase structure, Multistage implementation of sampling rate conversion, Adaptive filters: concept and applications, Adaptive direct form FIR filters, The LMS algorithm (without proof).

Unit-V **08hrs**

Wavelet Transforms: The origin of Wavelets, Wavelets and other reality transforms, continuous Wavelet and Short Time Fourier Transform, Mathematical preliminaries, Properties of wavelets. Discrete Wavelet Transform: Haar scaling functions, Haar wavelet function, Daubechies Wavelets

Text books:

1. S. K. Mitra;Digital signal processing: A computer based approach", 3rd edition,TMH, India, 2007.
2. E.C. Ifeachor, and B. W. Jarvis;Digital signal processing: A Practitioner approach, Second Edition, Pearson Education, India, 2002,
3. Proakis, and Manolakis,;Digital signal processing", 3rd edition, Prentice Hall, 1996
4. Insight into Wavelets- from Theory to Practice", K.P Soman, Ramachandran, Resmi-PHI Third Edition-201

MOOC / e-resources:

1. Podcasts by MIT: https://podcasts.apple.com/us/podcast/digital-signal-processing/id481803782
2. NPTEL from IIT Bombay and IIT Madras: https://nptel.ac.in/courses/117/101/117101001/ https://nptel.ac.in/courses/108/106/108106151/
3. **A note on Tutorial conduction**: Topic wise conceptual and numerical problem solving.
4. Detailed Study of a research paper from related IEEE journals.

Course Title	Low Power VLSI				
Course Code	20ECELPELP	Credits	3	L-T-P	3:0:0
CIE	50 Marks(100% weightage)	SEE		100 Marks (50% weightage)	

Prerequisites:

Course outcomes:

At the end of the course, the student will have the ability to

CO-1	Extend the knowledge on basics of MOSFETs and Power Dissipation in MOS circuits to obtain the concepts of different techniques for power optimization.
CO-2	Ability to apply the low power concepts to find the static and dynamic power consumption in a design
CO-3	Ability to design the power optimised circuit for the given specification
CO-4	Usage of EDA tool to implement the designed circuit with techniques of power optimisation in the design and justify obtained report by class room presentation.
CO-5	Understand the journal research papers related to low power and update the knowledge for new techniques to incorporate in projects of the specified stream.

Unit-I **06hrs**

Basics of MOS circuits, Sources of Power dissipation: Dynamic Power Dissipation - Short Circuit Power, Switching Power, Glitching Power, Static Power Dissipation, Degrees of Freedom

Unit-II **08hrs**

Supply Voltage Scaling Approaches: Device feature size scaling Multi-Vdd Circuits Architectural level approaches: Parallelism, Pipelining Voltage scaling using high-level transformations Dynamic voltage scaling Power Management

Unit-III **08 hrs**

Switched Capacitance Minimization Approaches: Hardware Software Tradeoff Bus Encoding Two's complements Vs Sign Magnitude Architectural optimization Clock Gating Logic styles

Unit-IV **08hrs**

Leakage Power minimization Approaches: Variable-threshold-voltage CMOS (VTCMOS) approach Multi-threshold-voltage CMOS (MTCMOS) approach Power gating Transistor stacking Dual-V_t assignment approach (DTCMOS)

Unit-V **09hrs**

Special Topics: Adiabatic Switching Circuits Battery-aware Synthesis Variation tolerant design CAD tools for low power synthesis

Text books:

1. Sung Mo Kang, Yusuf Leblebici, CMOS Digital Integrated Circuits, Tata Mcgrag Hill
2. Bellamour, and M. I. Elmasri, Low Power VLSI CMOS Circuit Design, Kluwer Academic Press, 1995

3. Anantha P. Chandrakasan and Robert W. Brodersen, Low Power Digital CMOS Design, Kluwer Academic Publishers, 1995.

REFERENCE BOOKS

1. Kaushik Roy and Sharat C. Prasad, Low-Power CMOS VLSI Design, Wiley-Inter science, 2000.

MOOC:

1. NPTEL http://nptel.iitm.ac.in Computer Science and Engineering, Department of Computer Science and Engineering ,IIT Kharagpur

