

**M.TECH**  
**VLSI DESIGN and EMBEDDED SYSTEMS**  
**SCHEME OF INSTRUCTION AND SYLLABUS**  
**M.Tech-23**  
**(w.e.f 2023– 2024)**  
**Department of Electronics and Communication**  
**Engineering**



**VELAGAPUDI RAMAKRISHNA**  
**SIDDHARTHA ENGINEERING COLLEGE**

(An Autonomous, ISO 21001:2018 Certified Institution)

(Approved by AICTE, Accredited by NAAC with 'A+' Grade, Affiliated to JNTUK, Kakinada)

(Sponsored by Siddhartha Academy of General & Technical Education)

Kanuru, Vijayawada

Andhra Pradesh - 520007, INDIA.

[www.vrsiddhartha.ac.in](http://www.vrsiddhartha.ac.in)

### **INSTITUTE VISION**

To nurture excellence in various fields of engineering by imparting timeless core values to the learners and to mould the institution into a center of academic excellence and advanced research.

### **INSTITUTE MISSION**

To impart high quality technical education in order to mould the learners into globally competitive technocrats who are professionally deft, intellectually adept and socially responsible. The institution strives to make the learners inculcate and imbibe pragmatic perception and pro-active nature so as to enable them to acquire a vision for exploration and an insight for advanced enquiry.

### **DEPARTMENT VISION**

To produce globally competitive and socially sensitized engineering graduates and to bring out quality research in the frontier areas of Electronics & Communication Engineering.

### **DEPARTMENT MISSION**

To provide quality and contemporary education in the domain of Electronics & Communication Engineering through periodically updated curriculum, best of breed laboratory facilities, collaborative ventures with the industries and effective teaching learning process.

To pursue research and new technologies in Electronics & Communication Engineering and related disciplines in order to serve the needs of society, industry, government and scientific community.

## **PROGRAM OUTCOMES**

- PO1 Independently carry out research /investigation and development work to solve practical problems.
- PO2 Write and present a substantial technical report/document.
- PO3 Demonstrate a degree of mastery over the area as per the VLSI Design and Embedded Systems program.
- PO4 Devise and apply appropriate techniques and modern engineering tools to complex engineering activities with an understanding of the limitations
- PO5 Recognize the need for and an ability to engage in lifelong learning to keep oneself abreast of the knowledge to be competent.

**VELAGAPUDI RAMAKRISHNA SIDDHARTHA ENGINEERING COLLEGE**  
**Department of ELECTRONICS AND COMMUNICATION ENGINEERING**  
**SCHEME OF INSTRUCTION FOR TWO YEAR PG PROGRAMME [M.Tech 23]**  
**M.Tech in VLSI Design and Embedded Systems**

**SEMESTER I**

Contact Hours: 26

S. No	Course Category	Course Code	Title of the Course	L	T	P	C
1	Programme Core - I	23ECVE1001	Design and verification through System Verilog	3	0	0	3
2	Programme Core - II	23ECVE1002	ARM controllers for embedded systems	3	0	0	3
3	Programme Core - III	23ECVE1003	CMOS VLSI Design ( Integrated Course)	2	0	2	3
4	Programme Elective – I	23ECVE1014/1	Device Modelling	3	0	0	3
		23ECVE1014/2	IC Fabrication Technology				
		23ECVE1014/3	VLSI signal processing				
		23ECVE1014/4	MEMS				
		23ECVE1014/5	MOOCS-I				
5	Programme Elective - II	23ECVE1015/1	Embedded Systems Design and Architecture	3	0	0	3
		23ECVE1015/2	Embedded C Programming				
		23ECVE1015/3	Electronics Design: Sensor and Actuator Interface				
		23ECVE1015/4	Internet of Things for Real time systems				
		23ECVE1015/5	MOOCS-II & III				
6	Mandatory Learning Course	23MTMC1026	Research Methodology and IPR	2	0	0	0
7	Laboratory – I	23ECVE1051	Digital System Design Lab	0	0	3	1.5
8	Laboratory - II	23ECVE1052	Embedded Systems Design Lab	0	0	3	1.5
9	Project	23ECVE1063	Capstone project-I	0	0	2	1
<b>Total</b>				<b>16</b>	<b>0</b>	<b>10</b>	<b>19</b>

## SEMESTER II

Contact Hours: 28

S. No	Course Category	Course Code	Title of the Course	L	T	P	C
1	Programme Core - IV	23ECVE2001	Real Time Operating Systems	3	0	0	3
2	Programme Core - V	23ECVE2002	Analog and Mixed Signal Design	3	0	0	3
3	Programme Core - VI	23ECVE2003	Hardware-Software codesign (Integrated course)	2	0	2	3
4	Programme Elective – III	23ECVE2014/1	Low Power VLSI Design	3	0	0	3
		23ECVE2014/2	Semiconductor Packaging and Testing				
		23ECVE2014/3	Digital Design Using High Level Synthesis				
		23ECVE2014/4	Radio Frequency IC Design				
		23ECVE2014/5	MOOCs-IV				
5	Programme Elective - IV	23ECVE2015/1	LINUX Shell Scripting	3	0	0	3
		23ECVE2015/2	Embedded Linux Device Drivers				
		23ECVE2015/3	Communication Busses and Interfaces				
		23ECVE2015/4	Industrial Product Design				
		23ECVE2015/5	MOOCs-V & VI				
6	Audit Course	23MTAC2036	Technical Report Writing	2	0	0	—
7	Term Paper	23ECVE2064	Term Paper	2	0	0	1
8	Laboratory – I	23ECVE2051	Real Time Operating Systems Lab	0	0	3	1.5
9	Laboratory - II	23ECVE2052	Analog and Mixed Signal Design Lab	0	0	3	1.5
10	Project	23ECVE2063	Capstone project-II	0	0	2	1
Total				<b>18</b>	<b>0</b>	<b>10</b>	<b>20</b>

**SEMESTER III**

Contact Hours: 23

S. No	Course Category	Course Code	Title of the Course	L	T	P	C
1	Programme Elective - V	23ECVE3011	Students to complete course in any MOOCS Platform such as NPTEL	3	0	0	3
2	Project (Part-A)	23ECVE3061	Dissertation/ Industrial Project Project - Part A*	0	0	20	10
3	Internship	23ECVE3052	Internship/Summer Training in Research Organizations/ Institutions of Higher Learning (After II Sem)	0	0	0	2
<b>Total</b>				<b>3</b>	<b>0</b>	<b>20</b>	<b>15</b>

\*To be continued in the IV Semester

Program Elective V may be completed in semester I or II by satisfying the pre-requisites

#Evaluation done by MOOCS providers will be considered.

**Semester IV**

Contact Hours:32

S. No	Course Category	Course Code	Title of the Course	L	T	P	C
1	Project (Part-B)	23ECVE4061	Dissertation/ Industrial Project Project - Part B	0	0	32	16
<b>Total</b>				<b>0</b>	<b>0</b>	<b>32</b>	<b>16</b>

**L – Lecture, T: Tutorial, P – Practical, C – Credits****Total Credits:70**

Semester	Credits
1	19
2	20
3	15
4	16
Total	70

**Note:**

1. Student has to carry out a project applying the knowledge and hands on technical skills they have gained through course work and lab sessions in Semester-I under Capstone Project 1
2. Student should carry out literature survey of the selected problem and present it in a Seminar for the yearlong Project Work under Term Paper.
3. Student has to carry out a project applying the knowledge and hands on technical skills they have gained through course work and lab sessions in Semester-II under Capstone Project 2
4. At least one theory course in the I & II semesters can be made as integrated course (Theory coupled with Laboratory).
5. Maximum of three theory courses (40% of courses) can be offered as self-learning courses in each of the First and Second semesters.

# SEMESTER I

### 23ECVE1001: DESIGN AND VERIFICATION THROUGH SYSTEM VERILOG

<b>Course Category:</b>	Programme Elective	<b>Credits:</b>	3
<b>Course Type:</b>	Theory	<b>Lecture - Tutorial -Practice:</b>	3-0-0
<b>Prerequisites:</b>	Digital Logic Design	<b>Continuous Evaluation:</b>	40
		<b>Semester end Evaluation:</b>	60
		<b>Total Marks:</b>	100

<b>Course outcomes</b>	Upon successful completion of the course, the student will be able to:					
	CO1	Understand the concepts of verification methodologies and data types.				
	CO2	Summarize the concepts of procedural statements, routines and assertions.				
	CO3	Analyze the concepts of functional coverage.				
<b>Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 – Medium, 3 – High)</b>		PO1	PO2	PO3	PO4	PO5
	CO1	3		3		2
	CO2	2		3		2
	CO3	3		3		2
<b>Course Content</b>	<p><b>UNIT I: ( 10Hrs )</b>  <b>Verification Guidelines:</b> Verification process, Basic Testbench functionality, Directed Testing, Methodology Basics, Constrained Random Stimulus, Functional coverage, Testbench components, Layered Testbench, Building layered Testbench, Simulation Environment phases.</p> <p><b>UNIT II: ( 12Hrs )</b>  <b>Data Types:</b> Built in data types, Fixed sized arrays, Dynamic arrays, Queues, Associative Arrays, Linked lists, Array methods, Choosing a storage data type, Creating new types with typedef, Creating user defined structures, Enumerated types, Constant, strings, Expression width, net types.</p> <p><b>UNIT III: ( 12Hrs )</b>  <b>Procedural statements and routines:</b> Procedural statements, tasks, Functions, Routine Arguments, Returning from a routine, Local data storage, Time values  <b>Basic OOP:</b> Introduction, think of nouns, Not verbs, your first class, where to define a class, OOP terminology, creating new objects, Object De-allocation using objects, Static variable vs Global variable, Class methods, Defining methods outside of the class, Scoping rules, using one class inside another, Understanding dynamic objects, Public vs. Local, Straying offcourse building a testbench</p> <p><b>UNIT – IV: ( 12Hrs )</b></p>					

	<p><b>Connecting the Testbench and Design:</b> Separating the testbench and design, Interface constructs, Stimulus timing, Interface driving and sampling, connecting it all together, Top level scope program – Module interactions.</p> <p><b>System Verilog Assertions:</b> Immediate Assertions, Customizing the Assertion Actions, Concurrent Assertions, Exploring Assertions.</p>
<b>Text books and Reference books</b>	<p><b>Text Books</b></p> <p>1. Chris Spears, “System Verilog for Verification”, Springer, 2<sup>nd</sup> Edition.</p> <p><b>Reference Books</b></p> <p>1. M. Bushnell and V.D. Agarwal “Essential of electronic Testing for Digital, Memory and Mixed Signal VLSI Circuits”, Kluwer Academic Publisher.</p>
<b>E-resources and other digital material</b>	<p>1. IEEE 1800-2009 standard (IEEE Standard for SystemVerilog – Unified Hardware Design, Specification and Verification Language).</p> <p>2. System Verilog website – <a href="http://www.systemverilog.org">www.systemverilog.org</a></p>

**Name of Course Coordinator :**Dr G Kishore Kumar

## 23ECVE1002: ARM CONTROLLERS FOR EMBEDDED SYSTEMS

<b>Course Category:</b>	Theory	<b>Credits:</b>	3
<b>Course Type:</b>	Programme Core-II	<b>Lecture - Tutorial -Practice:</b>	3-0-0
<b>Prerequisites:</b>	Computer Organization	<b>Continuous Evaluation:</b>	40
		<b>Semester end Evaluation:</b>	60
		<b>Total Marks:</b>	100

<b>Course Outcomes</b>	Upon successful completion of the course, the student will be able to:					
	CO1	Understand and analyze the design aspects, Architecture, and instruction set associated with ARM processors.				
	CO2	Analyze the C programming optimization methods for ARM processor.				
	CO3	Examines various cache-technologies that surround the ARM cores.				
	CO4	Analyze the Memory Protection Units and Memory Management Units around ARM				
<b>Contribution of Course Outcomes towards achievement of Program Outcomes (1– Low, 2 - Medium, 3 – High)</b>		PO1	PO2	PO3	PO4	PO5
	CO1			2		
	CO2				2	
	CO3					1
	CO4					2
<b>Course Content</b>	<p><b>UNIT I:</b></p> <p><b>ARM Processor Fundamentals:</b> ARM Design Philosophy, Registers, CPSR, Pipeline, Exceptions, Interrupts and Vector Table, Core Extensions.</p> <p><b>Introduction to the ARM Instruction Set:</b> Data Processing Instructions, Branch Instructions, Load –Store Instructions, Software Interrupt Instruction, PSR Instructions.</p> <p><b>Introduction to the Thumb Instruction Set:</b> Thumb Register Usage, Branch Instructions, Data Processing Instructions, Load-Store Instructions, Stack instructions, Software Interrupt Instruction. <span style="float: right;"><b>( 12 Hrs)</b></span></p> <p><b>UNIT II:</b></p> <p><b>Efficient C Programming:</b> Basic C Data Types, C Looping Structures, Register Allocation, Function Calls, Structure Arrangement.</p> <p><b>Writing and Optimizing ARM Assembly Code:</b> Writing Assembly Code, Profiling and Cycle Counting, Instruction Scheduling, Register Allocation, Conditional Execution, Looping Constructs. <span style="float: right;"><b>(12 Hrs)</b></span></p> <p><b>UNIT III:</b></p>					

	<p><b>Exception and Interrupt Handling:</b> Exception Handling, Interrupts, Interrupt Handling Schemes</p> <p><b>Caches :</b>The Memory Hierarchy and Cache Memory, Cache Architecture, Cache Policy, Flushing and Cleaning Cache Memory. <b>( 10 Hrs)</b></p> <p><b>UNIT – IV:</b></p> <p><b>Memory Protection Units :</b>Protected Regions, Initializing the MPU, Caches and Write Buffer.</p> <p><b>Memory Management Units:</b> Moving from an MPU to an MMU, How Virtual Memory Works, Details of the ARM MMU, Page Tables, Translation Lookaside Buffer, Domains And Memory Access Permission, The Fast Context Switch Extension <b>( 10 Hrs)</b></p>
<p><b>Text books and Reference books</b></p>	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>1. A.Sloss, D.Symes, C.Wright, “ARM system Developers Guide: Designing and Optimizing System Software”, Morgan Kaufmann publishers, 2012.</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>1. Steve Furber, “ARM System on Chip Architecture”, 2<sup>nd</sup>ed., Addison Wesley Professional,2000.</li> <li>2. Valvano, J,”Embedded microcomputer systems: real time interfacing”, 3<sup>rd</sup> Edition, Cengage Learning, 2011.</li> <li>3. Frank Vahid, TonyGivargis, “Embedded System Design”, J Wiley India,2005.</li> </ol>
<p><b>E-resources and other digital material</b></p>	<ol style="list-style-type: none"> <li>1. <a href="https://nptel.ac.in/courses/106105193/">https://nptel.ac.in/courses/106105193/</a></li> <li>2. <a href="https://www.arm.com/resources/education/education-kits/efficient-embedded-systems">https://www.arm.com/resources/education/education-kits/efficient-embedded-systems</a></li> </ol>

**Name of Course Coordinator :Dr M Padmaja**

**23ECVE1003: CMOS VLSI DESIGN (INTEGRATED COURSE)**

<b>Course Category:</b>	Program Core-III	<b>Credits:</b>	3
<b>Course Type:</b>	Integrated Course	<b>Lecture - Tutorial - Practice:</b>	2-0-2
<b>Prerequisites:</b>	Device Physics	<b>Continuous Evaluation: Semester end Evaluation: Total Marks:</b>	40 60 100

