

**MADANAPALLE INSTITUTE OF TECHNOLOGY & SCIENCE  
MADANAPALLE**

(UGC-AUTONOMOUS)

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



**MASTER OF TECHNOLOGY  
VLSI DESIGN AND EMBEDDED SYSTEMS**

**COURSE STRUCTURE  
&  
DETAILED SYLLABI**

**For the students admitted to**

**Master of Technology in VLSI Design and Embedded Systems from the academic year  
2024-25 Batches onwards**



**M. Tech Regular Two Year P. G. Degree Course**

**MADANAPALLE INSTITUTE OF TECHNOLOGY & SCIENCE**

**MADANAPALLE**

**M. Tech Two Year Curriculum Structure**

**Branch: VLSI DESIGN AND EMBEDDED SYSTEMS**

<b>Total Credits</b>	70 Credits for 2024 Admitted Batch onwards
----------------------	--

**R24 - Curriculum Structure**  
**I Year I Semester**

S. No.	Category	Course Code	Course Title	Hours Per Week				Credits
				L	T	P	Total	
1	PCC	24VESP101	CMOS Digital IC Design	3	0	0	3	3
2	PCC	24VESP102	Microcontrollers and Programmable Digital Signal Processors	3	0	0	3	3
3	PEC		<b>Professional Elective – I</b> <i>(Refer ANNEXURE – I)</i>	3	0	0	3	3
4	PEC		<b>Professional Elective – II</b> <i>(Refer ANNEXURE – I)</i>	3	0	0	3	3
5	PCC	24VESP201	CMOS Digital IC Design Laboratory	0	0	4	4	2
6	PCC	24VESP202	Microcontrollers and Programmable Digital Signal Processors Laboratory	0	0	4	4	2
7	MC	24RMP101	Research Methodology and IPR	2	0	0	2	2
8	AC		<b>Audit Course - I</b> <i>(Refer ANNEXURE – II)</i>	2	0	0	2	0
<b>Total</b>				<b>16</b>	<b>0</b>	<b>8</b>	<b>24</b>	<b>18</b>

**I Year II Semester**

S. No.	Category	Course Code	Course Title	Hours Per Week				Credits
				L	T	P	Total	
1	PCC	24VESP103	CMOS Analog IC Design	3	0	0	3	3
2	PCC	24VESP104	Embedded System Design	3	0	0	3	3
3	PEC		<b>Professional Elective – III</b> <i>(Refer ANNEXURE – I)</i>	3	0	0	3	3
4	PEC		<b>Professional Elective – IV</b> <i>(Refer ANNEXURE – I)</i>	3	0	0	3	3
5	PCC	24VESP203	CMOS Analog IC Design Laboratory	0	0	4	4	2
6	PCC	24VESP204	Embedded System Design Laboratory	0	0	4	4	2
7	PR	24VESP701	Technical Seminar	0	0	4	4	2
8	AC		<b>Audit Course – II</b> <i>(Refer ANNEXURE – II)</i>	2	0	0	2	0
<b>Total</b>				<b>14</b>	<b>0</b>	<b>12</b>	<b>26</b>	<b>18</b>

(L = Lecture, T = Tutorial, P = Practical)

## II Year I Semester

S. No.	Category	Course Code	Course Title	Hours Per Week				Credits
				L	T	P	Total	
1	PEC		<b>Professional Elective – V</b> <i>(Refer ANNEXURE – I)</i>	3	0	0	3	3
2	OE		<b>Open Elective</b> <i>(Refer ANNEXURE – III)</i>	3	0	0	3	3
3	SEC		<b>Skill Enhancement Course</b> <i>(Refer ANNEXURE – IV)</i>	1	0	2	3	2
4	PR	24VESP702	Dissertation Phase I	0	0	20	20	10
<b>Total</b>				7	0	22	29	18

## II Year II Semester

S. No.	Category	Course Code	Course Title.	Hours Per Week				Credits
				L	T	P	Total	
1	PR	24VESP703	Dissertation Phase II	0	0	32	32	16
<b>Total</b>				0	0	32	32	16

(L = Lecture, T = Tutorial, P = Practical)

**ANNEXURE - I****LIST OF PROFESSIONAL ELECTIVES**

<b>Professional Elective – I</b>		
<b>Sl. No.</b>	<b>Course Code</b>	<b>Course Title</b>
1.	24VESP401	Communication Buses and Interfaces
2.	24VESP402	Data Acquisition System Design
3.	24VESP403	FPGA Architectures and Applications
Any advanced courses can be appended in future.		

<b>Professional Elective – II</b>		
<b>Sl. No.</b>	<b>Course Code</b>	<b>Course Title</b>
1.	24VESP404	Low Power VLSI Design
2.	24VESP405	Nano-materials and Nanotechnology
3.	24VESP406	Network Security and Cryptography
Any advanced courses can be appended in future.		

<b>Professional Elective – III</b>		
<b>Sl. No.</b>	<b>Course Code</b>	<b>Course Title</b>
1.	24VESP407	Pattern Recognition and Machine Learning
2.	24VESP408	Programming Languages for Embedded Software
3.	24VESP409	RF IC Design
Any advanced courses can be appended in future.		

<b>Professional Elective – IV</b>		
<b>Sl. No.</b>	<b>Course Code</b>	<b>Course Title</b>
1.	24VESP410	SoC Architecture
2.	24VESP411	System Design with Embedded Linux
3.	24VESP412	Physical Design Automation
Any advanced courses can be appended in future.		

<b>Professional Elective – V</b> (To be offered under MOOC's Category from SWAYAM – NPTEL)		
<b>Sl. No.</b>	<b>Course Code</b>	<b>Course Title</b>
1.	24VESP4M01	VLSI Interconnects
2.	24VESP4M02	C-Based VLSI Design
3.	24VESP4M03	Multi-Core Computer Architecture
Any other new Disciplinary Course which doesn't exist in the Curriculum can be appended in future.		

**ANNEXURE - II**

**LIST OF AUDIT COURSES**

<b>Audit Course – I</b>		
<b>Sl. No.</b>	<b>Course Code</b>	<b>Course Title</b>
1.	24AUP901	Disaster Management
2.	24AUP902	Constitution of India

<b>Audit Course – II</b>		
<b>Sl. No.</b>	<b>Course Code</b>	<b>Course Title</b>
1.	24AUP903	English for Research Paper Writing
2.	24AUP904	Value Education
3.	24AUP905	Stress Management by Yoga

**ANNEXURE - III****LIST OF OPEN ELECTIVE COURSES**

<b>Open Elective</b> (To be offered under Conventional Mode)		
<b>Sl. No.</b>	<b>Course Code</b>	<b>Course Title</b>
1.	24CSEP303	Advanced Data Visualization Techniques
2.	24CSEP304	Enterprise Cloud Computing
3.	24MEP302	Automation and Robotics
Any new Interdisciplinary Course can be appended in future.		

**ANNEXURE – IV****LIST OF SKILL ENHANCEMENT COURSE**

<b>Skill Enhancement Course</b>		
<b>Sl. No.</b>	<b>Course Code</b>	<b>Course Title</b>
1.	24VESP601	QNX Embedded Real Time Operating System
Any advanced courses can be appended in future.		

# **I YEAR I SEMESTER**

## **M. Tech I Year I Semester**

24VESP101 CMOS DIGITAL IC DESIGN

L	T	P	C
3	0	0	3

## Pre-requisite      Digital system design

## Course Objectives:

This course enables students to

1. To understand the fundamentals of CMOS technology and its significance in digital circuit design.
2. To design and analyze basic and complex CMOS logic gates and circuits.
3. To teach fundamentals of CMOS Digital integrated circuit design such as importance of Pseudo logic, Combinational MOS logic circuits and Sequential MOS logic circuits.
4. To understand the trade-offs involved in optimizing power, performance, and area in CMOS digital circuits.
5. To gain knowledge of advanced topics in CMOS design, such as low power techniques, high-speed design, and emerging technologies in semi-conductor memories

## UNIT I MOS DESIGN PSEUDO NMOS LOGIC

9 hours

Inverter, Inverter threshold voltage, Output high voltage, Output Low voltage, Gain at gate threshold voltage, Transient response, Rise time, Fall time, Pseudo NMOS logic gates, Transistor equivalency, CMOS Inverter logic.