Course Title	Nano Electronics				
Course Code	20ECELPENE	Credits	3	L-T-P	3:0:0
CIE	50 Marks(100% weightage)	SEE		100 Marks (50% weightage)	

Prerequisites:

Course outcomes:

At the end of the course, the student will have the ability to

CO-1	Ability to extend the knowledge of electronic engineering materials from a micro level to a nano scale
CO-2	Ability to analyse nano materials in a quantitative manner from the perspective of physics and also in terms of the required instrumentation techniques
CO-3	Ability to analyse and devise fabrication techniques at nano scale for useful applications

Unit-I **06hrs**

Introduction: Overview of nano-science & engineering. Development milestones in microfabrication and electronic industry.Moores law and continued miniaturization. Classification of nano structures. Electronic properties of atoms and solids: Isolated atom, Bonding between atoms, Giantmolecular solids, free electron models and energy bands, crystalline solids periodicity of crystal lattices, electronic conduction, effects of nanometer length scale, fabrication methods: Top down processes, Bottom up processes methods for templating the growth of nanomaterials, ordering of nanosystems

Unit-II **08hrs**

Characterization: Classification, microscopic techniques, Field ion microscopy, scanning probe techniques, diffraction techniques: bulk, surface, spectroscopy techniques: photon, radio frequency, electron, surface analysis and dept profiling: electron, mass, Ion beam, Reflectrometry, Techniques for property measurement: mechanical, electron, magnetic, thermal properties. Inorganic semiconductor nanostructures: Overview of semiconductor physics. Quantum confinement in semiconductor nanostructures: quantum wells, quantum wires, quantum dots, super-lattices, band offsets, electronic density of states.

Unit-III **08 hrs**

Fabrication techniques: requirements of ideal semiconductor, epitaxial growth of quantum wells, lithography and etching, cleaved edgeover growth, growth of vicinal substrates, strain induced dots and wires, electrostatically induced dots and wires, Quantum well width fluctuations, thermally annealed quantum wells, semiconductor nanocrystals, colloidal quantum dots, self-assembly techniques.

Unit-IV **08hrs**

Physical processes: modulation doping, quantum hall effect, resonant tunnelling, charging effects, ballistic carrier transport, Inter band absorption, intraband absorption, light emission processes, photon bottleneck, quantum confined stark effect, nonlinear effects, coherence and dephasing, characterization of semiconductor nanostructures: optical electrical and structural

Unit-V **09hrs**

Methods of measuring properties-structure: atomic, crystallography, microscopy, spectroscopy. Properties of nanoparticals: metal nano clusters, semiconducting nanoparticles, rare gas and molecular clusters, methods of synthesis (RF, chemical, thermolysis, pulsed laser methods) Carbon nanostructures and its applications (field emission and shielding, computers fuelcells, sensors, catalysis). Self assembling nanostructured molecular materials and devices: building blocks, principles of self assembly, methods to prepare and pattern nanoparticles, template nanostructures, liquid crystal mesophases. Nanomagnetic materials and devices: magnetism, materials, magnetoresistance, nanomagnetism in technology, challenges facing nanomagnetism
Applications: Injection lasers, quantum cascade lasers, single photon sources, biological tagging, optical memories, coulomb blockage devices, photonic structures, QWIP's NEMS, MEMS.

Reference Books:

1. Ed Robert Kelsall, Ian Hamley, Mark Geoghegan, "Nanoscale science and technology", John Wiley and sons, 2007
2. Charles P Poole, Jr.Frank J owens, "Introduction to Nanotechnology", John Wiley, Copyright 2006, Reprint 2011
3. Ed William A Goddart III, Donald W Brenner, Sergey Edward Lyshevski, Gerald J Lafrate, "Hand book of Nanoscience Engineering and Technology", CRC Press 2003

Course Title	Optimization Techniques				
Course Code	20ECELOEOT	Credits	3	L-T-P	3:0:0
CIE	50 Marks(100% weightage)	SEE		100 Marks (50% weightage)	

Prerequisites:

Course outcomes:

At the end of the course, the student will have the ability to

CO-1	To appreciate the motivational factors for system optimization with case studies of linear and non-linear system
CO-2	To understand the mathematical concepts to implement system optimization
CO-3	To gather skill and be able to practice linear programming technique for system optimization

Unit-I **06hrs**

Single Variable Non-Linear Unconstrained Optimization: One dimensional Optimization methods:-Uni-modal function, elimination methods, ,, Fibonacci method, golden section method, interpolation methods – quadratic & cubic interpolation methods.