Course outcomes	Upon successful completion of the course, the student will be able to:					
	CO1	Demonstrate advanced knowledge in Static and dynamic characteristics of CMOS, Estimation of Delay and Power.				
	CO2	Analyze, design and implement combinational MOS logic circuits.				
	CO3	Analyze, design and implement sequential MOS logic circuits.				
	CO4	Classify different semiconductor memories.				
Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 -Medium, 3 – High)		PO1	PO2	PO3	PO4	PO5
	CO1	1	1	3	3	2
	CO2	2	1	3	3	2
	CO3	2	1	3	3	2
	CO4	2	1	3	3	3
Course Content	<p><b>Unit-I:</b>  <b>The CMOS Inverter:</b> The MOS(FET) Transistor , Introduction, The Static CMOS Inverter — An Intuitive Perspective, Evaluating the Robustness of the CMOS Inverter: The Static Behavior, Performance of CMOS Inverter: The Dynamic Behavior, Power, Energy, and Energy-Delay, Technology Scaling, and its Impact on the Inverter Metrics <b>( 12 Hrs)</b></p> <p><b>Unit II: Designing Combinational Logic Gates In CMOS:</b>  Introduction, Static CMOS Design, Dynamic CMOS Design, How to Choose a Logic Style</p> <p><b>Designing Sequential Logic Circuits:</b> Introduction, Static Latches and Registers, Dynamic Latches and Registers, Alternative Register Styles, Pipelining: An approach to optimize sequential circuits, Choosing a Clocking Strategy <b>( 13 Hrs)</b></p> <p><b>Unit III: Datapath Subsystems:</b> Introduction, Addition/Subtraction, One/Zero Detectors, Comparators, Counters, Boolean Logical operations, Coding, Shifters, Multiplication <b>( 10 Hrs)</b></p>					

	<p><b>Unit IV: Array Subsystems:</b> Introduction, SRAM, DRAM, Read-Only Memory, Serial Access Memories, Content-addressable memory, Robust Memory Design <b>( 10 Hrs)</b></p> <p>The students are required to design and implement the Circuit and Layout of any SIX Experiments using CMOS 90nm Technology with Mentor Graphics Tool/ Cadence/ Synopsys/Industry Equivalent Standard Software.</p> <p>List of Experiments:</p> <ol style="list-style-type: none"> <li>1. Inverter Characteristics.</li> <li>2. NAND and NOR Gate</li> <li>3. XOR and XNOR Gate</li> <li>4. 2:1 Multiplexer</li> <li>5. Full Adder</li> <li>6. RS-Latch</li> <li>7. Clock Divider</li> <li>8. JK-Flip Flop</li> <li>9. Synchronous/ Asynchronous Counter</li> <li>10. Static RAM Cell</li> </ol>
Text books and Reference books	<p><b>Textbooks:</b></p> <ol style="list-style-type: none"> <li>1. Digital Integrated Circuits – A Design Perspective, Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, 2<sup>nd</sup> Ed., PHI.</li> <li>2. CMOS VLSI Design: A Circuits and Systems Perspective, Neil H. E. Weste, David Money Harris, 4<sup>th</sup> Edition, Addison- Wesley,2011</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>1. Digital Integrated Circuit Design – Ken Martin, Oxford University Press, 2011.</li> <li>2. CMOS Digital Integrated Circuits Analysis and Design – Sung-Mo Kang, Yusuf Leblebici, TMH, 3<sup>rd</sup> Ed., 2011.</li> <li>3. Introduction to VLSI Systems: A Logic, Circuit and System Perspective – Ming-BO Lin, CRC Press, 2011</li> </ol>
E-resources and other digital material	<ol style="list-style-type: none"> <li>1. <a href="https://archive.nptel.ac.in/courses/108/107/108107129/">https://archive.nptel.ac.in/courses/108/107/108107129/</a></li> <li>2. <a href="http://ee.iitm.ac.in/vlsi/courses/ee5311_2020">http://ee.iitm.ac.in/vlsi/courses/ee5311_2020</a></li> <li>3. <a href="https://www.udemy.com/course/cmos-digital-integrated-circuit-design/">https://www.udemy.com/course/cmos-digital-integrated-circuit-design/</a></li> <li>4. <a href="https://www.udemy.com/course/cmos-digital-vlsi-for-beginners/">https://www.udemy.com/course/cmos-digital-vlsi-for-beginners/</a></li> </ol>

Name of Course Coordinator : Dr.G.L.Madhumati

**23ECVE1014/1: DEVICE MODELLING**

<b>Course Category:</b>	Program Elective-I	<b>Credits:</b>	3
<b>Course Type:</b>	Theory	<b>Lecture - Tutorial -Practice:</b>	3-0-0
<b>Prerequisites:</b>	Basic Electronics VLSI Design	<b>Continuous Evaluation:</b>	40
		<b>Semester end Evaluation:</b>	60
		<b>Total Marks:</b>	100

<b>Course outcomes</b>	Upon successful completion of the course, the student will be able to:				
	CO1	Understand MOS capacitor working principles, modes of operations, electrostatics of MOS, and properties of semiconductors.			
	CO2	Analyse the physics of MOSFET, evaluate the current-voltage characteristics, understand MOSFET reliability issues, and analyse advanced MOSFETs.			
	CO3	Understand the principles of Silicon on Insulator MOSFET, analyse intrinsic MOSFET capacitances and resistances, and evaluate FDSOI MOS and its sub-threshold slope.			
	CO4	Understand the theory of Ballistic nano transistors, evaluate the modeling of Ballistic planer and nanowire-FET, and analyze advanced MOSFETs such as Strain Engineered Channel materials, Electrostatics of double gate, and Fin-FET device.			

<b>Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)</b>		PO1	PO2	PO3	PO4	PO5
	CO1	2		2		2
	CO2	2		2		2
	CO3	1		2		2
	CO4	3		2		2

<b>Course Content</b>	<p><b>UNIT I:</b> ( 10Hrs)  <b>MOS Transistor Basics:</b> Electrons and holes in silicon, Energy band diagram of PN Diode, Types of MOSFET, MOSFET Mode of Operations, CV characteristics of MOS, low frequency and high frequency capacitor-voltage characteristics, Non-idealities in MOS, oxide fixed charges, interfacial charges, Poly-Silicon contact and poly silicon properties, Electrostatics of non-uniform substrate doping, carrier transport in insulating films, ultrathin gate-oxide.</p> <p><b>UNIT II:</b> (12 Hrs)  <b>MOSFET:</b> Drift-Diffusion Approach for current-voltage analysis, Gradual Channel Approximation, channel conductance, trans conductance, MOSFET equivalent circuit, Sub-threshold current and slope, Body effect, mobility behavior, temperature behaviors MOSFET two dimensional effects, buried channels, effect of ion implantation on threshold voltage, High field effects and MOSFET reliability issues.</p> <p><b>UNIT III:(12 Hrs)</b></p>
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	<p><b>SOI:</b> Leakage mechanisms in thin gate oxide, High-K-Metal Gate MOSFET devices and technology issues, Intrinsic MOSFET capacitances and resistances, SOI, FDSOI and PDSOI, VT definitions, Back gate coupling and body effect parameter, IV characteristics of FDSOI-FET, FDSOI-sub-threshold slope, Floating body effect, SOI materials: sapphire, zirconia, spinel, and calcium fluoride.</p> <p><b>UNIT – IV:( 10Hrs)</b></p> <p><b>Advanced Nano-Transistors:</b> Modern bipolar transistor structures, Quasi Ballistic &amp; Ballistic Transports, theory of ballistic nano transistors, Ballistic planer and nanowire-FET modeling: semi-classical and quantum treatments Advanced MOSFETs: Electrostatics of double gate, and Fin-FET device, high-k/metal gate Fin-FET.</p>
<p><b>Textbooks and Reference books</b></p>	<p><b>Textbooks:</b></p> <ol style="list-style-type: none"> <li>1. S.M. Sze&amp; Kwok K. Ng, Physics of Semiconductor Devices, Wiley</li> <li>2. B. G. Streetman, S. K. Banerjee, Solid State Electronic Devices, Pearson, (2016)</li> <li>3. Jean-Pierre Colinge, Silicon-on-Insulator Technology: Materials to VLSI, Springer Science Business Media, LLC</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>1. N. Arora, MOSFET modeling for VLSI Simulation: Theory and Practice, World</li> <li>2. Mark S. Lundstrom and Jing Guo Nanoscale Transistors Device Physics, Modeling and Simulation, Springer</li> <li>3. Yannis Tsividis, Operation and Modeling of the MOS Transistor, Oxford University Press</li> </ol>
<p><b>E-resources and other digital material</b></p>	<ol style="list-style-type: none"> <li>1. <a href="https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-012-microelectronic-devices-and-circuits-fall-2009/lecture-notes/">https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-012-microelectronic-devices-and-circuits-fall-2009/lecture-notes/</a></li> </ol>

**Name of Course Coordinator :** Dr. Aniruddh Bahadur Yadav

## 23ECVE1014/2: IC FABRICATION TECHNOLOGY

<b>Course Category:</b>	Programme Elective-I	<b>Credits:</b>	3
<b>Course Type:</b>	Theory	<b>Lecture - Tutorial -Practice:</b>	3-0-0
<b>Prerequisites:</b>	Semiconductor Devices ,Linear Integrated Circuits	<b>Continuous Evaluation:</b>	40
		<b>Semester end Evaluation:</b>	60
		<b>Total Marks:</b>	100

<b>Course Outcomes</b>	Upon successful completion of the course, the student will be able to:					
	CO1	Appreciate the various techniques involved in the VLSI fabrication process.				
	CO2	Understand the different lithography methods, Oxidation and etching process.				
	CO3	Appreciate the deposition and diffusion mechanisms				
	CO4	Understand the ion implantation and metallization process				
Contribution of Course Outcomes towards achievement of Program Outcomes (1 –Low,2 - Medium,3– High)		PO1	PO2	PO3	PO4	PO5
	CO1			<b>2</b>		<b>2</b>
	CO2			<b>2</b>		<b>2</b>
	CO3			<b>2</b>		<b>2</b>
	CO4			<b>2</b>		<b>2</b>
<b>Course Content</b>	<p><b>UNIT-I:Introduction to IC Technology</b> – Basics of wafer preparation and crystal growth, Electronic grade silicon, Czochralski crystal growing process, Basic properties of silicon wafers.</p> <p><b>Epitaxy</b>–Introduction, Vapor phase epitaxy, Molecular beam epitaxy, Silicon-on-insulators, Epitaxial evaluation.(10 Hrs)</p> <p><b>UNIT-II:</b></p> <p><b>Oxidation</b>–Introduction, First order planar growth mechanism and kinetics, Effect of pressure and crystal orientation on growth kinetics, 2D oxide growth kinetics, poly-silicon oxidation, silicide and silicon nitride oxidation, advanced defect models related to oxidation induced defects.</p> <p><b>Lithography</b>-Introduction, properties of photoresists, Optical lithography, Electron lithography, XRay lithography, Ion lithography.</p> <p><b>Reactive Plasma Etching</b>–Introduction, Plasma properties, Feature size control and anisotropic etch mechanisms, Reactive plasma etching techniques and equipment.(13 Hrs)</p> <p><b>UNIT-III:</b></p> <p><b>Thin Film Deposition</b> – Basics of different Chemical and Physical vapour deposition techniques, Methods for Polysilicon, Silicon dioxide, Silicon Nitride, and Metal depositions.</p> <p><b>Diffusion</b>–Introduction, Models of diffusion in solids, Models for diffusion damage annealing, Diffusion in polycrystalline silicon, Diffusion in SiO<sub>2</sub>.(12 Hrs)</p> <p><b>UNIT-IV:</b></p> <p><b>Ion Implantation</b>–Introduction, Range theory, Implantation equipment, Annealing, Shallow junctions, High-energy implantation, Limitation and future scope of ion implantation.</p> <p><b>Metallization</b>–Introduction, Metallization choices, Physical vapor deposition, Patterning.</p>					

	<b>Back-End Process-</b> Introduction, Contacts, Interconnects and Vias, Source, Drain and Gate Contacts. <b>(10 Hrs)</b>
<b>Text books and Reference books</b>	<p><b>Text Books:</b> 1. S.M.Sze, “VLSI Technology (2nd edition), McGraw Hill, 2003. 2. W. Wolf, “Modern VLSI Design”, (3rd edition), Pearson,2002</p> <p><b>Reference Books:</b> 1. Plummer (2001), “Silicon VLSI Technology: Fundamentals, Practice, and Modeling”, Pearson Education India. 2. C.Y. Chang and S.M.Sze (Ed), (1996), “ULSI Technology”, McGraw Hill Companies Inc. 3. Stephen Campbell (2012), “The Science and Engineering of Microelectronics”, Oxford University Press,.</p>
<b>E-resources and other digital material</b>	<p>1. Lecture Series on VLSI Design by Dr.Nandita Dasgupta, Department of Electrical Engineering, IIT Madras. <a href="http://nptel.ac.in">http://nptel.ac.in</a> 2. <a href="https://www.youtube.com/watch?v=Hp4xFkEZUos&amp;list=PL5060CE8F13023479">https://www.youtube.com/watch?v=Hp4xFkEZUos&amp;list=PL5060CE8F13023479</a> Video lecture series from IIT Professors VLSI Technology by Prof.SantiramKal, IIT KGP. 3.<a href="https://archive.nptel.ac.in/courses/113/106/113106062/">https://archive.nptel.ac.in/courses/113/106/113106062/</a></p>

**Name of Course Coordinator :** Dr. Ball Mukund Mani Tripathi

### 23ECVE1014/3: VLSI SIGNAL PROCESSING

<b>Course Category:</b>	Program Elective-I	<b>Credits:</b>	3
<b>Course Type:</b>	Theory	<b>Lecture - Tutorial - Practice:</b>	3-0-0
<b>Prerequisites:</b>	DSP, VLSI	<b>Continuous Evaluation:</b>	40
		<b>Semester end Evaluation:</b>	60
		<b>Total Marks:</b>	100

Course outcomes	Upon successful completion of the course, the student will be able to:					
	CO1	Comprehend parallel processing and pipe lining of FIR digital filters and analyse retiming concepts.				
	CO2	Analyse algorithms for folding and unfolding.				
	CO3	Design architectures and methodology for systolic arrays, matrix multiplication.				
	CO4	Design fast convolution techniques and analyse algorithms for fast convolution.				
Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 -Medium, 3 – High)		PO1	PO2	PO3	PO4	PO5
	CO1	2	2	2		
	CO2	3	2	3	2	
	CO3	3	2	2	2	
	CO4	3	2	2	2	
Course Content	<p><b>UNIT-I</b>  <b>Pipelining and Parallel Processing:</b> Introduction, Pipelining of FIR Digital Filters, Parallel Processing. Pipelining and Parallel Processing for Low Power. Retiming: Introduction, Definition and Properties, Solving System of Inequalities, Retiming Techniques. <span style="float: right;"><b>(12 Hrs)</b></span></p> <p><b>UNIT-II</b>  <b>Unfolding:</b> Introduction to Algorithms for Unfolding, Properties of Unfolding, Critical Path, Unfolding and Retiming Application of Unfolding. <b>Folding:</b> Introduction to Folding Transformation, Register Minimization Techniques, Register Minimization in Folded Architectures, Folding in Multirate Systems. <span style="float: right;"><b>(12 Hrs)</b></span></p> <p><b>UNIT-III</b>  <b>Systolic Architecture Design:</b> Introduction, Systolic Array Design Methodology, FIR Systolic Arrays, Selection of Scheduling Vector, Matrix Multiplication and 2D Systolic Array Design, Systolic Design for Space Representations Containing Delays. <span style="float: right;"><b>(12 Hrs)</b></span></p>					