## UNIT II COMBINATIONAL MOS LOGIC CIRCUITS

9 hours

MOS logic circuits with NMOS loads, Primitive CMOS logic gates—NOR & NAND gate, Complex Logic circuits design—Realizing Boolean expressions using NMOS gates and CMOS gates, AOI and OIA gates, CMOS full adder, CMOS transmission gates, Designing with Transmission gates.

### UNIT III SEQUENTIAL MOS LOGIC CIRCUITS

9 hours

Behavior of bistable elements, SR Latch, Clocked latch and flip flop circuits, CMOS D latch and edge triggered flip-flop

## UNIT IV DYNAMIC LOGIC CIRCUITS

9 hours

Basic principle, Voltage Bootstrapping, Synchronous dynamic pass transistor circuits, Dynamic CMOS transmission gate logic, High performance Dynamic CMOS circuits.

## **UNIT V SEMICONDUCTOR MEMORIES**

9 hours

Types, RAM array organization, DRAM – Types, Operation, Leakage currents in DRAM cell and refresh operation, SRAM operation Leakage currents in SRAM cells, Flash Memory-NOR flash and NAND flash

### **Course Outcomes:**

Upon successful completion of the course, students will be able to

- CO1: Demonstrate advanced knowledge in Static and dynamic characteristics of CMOS,
- CO2: Estimate Delay and Power of Adders circuits.
- CO3: Classify different semiconductor memories.
- CO4: Analyze, design and implement combinational and sequential MOS logic circuits.
- CO5: Analyze complex engineering problems critically in the domain of digital IC design for conducting research.

### **Text Book(s)**

1. Neil Weste, David Harris, "CMOS VLSI Design: A Circuits and Systems Perspective", 4th Edition, Pearson, 2010
2. Digital Integrated Circuit Design – Ken Martin, Oxford University Press, 2011.
3. CMOS Digital Integrated Circuits Analysis and Design – Sung-Mo Kang, Yusuf Leblebici, TMH, 3rd Edition, 2011.

### **Reference Books**

1. Introduction to VLSI Systems: A Logic, Circuit and System Perspective – Ming-BO Lin, CRC Press, 2011
2. Digital Integrated Circuits – A Design Perspective, Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, 2nd Edition, PHI.

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

**M. Tech I Year I Semester****24VESP102 MICROCONTROLLERS AND PROGRAMMABLE  
DIGITAL SIGNAL PROCESSORS**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Pre-requisite** Microprocessor and Microcontroller

**Course Objectives:**

This course enables students to

1. To understand the architecture and applications of the ARM Cortex-Mx processor.
2. To comprehend the types, priority, and behaviour of exceptions and interrupts.
3. To study the architectural and advanced features of the LPC 17xx microcontroller.
4. To understand the architecture and features of programmable DSP processors.
5. To explore the architecture and programming considerations of the TMS320C62x, TMS320C64x, and TMS320C67x processors.

**UNIT I** **9 hours**

**ARM Cortex-Mx Processor:** Applications, Programming model – Registers, Operation - modes, Exceptions and Interrupts, Reset Sequence, Instruction Set (ARM and Thumb), Unified Assembler Language, Memory Maps, Memory Access Attributes, Permissions, Bit-Band Operations, Unaligned and Exclusive Transfers. Pipeline, Bus Interfaces.

**UNIT II** **9 hours**

**Exceptions and Interrupts:** Exceptions, Types, Priority, Vector Tables, Interrupt Inputs and Pending behaviour, Fault Exceptions, Supervisor and Pendable Service Call, Nested Vectored Interrupt Controller, Basic Configuration, SYSTICK Timer, Interrupt Sequences, Exits, Tail Chaining, Interrupt Latency.

**UNIT III** **9 hours**

**LPC 17xx microcontroller:** Internal memory, GPIOs, Timers, ADC, UART and other serial interfaces, PWM, RTC, WDT.

**UNIT IV** **9 hours**

**Programmable DSP (P-DSP) Processors:** Harvard architecture, Multi port memory, architectural structure of P-DSP- MAC unit, Barrel shifters, Introduction to TI DSP processor family.

**UNIT V** **9 hours**

VLIW architecture and TMS320C6000 series, architecture study, data paths, cross paths, Introduction to Instruction level architecture of C6000 family, Assembly Instructions memory addressing, for arithmetic, logical operations.

TMS320C55x – Architecture overview, Addressing modes, Instruction set, Programming considerations, system issues.

**TMS320C62x and TMS320C64x:** Architecture overview, Memory systems, External memory addressing, Instruction set, Programming considerations, system issues.

**TMS320C67X** – Architecture overview, Instruction set, Pipeline Architecture, Programming considerations, Realtime implementations

**Course Outcomes:**

Upon the completion of the course, the student is able to

- CO1: Explain the architecture, applications, and programming model of the ARM Cortex-Mx processor
- CO2: Explain and configure different types of exceptions and interrupts.
- CO3: Describe the architecture and peripheral interfaces of the LPC 17xx microcontroller and its advance features.
- CO4: Explain the architecture and key features of programmable DSP processors.
- CO5: Describe the architecture, instruction set, and programming considerations of various TI DSP processors.

**Text Book(s)**

- 1. N. Senthil Kumar and M Saravanan, “Microprocessors and Microcontrollers” 2<sup>nd</sup> Edition, Oxford university press, 2016.
- 2. Joseph Yiu, “The definitive guide to ARM Cortex-M3”, Elsevier, 2<sup>nd</sup> Edition
- 2. Venkatramani B. and Bhaskar M. “Digital Signal Processors: Architecture, Programming and Applications”, TMH, 2<sup>nd</sup> Edition.
- 3. TMS Manual on TMS320C62XX, TMS320C64XX and TMS320C67XX.

**Reference Books**

- 1. Sloss Andrew N, Symes Dominic, Wright Chris, “ARM System Developer's Guide: Designing and Optimizing”, Morgan Kaufman Publication.
- 2. Steve furber, “ARM System-on-Chip Architecture”, Pearson Education
- 3. Frank Vahid and Tony Givargis, “Embedded System Design”, Wiley
- 4. Technical references and user manuals on [www.arm.com](http://www.arm.com), NXP Semiconductor [www.nxp.com](http://www.nxp.com) and Texas Instruments [www.ti.com](http://www.ti.com)

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

**M. Tech I Year I Semester****24VESP201 CMOS DIGITAL IC DESIGN LABORATORY**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

**Pre-requisite**      Digital Logic Design

**Course Objectives:**

This course enables students to

1. To explain the VLSI Design Methodologies using any VLSI design tool.
2. To grasp the significance of various design logic Circuits in full-custom IC Design.
3. To explain the Physical Verification in Layout Extraction.
4. To fully appreciate the design and analyze of CMOS Digital Circuits.
5. To grasp the Significance of Pre-Layout Simulation and Post-Layout Simulation.

**List of Experiments**

The students are required to design and implement the Circuit and Layout of any TEN Experiments using CMOS 130nm Technology.

1. Inverter Characteristics.
2. NAND and NOR Gate
3. XOR and XNOR Gate
4. 2:1 Multiplexer
5. Full Adder
6. RS-Latch
7. Clock Divider
8. JK-Flip Flop
9. Synchronous Counter
10. Asynchronous Counter
11. Static RAM Cell
12. Dynamic Logic Circuits
13. Linear Feedback Shift Register

**Lab Requirements:****Software:**

Mentor Graphics Tool/ Cadence/ Synopsys/Industry Equivalent Standard Software

**Hardware:**

Personal Computer with necessary peripherals, configuration and operating System.