Unit-II **08hrs**

Multi variable non-linear unconstrained optimization: Direct search method – Univariant method – pattern search methods – Powell's- Hook -Jeeves, Rosenbrock search methods- gradient methods, gradient of function, steepest decent method, Fletcher Reeves method, variable metric method.

Unit-III **08 hrs**

Linear Programming: Formulation – Sensitivity analysis. Change in the constraints, cost coefficients, coefficients of the constraints, addition and deletion of variable, constraints. Simulation – Introduction – Types- steps – application – inventory – queuing – thermal system

Unit-IV **08hrs**

Integer Programming: Introduction – formulation – Gomory cutting plane algorithm – Zero or one algorithm, branch and bound method Stochastic programming: Basic concepts of probability theory, random variables- distributions-mean, variance, correlation, co variance, joint probability distribution- stochastic linear, dynamic programming.

Unit-V **09hrs**

Geometric Programming: Polynomials – arithmetic – geometric inequality – unconstrained G.Pconstrained G.P (<= TYPE ONLY) Non-traditional optimization Techniques: Genetic Algorithms-Steps-Solving simple problemsComparitions of similarities and dissimilarities between traditional and non-traditional techniques-Particle Swarm Optimization (PSO)- Steps(Just understanding)-Simulated Annealing-Steps-Simple problems.

Reference Books:

1. Optimization theory & Applications / S.S. Rao / New Age International.

2. Engineering Optimization-Kalyan Deb/ PHI
3. Introductory to operation Research / Kasan& Kumar / Springar
4. Optimization Techniques theory and practice / M. C. Joshi, K. M. Moudgalya/ Narosa Publications
5. Operation Research / H. A. Taha /TMH
6. Optimization in operations research / R. L Rardin
7. Optimization Techniques /Benugundu&Chandraputla / Pearson Asia

M. Tech- ELECTRONICS

Third Semester

Course Title	Machine Learning and AI				
Course Code	20ECELPEML	Credits	3	L-T-P	3:0:0
CIE	50 Marks(100% weightage)	SEE		100 Marks (50% weightage)	

Prerequisites: Programming in C/ C++ and Python

Course outcomes:

At the end of the course, the student will have the ability

CO-1	To infer on the dynamics, design and performance of ML paradigms using relevant mathematical paradigms
CO-2	To condition, portray and model engineering systems for a gamut of ML based techniques
CO-3	To analyse the performance of ML techniques vis-à-vis conventional techniques in a quantitative manner

Unit-I **06hrs**

Linear Models for Classification: Discriminant Functions, Probabilistic Generative Models, Probabilistic Discriminative Models, The Laplace Approximation, Bayesian Logistic Regression, Exercises

Unit-II **08hrs**

Neural Networks: Feed-forward Network Functions, Network Training, Error Backpropagation, The Hessian Matrix, Regularization in Neural Networks, Mixture Density Networks, Kernel Methods, Radial Basis Function Networks, Gaussian Processes, Exercises

Unit-III **08 hrs**

Sparse Kernel Machines: Maximum Margin Classifiers, SVMs for regression, Relevance Vector Machines, RVM for regression, RVM for classification, Exercises

Unit-IV **08hrs**

Graphical Models: Bayesian Networks, Example: Polynomial regression, Generative models, Linear-Gaussian models, Conditional Independence, Markov Random Fields, Inference in Graphical Models, Mixture Models: K-means Clustering, Mixtures of Gaussians, An Alternative View of EM, The EM Algorithm in General, Exercises