	<p><b>UNIT-IV</b></p> <p><b>Fast Convolution:</b> Introduction, Cook, Toom Algorithm, Winograd Algorithm, Iterated Convolution, Cyclic Convolution, Design of Fast Convolution Algorithm by Inspection. <b>(10 Hrs)</b></p>
Text books and Reference books	<p><b>Text Books:</b></p> <p>1. Keshab K. Parhi, "VLSI Digital Signal Processing Systems", Wiley-Inter Sciences, 1999</p> <p><b>Reference Books:</b></p> <p>1. Kung. S.Y., H.J. White house T.Kailath, VLSI and Modern singal processing, Prentice Hall, 1985.</p> <p>2. Jose E. France, YannisTsvidlis, Design of Analog Digital VLSI Circuits for Telecommunications and Signal Processing' Prentice Hall, 1994.</p>
E-resources and other digital material	<p>1.<a href="https://archive.nptel.ac.in/courses/108/105/108105157/">https://archive.nptel.ac.in/courses/108/105/108105157/</a></p> <p>2.<a href="https://www.classcentral.com/course/swayam-vlsi-signal-processing-17837">https://www.classcentral.com/course/swayam-vlsi-signal-processing-17837</a></p> <p>3.<a href="http://viplab.cs.nctu.edu.tw/">http://viplab.cs.nctu.edu.tw/</a></p> <p>4.<a href="http://people.ece.umn.edu/users/parhi/SLIDES/">http://people.ece.umn.edu/users/parhi/SLIDES/</a></p>

**Name of Course Coordinator :** Mrs. S Teena Mrudula

23ECVE1014/4: MEMS

<b>Course Category:</b>	Programme Elective-I	<b>Credits:</b>	3
<b>Course Type:</b>	Theory	<b>Lecture-Tutorial -Practice:</b>	3-0-0
<b>Prerequisites:</b>	Analog Electronics, Linear Integrated Circuit Applications	<b>Continuous Evaluation:</b> <b>Semester end Evaluation:</b> <b>Total Marks:</b>	40 60 100

<b>Course outcomes</b>	Upon successful completion of the course, the student will be able to:					
	CO1	Understand the basics of MEMS technology and micro actuation methods.				
	CO2	Comprehend and analyze microsystem design mechanics, scaling laws, and packaging technologies.				
	CO3	Examine different steps involved in MEMS fabrication, materials selection, and micromachining techniques.				
	CO4	Understand MEMS switch concepts and their design principles for practical applications.				
<b>Contribution of Course Outcomes towards achievement of Program Outcomes (1– Low, 2-Medium,3– High)</b>		PO1	PO2	PO3	PO4	PO5
	CO1	1		1		2
	CO2	2		3		2
	CO3	1		2		2
	CO4	3		3		2
<b>Course Content</b>	<p><b>UNIT-I</b>  <b>Introduction to MEMS:</b> Introduction, MEMS and Micro systems, Evolution of Micro fabrication, miniaturization, Advantages of MEMS, working principles of acoustic wave, bio-medical, pressure, thermal sensors, micro actuation: Basics of actuation, actuation using thermal forces, shape memory alloys, piezo electric crystals, actuation using electrostatic forces, micro grippers, micro motors, micro pumps, bending movement and strain, concept of micro cantilever(11 Hrs)</p> <p><b>UNIT-II</b>  <b>Mechanics for Micro system design and scaling laws:</b> Introduction, static bending of thin plates, mechanical vibrations, thermo mechanics, Fracture Mechanics, thin film mechanics, Finite element stress analysis, Scaling laws in miniaturization: scaling in geometry, scaling in rigid body dynamics scaling in electro static forces, scaling in electromagnetic forces, scaling in fluid mechanics, scaling in heat transfer, fluid flow in nano scale, Micro system Design: Introduction, design considerations, process design, mechanical design, micro system packaging and essential packaging technologies. (12 Hrs)</p> <p><b>UNIT-III</b>  <b>MEMS Fabrication Process:</b> Materials for MEMS and Microsystems, fabrication, Wafer selection, Photolithography, Ion implantation, diffusion, oxidation, wet and dry etching, chemical vapor deposition, Physical vapor deposition, RIE, Film deposition, deposition by epitaxy, Introduction to</p>					

	<p>Micromachining, bulk micromachining, surface micromachining: Basic process flow, release, stiction, material choices, comparison of bulk and surface micromachinings, LIGA and UE-LIGA process, Lift off, Mechanical Design <b>(11 Hrs)</b></p> <p><b>UNIT– IV</b></p> <p><b>MEMS Switches and Applications:</b> Fabrication of MEMS switches: capacitive switch, DC contact series switch, Integration and biasing issues of MEMS switches, Design of CPW MEMS Shunt Capacitive Switches, Inductive Matching of Shunt Capacitive Switches, Design of Single-Pole Multiple-Throw Switches, Design of Double-Pole Double-Throw switches, Inductively Resonant High-Isolation X-Band Capacitive Shunt Switches, Switch parameters- Basics of switching - Mechanical switches - Electronic switches for RF and microwave applications - Mechanical RF switches <b>(11 Hrs)</b></p>
<b>Textbooks and Reference books</b>	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>1. Tai-Ran Hsu, “MEMS and Microsystems: Design and Manufacture”, Tata McGraw Hill, 2002.</li> <li>2. Gabriel M.Rebeiz,“RF MEMS Theory, Design and Technology”,Wiley India Pvt Ltd.</li> <li>3. Marc J. Madou “Fundamentals of MICRO FABRICATION”,CRC Press, 2<sup>nd</sup> edition,2002.</li> </ol> <p><b>ReferenceBooks:</b></p> <ol style="list-style-type: none"> <li>1. Stephen D.Senturia,“Microsystem Design”,Springer International Edition, 2010.</li> <li>2. Maluf, M., “An Introduction to Microelectromechanical Systems Engineering”. Artech House, Boston 2000.</li> <li>3. Mohamed Gad-el-Hak,The MEMS Handbook,CRC Press,2002.</li> <li>4. ChangLiu,“Foundations of MEMS”,2<sup>nd</sup> Edition, Pearson Publication.</li> </ol>
<b>E-resources and other digital material</b>	<ol style="list-style-type: none"> <li>1. <a href="https://nptel.ac.in/courses/117105082/4">https://nptel.ac.in/courses/117105082/4</a></li> <li>2. <a href="https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-777j-design-and-fabrication-of-microelectromechanical-devices-spring-2007/lecture-notes/">https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-777j-design-and-fabrication-of-microelectromechanical-devices-spring-2007/lecture-notes/</a></li> <li>3. <a href="https://www.edx.org/course/micro-nanofabrication-mems-epflx-memsx-0">https://www.edx.org/course/micro-nanofabrication-mems-epflx-memsx-0</a></li> </ol>

**Name of Course Coordinator : Dr. V Narasimha Nayak**

## 23ECVE1015/1: EMBEDDED SYSTEM DESIGN AND ARCHITECTURE

<b>Course Category:</b>	Programme elective-II	<b>Credits:</b>	3
<b>Course Type:</b>	Theory	<b>Lecture - Tutorial -Practice:</b>	3-0-0
<b>Prerequisites:</b>	Computer Architecture	<b>Continuous Evaluation:</b>	40
		<b>Semester end Evaluation:</b>	60
		<b>Total Marks:</b>	100

<b>Course Outcomes</b>	Upon successful completion of the course, the student will be able to:					
	CO1	Comprehensive understanding of embedded systems with a focus on Instruction Set Architecture (ISA) models.				
	CO2	Understand the processor hardware, and techniques for assessing and optimizing processor performance.				
	CO3	Know the hardware components in embedded systems, with practical insights through examples like the PCI bus				
	CO4	Realize the concepts and practical applications of software in embedded systems with a particular focus on utilizing Java as a programming language in embedded systems development.				
<b>Contribution of Course Outcomes towards achievement of Program Outcomes (1– Low, 2 - Medium, 3 – High)</b>		PO1	PO2	PO 3	PO 4	PO5
	CO1	3		2		1
	CO2	3	1	2	2	2
	CO3	3	2	2	1	2
	CO4				2	3
<b>Course Content</b>	<p><b>UNIT I: (12 Hrs)</b>  <b>INTRODUCTION TO EMBEDDED SYSTEMS-</b> Embedded system model – embedded standards – block diagrams – powering the hardware - embedded board using von Neuman model.  EMBEDDED processors: ISA architecture models – application specific ISA models – general purpose ISA models – instruction level parallelism.</p> <p><b>UNIT II: (10 Hrs)</b>  <b>PROCESSOR HARDWARE</b> - Internal processor design: ALU – registers – control unit - clock – on chip memory – processor I/O – interrupts – processor buses – processor performance.</p> <p><b>UNIT III: (9 Hrs)</b>  <b>SUPPORT HARDWARE</b> -Board memory: ROM – RAM – cache – auxiliary memory – memory management – memory performance – board buses: arbitration and timing – PCI bus example – integrating bus with components – bus performance</p>					

	<p><b>UNIT – IV: (9 Hrs)</b></p> <p><b>SOFTWARE-</b> Middleware and applications: PPP – IP middleware – UDP – Java . application layer: FTP client – SMTP – HTTP server and client</p>
<b>Text books and Reference books</b>	<p><b>Text Books:</b></p> <p>1. Tammy Noergard, “Embedded system architecture”, Elsevier, 2022.</p> <p><b>Reference Books:</b></p> <p>1. Embedded System Design - Frank Vahid, Tony Givargis, John Wiley, 2021.</p> <p>2. An Embedded Software Primer - David E. Simon, Pearson Education, 2020.</p> <p>3. The Art of Designing Embedded Systems, Jack Ganssle, Newnes, 2019.</p>
<b>E-resources and other digital material</b>	<p>1. <a href="http://nptel.ac.in/courses/108102045/">http://nptel.ac.in/courses/108102045/</a></p> <p>2. <a href="https://www.coursera.org/learn/embedded-software-hardware">https://www.coursera.org/learn/embedded-software-hardware</a></p> <p>3. <a href="https://t.ly/oac-S">https://t.ly/oac-S</a></p>

**Name of Course Coordinator :Mr R V H Prasad**

### 23ECVE1015/2: EMBEDDED C PROGRAMMING

<b>Course Category:</b>	Programme Elective-II	<b>Credits:</b>	3			
<b>Course Type:</b>	Theory	<b>Lecture - Tutorial -Practice:</b>	3-0-0			
<b>Prerequisites:</b>	Programming in C, Digital Electronics Microprocessors and Microcontrollers	<b>Continuous Evaluation:</b> <b>Semester end Evaluation:</b> <b>Total Marks:</b>	40 60 100			
<b>Course Outcomes</b>	<b>Upon successful completion of the course, the student will be able to:</b>					
	CO1	Understand and analyze the design aspects, Architecture, and instruction set associated with ARM processors.				
	CO2	Analyze the GPIO Pins, Interrupt handling, and Timers concepts in task execution.				
	CO3	Apply the concepts of UART, ADC, and DAC to Peripherals				
	CO4	Design and implementation of embedded case study with serial protocols				
<b>Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 – Medium, 3 – High)</b>		PO1	PO2	PO3	PO4	PO5
	CO1	--	--	1	3	2
	CO2	2	--	2	3	3
	CO3	3	--	3	3	3
	CO4	3	--	3	3	3
<b>Course Content</b>	<p><b>UNIT-I: (12Hrs)</b>  <b>Introduction:</b> Definition of Embedded Systems, Real life examples of embedded systems, Basics of Developing for Embedded Systems</p> <p><b>ARM Instruction set Architecture:</b> ARM Cortex-M Organization, Arithmetic, Logical and Shift instructions, Data Movement Instructions, Branch instructions, Program Status register, Bitwise logic operations, Sign and Zero extension, Data Comparison, Memory addressing, Branch and conditional execution, Control structures, Subroutines, 64-bit data processing.</p> <p><b>UNIT-II: (12Hrs)</b>  <b>Interrupts:</b> Introduction to Interrupts, Interrupt Service Routines, Interrupt Vector Table, Interrupt Stacking and Unstacking, Nested Vectored Interrupt Controller (NVIC), Interrupt Priority</p> <p><b>GPIO:</b> GPIO Input Modes, GPIO Output Modes, Memory-mapped I/O, Push button, Programming exercises on GPIO and Push-button</p> <p><b>General-purpose Timers:</b> Clock Configuration, Timer Organization, and Counting Modes, Timer Update Events, PWM Registers, Configuration and initialization of PWM block, Programming exercises on the selection of clock source, Timer's concept, and PWM</p> <p><b>UNIT-III: (12Hrs)</b>  <b>UART:</b> UART Block, UART Registers, UART baud rate calculation, Configuration and initialization of UART</p>					

	<p><b>ADC/DAC:</b> ADC &amp; DAC registers, pin configuration, ADC modes, Configuring ADC and DAC module, Programming exercises on ADC and DAC</p> <p><b>Interfacing:</b> DC motor, Keypad, LCD, and Seven segment display interfacing with ARM Cortex-M3 Microcontroller</p> <p><b>UNIT-IV: (10Hrs)</b>  <b>Inter-Integrated Circuit (I<sup>2</sup>C):</b> I<sup>2</sup>C operating modes, Configuration of I<sup>2</sup>C, Interface a sensor using I<sup>2</sup>C protocol</p> <p><b>Serial Peripheral Interface (SPI):</b> SPI Modes, Master operation, Slave operation, Configuration of SPI</p> <p><b>Case Study:</b> Smart Home-Smart Door Locks and Interface a temperature sensor with an I<sup>2</sup>C Module to measure the room temperature.</p>
<b>Textbooks and Reference books</b>	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>1. Dr. Yifeng Zhu “Embedded Systems with ARM Cortex-M Microcontrollers in Assembly and C” Third edition, 2018</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>1. Ariel Lutenberg, Pablo Gomez, Eric Pernia “A Beginner’s Guide to Designing Embedded System Applications on Arm Cortex-M Microcontrollers”</li> <li>2. Qing Li, Caroline Yao “Real-time concepts for Embedded Systems” CMP books.</li> </ol>
<b>E-resources and other digital material</b>	<ol style="list-style-type: none"> <li>1.<a href="https://www.keil.com/dd/docs/datashts/philips/lpc17xx_um.pdf">https://www.keil.com/dd/docs/datashts/philips/lpc17xx_um.pdf</a></li> <li>2.<a href="https://www.nxp.com/docs/en/datasheet/LPC1769_68_67_66_65_64_63.pdf">https://www.nxp.com/docs/en/datasheet/LPC1769_68_67_66_65_64_63.pdf</a></li> <li>3.<a href="https://www.nxp.com/downloads/en/schematics/LPCXpresso-LPC1769-CMSIS-DAP.pdf">https://www.nxp.com/downloads/en/schematics/LPCXpresso-LPC1769-CMSIS-DAP.pdf</a></li> </ol>

**Name of Course Coordinator:** Mr. Siva Reddy Vanga

**23ECVE1015/3: ELECTRONICS DESIGN: SENSOR AND ACTUATOR INTERFACE**

<b>Course Category:</b>	Program Elective-II	<b>Credits:</b>	3
<b>Course Type:</b>	Theory	<b>Lecture - Tutorial - Practice:</b>	3-0-0
<b>Prerequisites:</b>		<b>Continuous Evaluation:</b>	40
		<b>Semester end Evaluation:</b>	60
		<b>Total Marks:</b>	100