**Course Outcomes:**

Upon successful completion of the course, students will be able to

CO1: Explain the VLSI Design Methodologies using any VLSI design tool.  
CO2: Grasp the significance of various design logic Circuits in full-custom IC Design.  
CO3: Explain the Physical Verification in Layout Extraction.  
CO4: Fully appreciate the design and analyze of CMOS Digital Circuits.  
CO5: Grasp the Significance of Pre-Layout Simulation and Post-Layout Simulation.

**Mode of Evaluation:** Continuous Internal Evaluation and End Semester Examination.

**M. Tech VLSI Design and Embedded Systems**

**M. Tech I Year I Semester****24VESP202 MICROCONTROLLERS AND PROGRAMMABLE DIGITAL SIGNAL PROCESSORS LABORATORY**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

**Pre-requisite** Microprocessor and Microcontroller**Course Objectives:**

This course enables students to

1. To write the ARM 'C' programming for applications
2. To understand the interfacing of various modules with ARM 7/ ARM Cortex-M3
3. To develop assembly and C Programming for DSP processors

**List of Experiments****Part A)** Experiments to be carried out on Cortex-Mx development boards and using GNU tool-chain

1. Blink an LED with software delay, delay generated using the SysTick timer.
2. System clock real time alteration using the PLL modules.
3. Control intensity of an LED using PWM implemented in software and hardware.
4. Control an LED using switch by polling method, by interrupt method and flash the LED once every five switch presses.
5. UART Echo Test.
6. Take analog readings on rotation of rotary potentiometer connected to an ADC channel.
7. Temperature indication on an RGB LED.
8. Mimic light intensity sensed by the light sensor by varying the blinking rate of an LED.
9. Evaluate the various sleep modes by putting core in sleep and deep sleep modes.
10. System reset using watchdog timer in case something goes wrong.
11. Sample sound using a microphone and display sound levels on LEDs.

**Part B)** Experiments to be carried out on DSP C6713 evaluation kits and using Code Composer Studio (CCS)

12. To develop an assembly code and C code to compute Euclidian distance between any two points
13. To develop assembly code and study the impact of parallel, serial and mixed execution
14. To develop assembly and C code for implementation of convolution operation
15. To design and implement filters in C to enhance the features of given input sequence/signal

**Software Requirements:**

Keil for ARM, Code Composer Studio

**Hardware Requirements:**

ARM Cortex Mx Development Boards, TI TMS C6713 evaluation kit

**Course Outcomes:**

Upon successful completion of the course, students will be able to

CO1: Install, configure and utilize tool sets for developing applications based on ARM processor core.

CO2: Design and develop the ARM7 based embedded systems for various applications.

CO3: Develop application programs on ARM and DSP development boards both in assembly and C

CO4: Design and implement the digital filters on DSP6713 processor.

CO5: Analyze the hardware and software interaction and integration.

**Mode of Evaluation:** Continuous Internal Evaluation and End Semester Examination.

**M. Tech I Year I Semester****24RMP101 RESEARCH METHODOLOGY AND IPR**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>2</b>	<b>0</b>	<b>0</b>	<b>2</b>

**Pre-requisite** Nil**Course Description:**

This course aims to provide students with a comprehensive understanding of research methodology and the principles and practices of intellectual property rights (IPR). The course will equip students with the skills needed to design, conduct, and evaluate research effectively while also understanding the legal and ethical considerations surrounding intellectual property.

**Course Objectives:**

To impart knowledge on

1. Formulation of research problems, design of experiment, collection of data, interpretation and presentation of result
2. Intellectual property rights, patenting and licensing

**UNIT I RESEARCH PROBLEM FORMULATION****9 hours**

Objectives of research, types of research, research process, approaches to research; conducting literature review- information sources, information retrieval, tools for identifying literature, Indexing and abstracting services, Citation indexes, summarizing the review, critical review, identifying research gap, conceptualizing and hypothesizing the research gap

**UNIT II RESEARCH DESIGN AND DATA COLLECTION****9 hours**

Statistical design of experiments- types and principles; data types & classification; data collection - methods and tools

**UNIT III DATA ANALYSIS, INTERPRETATION AND REPORTING****9 hours**

Sampling, sampling error, measures of central tendency and variation,; test of hypothesis- concepts; data presentation- types of tables and illustrations; guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript; guidelines for writing thesis, research proposal; References – Styles and methods, Citation and listing system of documents; plagiarism, ethical considerations in research

**UNIT IV INTELLECTUAL PROPERTY RIGHTS****9 hours**

Concept of IPR, types of IPR – Patent, Designs, Trademarks and Trade secrets, Geographical indications, Copy rights, applicability of these IPR, IPR & biodiversity; IPR development process, role of WIPO and WTO in IPR establishments, common rules of IPR practices, types and features of IPR agreement, functions of UNESCO in IPR maintenance.

**UNIT V PATENTS****9 hours**

Patents – objectives and benefits of patent, concept, features of patent, inventive steps, specifications, types of patent application; patenting process - patent filling, examination of patent, grant of patent, revocation; equitable assignments; Licenses, licensing of patents; patent agents, registration of patent agents.

**Course Outcomes:**

Upon completion of the course, the student can

- CO1: Describe different types of research; identify, review and define the research problem
- CO2: Select suitable design of experiment s; describe types of data and the tools for collection of data
- CO3: Explain the process of data analysis; interpret and present the result in suitable form
- CO4: Explain about Intellectual property rights, types and procedures
- CO5: Execute patent filing and licensing

**Text Book(s)**

- 1. Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education, 11e (2012).
- 2. Soumitro Banerjee, "Research methodology for natural sciences", IISc Press, Kolkata, 2022.
- 3. Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.

**Reference Books**

- 1. David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2007.
- 2. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013.

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

# **I YEAR II SEMESTER**

**M. Tech I Year II Semester****24VESP103 CMOS ANALOG IC DESIGN**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Pre-requisite** Semiconductor physics and devices/ Analog circuits**Course Objectives:**

1. This course focuses on theory, analysis and design of analog integrated circuits in both Bipolar and Metal-Oxide-Silicon (MOS) technologies.
2. Basic design concepts, issues and tradeoffs involved in analog IC design are explored.
3. Intuitive understanding and real-life applications are emphasized throughout the course.
4. To learn about Design of CMOS Op Amps, Compensation of Op Amps, Design of Two-Stage Op Amps, Power Supply Rejection Ratio of Two-Stage Op Amps, Cascade Op Amps, Measurement Techniques of OP Amp.
5. To know about Characterization of Comparator, Two-Stage, Open-Loop Comparators, Improving the Performance of Open-Loop Comparators, Discrete-Time Comparators etc.

**UNIT I** **9 hours**

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

**UNIT II** **9 hours**

**Differential Amplifiers:** Single Ended and Differential Operation, Basic Differential Pair, Common Mode Response, Differential Pair with MOS loads, Gilbert Cell. Passive and Active Current Mirrors – Basic Current Mirrors, Cascode Current Mirrors, Active Current Mirrors. Current Steering Circuit

**UNIT III** **9 hours**

**Frequency Response of Amplifiers:** General Considerations, Common Source Stage, Source Followers, Common Gate Stage, Cascode Stage, Differential Pair. Noise – Types of Noise, Representation of Noise in circuits, Noise in single stage amplifiers, Noise in Differential Pairs.

**UNIT IV** **9 hours**

**Feedback Amplifiers:** General Considerations, Feedback Topologies, Effect of Loading. Operational Amplifiers – General Considerations, One Stage Op Amps, Two Stage Op Amps, Gain Boosting, Common – Mode Feedback, Input Range limitations, Slew Rate, Power Supply Rejection, Noise in Op Amps, Stability and Frequency Compensation.

**UNIT V** **9 hours**

**Comparators:** Characterization of comparator, Two-Stage, Open-Loop comparators, Other Open-Loop Comparators, Improving the Performance of Open-Loop Comparators, Discrete-Time Comparators.

**Course Outcomes:**

- CO1: Design MOSFET based analog integrated circuits.
- CO2: Analyze analog circuits at least to the first order.
- CO3: Appreciate the trade-offs involved in analog integrated circuit design.
- CO4: Understand and appreciate the importance of noise and distortion in analog circuits.
- CO5: Analyze complex engineering problems critically in the domain of analog IC design for conducting research.