Unit-V **09hrs**

Approximate Inference: Variational Inference, Illustration: Variational Mixture of Gaussians, Variational distribution, Predictive density, Induced factorizations, Variational Linear Regression, Variational distribution, Predictive distribution, Local Variational Methods, Optimizing the variational parameters, Inference of hyperparameters, Expectation Propagation, Exercises

Text books:

1. Pattern Recognition and Machine Learning, Christopher M. Bishop
2. Machine Learning: A Probabilistic Perspective (Adaptive Computation and Machine Learning series) 1st Edition, Kevin P. Murphy

REFERENCE BOOKS:

1. Artificial Intelligence: A Modern Approach, Stuart J. Russell and Peter Norvig
2. Deep Learning, Ian Goodfellow, Yoshua Bengio, and Aaron Courville
3. Machine Learning, Tom M. Mitchell
4. Fundamentals of Machine Learning for Predictive Data Analytics: Algorithms, Worked Examples, and Case Studies (The MIT Press) 1st Edition, by John D. Kelleher, Brian Mac Namee, Aoife D'Arcy
5. Machine Learning: A Bayesian and Optimization Perspective (Net Developers) 1st Edition, Sergios Theodoridis

Course Title	Network Security and Cryptography				
Course Code	20ECELPENS	Credits	3	L-T-P	3:0:0
CIE	50 Marks(100% weightage)	SEE		100 Marks (50% weightage)	

Prerequisites: Programming in C/ C++ and Python

Course outcomes:

At the end of the course, the student will have the ability

CO-1	Understand the basic concepts of cryptography and encrypt various types of cipher
CO-2	Learn various encryption standards and Design the various key distribution and management schemes
CO-3	Analyse existing authentication protocols for two party communication and digital signatures
CO-4	Become proficient in the application of Number theory for design of various crypto algorithms.
CO-5	Ability to make an effective oral presentation and explore new ideas in a team

Unit-I **06hrs**

Overview: Introduction, Security Trends, The OSI Security Architecture, SecurityAttacks, Security Services, Security Mechanisms, A Model for Network Security. Classical Encryption Techniques, Symmetric Cipher Model, Substitution Techniques,Transposition Techniques, Rotor Machines, Steganography.

Unit-II **08hrs**

Block Ciphers and the Data Encryption Standard :Block Cipher Principles, The Data Encryption Standard ,The Strength of DES , Differential and Linear Cryptanalysis, Block Cipher Design Principles, Multiple Encryption and Triple DES ,Block Cipher Modes of Operation, Advanced Encryption Standard ,Evaluation Criteria For AES ,The AES Cipher

Unit-III **08 hrs**

Public Key Cryptography and Key Management: Principles of Public-Key Cryptosystems, The RSA Algorithm, Key Management,Diffie-Hellman Key Exchange.

Unit-IV **08hrs**

Message Authentication and Digital Signature: Message integrity, Random Oracle Model, Message Authentication codes, Digital Signature Process, Services, and Attacks on Digital Signature, Digital Signature Schemes and Applications.

Unit-V **09hrs**

Mathematics of Cryptography: Introduction to Number Theory, Prime Numbers, Fermat's and Euler's Theorems, the Chinese Remainder Theorem, Discrete Logarithms

Text books:

1. William Stallings, **"Cryptography and Network Security"**, 4thEdition, Pearson Education PHI

REFERENCE BOOKS:

2. BehrouzAForouzan, DebdeeepMukhopadhyay, "**Cryptography and Network Security",** 2nd Edition, McGraw Hill

3. AtulKahate ," **Cryptography and Network Security",** 2nd edition , Tata McGraw-Hill Publishing Company Limited.

MOOCs:

1. Fundamentals of Computer Network Security Specialization - Coursera
2. Cryptography and Network Security, Indian Institute of Technology, Kharagpur and NPTEL via Swayam - offered through classcentral.com

Course Title	Detection and Estimation Techniques				
Course Code	20ECELPEML	Credits	3	L-T-P	3:0:0
CIE	50 Marks(100% weightage)	SEE		100 Marks (50% weightage)	

Prerequisites: Foundation course in statistics and probability

Course outcomes:

At the end of the course, the student will have the ability

CO-1	Acquire the concepts of detection theory, estimation theory and binary/composite hypothesis testing
CO-2	Apply different techniques to perform detection of deterministic / random signals in the presence of noise
CO-3	Visualize higher applications of the concept in EC engineering applications through study of relevant IEEE papers

Unit-I **06hrs**

Fundamentals of estimation theory: Formulation of the General Parameter Estimation Problem, Relationship between Detection and Estimation Theory, Types of Estimation Problems. Properties of estimators, Applications

Unit-II **08hrs**

Hypothesis testing: Binary hypothesis testing, MAP criteria, Bayes' risk, Minimax and Neyman-Pearson testing, multiple hypothesis tests, Receiver operating characteristics Performance of Binary Receivers in AWGN, Composite Hypothesis testing, Sequential Detection and Performance, Generalized likelihood ratio tests

Unit-III **08 hrs**

Signal detection with random parameters: Detection of known signals in noise, Matched filter, Performance evaluations, Composite Hypothesis Testing, Unknown Phase, Unknown Amplitude, Unknown Frequency, White and Colored Gaussian Noise for Continuous Signals, Estimator Correlator

Unit-IV **08hrs**

Random Parameter Estimation: Bayesian formulation, Minimum mean squared error and MAP estimation, Linear MMSE estimation, Orthogonality principle, Applications to channel estimation problems

Unit-V **09hrs**

Non-Random Parameter Estimation: Least squares estimation, Best linear unbiased estimation, Geometric interpretations, Maximum likelihood Estimation, Efficiency and consistency of estimators and asymptotic properties

Text books:

1. H. L. Van Trees, "Detection, Estimation, and Modulation Theory, Part I," John Wiley, 1968

REFERENCE BOOKS:

1. Harry L. Van Trees,"Detection, Estimation, and Modulation Theory, Part I," John Wiley & Sons, Inc. 2001.
2. StevenM.kay, "Fundamentals of Statistical signal processing, volume-1: Estimation theory". Prentice Hall 1993.
3. A.Papolis and S.UnnikrishnaPillai, "Probability, Random Variables and stochastic processes", 4e,.The McGraw-Hill 2002.
4. H. V. Poor, "An Introduction to Signal Detection and Estimation," Springer, Second Edition, 1998
5. S. M. Kay, "Fundamentals of Statistical Signal Processing: Detection Theory," Prentice Hall, 1998
6. S. M. Kay, "Fundamentals of Statistical Signal Processing: Estimation Theory," Prentice Hall, 1993

MOOCs:

1. Stochastic Processes, Detection, and Estimation, MIT OCW

Course Title	SYSTEM ON CHIP				
Course Code	20ECELPESC	Credits	3	L-T-P	3:0:0
CIE	50 Marks(100% weightage)	SEE		100 Marks (50% weightage)	

Prerequisites: Basic VLSI Design, Embedded system design

Course outcomes:

At the end of the course, the student will have the ability

CO-1	Understand the System on Chip design ,Architecture and complexity in designing
CO-2	Apply the design concepts for Processors and interconnect architecture
CO-3	Analyze and Design solutions for issues at system level, and issues of Hardware-Software co design

Unit-I **08hrs**

Introduction to the Systems Approach: System Architecture, Components of the system, Hardware & Software, Processor Architectures, Memory and Addressing. System level interconnection, An approach for SOC Design, System Architecture and Complexity

Unit-II **08hrs**

Processors: Introduction , Processor Selection for SOC, Basic concepts in Processor Architecture, Basic concepts in Processor Micro Architecture, Basic elements in Instruction handling.

Buffers: Minimizing Pipeline Delays, Branches, More Robust Processors, Vector Processors and Vector Instructions extensions, VLIW Processors, Superscalar Processors, Processor Evolution with examples.

Unit-III

07hrsSystem On Chip Design Process: Introduction , Processor Selection for SOC, Basic concepts in Processor Architecture, Basic concepts in Processor Micro Architecture, Basic elements in Instruction handling.