Course outcomes	Upon successful completion of the course, the student will be able to:					
	CO1	Understand the working principles of different motion sensors and actuators.				
	CO2	Analyze the working of different optical sensors.				
	CO3	Interface the different sensors for different applications.				
	CO4	Understand the working principles of different smart sensors and their applications.				
Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 -Medium, 3 – High)		PO1	PO2	PO3	PO4	PO5
	CO1	1		3		1
	CO2	1		3		2
	CO3			2		2
	CO4	2		3		3
Course Content	<p><b>UNIT-I</b> [T1]  <b>MOTION SENSORS &amp; ACTUATORS:</b> Capacitor plate sensor, Inductive sensors, LVDT Accelerometer systems, rotation sensors drag cup devices, piezoelectric devices, Rotary encoders. Relays, Solenoid drive, Stepper Motors, Voice-Coil actuators, Hydraulic actuators –Variable transformers: synchros, resolvers, Inductosyn (12Hrs)</p> <p><b>UNIT-II</b> [T1]  <b>OPTICAL SENSORS:</b> Colour temperature, light flux, photo sensors, photomultiplier, photo resistor and photoconductors, photodiodes, phototransistors, photovoltaic devices, fibre optic sensors, electro optic sensors &amp; fibre-optic applications, light transducer, solid-state transducers and liquid crystal devices. (12Hrs)</p> <p><b>UNIT-III</b> [T1]  <b>INTERFACING ELECTRONIC SENSORS:</b> Proximity detectors – Inductive and capacitive, ultrasonic, photo beam detectors Reed switch, smoke</p>					

	<p>sensors. Direct Sensor-Microcontroller Interfacing, intelligent sensors. <b>(10Hrs)</b></p> <p><b>UNIT-IV</b> <span style="float: right;"><b>[T2]</b></span></p> <p><b>SMART SENSORS:</b> Smart Sensors: Introduction, Primary Sensors, Excitation, Amplification, Filters, Converters, Compensation, Information Coding/Processing, Data Communication (Standards for Smart Sensor Interface) and The Automation.</p> <p><b>SENSOR’S APPLICATIONS:</b> Introduction, On-board Automobile Sensors (Automotive Sensors), Home Appliance Sensors, Aerospace Sensors, Sensors for Manufacturing and Sensors for Environmental Monitoring. <b>(12Hrs)</b></p>
Text books and Reference books	<p><b>Text Books:</b></p> <p>[T1] Ian R Sinclair, Sensors and Transducers, Newnes publishers, Third Edition, 2001.</p> <p>[T2]. Patranabis D, Sensors and Transducers, Tata McGraw Hill, Seventh Edition, 2003.</p> <p><b>Reference Books:</b></p> <p>[1]. Mechatronics (4<sup>th</sup> Edition) by W. Bolton, Pearson, 2011</p> <p>[2]. Jacob Fraden “Sensor Technology Design &amp; Application” 4<sup>th</sup>edition ,Springer .2010</p>
E-resources and other digital material	<ol style="list-style-type: none"> <li>1. <a href="https://onlinecourses.nptel.ac.in/noc21_ee32/">https://onlinecourses.nptel.ac.in/noc21_ee32/</a></li> <li>2. <a href="https://archive.nptel.ac.in/courses/108/108/108108147/">https://archive.nptel.ac.in/courses/108/108/108108147/</a></li> </ol>

**Name of Course Coordinator :** Mrs. M. Sunitha

**23ECVE1015/4: INTERNET OF THINGS FOR REAL TIME SYSTEMS**

<b>Course Category:</b>	Programme Elective-II	<b>Credits:</b>	3
<b>Course Type:</b>	Theory	<b>Lecture - Tutorial -Practice:</b>	3-0-0
<b>Prerequisites:</b>	Embedded Systems	<b>Continuous Evaluation:</b>	40
		<b>Semester end Evaluation:</b>	60
		<b>Total Marks:</b>	100

<b>Course Outcomes</b>	Upon successful completion of the course, the student will be able to:					
	CO1	Identify and explain IoT protocols, enabling technologies, and communication models.				
	CO2	Design and implement IoT systems using a structured methodology.				
	CO3	Develop programming skills in Python for Raspberry Pi, enabling them to create IoT applications and projects.				
	CO4	Analyze real-world case studies representing diverse IoT applications.				
<b>Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2-Medium, 3 – High)</b>		PO1	PO2	PO3	PO4	PO5
	CO1	3				
	CO2	2		2		
	CO3			2	3	
	CO4				3	3
<b>Course Content</b>	<p><b>UNIT I: (12 Hrs)</b>                      Introduction: Definition &amp; Characteristics of IoT, Physical Design of IoT, Things in IoT, IoT Protocols, Logical Design of IoT, IoT Functional Blocks, IoT Communication Models, IoT Communication API's, IoT Enabling Technologies, Wireless Sensor Networks, Cloud Computing, Big Data Analytics, Communication Protocols, Embedded Systems                      Domain Specific IoTs: Introduction, Home Automation, Cities, Environment, Energy, Retail, Logistics, Agriculture, Industry, Health &amp; Lifestyle.</p> <p><b>UNIT II: (11 Hrs)</b>  <b>IoT and M2M:</b> Introduction, M2M, Difference between IoT and M2M, SDN and NFV for IoT, Software Defined Networking, Network Function Virtualization.  <b>IoT Platforms Design Methodology:</b> Introduction, IoT Design Methodology, Case Study on IoT System for Weather Monitoring,</p> <p><b>UNIT III: (10 Hrs)</b>  <b>IoT Physical Devices &amp; Endpoints:</b> Basic building blocks of anIoT Device, Exemplary Device: Raspberry Pi, Raspberry Pi Interfaces, serial, SPI, I2C, Programming Raspberry Pi with Python, Controlling LED with Raspberry Pi, Interfacing an LED and Switch with Raspberry Pi, Interfacing LDR with Raspberry Pi.</p> <p><b>UNIT – IV: (12 Hrs)</b></p>					

	<p><b>Case Studies illustrating IoT Design</b>  Introduction, Home Automation, Smart lighting, home intrusion detection, Cities, smart parking, Environment, weather monitoring system, weather reporting bot, air pollution monitoring, forest fire detection, Agriculture, smart irrigation.</p>
<p><b>Text books and Reference books</b></p>	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>1. Arshdeep Bahga, Vijay Madiseti, “Internet of Things A Hands-on Approach”, Universities press (India) Pvt. Ltd, first edition 2016</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>1. Rajkumar Buyya, Amir Vahid Dastjerdi, and Syed Shahrestani, “Internet of Things: Principles and Paradigms”, Morgan Kaufmann Publishers, 2016.</li> <li>2. Maciej Kranz, “Building the Internet of Things: Implement New Business Models, Disrupt Competitors, Transform Your Industry”, Jhon Wiley &amp; Sons publishers, 2016.</li> <li>3. Brian Russell and Drew Van Duren, “Practical Internet of Things Security”, PACKT publishers, 2016.</li> </ol>
<p><b>E-resources and other digital material</b></p>	<ol style="list-style-type: none"> <li>1. <a href="https://nptel.ac.in">Introduction To Internet Of Things - Course (nptel.ac.in)</a></li> <li>2. <a href="https://coursera.org/learn/iot-internet-of-things">coursera.org/learn/iot-internet-of-things</a></li> </ol>

**Name of Course Coordinator :** Dr Shaik Fayaz Ahamed

**23MTMC1026: RESEARCH METHODOLOGY AND IPR**

<b>Course Category:</b>	Mandatory Learning Course	<b>Credits:</b>	-
<b>Course Type:</b>	Theory	<b>Lecture - Tutorial - Practice:</b>	2-0-0
<b>Prerequisites:</b>		<b>Continuous Evaluation:</b>	40
		<b>Semester end Evaluation:</b>	60
		<b>Total Marks:</b>	100

<b>Course outcomes</b>	Upon successful completion of the course, the student will be able to:					
	CO1	Acquire an overview of the research methodology and techniques to define research problem				
	CO2	Review the literature and identify the problem				
	CO3	Analyze the optimum sampling techniques for collected data				
	CO4	Apply various forms of the intellectual properties for research work.				
<b>Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 -Medium, 3 – High)</b>		PO1	PO2	PO3	PO4	PO5
	CO1		3			1
	CO2		3			1
	CO3		3			1
	CO4		3			1
<b>Course Content</b>	<p><b>UNIT I</b>  <b>Research Methodology:</b> Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Research Approaches, Significance of Research, Research and Scientific Methods, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India. Research Problem: Defining the Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, an Illustration.</p> <p><b>UNIT II</b>  <b>Reviewing the literature:</b> Place of the literature review in research, improving research methodology, broadening knowledge base in research area, enabling contextual findings.</p> <p><b>Research Design:</b> Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Basic Principles of experimental Designs, Important Experimental Designs.</p> <p><b>UNIT III</b></p>					

	<p><b>Design of Sampling:</b> Introduction, Sample Design, Sampling and Nonsampling Errors, Sample Survey versus Census Survey, Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, sources of error in measurement tools.</p> <p><b>Data Collection:</b> Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method</p> <p><b>Testing of Hypotheses:</b> Hypothesis, Basic Concepts, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing.</p> <p><b>UNIT IV</b></p> <p><b>Interpretation and Report Writing:</b> Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, and Significance of Report Writing</p> <p><b>Intellectual Property:</b> The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999, The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act 1999, Copyright Act, 1957, Trade Secrets, Utility Models WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules, Patents, Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Trade Related Aspects of Intellectual Property Rights (TRIPS) Agreement.</p>
Text books and Reference books	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>1. Research methodology: Methods and Techniques, C.R. Kothari, Gaurav Garg, New Age International, 4th Edition, 2018.</li> <li>2. Research Methodology a step-by-step guide for beginners. Ranjit Kumar, SAGE Publications Ltd., 3rd Edition, 2011</li> <li>3. Study Material, Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body under an Act of Parliament, September 2013.</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>1. An introduction to Research Methodology, Garg B.L et al, RBSA Publishers 2002</li> <li>2. An Introduction to Multivariate Statistical Analysis Anderson T.W, Wiley 3<sup>rd</sup> Edition,</li> <li>3. Research Methodology, Sinha, S.C, Dhiman, EssEss Publications, 2002</li> <li>4. Research Methods: the concise knowledge base, Trochim, Atomic Dog Publishing, 2005</li> <li>5. How to Write and Publish a Scientific Paper, Day R.A, Cambridge University Press 1992</li> <li>6. Conducting Research Literature Reviews: From the Internet to Paper, Fink A, Sage Publications, 2009</li> <li>7. Proposal Writing, Coley S.M. Scheinberg, C.A, Sage Publications, 1990</li> <li>8. Intellectual Property Rights in the Global Economy, Keith Eugene Maskus, Institute for International Economics.</li> </ol>

E-resources and other digital material	<ol style="list-style-type: none"><li>1. <a href="https://onlinecourses.nptel.ac.in/noc22_ge08/">https://onlinecourses.nptel.ac.in/noc22_ge08/</a></li><li>2. <a href="https://onlinecourses.nptel.ac.in/noc23_ge36/">https://onlinecourses.nptel.ac.in/noc23_ge36/</a></li><li>3. <a href="https://onlinecourses.nptel.ac.in/noc21_hs08/">https://onlinecourses.nptel.ac.in/noc21_hs08/</a></li></ol>
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### 23ECVE1051: DIGITAL SYSTEM DESIGN LAB

<b>Course Category:</b>	Laboratory	<b>Credits:</b>	1.5
<b>Course Type:</b>	Practical	<b>Lecture - Tutorial -Practice:</b>	0-0-3
<b>Prerequisites:</b>	Digital Logic Design	<b>Continuous Evaluation:</b>	40
		<b>Semester end Evaluation:</b>	60
		<b>Total Marks:</b>	100

<b>Course Outcomes</b>	Upon successful completion of the course, the student will be able to:					
	CO1	Get acquainted with programmable logic design flow.				
	CO2	Implement designed digital circuits using FPGA.				
	CO3	Synthesize the designed circuits using CAD tools				
Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3– High)		PO1	PO2	PO3	PO4	PO5
	CO1		1	2	3	2
	CO2	2	1		3	2
	CO3		1		3	2
<b>Course Content</b>	<p><b>Experiments:</b></p> <ol style="list-style-type: none"> <li>1. Implement a System Verilog module for a 4-bit binary-to-BCD (Binary Coded Decimal) converter.</li> <li>2. Write a 4-bit adder-subtractor module in System Verilog.</li> <li>3. Write a System Verilog program to define a 4-bit shift register and implement left and right shifts.</li> <li>4. Implement a finite state machine (FSM) in System Verilog that counts in a sequence: 0, 1, 2, 3, 0, 1, 2, 3, ...</li> <li>5. Write a System Verilog program to implement a synchronous counter that counts from 0 to 15 and then resets.</li> <li>6. Implement a System Verilog program to define a 3x3 matrix multiplier.</li> <li>7. Write a System Verilog module to generate a PWM signal with variable duty cycle.</li> <li>8. Design a synchronous FIFO memory module in System Verilog.</li> <li>9. Test bench to Verify Full adder</li> <li>10. Test bench to Verify D-Flip-flop</li> <li>11. Test bench to Verify FIFO</li> <li>12. Test bench to Verify Binary to Gray Converter</li> </ol>					

**Name Of Course Coordinator :Dr G Kishore Kumar**

## 23ECVE1052:EMBEDDED SYSTEMS DESIGN LAB

<b>Course Category:</b>	Laboratory	<b>Credits:</b>	1.5
<b>Course Type:</b>	Practical	<b>Lecture - Tutorial -Practice:</b>	0-0-3
<b>Prerequisites:</b>	Computer Architecture	<b>Continuous Evaluation:</b>	40
		<b>Semester end Evaluation:</b>	60
		<b>Total Marks:</b>	100

<b>Course Outcomes</b>	Upon successful completion of the course, the student will be able to:					
	CO1	Design and execute the different concepts for embedded system using ARM processor				
<b>Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3– High)</b>		PO1	PO2	PO 3	PO 4	PO5
	CO1				2	
<b>Course Content</b>	<p><b>I. Experiments using ARM Cortex-M Microcontroller (NUCLEO board -F429ZI):</b></p> <ol style="list-style-type: none"> <li>1. Program to configure and control General Purpose Input / Output (GPIO) port pins.</li> <li>2. Program to demonstrate Serial communication. Transmission from Kit and reception from PC using Serial Port on IDE environment use debug terminal to trace the program.</li> <li>3. Program to demonstrate Time delay program using built in Timer / Counter feature on IDE environment.</li> <li>4. Program to demonstrate a simple interrupt handler and setting up a timer.</li> <li>5. Program to Displaying a message in a 2-line x 16 Characters LCD display and verify the result in debug terminal.</li> <li>6. Program to demonstrate ADC interfacing.</li> <li>7. Generation of PWM Signalwith the objective of introducing the practical application of timers and fundamental principles of control theory.</li> <li>8. To integrate a micro-SD card with the computing system for the purpose of storing event logs conveniently on the SD card.</li> <li>9. To establish a connection between the two computing systems using Bluetooth Low Energy (BLE), with the objective of monitoring pertinent information from one system system and facilitating gate control through the other system.</li> </ol>					

	<p>10. To enhance the smart home system by enabling it to host a web page through Wi-Fi connectivity, thereby allowing users to access information using a smartphone or PC.</p> <p>11. Project.</p>
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**Name of Course Coordinator :Mr. R V H Prasad**

## 23ECVE1063: CAPSTONE PROJECT-1

### Course Description:

Capstone Project-1 is the first part of a two-semester capstone project sequence in the M.Tech in VLSI Design and Embedded Systems program. This course is designed to guide students through the initial phases of their capstone project, including project proposal, literature review, and project planning.

### Course Objectives:

- Develop a comprehensive understanding of the chosen project topic.
- Define the scope and objectives of the capstone project.
- Create a project proposal that outlines the problem statement, methodology, and initial project plan.
- Conduct a literature review to identify existing solutions and gaps in knowledge.
- Develop a detailed project plan, including milestones and timelines.

### Course Prerequisites:

Students must have completed the core courses in the M.Tech in VLSI Design and Embedded Systems program, including courses in digital design, embedded systems, and relevant electives.