**Text Book(s)**

- 1. B. Razavi, "Design of Analog CMOS Integrated Circuits", 2<sup>nd</sup> Edition, McGraw Hill, 2016.
- 2. Paul. R. Gray & Robert G. Meyer, "Analysis and Design of Analog Integrated Circuits", Wiley, 5<sup>th</sup> Edition, 2009.

**Reference Books**

- 1. T. C. Carusone, D. A. Johns & K. Martin, "Analog Integrated Circuit Design", 2nd Edition, Wiley, 2012.
- 2. P. E. Allen & D. R. Holberg, "CMOS Analog Circuit Design", 3<sup>rd</sup> Edition, Oxford University Press, 2011.

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

**M. Tech I Year II Semester**

**24VESP104 EMBEDDED SYSTEM DESIGN**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Pre-requisite** Microcontrollers and Microprocessors, Digital Logic Design

**Course Objectives:**

This course enables students to

1. Understand the basics of an embedded system.
2. Analyse the typical components of an embedded system.
3. Understand different Embedded Firmware design approaches.
4. Learn the design process of embedded system applications.
5. Analyse the RTOS and inter-process communication.

**UNIT I INTRODUCTION TO EMBEDDED SYSTEMS 9 hours**

Definition of Embedded System, Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification, Major Application Areas, Purpose of Embedded Systems, Characteristics and Quality Attributes of Embedded Systems.

**UNIT II TYPICAL EMBEDDED SYSTEM 9 hours**

Core of the Embedded System: General Purpose and Domain Specific Processors, ASICs, PLDs, Commercial Off-The-Shelf Components (COTS), Memory: ROM, RAM, Memory according to the type of Interface, Memory Shadowing, Memory selection for Embedded Systems, Sensors and Actuators, Communication Interface: Onboard and External Communication Interfaces. DDR, Flash, NVRAM

**UNIT III EMBEDDED FIRMWARE 9 hours**

Reset Circuit, Brown-out Protection Circuit, Oscillator Unit, Real Time Clock, Watchdog Timer, **Embedded Firmware Design Approaches and Development Languages:**

Embedded firmware design approaches-super loop-based approach, operating system-based approach; embedded firmware development languages-assembly language-based development, high-level language-based development.

**UNIT IV RTOS Based Embedded System Design 9 hours**

Operating System Basics, Types of Operating Systems, Tasks, Processes and Threads, Multiprocessing and Multitasking, and Task Scheduling: Pre-emptive and Non-Premptive Scheduling, Interrupt Routines of RTOS.

**UNIT V TASK COMMUNICATION 9 hours**

Shared Memory, Message Passing, Semaphores, Remote Procedure Call and Sockets, Task Synchronization: Task Communication/Synchronization Issues, Task Synchronization Techniques, Device Drivers, How to Choose an RTOS.

**Course Outcomes:**

Upon successful completion of the course, students will be able to

- CO1: Understand the basics of an embedded system.
- CO2: Analyse the typical components of an embedded system.
- CO3: Understand different Embedded Firmware design approaches.
- CO4: Learn the design process of embedded system applications.
- CO5: Analyse the RTOS and inter-process communication.

**Text Book(s)**

- 1. Introduction to Embedded Systems - Shibu K.V, Mc Graw Hill.
- 2. Embedded Systems - Raj Kamal, TMH.

**Reference Books**

- 1. Embedded System Design - Frank Vahid, Tony Givargis, John Wiley.
- 2. An Embedded Software Primer - David E. Simon, Pearson Education.
- 3. Embedded Systems – Lyla, Pearson, 2013

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

**M. Tech I Year II Semester****24VESP203 CMOS ANALOG IC DESIGN LABORATORY**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

**Pre-requisite**      Analog circuits

**Course Objectives:**

This course enables students to

1. To explain the VLSI Design Methodologies using VLSI design tool.
2. To grasp the significance of various CMOS analog circuits in full-custom IC Design flow
3. To explain the Physical Verification in Layout Design
4. To fully appreciate the design and analyze of analog and mixed signal simulation
5. To grasp the Significance of Pre-Layout Simulation and Post-Layout Simulation

**List of Experiments**

The students are required to design and implement any TEN Experiments using CMOS 130nm Technology.

The students are required to implement LAYOUTS of any SIX Experiments using CMOS 130nm Technology and Compare the results with Pre-Layout Simulation.

1. MOS Device Characterization and parametric analysis
2. Common Source Amplifier
3. Common Source Amplifier with source degeneration
4. Cascode amplifier
5. Simple current mirror
6. Cascode current mirror.
7. Wilson current mirror.
8. Differential Amplifier
9. Operational Amplifier
10. Sample and Hold Circuit
11. Direct-conversion ADC
12. R-2R Ladder Type DAC

**Lab Requirements:**

Software: Mentor Graphics – Pyxis Schematic, IC Station, Calibre, ELDO Simulator

Hardware: Personal Computer with necessary peripherals, configuration and operating System.

**Course Outcomes:**

Upon successful completion of the course, students will be able to

CO1: Explain the VLSI Design Methodologies using VLSI design tool.

CO2: Grasp the significance of various CMOS analog circuits in full-custom IC Design flow

CO3: Explain the Physical Verification in Layout Design

CO4: Fully appreciate the design and analyze of analog and mixed signal simulation

CO5: Grasp the Significance of Pre-Layout Simulation and Post-Layout Simulation

**Mode of Evaluation:** Continuous Internal Evaluation and End Semester Examination.

**M. Tech I Year II Semester****24VESP204 EMBEDDED SYSTEM DESIGN LABORATORY**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

**Pre-requisite**      Embedded System

**Course Objectives:**

This course enables students to

1. To familiarize with embedded systems programming concepts
2. To implement different embedded communication and interfacing protocols

**List of Experiments**

1. Functional Testing of Devices  
Flashing the OS on to the device into a stable functional state by porting desktop environment with necessary packages.
2. Exporting Display on to other Systems  
Making use of available laptop/desktop displays as a display for the device using SSH client & X11 display server.
3. GPIO Programming  
Programming of available GPIO pins of the corresponding device using native programming language. Interfacing of I/O devices like LED/Switch etc., and testing the functionality.
4. Interfacing Chronos eZ430  
Chronos device is a programmable Texas Instruments watch which can be used for multiple purposes like PPT control, Mouse operations etc., Exploit the features of the device by interfacing with devices.
5. ON/OFF Control Based On Light Intensity  
Using the light sensors, monitor the surrounding light intensity & automatically turn ON/OFF the high intensity LED's by taking some pre-defined threshold light intensity value.
6. Battery Voltage Range Indicator  
Monitor the voltage level of the battery and indicating the same using multiple LED's (for ex: for 3V battery and 3 LEDs, turn on 3 LEDs for 2-3V, 2 LEDs for 1-2V, 1 LED for 0.1-1V & turn off all for 0V)
7. Dice Game Simulation  
Instead of using the conventional dice, generate a random value similar to dice value and display the same using a 16X2 LCD. A possible extension could be to provide the user with option of selecting single or double dice game.
8. Displaying RSS News Feed On Display Interface  
Displaying the RSS news feed headlines on a LCD display connected to device. This can be adapted to other websites like twitter or other information websites. Python can be used to acquire data from the internet.
9. Porting Open w.r.t the Device  
Attempt to use the device while connecting to a WiFi network using a USB dongle and at the same time providing a wireless access point to the dongle.
10. Hosting a website on Board  
Building and hosting a simple website (static/dynamic) on the device and make it accessible

online. There is a need to install server (eg: Apache) and thereby host the website.

11. Webcam Server  
Interfacing the regular USB webcam with the device and turn it into fully functional IP webcam & test the functionality.
12. FM Transmission  
Transforming the device into a regular FM transmitter capable of transmitting audio at desired frequency (generally 88-108 MHz)

**Software Requirements:**

Keil / Python

**Hardware Requirements:**

Arduino/Raspberry Pi/Beaglebone

**Course Outcomes:**

Upon successful completion of the course, students will be able to

- CO1: Understand the architecture and programming of embedded systems.
- CO2: Apply programming skills to develop embedded system applications.
- CO3: Design and implement hardware-software integration for embedded systems.
- CO4: Analyze and debug embedded system applications using simulation and debugging tools.
- CO5: Develop real-time embedded system projects using modern development platforms.