Buffers: Minimizing Pipeline Delays, Branches, More Robust Processors, Vector Processors and Vector Instructions extensions, VLIW Processors, Superscalar Processors, Processor Evolution with examples.

Unit-IV **08hrs**

Hardware-Software co design: Design for timing closure, Logic design issues, Verification strategy, On chip buses and interfaces, Low Power, Hardware Accelerators in Soc,

MPSoCs: What, Why, How MPSoCs, Techniques for designing MPSoCs, Performance and flexibility for MPSoCs design

Unit-V **08hrs**

Interconnect architectures for SoC: Bus architecture ,SOC Standard buses, Analytic bus models, Beyond the bus:. Network on Chip (NOC) with switch interconnects, NOC examples, Layered Architecture and NIU, Evaluating Interconnect networks

Text books:

1. Michael J. Flynn and Wayne Luk, “Computer System Design System-on-Chip”, Wiley India Pvt. Ltd
2. Michael Keating, Pierre Bricaud, “Reuse Methodology Manual for System on Chip designs”, Kluwer Academic Publishers, 2nd edition, 2008

REFERENCE BOOKS:

1. Sudeep Pasricha and Nikil Dutt,"On-Chip Communication Architectures: System on Chip Interconnect”, Morgan Kaufmann Publishers © 2008
2. Rao R. Tummala, Madhavan Swaminathan, “Introduction to system on package sop Miniaturization of the Entire System”, McGraw-Hill, 2008

E Books:

1 https://www.design-reuse.com/articles/4952/top-down-soc-design-methodology.html – (Top-down SoC design Methodology)
https://www.sciencedirect.com/science/article/pii/B9780123852519500141- (MPSoC)
2 https://www.sciencedirect.com/science/article/pii/B9780123852519500165-(Techniques for designing MPSoC).
3 https://nanohub.org/courses/ECE695R/o1a - (introduction SoC)

MOOCs:

1. https://nptel.ac.in/courses/108/102/108102045/
2. https://freevideolectures.com/course/2341/embedded-systems/10

Course Title	UVM METHODOLOGY CONCEPTS				
Course Code	20ECELGEUV	Credits	3	L-T-P	2:1:0
CIE	50 Marks(100% weightage)	SEE		100 Marks (50% weightage)	

Prerequisites: Programming basics, Embedded systems knowledge

Course outcomes:

At the end of the course, the student will have the ability

CO-1	Understand the System on Chip design ,Architecture and complexity in designing
CO-2	Apply the design concepts for Processors and interconnect architecture
CO-3	Analyze and Design solutions for issues at system level, and issues of Hardware-Software co design

Unit-I **08hrs**

Introduction to Universal Verification Methodology, Overview of UVM Base Classes and simulation phases in UVM and UVM macros. Unified messaging in UVM, UVM environment structure, connecting DUT- Virtual Interface

Unit-II **08hrs**

Over view of OVM Environment with OVM Libraries, Introduction toOVM, OVM and Coverage-Driven Verification (CDV), Test bench and Environments. OVC Overview. Data Item (Transaction). Driver (BFM). Sequencer. Monitor. Agent. Environment. The System Verilog OVM Class Library. OVM Facilities.

Unit-III **08hrs**

Transaction-Level Modeling (TLM). Transaction-Level Modeling Overview. TLM Basics. Transaction-Level Communication. Basic TLM Communication. Communicating Between Processes. Blocking versus Nonblocking. Connecting Transaction-Level Components. Peer-to-Peer connections. Port/Export Compatibility. Encapsulation and Hierarchy. Hierarchical Connections. Analysis Communication, Ports, Exports

Unit-IV **08hrs**

Developing Reusable Open Verification Components (OVCs)

Modelling Data Items for Generation. Inheritance and Constraint Layering. Defining Control Fields ("Knobs"). Transaction-Level Components. Creating the Driver. Creating the Sequencer. Connecting the Driver and Sequencer. Fetching Consecutive Randomized Items. Sending Processed Data Back to the Sequencer