### Course Outline:

#### Week 1-2: Project Topic Selection

- Introduction to the course and capstone project expectations
- Brainstorm project ideas
- Form project teams
- Choose a project topic and define initial objectives

#### Week 3-5: Project Proposal

- Develop a project proposal that includes a clear problem statement
- Outline the methodology and approach to be used
- Create a preliminary project timeline
- Submit project proposals for approval

#### Week 6-8: Literature Review

- Conduct a literature review of relevant research and existing solutions
- Identify key papers, articles, and resources
- Document gaps in current knowledge and technologies

#### Week 9-11: Project Planning

- Refine project scope and objectives based on literature review
- Develop a detailed project plan with tasks, milestones, and deadlines
- Allocate resources and budget for the project

#### Week 12-14: Progress Report

- Prepare a progress report summarizing work completed to date
- Discuss challenges and potential solutions
- Review and adjust project plan if necessary

#### Week 15-16: Midterm Presentation

- Present the project proposal, literature review, and project plan to faculty and peers
- Receive feedback and suggestions for the next phase (Capstone Project-2)

**Assessment:**

Students will be assessed based on the following criteria:

- Project Proposal (20%)
- Literature Review (20%)
- Project Planning (30%)
- Progress Report (20%)
- Midterm Presentation (10%)

**Course Materials:**

- Recommended textbooks and research papers related to the project topic
- Access to relevant software and hardware tools
- Project management software (e.g., Microsoft Project or equivalent)

**Name of Course Coordinator :Dr. Ch.N. Raghuram**

## SEMESTER II

## 23ECVE2001: REAL TIME OPERATING SYSTEMS

<b>Course Category:</b>	Program Core - IV	<b>Credits:</b>	3
<b>Course Type</b>	Theory	<b>Lecture-Tutorial-Practice</b>	3-0-0
<b>Prerequisites:</b>	Embedded Systems concepts and Operating System	<b>Continuous Evaluation:</b>	40
		<b>Semester end Evaluation:</b>	60
		<b>Total Marks:</b>	100

<b>Course Outcomes</b>	Upon successful completion of the course, the student will be able to:					
	CO1	Demonstrate the Real-Time Operating System's core components and explain how tasks are managed and synchronized in real-time environments.				
	CO2	Apply the key synchronization concepts including semaphores, message queues, pipes, event registers, signals, and condition variables in applications based on real-time operating systems.				
	CO3	Analyze the key components related to exceptions, interrupts, timers, and related services for the implementation in embedded hardware based on real time operating system.				
	CO4	Build the I/O subsystems and applications for real-time operating system based IoT device.				
<b>Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)</b>		PO1	PO2	PO3	PO4	PO5
	CO1	3		2		3
	CO2	3		2		3
	CO3			2	2	3
	CO4			2	3	3
<b>Course Content</b>	<p><b>UNIT I: ( 9 Hrs)</b>  <b>Introduction to Real-Time Operating Systems</b> - Defining an RTOS, The scheduler, Kernel Objects and services, Key characteristics of an RTOS.  <b>Task-</b> Defining a Task, Task States and Scheduling, Typical Task Operations, Typical Task Structure, Synchronization, Communication and Concurrency.</p> <p><b>UNIT II: ( 9 Hrs)</b>  <b>Semaphores</b> - Defining Semaphores, Typical Semaphore Operations, Typical Semaphore Use.  <b>Message Queues</b> - Defining Message Queues, Message Queue States, Message Queue Content, Message Queue Storage, Typical Message Queue Operations, Typical Message Queue Use, Pipes, Event Registers, Signals and condition Variables.</p> <p><b>UNIT III: (9 Hrs)</b></p>					

	<p><b>Exceptions and Interrupts</b> - Exceptions and Interrupts, Applications of Exceptions and Interrupts, Closer look at exceptions and interrupts, Nature of Spurious Interrupts</p> <p><b>Timer and Timer Services</b> - Real-Time clocks and System Clocks, Programmable Interval Timers, Timer Interrupt Service Routines.</p> <p><b>UNIT – IV: (9 Hrs)</b></p> <p><b>I/O Subsystems</b> - I/O concepts, I/O subsystems</p> <p><b>Synchronization and Communication</b> - Synchronization, Communication, Resource Synchronization Methods, Critical section, Common practical design patterns, Priority Inversion.</p> <p><b>Common Design Problems</b> – Resource Classification, Dead locks, Priority inversion.</p>
<p><b>Text books and Reference books</b></p>	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>1. Qing Li, Caroline Yao (2020), “Real-Time Concepts for Embedded Systems”, CMP Books</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>1. Albert Cheng, (2022), “Real-Time Systems: Scheduling, Analysis Verification”, Wiley Interscience.</li> <li>2. Hermann Kopetz, (2017), “Real-Time Systems: Design Principles for Distributed Embedded Applications”, Kluwer.</li> <li>3. Insup Lee, Joseph Leung, and Sang Son, (2018) “Handbook of Real Time Systems”, Chapman and Hall.</li> <li>4. Krishna and Kang G Shin, (2021), “Real-Time Systems”, McGraw Hill</li> </ol>
<p><b>E-resources and other digital material</b></p>	<ol style="list-style-type: none"> <li>1. <a href="https://nptel.ac.in/courses/106105036/">https://nptel.ac.in/courses/106105036/</a></li> <li>2. <a href="https://nptel.ac.in/noc/individual_course.php?id=noc18-cs12">https://nptel.ac.in/noc/individual_course.php?id=noc18-cs12</a></li> </ol>

**Name of Course Coordinator:** Mr. R V H Prasad

## 23ECVE2002: ANALOG AND MIXED SIGNAL DESIGN

<b>Course Category</b>	Program Core - V	<b>Credits</b>	3
<b>Course Type</b>	Theory	<b>Lecture-Tutorial-Practice</b>	3-0-0
<b>Prerequisite</b>	CMOS VLSI Design	<b>Continuous Evaluation:</b> <b>Semester end Evaluation:</b> <b>Total Marks:</b>	40 60 100

<b>Course Outcomes</b>	Upon successful completion of the course, the student will be able to:					
	CO1	Design and analyze CMOS single-stage amplifiers and current mirrors.				
	CO2	Evaluate and design CMOS operational amplifiers, applying matching techniques for enhanced CMRR and assessing trade-offs to meet specific performance requirements.				
	CO3	Design feedback amplifiers, oscillators, and PLLs, showcasing proficiency in stability analysis for practical analog and mixed-signal applications.				
	CO4	Demonstrates expertise in designing switched-capacitor circuits and implement advanced layout techniques for optimal analog and mixed-signal performance.				
<b>Contribution of Course Outcomes towards achievement of Program Outcomes (1-Low, 2-Medium, 3 - High)</b>		PO1	PO2	PO3	PO4	PO5
	CO1	2		3		
	CO2		2	3		
	CO3	3		3		
	CO4	3		3		
<b>Course Content</b>	<p><b>UNIT-I: (10Hrs)</b> Single Stage Amplifiers and Current Mirrors-Common source, common Gate and source follower stages-Cascode and folded cascode structures-Frequency response, MOS current mirrors-sources.</p> <p><b>UNIT-II: (13Hrs)</b> MOS Differential Amplifiers and Operational Amplifiers-Single ended and differential operation, Basic differential pair, Common mode response, Frequency response-CMOS operational amplifiers-One-stage op-amps, Folded Cascode Op Amps and Properties.</p> <p><b>UNIT-III: (12Hrs)</b> Feedback Amplifiers- General considerations, Feedback topologies. Switched-Capacitor circuits – Sampling switches, Switched-Capacitor amplifiers, Switched-Capacitor integrator.</p> <p><b>UNIT-IV: (10 Hrs)</b> Comparators and Analog-Digital converters – Two stage, Open-loop comparators, Parallel digital-analog converters. Layout Design– General Layout Considerations, Analog Layout Techniques, Substrate Coupling.</p>					

<b>Text books and Reference books</b>	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>1. Behzad Razavi (2018), “Design of Analog CMOS Integrated Circuits” Second Edition, Tata-McGraw Hill.</li> <li>2. Philip Allen &amp; Douglas Holberg (2002), “CMOS Analog Circuit Design”, Oxford University Press.</li> <li>3. Alan Hastings (2004) The Art of Analog Layout, Second Edition, Pearson Education.</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>1. David A Johns &amp; Ken Martin (2001), “Analog Integrated Circuit Design” John Wiley and Sons.</li> </ol>
<b>E-resources and other digital material</b>	<p>CMOS Analog VLSI Design by Prof. A.N. Chandorkar, Department of Electronics &amp; Communication Engineering, IIT Bombay.</p> <p>For more details on NPTEL visit <a href="http://nptel.ac.in">http://nptel.ac.in</a></p>

**Name of Course Coordinator:** Dr CH N Raghuram.

## 23ECVE2003:HARDWARE SOFTWARE CODESIGN

<b>Course Category:</b>	Programme Core - VI	<b>Credits:</b>	3
<b>Course Type:</b>	Integrated	<b>Lecture - Tutorial -Practice:</b>	2-0-2
<b>Prerequisites:</b>	Embedded Systems	<b>Continuous Evaluation:</b>	40
		<b>Semester end Evaluation:</b>	60
		<b>Total Marks:</b>	100

<b>Course Outcomes</b>	Upon successful completion of the course, the student will be able to:					
	CO1	Demonstrate a comprehensive understanding of co-design principles, models, and methodologies.				
	CO2	Demonstrate the ability to apply prototyping and emulation techniques, effectively utilizing relevant environments.				
	CO3	Apply advanced compilation techniques and tools specifically designed for contemporary embedded processor architectures.				
	CO4	Develop and verify co-design computational model				
<b>Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2-Medium, 3 – High)</b>		PO1	PO2	PO3	PO4	PO5
	CO1	2				
	CO2	3		2		
	CO3	2		2	3	
	CO4	2		2	3	
<b>Course Content</b>	<p><b>UNIT I: (10 Hrs)</b>  <b>Co- Design Issues</b>                      Co- Design Models, Architectures, Languages, A Generic Co-design Methodology.</p> <p><b>Co- Synthesis Algorithms</b>                      Hardware software synthesis algorithms: hardware – software partitioning distributed system co-synthesis.</p> <p><b>UNIT II: (12 Hrs)</b>  <b>Prototyping and Emulation</b>                      Prototyping and emulation techniques, prototyping and emulation environments, future developments in emulation and prototyping architecture specialization techniques, system communication infrastructure.</p> <p><b>Target Architectures</b>                      Architecture Specialization techniques, System Communication infrastructure, Target Architecture and Application System classes, Architecture for control dominated systems (8051-Architectures for High performance control), Architecture for Data dominated systems (ADSP21060, TMS320C60), Mixed Systems.</p> <p><b>UNIT III: (11 Hrs)</b></p>					

	<p><b>Compilation Techniques and Tools for Embedded Processor Architectures</b>  Modern embedded architectures, embedded software development needs, compilation technologies, practical consideration in a compiler development environment. –</p> <p><b>UNIT – IV: (12 Hrs)</b></p> <p><b>Design Specification and Verification</b>  Design, co-design, the co-design computational model, concurrency coordinating concurrent computations, interfacing components, design verification, implementation verification, verification tools, Interface verification.</p> <p>The students are required to design and implement any SIX Experiments on FPGA board (Zynq board) using Vivado software.</p> <ol style="list-style-type: none"> <li>i. Blinking LEDs</li> <li>ii. Key press detection</li> <li>iii. UART communication</li> <li>iv. Analog to Digital conversion</li> <li>v. PWM signal generation</li> <li>vi. Interrupt based communication.</li> <li>vii. SPI communication</li> <li>viii. FIR filter implementation</li> <li>ix. Memory interface (DDR)</li> <li>x. Timer Based Synchronization</li> </ol>
<p><b>Text books and Reference books</b></p>	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>1. Hardware / Software Co- Design Principles and Practice – Jorgen Staunstrup, Wayne Wolf – 2009, Springer.</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>1. Hardware / Software Co- Design - <u>Giovanni De Micheli, Maria Giovanna Sami</u>, 2002, Kluwer Academic Publishers.</li> <li>2. A Practical Introduction to Hardware/Software Co-design -Patrick R. Schaumont - 2010 – Springer Publications.</li> </ol>
<p><b>E-resources and other digital material</b></p>	<ol style="list-style-type: none"> <li>1. <a href="https://dspace.mit.edu/handle/1721.1/84891">https://dspace.mit.edu/handle/1721.1/84891</a></li> <li>2. <a href="https://www.coursera.org/learn/computer-hardware-software">https://www.coursera.org/learn/computer-hardware-software</a></li> </ol>

**Name of Course Coordinator:** Dr. Shaik Fayaz Ahmed

## 23ECVE2014/1: LOW POWER VLSI DESIGN

<b>Course Category:</b>	Programme Elective – III	<b>Credits:</b>	3
<b>Course Type:</b>	Theory	<b>Lecture - Tutorial -Practice:</b>	3-0-0
<b>Prerequisites:</b>	Devices and circuits	<b>Continuous Evaluation:</b>	40
		<b>Semester end Evaluation:</b>	60
		<b>Total Marks:</b>	100

<b>Course outcomes</b>	Upon successful completion of the course, the student will be able to:					
	CO1	Apply different circuit techniques to manage the leakage currents				
	CO2	Comprehend and analyze various low power adder and multiplier architectures.				
	CO3	Understand the architectural and circuit level techniques for attaining low power ROM.				
	CO4	Design and analyze the different types of low power SRAM and DRAM circuits.				
<b>Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)</b>		PO1	PO2	PO3	PO4	PO5
	CO1	3	3	2	1	1
	CO2	3	3	2	1	2
	CO3	3	3	3	1	2
	CO4	3	3	3	1	2

<b>Course Content</b>	<p><b>UNIT I: (10 Hrs)</b>  <b>Low power CMOS VLSI design</b> - Introduction, sources of power dissipation, static power dissipation, active power dissipation.  <b>Circuit techniques for low power design</b> - Introduction, designing for low-power, circuit techniques for leakage power reduction</p> <p><b>UNIT II: (12 Hrs)</b>  <b>Low voltage low power adders</b> - Introduction, standard adder cells, CMOS adder's architectures, low voltage low power design techniques, current mode adders.  <b>Low voltage low power multipliers</b> - Introduction, overview of multiplication, types of multiplier architectures, Braun multiplier, booth multiplier, Wallace tree multiplier</p> <p><b>UNIT – III: (10 Hrs)</b>  <b>Low- Voltage Low Power Read-Only Memories</b> - Introduction, types of ROM, basics physics of floating gate nonvolatile devices, floating gate memories, basics of ROM, low power ROM Technology</p> <p><b>UNIT IV: (12 Hrs)</b>  <b>Low voltage low power static RAM</b> - Basics of SRAM, memory cell, precharge and equalization circuit, address transition detection, sense amplifier, output latch, low power SRAM technologies,</p>
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	<b>Low voltage low power dynamic RAM</b> - Types of DRAM, basics of DRAM, self-refresh circuit, half voltage generator, voltage down converter, future trends and developments of DRAM
<b>Textbooks and Reference books</b>	<p><b>Textbooks:</b></p> <ol style="list-style-type: none"> <li>1. Kiat Seng Yeo, Kaushik Roy (2012),” Low Voltage, Low Power VLSI Subsystems”, TATA McGraw-Hill</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>1. Yeo Rofail, Gohl (2009),” CMOS/BiCMOS ULSI Low Voltage, Low, Power”, Pearson Education Asia 1<sup>st</sup> Indian reprint.</li> <li>2. Anantha P. Chandrakasan, Robert W. Brodersen, “Low Power DigitalCMOS Design”, Springer Science</li> <li>3. Jan M. Rabaey, Anantha P. Chandrakasan, Borivoje Nikolic, (2011) “Digital Integrated Circuits: a Design Perspective”, PearsonEducation, 2<sup>nd</sup> Edition.</li> </ol>
<b>E-resources and other digital material</b>	<ol style="list-style-type: none"> <li>1. <a href="http://www.nptelvideos.com/course.php?id=422">http://www.nptelvideos.com/course.php?id=422</a></li> <li>2. <a href="http://leda.elfak.ni.ac.rs/education/projektovanjeVLSI/predavanja/10%20Low%20Power%20Design%20in%20VLSI.pdf">http://leda.elfak.ni.ac.rs/education/projektovanjeVLSI/predavanja/10%20Low%20Power%20Design%20in%20VLSI.pdf</a></li> <li>3. <a href="https://www.egr.msu.edu/classes/ece410/salem/files/s16/lectures/Ch2_S2_N.pdf">https://www.egr.msu.edu/classes/ece410/salem/files/s16/lectures/Ch2_S2_N.pdf</a></li> </ol>