**Mode of Evaluation:** Continuous Internal Evaluation and End Semester Examination.

## **Professional Electives**

**Professional Elective – I****24VESP401 COMMUNICATION BUSES AND INTERFACES**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Pre-requisite** Computer Communication Networks

**Course Objectives:**

This course enables students to

1. Understand the concepts of different types of serial buses.
2. Learn about CAN Architecture and its standards,
3. Familiarize with PCI Express Technology and its protocols
4. Analyse USB architecture, its transfer types, and device drivers.
5. Learn about data streaming using serial communication protocols

**UNIT I SERIAL BUSSES** **9 hours**

Cables, Serial busses, serial versus parallel, Data and Control Signal- data frame, data rate, features, Limitations and applications of RS232, RS485, I2C, SPI

**UNIT II CAN ARCHITECTURE** **9 hours**

ISO 11898-2, ISO 11898-3, Data Transmission- ID allocation, Bit timing, Layers- Application layers, Object layer, Transfer layer, Physical layer, Frame formats- Data frame, Remote frame, Error frame, Over load frame, Ack slot, Inter frame spacing, Bit spacing, Applications.

**UNIT III PCIe** **9 hours**

Revision, Configuration space- configuration mechanism, Standardized registers, Bus enumeration, Hardware and Software implementation, Hardware protocols, Applications.

**UNIT IV USB** **9 hours**

Transfer Types- Control transfers, Bulk transfer, Interrupt transfer, Isochronous transfer. Enumeration- Device detection, Default state, Addressed state, Configured state, enumeration sequencing. Descriptor types and contents- Device descriptor, configuration descriptor, Interface descriptor, Endpoint descriptor, String descriptor. Device driver.

**UNIT V DATA STREAMING SERIAL COMMUNICATION PROTOCOL** **9 hours**

Serial Front Panel Data Port(SFPDP) configurations, Flow control, serial FPD frames, fiber frames and copper cable

**Course Outcomes:**

Upon successful completion of the course, students will be able to

CO1: Understand the concepts of different types of serial buses.

CO2: Learn about CAN Architecture and its standards.

CO3: Familiarize with PCI Express Technology and its protocols.

CO4: Analyse USB architecture, its transfer types, and device drivers.

CO5: Learn about data streaming using serial communication protocols.

**Text Book(s)**

1. A Comprehensive Guide to controller Area Network – Wilfried Voss, Copperhill Media Corporation, 2nd Ed., 2005.
2. Serial Port Complete-COM Ports, USB Virtual Com Ports and Ports for Embedded Systems- Jan Axelson, Lakeview Research, 2nd Ed.,

**Reference Books**

1. USB Complete – Jan Axelson, Penram Publications.
2. PCI Express Technology – Mike Jackson, Ravi Budruk, Mindshare Press.

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

**Professional Elective – I****24VESP402 DATA ACQUISITION SYSTEM DESIGN**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Pre-requisite** Computer Networks

**Course Objectives:**

This course enables students to

1. To understand the different types of communication interface buses.
2. To familiarize different methods of ADC's and DAC characteristics, specifications
3. To study the software tools to develop the code and implementation for data acquisition system

**UNIT I** **9 hours**

Fundamentals of Data Acquisition Systems, Sensors and Transducers, Signal conditioning Introduction, Types of signal conditioning, Classes of signal conditioning, DAQ Hardware, DAQ Software, Communications Cabling, Parameters of a DAQ System.

**UNIT II** **9 hours**

Data acquisition system configuration, Computer plug in I/O, Distributed I/O, Stand-alone or distributed loggers/controllers- Introduction, Methods of operation, Stand-alone logger/controller hardware, firmware & software design, Communications hardware interface, Host software, Considerations, internal systems, USB overall structure, PCMCIA card. Application Layer Protocols.

**UNIT III** **9 hours**

Data Acquisition Systems: Hardware-Introduction, Plug-in DAQ Systems, Converters A/D, Converters D/A, Amplifier, Multiplexer/De-multiplexer, Power Management, Timing System, Filtering, Memory Board, Bus Interface

**UNIT IV** **9 hours**

Communication Bus-Bus and FireWire, Serial Communications, Wireless, Ethernet and Bluetooth, GSM for Data Acquisition System, PCI and PCI Express, Standard VME. High speed data acquisition and interface, SPI read/write protocol, RTC interfacing and programming.

**UNIT V** **9 hours**

Design of Data Acquisition System: Introduction to the Design, Functional Design of high-Speed Computers-Based DAS, Portable DAS, Design Guidelines for High-Performance Multichannel. Software for Data Acquisition Systems, Introduction to LabVIEW, Android for DAQ, Design of Firmware, Example of Implementation of a Software.

**Course Outcomes:**

Upon successful completion of the course, students will be able to

- CO1: Understand the fundamental concepts and components of data acquisition systems.
- CO2: Apply knowledge of analog-to-digital (ADC) and digital-to-analog (DAC) converters in data acquisition.
- CO3: Design and implement hardware for data acquisition systems.
- CO4: Analyze the performance of data acquisition systems, including resolution, accuracy, and speed.
- CO5: Develop and implement software solutions for data collection and processing.

**Text Book(s)**

1. Maurizio Di Paolo Emilio "Data acquisition systems-from fundamentals to applied design" springer, 2013.
2. John Park and Steve Mackay "Practical Data acquisition for instrumentation and control systems" Elsevier, 2003.

**Reference Books**

1. Robert H King, "Introduction to Data Acquisition with LabVIEW", 2nd edition, 2012, McGraw

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

**Professional Elective – I****24VESP403 FPGA ARCHITECTURES AND APPLICATIONS**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Pre-requisite**      Digital System Design, ASIC Design

**Course Objectives:**

This course enables students to

1. To acquire knowledge about various architectures and device technologies of PLD's.
2. To comprehend FPGA Architectures.
3. To analyze System level Design and their application for Combinational and Sequential Circuits.
4. To familiarize with Anti-Fuse Programmed FPGAs.
5. To apply knowledge of this subject for various design applications.

**UNIT I****9 hours**

**Introduction to Programmable Logic Devices:** Introduction, Simple Programmable Logic Devices – Read Only Memories, Programmable Logic Arrays, Programmable Array Logic, Programmable Logic Devices/Generic Array Logic; Complex Programmable Logic Devices–Architecture of Xilinx Cool Runner XCR3064XL CPLD, CPLD Implementation of a Parallel Adder with Accumulation.

**UNIT II****9 hours**

**Field Programmable Gate Arrays:** Organization of FPGAs, FPGA Programming Technologies, Programmable Logic Block Architectures, Programmable Interconnects, and Programmable I/O blocks in FPGAs, Dedicated Specialized Components of FPGAs, and Applications of FPGAs.

**UNIT III****9 hours**

**SRAM Programmable FPGAs:** Introduction, Programming Technology, Device Architecture, the Xilinx XC2000, XC3000 and XC4000 Architectures.

**UNIT IV****9 hours**

**Anti-Fuse Programmed FPGAs:** Introduction, Programming Technology, Device Architecture, The Actel ACT1, ACT2 and ACT3 Architectures.

**UNIT V****9 hours**

**Design Applications:** General Design Issues, Counter Examples, A Fast Video Controller, A Position Tracker for a Robot Manipulator, A Fast DMA Controller, Designing Counters with ACT devices, Designing Adders and Accumulators with the ACT Architecture.

**Course Outcomes:**

Upon successful completion of the course, students will be able to

CO1: Acquire knowledge about various architectures and device technologies of PLD's.

CO2: Comprehend FPGA Architectures.

CO3: Analyze System level Design and their application for Combinational and Sequential Circuits.

CO4: Familiarize with Anti-Fuse Programmed FPGAs.