Unit-V **07hrs**

Using TLM-Based Drivers. Creating the Monitor. Instantiating Components. Creating the Agent. Creating the Environment. The Environment Class. The OVM Configuration Mechanism

REFERENCE BOOKS:

1. OVM User Guide, Version 2.1.2, © 2008–2011 Cadence Design Systems, Inc. (Cadence). All rights reserved. Cadence Design Systems, Inc., 2655 Seely Ave., San Jose, CA 95134, USA.© 2008–2011 Mentor Graphics, Corp. (Mentor). All rights reserved. Mentor Graphics, Corp., 8005 SW Boeckman Rd., Wilsonville, OR 97070, USA
   http://www.specman-verification.com/source_bank/ovm-2.1.2/ovm-2.1.2/OVM_UserGuide.pdf

2. Verification Methodology Manual for System Verilog, © 2008–2011 Cadence Design Systems, Inc. (Cadence). All rights reserved.Cadence Design Systems, Inc., 2655 Seely Ave., San Jose, CA 95134, USA. © 2008–2011 Mentor Graphics, Corp. (Mentor). All rights reserved.Mentor Graphics, Corp., 8005 SW Boeckman Rd., Wilsonville, OR 97070, USA
   http://read.pudn.com/downloads178/ebook/825398/vmm_sv.p

Course Title	Internship				
Course Code	20ECELPCIN	Credits	09	L-T-P	N.A.
CIE	50 Marks(100% weightage)	SEE		100 Marks (50% weightage)	

Prerequisites: -

Course outcomes:

At the end of the course, the student will have the ability

CO-1	Able to develop a sound theoretical and practical knowledge of new technologies.
CO-2	Able develop domain specific problem solving and critical thinking skills
CO-3	Able to develop individual responsibility towards their internship goal as well as participate as an effective team member
CO-4	Able to develop individual responsibility towards their internship goal as well as participate as an effective team member
CO-5	Gain exposure to professional work culture & practices
CO-6	Able to develop effective presentation & communication skills, and create proper documentation of the work

Course Title	Project work (I-Phase)				
Course Code	20ECELPWP1	Credits	08	L-T-P	N.A.
CIE	50 Marks(100% weightage)	SEE		100 Marks (50% weightage)	

COURSE OUTCOMES

CO1	Identify a suitable project ,making use of the technical and engineering knowledgegained from previous courses with the awareness of impact of technology on the
CO2	Collect and disseminate information related to the selected project within given timeframe.
CO3	Communicate technical and general information by means of oral as well as written

Course Title	Technical Seminar 1				
Course Code	20ECELSR01	Credits	02	L-T-P	N.A.
CIE	50 Marks(100% weightage)	SEE		100 Marks (50% weightage)	

COURSE OUTCOMES

CO1	Identify the problem through literature survey by applying depth knowledge of the chosen domain
CO2	Analyse, synthesize and conceptualize the identified problem
CO3	Communicate clearly, write effective reports and make effective presentations following the professional code of conduct and ethics
CO4	Comprehensively study the domains and reflect the same towards the future enhancements of the work

M. Tech- ELECTRONICS

Fourth Semester

Course Title	Project work (Phase 2)				
Course Code	20ECELPWP2	Credits	20	L-T-P	N.A.
CIE	50 Marks(100% weightage)	SEE		100 Marks (50% weightage)	

COURSE OUTCOMES

CO1	Identify the modern tools required for the implementation of the project.
CO2	Design, examine critically and implement or develop a prototype for the identified problem during Phase I
CO3	Communicate technical information by means of oral as well as written presentation skills with professionalism and engage in lifelong learning.

Course Title	Technical Seminar 2				
Course Code	20ECELSR02	Credits	02	L-T-P	N.A.
CIE	50 Marks(100% weightage)	SEE		100 Marks (50% weightage)	

COURSE OUTCOMES

CO1	Identify the problem through literature survey by applying depth knowledge of the chosen domain
CO2	Analyse, synthesize and conceptualize the identified problem
CO3	Communicate clearly, write effective reports and make effective presentations following the professional code of conduct and ethics
CO4	Comprehensively study the domains and reflect the same towards the future enhancements of the work