**Name of Course Coordinator:** Dr. A.B. Yadav

**23ECVE2014/2: SEMICONDUCTOR PACKAGING AND TESTING**

<b>Course Category:</b>	Programme Elective-III	<b>Credits:</b>	3
<b>Course Type:</b>	Theory	<b>Lecture - Tutorial -Practice:</b>	3-0-0
<b>Prerequisites:</b>	IC Technology	<b>Continuous Evaluation:</b>	40
		<b>Semester end Evaluation:</b>	60
		<b>Total Marks:</b>	100

<b>Course outcomes</b>	Upon successful completion of the course, the student will be able to:					
	CO1	Comprehend IC packaging, Microsystems Packaging and electrical issues in system packaging.				
	CO2	Summarize chip packaging and system-in-package (SIP) concepts				
	CO3	Explore CAD tools for PCB design and board assembly techniques.				
	CO4	Analyze the concepts of Testing and reliability of microsystems.				
<b>Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 – Medium, 3 – High)</b>		PO1	PO2	PO3	PO4	PO5
	CO1	3	2	3	1	1
	CO2	2	2	3	2	1
	CO3	3	2	3	1	1
	CO4	3	2	3	1	1
<b>Course Content</b>	<p><b>UNIT I: ( 12Hrs )</b>                      Introduction of Microsystems Packaging and its importance, Packaging Hierarchy, IC packaging: MEMS Packaging, Packaging for communication applications, Packaging Related to Medical Electronics, Future Trends and Challenges, Materials and their properties for Microelectronic Packaging , Ceramics, Polymers, and Metals in Packaging, Materials used for high density interconnect substrates.                      Electrical Issues of Systems Packaging, Signal Distribution, Power Distribution, Electromagnetic Interference, Transmission Lines, Clock Distribution, Noise Sources, Digital and RF Issues. Design Process Electrical Design: Interconnect Capacitance, Resistance and Inductance fundamentals; Various Parasitics</p> <p><b>UNIT II: ( 11Hrs )</b>  <b>Chip Packages:</b> IC Assembly - Purpose, Requirements, Technologies, Wire Bonding, Tape Automated Bonding, Flip Chip, Wafer Level Packaging, Reliability, Wafer Level Burn – in and Test. Single Ship Packaging: Functions, Types, Materials Processes, Properties, Characteristics. Multi chip Packaging: Types, Design, comparison. System – in - package (SIP); Passives: Discrete, Integrated, and embedded.</p> <p><b>UNIT III: ( 11Hrs )</b>  <b>PCB and surface mount technology:</b></p>					

	<p>Printed Circuit Board: Anatomy, CAD Tools for PCB Design, Micro via boards. Board Assembly: Surface Mount Technology, Thorough Hole technology, Process Control and Design Challenges.</p> <p>Thermal Considerations: Thermal management, Heat Transfer Fundamentals, Thermal Conductivity and Resistance, Conduction, Convection and Radiation, Importance of Cooling.</p> <p><b>UNIT – IV: ( 11Hrs )</b></p> <p><b>Testing Technology and Reliability:</b> Basic Concepts, Environmental Interactions. Thermal Mismatch and Fatigue–Failures–Thermo Mechanically Induced, Electrically Induced, Chemically Induced. Electrical Testing: System Level Electrical Testing, Interconnection tests, Active Circuit Testing, Design for Testability, Basics of Reliability of Microsystems.</p>
<b>Text books and Reference books</b>	<p><b>Text Books</b></p> <p>1. Tummala, Rao R., Fundamentals of Microsystems Packaging, McGraw Hill, 2001.</p> <p><b>Reference Books</b></p> <p>1. Blackwell (Ed), The electronic packaging handbook, CRC Press, 2000.</p> <p>2. Tummala, Rao R, Microelectronics packaging handbook, McGraw Hill, 2008.</p> <p>3. Bosshart, Printed Circuit Boards Design and Technology, Tata Mc Graw Hill, 1988.</p> <p>4. R.G. Kaduskar and V.B.Baru, Electronic Product design, Wiley India, 2011</p> <p>5. R.S.Khandpur, Printed Circuit Board, Tata McGraw Hill, 2005</p>
<b>E-resources and other digital material</b>	<p>1. An Introduction to Electronics Systems Packaging by Prof. G.V. Mahesh, Department of Electronic system Engineering, IISc Bangalore.</p> <p>For more details on NPTEL visit <a href="http://nptel.iitm.ac.in">http://nptel.iitm.ac.in</a>.</p>

**Name of Course Co-ordinator:** Dr. Ball Mukund Mani Tripathi

**23ECVE2014/3: DIGITAL DESIGN USING HIGH LEVEL SYNTHESIS**

<b>Course Category:</b>	Programme Elective-III	<b>Credits:</b>	3
<b>Course Type:</b>	Theory	<b>Lecture - Tutorial -Practice:</b>	3-0-0
<b>Prerequisites:</b>	Digital Logic Design	<b>Continuous Evaluation:</b>	40
		<b>Semester end Evaluation:</b>	60
		<b>Total Marks:</b>	100

<b>Course outcomes</b>	Upon successful completion of the course, the student will be able to:					
	CO1	Apply C++ programming concepts and showcase adeptness in designing modular and optimized code.				
	CO2	Design combinational and sequential circuits using high-level synthesis techniques				
	CO3	Design advanced memory architectures using high-level synthesis techniques.				
	CO4	Design and implement diverse Digital Filters using high-level synthesis techniques.				
<b>Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)</b>		PO1	PO2	PO3	PO4	PO5
	CO1	3		3		2
	CO2	3		3		2
	CO3	3		3		2
	CO4	3		3		2
<b>Course Content</b>	<p><b>UNIT I: ( 12Hrs )</b>  <b>Bit Accurate Data Types:</b> Introduction, Compilation, Debug, and Simulation Speed, Header Files and Typedefs, Integer Data Types, Unsigned integer, Signed Integer, Fixed Point Data Types, Unsigned Fixed Point, Signed Fixed Point, Quantization and Overflow, Operators, Bitwise Arithmetic Operators: *, +, -, /, &amp;,  , ^, %, Bit Select Operator: [].  <b>Fundamentals of High Level Synthesis:</b> Introduction, The Top-level Design Module, Registered Outputs, Control Ports, Port Width, Port Direction, High-level C++ Synthesis, Data Flow Graph Analysis, Resource Allocation, Scheduling, Classic RISC Pipelining, Loop Pipelining, Loops, Rolled Loops, Loop Unrolling, Loops with Conditional Bounds, Optimizing the Loop Counter, Optimizing the Loop Control Nested Loops, Sequential Loops, Conditions Sharing, Functions and Multiple Conditional Returns.</p> <p><b>UNIT II: ( 12Hrs )</b>  <b>Sequential and Combinational Hardware:</b> Introduction, Shift Registers, Basic Shift Register, Shift Register with Enable, Shift Register with Synchronous Clear, Shift Register with Load, Shift Register Template Function, Class Based Shift Register, Helper Classes for Design Reuse, Log2Ceil, NextPow2, Multiplexors, Binary MUX, Automatic Binary to Onehot MUX Optimizations, Manual Optimization of Binary Selection MUXes, One Hot MUX, Finding Leading 1's in a Bit-vector, Finding the</p>					

	<p>Maximum Value in an Array, Absolute Value (abs), Linear Feedback Shift Register (LFSR), Accumulator, Shifters, Barrel shifter, Constant Shifts, Adder Trees, Automatic Tree Balancing, Preventing Automatic Tree Balancing, Coding to Facilitate Automatic Tree Balancing, Lookup Tables (LUT).</p> <p><b>UNIT III: ( 12Hrs )</b></p> <p><b>Memory Architecture:</b> Introduction, Memory-based Shift Register, Circular Buffer, Memory Organization, Interleaving Memories, Widening the Word Width of Memories, Caching, Using True Single Port RAM as a Dualport RAM, “Windowing” of 1-D Data Streams, 2-D Windowing.</p> <p><b>Hierarchical Design:</b> Introduction, Arrays Shared Between Blocks, Out-of-order Array Access, In-order Array Access, Blocks with Common Interface Control Variables, Passing Control Variables Between Blocks, Connecting Interface Control Variables to Multiple Blocks, Duplicating Control IO.</p> <p><b>UNIT – IV: ( 12Hrs )</b></p> <p><b>Digital Filters:</b> Introduction, FIR Filters, Register Based Filters, External Coefficients, Constant Coefficients, Loadable Coefficients, Symmetric Coefficients, Even Symmetric, Odd Symmetric, Transposed, Systolic, Multi-rate Filtering, Decimation, Interpolation.</p>
<b>Text books and Reference books</b>	<p><b>Text Books</b></p> <p>1. Fingeroff, Michael, “High-level synthesis: blue book”, Xlibris Corporation, 2010.</p> <p><b>Reference Books</b></p> <p>1. P Coussy, A Morawiec, “High-level synthesis”. Vol. 1. Springer, 2010.</p> <p>2. Vanhoof, Jan, “High-Level Synthesis for Real-Time Digital Signal Processing: The CATHEDRAL-II Silicon Compiler”, Springer Science &amp; Business Media, 1993.</p>
<b>E-resources and other digital material</b>	<p>1. <a href="https://www.udemy.com/course/hls-combinational-circuits/#instructor-12">https://www.udemy.com/course/hls-combinational-circuits/#instructor-12</a> .</p> <p>2. <a href="https://www.udemy.com/course/fpga-design-with-high-level-synthesis-vivado-hls/">https://www.udemy.com/course/fpga-design-with-high-level-synthesis-vivado-hls/</a></p>

**Name of Course Coordinator:** Dr. G. Kishore Kumar

### 23ECVE2014/4: Radio Frequency IC Design

<b>Course Category:</b>	Programme Elective-III	<b>Credits:</b>	3
<b>Course Type:</b>	Theory	<b>Lecture - Tutorial -Practice:</b>	3-0-0
<b>Prerequisites:</b>	RF& MW Theory, VLSI Design	<b>Continuous Evaluation:</b>	40
		<b>Semester end Evaluation:</b>	60
		<b>Total Marks:</b>	100

<b>Course outcomes</b>	Upon successful completion of the course, the student will be able to:					
	CO1	Analyze the different characteristics of RF circuits and Systems				
	CO2	Design active and passive CMOS circuits in RF applications				
	CO3	Analyze the low noise and power amplifiers				
	CO4	Analyze the mixers, oscillators and frequency synthesizers				
Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)		PO1	PO2	PO3	PO4	PO5
	CO1	3	2	2	1	1
	CO2	3	3	3	1	1
	CO3	3	2	3	1	1
	CO4	3	3	2	1	1
<b>Course Content</b>	<p><b>UNIT I: ( 10Hrs )</b>  <b>Fundamentals of RF circuits and systems:</b> Duplexing, FDMA, dB, dBm, Voltage gain, Channel, ACR, AACR, Noise factor, NF of a cascaded system, Sensitivity, HD, Gain compression, P1 dB, Cross modulation, Inter modulation, IM3, IIP3, SFDR, Transmit mask.  <i>Transmitter and Receiver architectures:</i> Review of modulation schemes, Receiver architectures, Transmitter architectures</p> <p><b>UNIT II: ( 12Hrs )</b>  <b>Passive and active components for CMOS RFIC:</b> Review of MOSFET, RF transistor layout, CMOS process, Capacitors, Varactors, Resistors, Inductors, Transformers, Transmission lines Resonance, Matching, S-parameters, etc. Noise in electrical circuits and NF calculations, Two port noise theory.</p> <p><b>UNIT III: ( 12Hrs )</b>  <b>Low Noise Amplifiers:</b> Resistive terminated CS and CG LNA, Inductive degenerated LNA, Shunt feedback LNA, Noise canceling LNAs, Linearity improvement techniques  <b>Power Amplifiers:</b> Class A, B, C, D, E, F and other configurations, Power combining, Linearity improvement techniques.</p> <p><b>UNIT – IV: ( 12Hrs )</b>  <b>Mixers:</b> Specifications, NL system as a mixer, Active mixers, Passive mixers  <b>Oscillators:</b> Introduction, LC Oscillators, Phase noise, Introduction to PLLs; Type-I PLLs, Charge pump PLLs: Mathematical model, Design issues and Phase noise  <b>Frequency synthesizers:</b> Integer N synthesizers, Dividers.</p>					

<p><b>Text books and Reference books</b></p>	<p><b>Text Books</b></p> <ol style="list-style-type: none"> <li>1. B. Razavi, "RF Microelectronics", 2<sup>nd</sup> Edition, Pearson, 2012.</li> <li>2. Thomas H. Lee, "The design of CMOS radio-frequency integrated circuits", 2<sup>nd</sup> Edition, Cambridge University Press, 2004.</li> <li>3. Leung, Bosco, "VLSI for wireless communication", Springer Science &amp; Business Media, 2011.</li> </ol> <p><b>Reference Books</b></p> <ol style="list-style-type: none"> <li>1. Samar K. Saha, "Compact Models for Integrated Circuit Design: Conventional Transistors and Beyond", Taylor &amp; Francis, 2015.</li> <li>2. H. Ruiz, R. Pérez, "Linear CMOS RF Power Amplifiers: A Complete Design Workflow", Springer, 2014 edition.</li> <li>3. Manganaro, Gabriele, and Domine MW Leenaerts, "Advances in analog and RF IC design for wireless communication systems", Academic Press, 2013.</li> <li>4. Noulis, Thomas, Mixed-signal circuits, CRC Press, 2018.</li> <li>5. Rincon-Mora, Gabriel, "Analog IC design with low-dropout regulators (LDOs)", McGraw-Hill, 2009.</li> </ol>
<p><b>E-resources and other digital material</b></p>	<ol style="list-style-type: none"> <li>1. RF Integrated Circuits, IIT Delhi, Dr. Shouribrata Chatterjee  <a href="https://nptel.ac.in/courses/117102012">https://nptel.ac.in/courses/117102012</a></li> </ol>

**Name of Course Coordinator :Dr. R. Santosh**

### 23ECVE2015/1: LINUX SHELL SCRIPTING

<b>Course Category:</b>	Program Elective-IV	<b>Credits:</b>	3
<b>Course Type:</b>	Theory	<b>Lecture-Tutorial-Practice:</b>	3-0-0
<b>Prerequisites:</b>	C Programming	<b>Continuous Evaluation:</b>	40M
		<b>Semester End Evaluation:</b>	60M
		<b>Total Marks:</b>	100M