CO5: Apply knowledge of this subject for various design applications.

**Text Book(s)**

1. Field Programmable Gate Array Technology - Stephen M. Trimberger, Springer International Edition.
2. Digital Systems Design - Charles H. Roth Jr, Lizy Kurian John, Cengage Learning.

**Reference Books**

1. Field Programmable Gate Arrays-John V.Oldfield, Richard C.Dorf, Wiley India.
2. Digital Design Using Field Programmable Gate Arrays - Pak K. Chan/SamihaMourad, Pearson Low Price Edition.
3. Digital Systems Design with FPGAs and CPLDs-Ian Grout, Elsevier, Newnes.
4. FPGA based System Design-Wayne Wolf, Prentice Hall Modern Semiconductor Design Series.

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

## **Professional Elective – II**

24VESP404 LOW POWER VLSI DESIGN

L	T	P	C
3	0	0	3

## Course Objectives:

This course enables students to

1. To understand the concepts of velocity saturation, Impact Ionization and Hot Electron Effect.
2. To implement Low power design approaches for system level and circuit level measures.
3. To design low power adders for efficient design of systems.
4. To design low power multipliers for efficient design of systems.
5. To design memory circuits with low power dissipation.

9 hours

Need for Low Power Circuit Design, Sources of Power Dissipation – Static and Dynamic Power Dissipation, Short Circuit Power Dissipation, Glitching Power Dissipation, Short Channel Effects – Drain Induced Barrier Lowering and Punch Through, Surface Scattering, Velocity Saturation, Impact Ionization, Hot Electron Effect.

## UNIT II      Low-Power Design Approaches

9 hours

Low-Power Design through Voltage Scaling – VTCMOS circuits, MTCMOS circuits, Architectural Level Approach –Pipelining and Parallel Processing Approaches. Switched Capacitance Minimization Approaches: System Level Measures, Circuit Level Measures, Mask level Measures.

## UNIT III Low-Voltage Low-Power Adders

9 hours

Introduction, Standard Adder Cells, CMOS Adder's Architectures – Ripple Carry Adders, Carry Look Ahead Adders, Carry Select Adders, Carry Save Adders, Low-Voltage Low-Power Design Techniques – Trends of Technology and Power Supply Voltage, Low-Voltage Low-Power Logic Styles.

## UNIT IV Low-Voltage Low-Power Multipliers

9 hours

Introduction, Overview of Multiplication, Types of Multiplier Architectures, Braun Multiplier, Baugh Wooley Multiplier, Booth Multiplier, Introduction to Wallace Tree Multiplier.

UNIT V Low-Voltage Low-Power Memories

9 hours

UNIT V Low Voltage Low Power Memories 9 hours

Basics of ROM, Low-Power ROM Technology, Future Trend and Development of ROMs, Basics of SRAM, Memory Cell, Precharge and Equalization Circuit, Low-Power SRAM Technologies, Basics of DRAM, Self-Refresh Circuit, Future Trend and Development of DRAM.

**Course Outcomes:**

Upon successful completion of the course, students will be able to

- CO1: Understand concepts of velocity saturation, Impact Ionization and Hot Electron Effect.
- CO2: Implement Low power design approaches for system level and circuit level measures.
- CO3: Design low power adders for efficient design of systems.
- CO4: Design low power multipliers for efficient design of systems.
- CO5: Design memory circuits with low power dissipation.

**Text Book(s)**

- 1. CMOS Digital Integrated Circuits – Analysis and Design – Sung-Mo Kang, Yusuf Leblebici, TMH, 2011.
- 2. Low-Voltage, Low-Power VLSI Subsystems – Kiat-Seng Yeo, Kaushik Roy, TMH Professional Engineering.

**Reference Books**

- 1. Introduction to VLSI Systems: A Logic, Circuit and System Perspective – Ming-BO Lin, CRC Press, 2011.
- 2. Low Power CMOS Design – Anantha Chandrakasan, IEEE Press/Wiley International, 1998.
- 3. Low Power CMOS VLSI Circuit Design – Kaushik Roy, Sharat C. Prasad, John Wiley & Sons, 2000

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

**Professional Elective – II****24VESP405 NANO-MATERIALS AND NANOTECHNOLOGY**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Pre-requisite** Material science, Basic chemistry

**Course Objectives:**

This course enables students to

1. To understand the basic idea behind the design and fabrication of nano scale systems.
2. To understand and formulate new engineering solutions for current problems and technologies for future applications.
3. To acquire knowledge on the operation of fabrication and characterization devices to achieve precisely designed systems.

**UNIT I** **9 hours**

Introduction of nano materials and nanotechnologies, Features of nanostructures, Applications of nano materials and technologies. Nano dimensional Materials 0D, 1D, 2D structures – Size Effects – Fraction of Surface Atoms – Specific Surface Energy and Surface Stress – Effect on the Lattice Parameter – Phonon Density of States – the General Methods available for the Synthesis of Nanostructures – precipitate – reactive – hydrothermal/solvo thermal methods – suitability of such methods for scaling – potential Uses.

**UNIT II** **9 hours**

Fundamentals of nanomaterials, Classification, Zero-dimensional nanomaterials, One-dimensional nanomaterials, Two-dimensional nano materials, three dimensional nanomaterials. Low Dimensional Nanomaterials and its Applications, Synthesis, Properties and applications of Low Dimensional Carbon-Related Nanomaterials.

**UNIT III** **9 hours**

Micro- and Nanolithography Techniques, Emerging Applications, Introduction to Micro electromechanical Systems (MEMS), Advantages and Challenges of MEMS, Fabrication Technologies, Surface Micromachining, Bulk Micromachining, Molding. Introduction to Nano Phonics.

**UNIT IV** **9 hours**

Introduction, Synthesis of CNTs - Arc-discharge, Laser-ablation, Catalytic growth, Growth mechanisms of CNT's - Multi-walled nanotubes, Single-walled nano tubes Optical properties of CNT's, Electrical transport in perfect nanotubes, Applications as case studies. Synthesis and Applications of CNTs.

**UNIT V** **9 hours**

Ferroelectric materials, coating, molecular electronics and Nano electronics, biological and environmental, membrane based application, polymer based application.

### **Course Outcomes:**

Upon successful completion of the course, students will be able to

- CO1: Understand the fundamental principles and concepts of nanotechnology and nanomaterials.
- CO2: Analyze the synthesis methods of nanomaterials, including top-down and bottom-up approaches.
- CO3: Evaluate the physical, chemical, and mechanical properties of nanomaterials.
- CO4: Gather detailed knowledge of the operation of fabrication and characterization devices to achieve precisely designed systems.
- CO5: Understand the applications of nanomaterials in various fields, including electronics, energy, medicine, and environmental science.

### **Text Book(s)**

1. Kenneth J. Klabunde and Ryan M. Richards, “Nanoscale Materials in Chemistry”, 2nd edition, John Wiley and Sons, 2009.
2. I Gusev and A Rempel, “Nanocrystalline Materials”, Cambridge International Science Publishing, 1st Indian edition by Viva Books Pvt. Ltd. 2008.
3. B. S. Murty, P. Shankar, Baldev Raj, B. B. Rath, James Murday, “Nanoscience and Nanotechnology”, Tata McGraw Hill Education 2012.

### **Reference Books**

1. Digital Integrated Circuit Design – Ken Martin, Oxford University Press, 2011.
2. Digital Integrated Circuits - A Design Perspective, Jan M. Rabaey, Anant Chandrakasan, Borivoje Nikolic, 2nd Edition, PHI.

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

**Professional Elective – II****24VESP406 NETWORK SECURITY AND CRYPTOGRAPHY**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Pre-requisite** Computer Networks**Course Objectives:**

This course enables students to

1. To identify and utilize different forms of cryptography techniques.
2. To incorporate authentication and security in the network applications.
3. To distinguish among different types of threats to the system and handle the same.