<b>Course outcomes</b>	Upon successful completion of the course, the student will be able to:					
	CO1	Understand the Linux kernel and Graphical Environment .				
	CO2	Explore the bash shell commands to access files and directories.				
	CO3	Develop the shell scripts using structured commands for solving problems.				
	CO4	Create Functions, Library using advanced shell scripts.				
<b>Contribution of Course Outcomes towards achievement of Program Outcomes: (1 - Low, 2 - Medium, 3 - High)</b>		PO1	PO2	PO3	PO4	PO5
	CO1				2	
	CO2	2	2		2	2
	CO3	3	2	2	3	3
	CO4	2			3	2
<b>Course Content</b>	<p><b>UNIT-I (10 Hrs)</b>  <b>INTRODUCTION TO LINUX KERNELS-</b> What Is Linux, The GNU utilities, The Linux desktop environment, Linux Distributions, Reaching the Command Line, Accessing CLI via a Linux Console Terminal, Graphical Terminal Emulation, GNOME Terminal, Console terminal and xterm Terminal Emulator.</p>					
	<p><b>UNIT-II (10 Hrs)</b>  <b>BASH SHELL COMMANDS-</b> Starting the Shell, Using the Shell Prompt, Interacting with the bash Manual, Navigating the File system, Listing Files and Directories, Handling Files, Managing Directories, Viewing File Contents, Monitoring Programs and Disk Space, Working with Data Files, Exploring Environment Variables, Setting User-Defined Variables, Removing Environment Variables.</p>					
	<p><b>UNIT-III (12 Hrs)</b>  <b>SHELL SCRIPTING-</b> Creating a Script File, Displaying Messages, Structured Commands : Working with the if-then Statement, if-then-else, Nesting ifs, case Command, For Command, While Command, Until Command, Nested loops, Controlling the loops, Processing the Output of a Loop, Practical Examples, Presenting Data: Understanding Input and Output, Redirecting Output and Input in Scripts, Creating Your Own Redirection, Practical Example</p>					
	<p><b>UNIT-IV (12 Hrs)</b>  <b>SCRIPT CONTROL -</b>Handling Signals, Running Scripts in Background Mode, Running Scripts without a Hang-Up, Controlling the Job, Running Like Clockwork,</p>					

	Basic Script Functions, Returning a Value, Using Variables in Functions, Function Recursion, Creating a Library, Using Functions on the Command Line, Working with Alternative Shells: dash Shell, The dash Shell Features, Scripting in dash, The zsh Shell, Parts of the zsh Shell.
<b>Text Book and Reference Books</b>	<p><b>Text Book:</b> [1]. Richard Blum and Christine Bresnahan, “Linux Command Line and Shell Scripting BIBLE”,3<sup>rd</sup> Edition, Wiley.</p> <p><b>Reference Books:</b> [1].Neil Matthew and Richard Stones, “Beginning Linux Programming”, 4<sup>th</sup> Edition, Wiley. [2]. B. A. Forouzan and R. F. Gilberg,“Unix and Shell Programming”, Cengage Learning.</p>
<b>E-Resources and other digital material</b>	<p>[1]. <a href="https://nptel.ac.in/courses/117106113/">https://nptel.ac.in/courses/117106113/</a> [2]. <a href="https://vlsiresources.com/linux-and-scripting/">https://vlsiresources.com/linux-and-scripting/</a> [3].<a href="http://www.edx.org/course/introductionvtolinux?source=aw&amp;awc=6798_1542702468_21911ce46d678d6e6c9d565e4a3be10e">www.edx.org/course/introductionvtolinux?source=aw&amp;awc=6798_1542702468_21911ce46d678d6e6c9d565e4a3be10e</a></p>

**Name of Course Coordinator:** Dr. Sk. Khaleel Ahmed &Mrs. M. Sunitha

**23ECVE2015/2: Embedded Linux Device Drivers**

<b>Course Category:</b>	Programme Elective-IV	<b>Credits:</b>	3			
<b>Course Type:</b>	Theory	<b>Lecture- Tutorial -Practice:</b>	3-0-0			
<b>Prerequisites:</b>	Microcontrollers	<b>Continuous Evaluation:</b>	40			
		<b>Semester end Evaluation:</b>	60			
		<b>Total Marks:</b>	100			
<b>Course Outcomes</b>	<b>Upon successful completion of the course, the student will be able to:</b>					
	<b>CO1</b>	Differentiate Embedded Linux and Desktop Linux				
	<b>CO2</b>	Demonstrate Embedded Linux Architecture and IPC.				
	<b>CO3</b>	Understand the concepts and components of Embedded Storage and device drivers				
	<b>CO4</b>	Analyze the Real-Time Linux and Real-time programming by porting applications				
<b>Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 – Medium, 3 – High)</b>		<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>
	<b>CO1</b>	--	--	2	--	2
	<b>CO2</b>	--	--	2	--	3
	<b>CO3</b>	3	--	3	--	3
	<b>CO4</b>	3	--	3	--	3
<b>Course Content</b>	<p><b>UNIT-I: (12Hrs)</b>  <b>Introduction to Real Time Operating Systems:</b> Characteristics of RTOS, Tasks Specifications and types, Real-Time Scheduling Algorithms, Concurrency, Inter-process Communication and Synchronization mechanisms, Priority Inversion, Inheritance and Ceiling. Embedded Linux Vs Desktop Linux, Embedded Linux Distributions, System calls, Static and dynamic libraries, Cross tool chains</p> <p><b>UNIT-II: (10Hrs)</b>          Embedded Linux Architecture, Kernel Architecture – HAL, Memory manager, Scheduler, File System, I/O and Networking subsystem, IPC, User space, Start-up sequence</p> <p><b>UNIT-III: (12Hrs)</b>  <b>Board Support Package Embedded Storage:</b> MTD, Architecture, Drivers, Embedded File System  <b>Embedded Device Drivers:</b> Communication between user space and kernel space drivers, Character and Block Device Drivers, Interrupt handling, Kernel modules  <b>Embedded Drivers:</b> Serial, Ethernet, I2C, USB, Timer, Kernel Modules</p> <p><b>UNIT-IV: (12Hrs)</b>  <b>Porting Applications Real-Time Linux:</b> Linux and Real time, Programming, Hard Real-time Linux  <b>Building and Debugging:</b> Bootloaders, Kernel, Root file system, Device Tree</p>					
<b>Textbooks and Reference books</b>	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>1. Chris Simmonds, “Mastering Embedded Linux Programming” - Second Edition, PACKT Publications Limited.</li> <li>2. Karim Yaghmour, “Building Embedded Linux Systems”, O’Reilly &amp; Associates</li> <li>3. P Raghvan, Amol Lad, Sriram Neelakandan, “Embedded Linux System Design and Development”, Auerbach Publications</li> </ol> <p><b>Reference Books:</b></p>					

	<ol style="list-style-type: none"> <li>1. Christopher Hallinan, “Embedded Linux Primer: A Practical Real-World Approach”, Prentice Hall, 2<sup>nd</sup> Edition, 2010.</li> <li>2. Derek Molloy, “Exploring Beagle Bone: Tools and Techniques for Building with Embedded Linux”, Wiley, 1<sup>st</sup> Edition, 2014</li> </ol>
<b>E-resources and other digital material</b>	<ol style="list-style-type: none"> <li>1. <a href="https://training.linuxfoundation.org/training/developing-embedded-linux-device-drivers/">https://training.linuxfoundation.org/training/developing-embedded-linux-device-drivers/</a></li> <li>2. <a href="https://nptel.ac.in/courses/117106113">https://nptel.ac.in/courses/117106113</a></li> </ol>

**Name of Course Coordinator:** Mr. Siva Reddy Vanga

### 23ECVE2015/3: COMMUNICATION BUSES AND INTERFACES

<b>Course Category:</b>	Programme Elective-IV	<b>Credits:</b>	3
<b>Course Type:</b>	Theory	<b>Lecture - Tutorial -Practice:</b>	3-0-0
<b>Prerequisites:</b>	Computer Networks	<b>Continuous Evaluation:</b>	40
		<b>Semester end Evaluation:</b>	60
		<b>Total Marks:</b>	100

<b>Course Outcomes</b>	Upon successful completion of the course, the student will be able to:					
	CO1	Select and apply a particular Low-Speed serial bus Interface suitable for a given application.				
	CO2	Analyze and make a decision to use Medium-Speed serial bus Interface for an application.				
	CO3	Examine and decide a High-Speed serial bus Interface for an application.				
	CO4	Investigate the use of Broadband and wireless Interfaces				
<b>Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3– High)</b>		PO1	PO2	PO3	PO4	PO5
	CO1	3				2
	CO2	3				2
	CO3	3				2
	CO4	3				2
<b>Course Content</b>	<p><b>UNIT I: (12 Hrs)</b> Introduction to Serial I/O Communications, Serial I/O Primer: A Short Course in Data Communications and Networking <b>Low-Speed Interfaces:</b> Controller Area Network (CAN), standard CAN, Extended CAN, CAN message, arbitration, message types, CAN bus, Inter-Integrated Circuit (I2C) Bus, RS-232, RS-485.</p> <p><b>UNIT II: (11Hrs)</b> <b>Medium-Speed Interfaces:</b> Ethernet, Firewire, Joint Test Action Group (JTAG), Media oriented system transport, Serial Peripheral Interface, Universal Serial Bus, host and devices, assigning a driver on the host, transfer types, transactions,</p> <p><b>UNIT III: (11Hrs)</b> <b>High-Speed Interfaces:</b> 100 Gigabit Ethernet attachment unit interface, Fiber channel, high-definition multimedia interface (HDMI), hyper transport, optical transport network, PCI express, Synchronous optical network and synchronous digital hierarchy, thunderbolt.</p> <p><b>UNIT – IV: (10 Hrs)</b> <b>Broadband Interfaces:</b> Broadband Interface concepts, Digital subscriber Line, Multimedia over cable alliance.</p>					

	<b>Wireless Interfaces:</b> Wireless Interfaces, 802.15.4, Bluetooth, Industrial Scientific Medical Wireless, Near Field Communications, Ultra-Wideband, Wi-Fi, ZigBee
<b>Text books and Reference books</b>	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>1. Louis E Frenzel Jr, “Hand book of Serial Communication Interfaces”, Newness publications, 2016</li> <li>2. Jan Axelson, “Serial Port Complete<b>COM Ports, USB Virtual COM Ports, and Ports for Embedded Systems</b>”, Lakeview Research Published, 2<sup>nd</sup> edition Mindshare Press</li> <li>3. Steve Corrigan, “Introduction to the Controller Area Network (CAN)”, Texas Instruments, 2016.</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>2. Jan Axelson, “USB Complete”, Penram Publications, 2016</li> <li>3. Serial Front Panel Draft Standard VITA 17.1 – 200x</li> </ol>
<b>E-resources and other digital material</b>	<ol style="list-style-type: none"> <li>1. <a href="http://www.can-cia.org">www.can-cia.org</a></li> <li>2. <a href="http://www.pcisig.com">www.pcisig.com</a></li> <li>3. <a href="http://www.usb.org">www.usb.org</a></li> </ol>

**Name of Course Coordinator:** Dr.M.Padmaja

**23ECVE2015/4: INDUSTRIAL PRODUCT DESIGN**

<b>Course Category:</b>	Programme Elective-IV	<b>Credits:</b>	3
<b>Course Type:</b>	Theory	<b>Lecture - Tutorial -Practice:</b>	3-0-0
<b>Prerequisites:</b>	--	<b>Continuous Evaluation:</b>	40
		<b>Semester end Evaluation:</b>	60
		<b>Total Marks:</b>	100

<b>Course Outcomes</b>	Upon successful completion of the course, the student will be able to					
	CO1	Understand various processes and systems to address human needs by using tangible Electronic Products				
	CO2	Illustrate product design concepts using visual communication techniques.				
	CO3	Apply design principles like figure-ground relationships and visual information.				
	CO4	Design product layouts and structures adhering to industrial standards.				
<b>Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3– High)</b>		PO1	PO2	PO3	PO4	PO5
	CO1	3		2		3
	CO2	3	2	3		
	CO3	3	2	3		
	CO4			3	3	3
<b>Course Content</b>	<b>UNIT I</b> <span style="float:right"><b>12 Hrs</b></span> <b>Introduction to Industrial Design:</b> Introduction to the course, role of ID in the domain of industry, product innovation, Designer’s philosophy and role in product design, what is good design, Product Design Methodology, User centered Design methods, Electronic Product Design and Development Methodology,					
	<b>UNIT II</b> <span style="float:right"><b>10 Hrs</b></span> <b>Product Design-Product Analysis:</b> Visual Communication Techniques: Free Hand sketching and drawing techniques for concept presentation, Perspectives, and rendering techniques, colour in design, Engineering drawing practice, exploded views.					
	<b>UNIT III</b> <span style="float:right"><b>12Hrs</b></span> <b>Design Principles:</b> Visual information through design principles, Figure-ground relationship, Visual information distribution, Gestalt principles, Theory of object perception, Symmetry, Asymmetry, Closure, Continuance, Unifying principles of design. Design Expressions.					
	<b>UNIT IV</b> <span style="float:right"><b>10Hrs</b></span> <b>Product Anatomy:</b> Layout design, structure design, standard and non-standard					

	structures, Industrials standards, Product detailing in sheet metal and plastics for easy of assembling.
<b>Text books and Reference books</b>	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>1. Peter Z. , “German Design Standard Vol 2”, Reddot, 2019.</li> <li>2. Clarkson P.J, Coleman R. and Keates, S., “Inclusive Design, Design for the whole population”, Springer Verlag Gmbh, 2019</li> <li>3. Jordan P. W., “Designing Pleasurable Products: An Introduction to the New Human Factors.” Taylor and Francis, 2002.</li> <li>4. Otto K. and Wood K., “Product design: Techniques in Reverse Engineering and New Product development”, Prentice Hall, 2001.</li> <li>5. Cross N. “Engineering Design Methods: Strategies for Product Design”, Willey, 2020</li> </ol> <p><b>Reference Books</b></p> <ol style="list-style-type: none"> <li>1. Cagan J. and Vogel C. M., Creating Breakthrough Products, “Innovation from Product Planning to Program Approval”. Pearson Education, 2018.</li> <li>2. Coats D., “Watches Tell More than Time: Product Design, Information, Quest for elegance” McGraw Hill, 2002</li> <li>3. Norman D. A. , “The design of everyday things, Basic Books, 2002.</li> <li>4. Chakrabarty D.,“ Indian Anthropometric Dimensions for Ergonomic Design Practice”, NID, Ahmedabad, 1999.</li> <li>5. Kelley T. and Littman J. “The Art of Innovation: Lessons in Creativity from Ideo, America's Leading Design Firm, Doubleday”, Ver: 4 November 2011 MI – PDN2524, 2001.</li> <li>6. E.J. McCormic, Human factors in engineering design, McGraw Hill, 1976.</li> </ol>
<b>E-resources and other digital material</b>	<ol style="list-style-type: none"> <li>1. <a href="http://www.ulrich-eppinger.net/">http://www.ulrich-eppinger.net/</a></li> <li>2. <a href="http://www.npd-solutions.com">http://www.npd-solutions.com</a></li> <li>3. <a href="http://www.qfdi.org">http://www.qfdi.org</a></li> <li>4. <a href="http://www.cheshirehenbury.com/rapid/">http://www.cheshirehenbury.com/rapid/</a></li> </ol>

**Name of Course Co-Ordinator:** Mrs.B. Sujitha & Mrs .J. Sravanthi

## 23MTAC2036- TECHNICAL REPORT WRITING

<b>Course Category:</b>	Audit Course	<b>Credits:</b>	0
<b>Course Type:</b>	Theory	<b>Lecture - Tutorial -Practice:</b>	2-0-0
<b>Prerequisites:</b>	Nil	-	-

<b>Course Outcomes</b>	Upon successful completion of the course, the student will be able to:					
	CO1	Understand the significance of Technical Report writing.				
	CO2	Develop Proficiency in writing technical reports.				
	CO3	Apply the basic principles to prepare documentation using LATEX				
	CO4	Understand the need of Bibliography and references for quality report writing				
<b>Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)</b>		PO1	PO2	PO3	PO4	PO5
	CO1	-	2	-	-	-
	CO2	-	2	-	-	-
	CO3	-	2	-	-	-
	CO4	-	2	-	-	-
<b>Course Content</b>	<p><b>UNIT I:</b>  <b>Writing scientific and engineering papers</b>-Title, Abstract, Introduction, Materials And Methods, Result, Discussion, Conclusion, References, Acknowledgements, Appendices, Hedging and Criticizing, Paraphrasing and Plagiarism.</p> <p><b>UNIT II:</b>  <b>Effective use of charts, graphs and tables</b>-Bar Chart, Line Chart, Pie Chart, Area Chart, Cylindrical Chart, Column Bars, Bubble Chart, Flow Diagram, Screen Capture, Tables</p> <p><b>Writing Technical Reports</b>-Objectives Of Technical Report, Types Of Reports, Steps In Writing A Technical Report, Guidelines For Writing A Technical Report.</p> <p><b>UNIT III:</b>  LATEX- Introduction, Document Structure- Creating a Title, Sections, Labeling, Table of Contents</p> <p><b>Typesetting Text</b>- Font Effects, Colored Text, Font Sizes, Lists, Comments &amp; Spacing, Special Characters</p> <p><b>UNIT IV:</b>  <b>Tables, Figures, Equations</b>- Inserting Equations, Mathematical Symbols, Practical.</p> <p><b>Inserting References</b>- Introduction, The Bib TeX file, Inserting the bibliography, Citing references, Styles, Practical.</p>					
<b>Text books and Reference books</b>	<p><b>Text Books:</b>  1. Barun K Mitra, Effective Technical Communication-A Guide for Scientists and Engineers, Oxford University Press,2006, ISBN:978019568291.</p>					

	2. LATEX for Beginners, Workbook Edition 5, March 2014 Document Reference: 3722-2014.
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**Reference Books:**

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press

**Name of Course Co-Ordinator:** Dr.A.Jhansi Rani

## 23ECVE2051: REAL TIME OPERATING SYSTEMS LAB

<b>Course Category:</b>	Practical	<b>Credits:</b>	1.5
<b>Course Type:</b>	Laboratory - I	<b>Lecture - Tutorial -Practice:</b>	0-0-3
<b>Prerequisites:</b>	Micro controller and Embedded systems lab	<b>Continuous Evaluation:</b>	40
		<b>Semester end Evaluation:</b>	60
		<b>Total Marks:</b>	100

<b>Course Outcomes</b>	Upon successful completion of the course, the student will be able to:					
	CO1	Design and execute the different RTOS concepts for real time embedded system design.				
	CO2	Developing the RTOS applications for Micro controller boards.				
<b>Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)</b>		PO1	PO2	PO3	PO4	PO5
	CO1	3	3	3	3	3
	CO2	2	2	2	2	2
<b>Course Content</b>	<b>I. RTOS Experiments:</b> <ol style="list-style-type: none"> <li>1. Develop a program that involves various operations related to real-time tasks, such as creation, deletion, and synchronization.</li> <li>2. Implement a program to understand and simulate task scheduling algorithms in a real-time operating system.</li> <li>3. Create a program to explore the concept and mechanisms of context switching in the context of real-time operating systems.</li> <li>4. Develop a program to illustrate the use of semaphores for synchronization and communication between different tasks.</li> <li>5. Implement a program that demonstrates the usage of mutexes for managing critical sections in a multitasking environment.</li> <li>6. Write a program to handle interrupts effectively, exploring the ways an operating system manages and responds to external interrupts.</li> <li>7. Develop a program to manage and manipulate queues within the real-time operating system environment.</li> <li>8. Implement a program that showcases the effective management of pipes for inter-process communication.</li> <li>9. Write a program to understand and implement signal handling mechanisms within the real-time operating system.</li> <li>10. Develop a program that explores memory management techniques in the context of real-time operating systems.</li> </ol>					
<b><u>Lab Requirements:</u>Software:</b>	<ol style="list-style-type: none"> <li>1. Free RTOS</li> <li>2. Open STM32 System Work bench</li> </ol>					

<b><u>Hardware:</u></b>	<ol style="list-style-type: none"> <li>1. The development kits of ARM Developer Kits/ STM32F4 Discovery and Nucleo board.</li> <li>2. Serial Cables, Network Cables and recommended power supply for the board.</li> </ol>
<b>E-resources and other digital material</b>	<ol style="list-style-type: none"> <li>1. <a href="https://training.ti.com/ti-rtos-workshop-series-1-10-welcome">https://training.ti.com/ti-rtos-workshop-series-1-10-welcome</a></li> <li>2. <a href="https://www.udemy.com/share/101XDy3@Lh74iiF3rMDF83Kk7Od1fQ7-RimKmKiI6HvZDtQmMx77GjLqvX7GSt0-52seWg-J/">https://www.udemy.com/share/101XDy3@Lh74iiF3rMDF83Kk7Od1fQ7-RimKmKiI6HvZDtQmMx77GjLqvX7GSt0-52seWg-J/</a></li> </ol>

**Name of Course Coordinator:** Mr. R V H Prasad, Assistant Professor

**23ECVE2052: ANALOG & MIXED SIGNAL DESIGN LAB**

<b>Course Category</b>	Laboratory	<b>Credits</b>	1.5
<b>Course Type</b>	Practical	<b>Lecture-Tutorial-Practice</b>	0-0-3
<b>Prerequisite</b>	Analog and Mixed Signal IC Design	<b>Continuous Evaluation:</b> <b>Semester end Evaluation:</b> <b>Total Marks:</b>	40 60 100

<b>Course Outcomes</b>	Upon successful completion of the course, the student will be able to:					
	CO1	Design and analyze analog circuits, with DC, transient, operational, and AC analyses.				
	CO2	Develop and validate the layout through rigorous Design Rule Checks (DRC) and Layout vs. Schematic (LVS) verification.				
	CO3	Extract RC parameters, back-annotate designs, and excel in post-layout analysis.				
<b>Contribution of Course Outcomes towards achievement of Program Outcomes (1-Low, 2-Medium, 3 - High)</b>		PO1	PO2	PO3	PO4	PO5
	CO1	3	1	3	3	2
	CO2	3	1	3	3	2
	CO3	3	1	3	3	2
<b>List of Experiments</b>	<p align="center"><b><u>LIST OF EXPERIMENTS</u></b></p> <p><b>Design the following circuits with given specifications, completing the design flow mentioned below:</b></p> <p align="center">(Minimum 10 Experiments)</p> <p>a. Design and perform the following analysis as per the requirement.</p> <ol style="list-style-type: none"> <li>i. DC</li> <li>ii. Transient</li> <li>iii. Op</li> <li>iv. AC</li> </ol> <p>b. Draw the Layout and verify the DRC and LVS</p> <p>c. Extract RC and back annotate the same and verify the Design</p> <p>d. Verify &amp; Optimize for Power and Area to the given constraint</p> <ol style="list-style-type: none"> <li>1. Inverter</li> <li>2. Common source amplifier</li> <li>3. Common gate amplifier</li> <li>4. Common drain amplifier</li> <li>5. Current mirror</li> <li>6. MOS Differential amplifier</li> <li>7. Operational amplifier</li> <li>8. R-2R DAC</li> <li>9. Ring Oscillator</li> <li>10. Unity Gain Sampler</li> </ol>					
<b>Textbooks and Reference books</b>	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>1. David A Johns &amp; Ken Martin (2001), “Analog Integrated Circuit Design” John Wiley and Sons.</li> <li>2. Behzad Razavi (2002), ‘Design of Analog CMOS Integrated Circuits’ Tata-McGraw Hill.</li> </ol>					

**Name of Course Coordinator:** Dr CH N Raghuram.

### 23ECVE2063: CAPSTONE PROJECT-II

<b>Course Category:</b>	Project	<b>Credits:</b>	1
<b>Course Type:</b>	Project	<b>Lecture - Tutorial -Practice:</b>	0-0-2
<b>Prerequisites:</b>	Capstone Project-I	<b>Continuous Evaluation:</b>	40
		<b>Semester end Evaluation:</b>	60
		<b>Total Marks:</b>	100

#### **Course Description:**

For capstone project, a student under the supervision of a faculty member, shall apply the knowledge and hands on technical skills they have gained through course work and lab sessions and submit it to the department in a report form and shall make an oral presentation before the Departmental Committee.

#### **Course Objectives:**

- To integrate knowledge acquired across various courses and disciplines throughout the academic program.
- Apply theoretical concepts and practical skills gained in coursework and laboratory sessions to solve real-world problems or address specific challenges within the chosen field of study.
- Provide practical and hands-on experience that prepares them for the expectations and challenges of the workforce in their respective fields.

#### **Course Materials:**

- Recommended textbooks and research papers related to the project topic
- Access to relevant software and hardware tools
- Project management software (e.g., Microsoft Project or equivalent)

## 23ECVE2064: TERM PAPER

<b>Course Category:</b>	<b>Term Paper</b>	<b>Credits:</b>	1
<b>Course Type:</b>	<b>Theory</b>	<b>Lecture - Tutorial -Practice:</b>	0-0-2
<b>Prerequisites:</b>	<b>Research Methodology and IPR</b>	<b>Continuous Evaluation:</b>	40
		<b>Semester end Evaluation:</b>	60
		<b>Total Marks:</b>	100

<b>Course Outcomes</b>	Upon successful completion of the course, the student will be able to					
	CO1	Identify and analyze the real-world problems beyond the curriculum				
	CO2	Get awareness on current trends in specific area of interest.				
	CO3	Prepare and write technical report on the topic selected after literature survey				
	CO4	Develop communication skills to explain and interact with a cross section of audiences.				
<b>Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3– High)</b>		PO1	PO2	PO3	PO4	PO5
	CO1	2		1		2
	CO2	2			1	2
	CO3		3			2
	CO4					2
<b>Course Content</b>	<p><b>The following method is adapted by the department for conducting Term Paper.</b></p> <ul style="list-style-type: none"> <li>• Term Paper and Project Work are to be carried out individually by M.Tech. students under the supervision of a faculty member.</li> <li>• The faculty member allotted to supervise the Term Paper in second Semester shall continue to be the supervisor for the Project Work also.</li> <li>• Each faculty member may be permitted to supervise not more than TWO students.</li> <li>• If any student/batch left over without supervisor, HOD shall use his/her discretion to allot the supervisor as supervisors are to be selected by the students themselves.</li> </ul> <p><b>Expected outcomes of Term Paper</b></p> <ul style="list-style-type: none"> <li>• To carry out literature survey (Reputed international journals / Proceedings of international conferences).</li> <li>• To select a technical topic related to area of specialization.</li> <li>• To submit an abstract at the beginning of second semester.</li> <li>• To critically review the topic selected, prepare a report on the topic reviewed under the guidance of supervisor and submit at the end of second semester.</li> <li>• To present the term paper before review panel and assessment will be done based on scholarship of knowledge, report writing and presentation skills.</li> </ul>					

## SEMESTER III

### 23ECVE3011: SELF LEARNING COURSE

<b>Course Category:</b>	Program Elective-V	<b>Credits:</b>	3
<b>Course Type</b>	Theory	<b>Lecture-Tutorial-Practice:</b>	3-0-0
<b>Prerequisites:</b>	---	<b>Continuous Evaluation:</b>	-
		<b>Semester end Evaluation:</b>	100
		<b>Total Marks:</b>	100

<b>Course Content</b>	The courses under this category shall carry three credits and must have a minimum duration of 12 weeks/36 hours. The department will recommend the self-learning courses from the available open courseware. The self-learning courses shall be taken from the list of approved MOOCs providers (SWAYAM / NPTEL/ EDX / Others). They must be approved/ratified in the respective Board of Studies.
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### 23ECVE3061: PROJECT- PART A

<b>Course Category:</b>	Project	<b>Credits:</b>	10
<b>Course Type</b>	Project	<b>Lecture-Tutorial-Practice</b>	0-0-20
<b>Prerequisites:</b>	Research Methodology and IPR Technical Report Writing	<b>Continuous Evaluation:</b> <b>Semester end Evaluation:</b> <b>Total Marks:</b>	40 60 100

<b>Course Outcomes</b>	Upon successful completion of the course, the student will be able to:					
	CO1	Identify a topic in relevant areas of Communication Engineering & Signal Processing.				
	CO2	Review literature to identify gaps and define objectives & scope of the work.				
	CO3	Understand the methods and processes from literature and apply appropriate research methodologies.				
	CO4	Develop an analytical/ computational model/ experimental set-up and prepare a report and develop competence in presenting.				
<b>Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)</b>		PO1	PO2	PO3	PO4	PO5
	CO1	2		1		
	CO2	2			1	
	CO3				3	
	CO4		3			2
<b>Course Content</b>	<p><b>Expected outcomes of the Project Work from Part-A:</b></p> <ul style="list-style-type: none"> <li>• To select a technical topic (from the literature survey carried out as a part of Term Paper) related to specialization in consultation with supervisor and submit an abstract to Project Review Committee PRC at the beginning of the third semester.</li> <li>• To critically evaluate the recent literature for the problem identified To carry out the project work under the guidance of supervisor on the topic selected.</li> <li>• To submit reports periodically and present before PRC for a review on the progress of work carried out.</li> <li>• To prepare a report on the work carried out and submit at the end of fourth semester.</li> </ul>					

**23ECVE3052: INTERNSHIP**

<b>Course Category:</b>	Internship	<b>Credits:</b>	2
<b>Course Type</b>	Practical	<b>Lecture-Tutorial-Practice</b>	0-0-4
<b>Prerequisites:</b>		<b>Continuous Evaluation:</b>	-
		<b>Semester end Evaluation:</b>	100
		<b>Total Marks:</b>	100

<b>Course Content</b>	The students shall undergo Internship for a period of six weeks in Industry/ Research organizations/ institute of higher learning approved by the Head of the Department during any time after the second semester and shall earn two credits.
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## SEMESTER IV

**23ECVE4061: PROJECT- PART B**

<b>Course Category:</b>	Project	<b>Credits:</b>	16
<b>Course Type</b>	Project	<b>Lecture-Tutorial-Practice</b>	0-0-32
<b>Prerequisites:</b>	Research Methodology and IPR Technical Report Writing	<b>Continuous Evaluation:</b> <b>Semester end Evaluation:</b> <b>Total Marks:</b>	40 60 100

<b>Course Outcomes</b>	Upon successful completion of the course, the student will be able to:					
	CO1	Identify methods and resources to carry out analysis and experiments				
	CO2	Reorganize the procedures with a concern for society, environment and ethics.				
	CO3	Find solutions to complex engineering activities using modern engineering tools.				
	CO4	Analyze and discuss the results to draw valid conclusions.				
	CO5	Prepare a report and defend the work and publish the work in National /International Conferences/journals.				
<b>Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)</b>		PO1	PO2	PO3	PO4	PO5
	CO1	2		1		
	CO2	2			1	
	CO3				3	
	CO4			2		2
	CO5		3			1
<b>Course Content</b>	<p align="center"><b>Expected outcomes of the Project Work from Part-B:</b></p> <ul style="list-style-type: none"> <li>• To critically evaluate the recent literature for the problem identified</li> <li>• To carry out the project work under the guidance of supervisor on the topic selected.</li> <li>• To submit reports periodically and present before PRC for a review of the progress of work carried out.</li> <li>• To test the work carried out, report the results obtained and perform comparative analysis</li> <li>• To publish the paper in Peer reviewed journals/conferences</li> <li>• To prepare a report on the work carried out and submit at the end of fourth semester.</li> </ul>					