**UNIT I SECURITY** **9 hours**

Need of security, security services, Attacks, OSI Security Architecture, one-time passwords, Model for Network security, Classical Encryption Techniques like substitution ciphers, Transposition ciphers, Cryptanalysis of Classical Encryption Techniques

**UNIT II NUMBER THEORY** **9 hours**

Introduction, Fermat's and Euler's Theorem, The Chinese Remainder Theorem, Euclidean Algorithm, Extended Euclidean Algorithm, and Modular Arithmetic

**UNIT III PRIVATE- KEY(SYMMETRIC) CRYPTOGRAPHY:** **9 hours**

Block Ciphers, Stream Ciphers, RC4 Stream cipher, Data Encryption Standard (DES), Advanced Encryption Standard (AES), Triple DES, RC5, IDEA, Linear and Differential Cryptanalysis.

**UNIT IV PUBLIC- KEY(ASYMMETRIC) CRYPTOGRAPHY:** **9 hours**

RSA, Key Distribution and Management, Diffie-Hellman Key Exchange, Elliptic Curve Cryptography, Message Authentication Code, hash functions, message digest algorithms: MD4 MD5, Secure Hash algorithm, RIPEMD-160, HMAC

**UNIT V AUTHENTICATION AND SYSTEM SECURITY:** **9 hours**

IP and Web Security Digital Signatures, Digital Signature Standards, Authentication Protocols, Kerberos,

IP security Architecture, Encapsulating Security Payload, Key Management, Web Security Considerations, Secure Socket Layer, Secure Electronic Transaction Intruders, Intrusion Detection, Password Management, Worms, viruses, Trojans, Virus Countermeasures, Firewalls, Trusted Systems.

**Course Outcomes:**

Upon successful completion of the course, students will be able to

- CO1: Understand the fundamental principles of network security and cryptography.
- CO2: Analyze various cryptographic algorithms, including symmetric and asymmetric encryption.
- CO3: Apply cryptographic techniques for securing data transmission over networks.
- CO4: Understand and implement security protocols for network communication.
- CO5: Analyze potential vulnerabilities and threats in computer networks.

**Text Book(s)**

1. William Stallings, "Cryptography and Network Security, Principles and Practices", Pearson Education, 3rd Edition.
2. Charlie Kaufman, Radia Perlman and Mike Speciner, "Network Security, Private Communication in a Public World", Prentice Hall, 2ND Edition. .

**Reference Books**

1. Christopher M. King, Ertem Osmanoglu, Curtis Dalton, "Security Architecture, Design Deployment and Operations", RSA Pres,
2. Stephen Northcutt, Leny Zeltser, Scott Winters, Karen Kent, and Ronald W. Ritchey, "Inside Network Perimeter Security", Pearson Education, 2 nd Edition
3. Richard Bejtlich, "The Practice of Network Security Monitoring: Understanding Incident Detection and Response", William Pollock Publisher, 2013

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

**Professional Elective – III****24VESP407 PATTERN RECOGNITION AND MACHINE LEARNING**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Pre-requisite** Statistics and Probability Theory**Course Objectives:**

This course enables students to

1. To understand the mathematical formulation of patterns.
2. To comprehend the principles and mathematical foundations of linear models.
3. To explore various kernel-based algorithms and their applications.
4. To study different types of graphical models and Markov random fields.
5. To understand the theory behind mixture models the EM algorithms

**UNIT I****9 hours**

Introduction to Pattern recognition: Mathematical Formulation and Basic Functional Equation, Reduction of Dimensionality, Experiments in Pattern Classification, Backward Procedure for Both Feature Ordering- and Pattern Classification, Suboptimal Sequential Pattern Recognition, Nonparametric Design of Sequential Pattern Classifiers, Analysis of Optimal Performance and a Multiclass Generalization

**UNIT II****9 hours**

Linear Models: Linear Basis Function Models -Maximum likelihood and least squares, Geometry of least squares , Sequential learning, Regularized least squares, Multiple outputs , The Bias-Variance Decomposition, Bayesian Linear Regression -Parameter distribution, Predictive, Equivalent, Bayesian Model Comparison, Probabilistic Generative Models-Continuous inputs , Maximum likelihood solution, Discrete features, Exponential family, Probabilistic Discriminative Models - Fixed basis functions, Logistic regression, Iterative reweighted least squares, Multiclass logistic regression, Probit regression, Canonical link functions

**UNIT III****9 hours**

Kernel Methods: Constructing Kernels, Radial Basis Function Networks - Nadaraya-Watson model, Gaussian Processes -Linear regression revisited, Gaussian processes for regression, Learning the hyper parameters, Automatic relevance determination, Gaussian processes for classification, Laplace approximation, Connection to neural networks, Sparse Kernel Machines- Maximum Margin Classifiers, Overlapping class distributions, Relation to logistic regression, Multiclass SVMs, SVMs for regression, Computational learning theory, Relevance Vector Machines- RVM for regression, Analysis of sparsity, RVM for classification

**UNIT IV****9 hours**

Graphical Models: Bayesian Networks, Example: Polynomial regression, Generative models, Discrete variables, Linear-Gaussian models, Conditional Independence- Three example graphs, Markov Random Fields -Conditional independence properties, Factorization properties, Illustration: Image de-noising, Relation to directed graphs, Inference in Graphical Models- Inference on a chain,

Trees, Factor graphs, The sum-product algorithm, The max-sum algorithm, Exact inference in general graphs, Loopy belief propagation, Learning the graph structure.

**UNIT V** **9 hours**

Mixture Models and EM algorithm: Image segmentation and compression - K-means Clustering, Mixtures of Gaussians-Maximum likelihood, EM for Gaussian mixtures, An Alternative View of EM Gaussian mixtures revisited, Relation to K-means, Mixtures of Bernoulli distributions, EM for Bayesian linear regression, The EM Algorithm in General, Combining Models- Tree-based Models, Conditional Mixture Models- Mixtures of linear regression models, Mixtures of logistic models, Mixtures of experts.

**Course Outcomes:**

Upon successful completion of the course, students will be able to

**CO1:** Explain the basic concepts and importance of pattern recognition in machine learning.

**CO2:** Evaluate and interpret the performance of linear models on different datasets.

**CO3:** Apply kernel-based algorithms to solve non-linear pattern recognition problems

**CO4:** Construct and interpret different types of graphical models for various applications.

**CO5:** Apply mixture models and the EM algorithm to practical problems and datasets.

**Text Book(s)**

1. Sequential methods in Pattern Recognition and Machine Learning-K. S. Fu, Academic Press, volume no. 52.
2. Pattern Recognition and Machine Learning- C. Bishop-Springer, 2006.

**Reference Books**

1. Pattern Classification- Richard o. Duda, Peter E. hart, David G. Stork, John Wiley& Sons, 2nd Ed., 2001.
2. The elements of Statistical Learning- Trevor Hastie, Robert Tibshirani, Jerome H. Friedman, Springer, 2nd Ed., 2009

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

### Professional Elective – III

### 24VESP408 PROGRAMMING LANGUAGES FOR EMBEDDED SOFTWARE

L	T	P	C
3	0	0	3

**Pre-requisite** Microcontrollers and Microprocessors:

#### Course Objectives:

This course enables students to

1. To introduce students to various programming languages like C, C++, Java script, PERL, etc.
2. To distinguish between Procedural and OOP language, Introduce features of OOPs etc.
3. To demonstrate the development of some typical applications using different Programming languages.

#### UNIT I 9 hours

**Embedded ‘C’ Programming:** Bitwise operations, Dynamic memory allocation, OS services, linked stack and queue, Sparse matrices, Binary tree, Interrupt handling in C, Code optimization issues, Writing LCD drives, LED drivers, Drivers for serial port communication, Embedded Software Development Cycle and Methods (Waterfall, Agile).

#### UNIT II 9 hours

**Object Oriented Programming:** Introduction to procedural, modular, object oriented and generic programming techniques, Limitations of procedural programming, objects, classes, data members, methods, data encapsulation, data Abstraction and information hiding, inheritance, polymorphism.

#### UNIT III 9 hours

**CPP Programming:** ‘cin’, ‘cout’, formatting and I/O manipulators, new and delete operators, Defining a class, data members and methods, ‘this’ pointer, constructors, destructors, friend function, dynamic memory allocation.

#### UNIT IV 9 hours

**Overloading and Inheritance:** Need of operator overloading, overloading the assignment, overloading using friends, type conversions, single inheritance, base and derived classes, friend classes, types of inheritance, hybrid inheritance, multiple inheritance.

**Templates:** Function template and class template, member function templates and template arguments

#### UNIT V 9 hours

**Exception Handling:** Syntax for exception handling code: try-catch-throw, Multiple Exceptions.

**Scripting Languages:** Overview of Scripting Languages – PERL, CGI, VB Script, Java Script.

**PERL:** Operators, Statements Pattern Matching etc. Data Structures, Modules, Objects, Tied Variables, Inter process Communication Threads, Compilation & Line Interfacing.

**Course Outcomes:**

Upon successful completion of the course, students will be able to

CO1: Introduce students to various programming languages like C, C++, Java script, PERL, etc.

CO2: Distinguish between Procedural and OOP language, Introduce features of OOPs etc.

CO3: Demonstrate the development of some typical applications using different Programming languages.

CO4: Analyze the trade-offs between various embedded programming languages and platforms.

CO5: Integrate hardware and software to design complete embedded system projects..

**Text Book(s)**

1. Michael J. Pont, "Embedded C", Pearson Education, 2<sup>nd</sup> Edition, 2008.
2. Robert Sedgewick, "Algorithms in C++", Addison Wesley Publishing Company, 1999.

**Reference Books**

1. Randal L. Schwartz, "Learning Perl", O'Reilly Publications, 6<sup>th</sup> Edition 2011.
2. Michael Berman, "Data structures via C++", Oxford University Press, 2002

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

**Professional Elective – III****24VESP409 RF IC DESIGN**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Pre-requisite** Microwave, Electromagnetics**Course Objectives:**

This course enables students to

1. To introduce students the concept of tuned circuit, matching network, reflection coefficients, transmission lines and MOS high frequency behavior etc.
2. To demonstrate design of High Frequency Amplifiers.
3. To introduce various types of Power Amplifiers and PLLs

**UNIT I** **9 hours**

**RF Tuned Circuits:** RF systems – Basic architectures, Maximum Power Transfer, Passive RLC Networks, Parallel RLC tank, Q, Series RLC networks, matching, Pi match, T match, Passive components in IC: Resistors, capacitors, Inductors, Transceiver Architectures.

**UNIT II** **9 hours**

Nonlinearity and Time Variance of system, sensitivity and dynamic range, Review of MOS Device Physics, MOS device review, Distributed Systems, Transmission lines, reflection coefficient, the wave equation Lossy transmission lines Smith charts – plotting gamma, Noise in FET: Thermal noise, flicker noise review

**UNIT III** **9 hours**

**High Frequency Amplifier Design:** Bandwidth estimation using open-circuit time constants, Bandwidth estimation using short-circuit time constants, Rise-time, delay and bandwidth, Zeros to enhance bandwidth, Shunt- series amplifiers, tuned amplifiers Cascaded amplifiers, Noise figure, Intrinsic MOS noise parameters, LNA Design, Power match versus noise match

**UNIT IV** **9 hours**

**RF Power Amplifiers:** Multiplier based mixers, Subsampling mixers & Mixer Design, RF Power Large signal performance Amplifiers, Class A, AB, B, C amplifiers, Class D, E, F amplifiers, RF Power amplifier design issues. LC Oscillators, Voltage Controlled Oscillators, Ring oscillators, Delay Cells, tuning range in ring oscillators, Tuning in LC oscillators, Tuning sensitivity, Phase Noise in oscillators, sources of phase noise

**UNIT V** **9 hours**

**PLL:** Voltage controlled oscillators, Resonators, Negative resistance oscillators, Phase locked loops, Linearized PLL models, Phase detectors, charge pumps, Loop filters, PLL design examples, Frequency synthesis and oscillator Frequency division, integer-N synthesis, Phase noise

**Course Outcomes:**

Upon successful completion of the course, students will be able to

CO1: Understand relation between automation algorithms and constraints posed by VLSI technology.

CO2: Introduce students the concept of tuned circuit, matching network, reflection coefficients, transmission lines and MOS high frequency behavior etc.

CO3: Demonstrate design of High Frequency Amplifiers.

CO4: Introduce various types of Power Amplifiers.

CO5: Apply frequency division techniques in oscillators and PLLs, and understand their role in frequency synthesis.

**Text Book(s)**

1. Thomas H. Lee, "The Design of CMOS Radio-Frequency Integrated Circuits", Cambridge University Press, 2004.
2. Behzad Razavi, "RF Microelectronics", Prentice Hall, 1997.

**Reference Books**

1. Abidi, P.R. Gray, and R.G. Meyer, eds., "Integrated Circuits for Wireless Communications", New York: IEEE Press, 1999.
2. R. Ludwig and P. Bretchko, "RF Circuit Design, Theory and Applications", Pearson, 2000.

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

**Professional Elective – IV****24VESP410 SoC ARCHITECTURE**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Pre-requisite** Computer architecture, Digital logic design

**Course Objectives:**

This course enables students to

1. To understand the basics related to SoC architecture and different approaches related to SoC Design.
2. To select an appropriate robust processor for SoC Design
3. To select an appropriate memory for SoC Design.
4. To realize real time case studies

**UNIT I****9 hours**

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

**UNIT II****9 hours**

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

**Buffers:** minimizing Pipeline Delays, Branches, More Robust Processors, Vector Processors and Vector Instruction extensions, VLIW Processors, Superscalar Processors

**UNIT III****9 hours**

**Memory Design for SOC:** Overview: SOC external memory, SOC Internal Memory, Size, Scratchpads and Cache memory, Cache Organization, Cache data, Write Policies, Strategies for line replacement at miss time, Other Types of Cache, Split – I, and D – Caches, Multilevel Caches, SOC Memory System, Models of Simple Processor – memory interaction.

**UNIT IV****9 hours**

**Interconnect, Customization and Configurability:** Interconnect Architectures, Bus: Basic Architectures, SOC Standard Buses, Analytic Bus Models, Using the Bus model, Effects of Bus transactions and contention time.

**SOC Customization:** An overview, Customizing Instruction Processor, Reconfigurable Technologies, Mapping design onto Reconfigurable devices, Instance- Specific design, Customizable Soft Processor, Reconfiguration - overhead analysis and trade-off analysis on Reconfigurable Parallelism.

**UNIT V****9 hours**

**Application Studies / Case Studies:** SOC Design approach; AES-algorithms, Design and evaluation; Image compression–JPEG compression.

**Course Outcomes:**

Upon successful completion of the course, students will be able to

CO1: Understand the basics related to SoC architecture and different approaches related to SoC Design.

CO2: Select an appropriated robust processor for SoC Design

CO3: Select an appropriate memory for SoC Design.

CO4: Design SoC

CO5: Realize real time case studies

**Text Book(s)**

1. Computer System Design System-on-Chip - Michael J. Flynn and Wayne Luk, Wiely India Pvt. Ltd.
2. ARM System on Chip Architecture – Steve Furber, 2ndEdition, 2000, Addison Wesley Professional.

**Reference Books**

1. Design of System on a Chip: Devices and Components – Ricardo Reis, 1st Ed., 2004, Springer.
2. Co-Verification of Hardware and Software for ARM System on Chip Design (Embedded Technology) – Jason Andrews – Newnes, BK and CDROM.
3. System on Chip Verification – Methodologies and Techniques –Prakash Rashinkar, Peter Paterson and Leena Singh L, 2001, Kluwer Academic Publishers

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

## Professional Elective – IV

### 24VESP411 SYSTEM DESIGN WITH EMBEDDED LINUX

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Pre-requisite**      Embedded Systems, Computer architecture

#### **Course Objectives:**

This course enables students to

1. To understand the importance of Embedded Linux in system design
2. To analyze the architecture of embedded Linux in detail
3. To explain the Linux BSP for a hardware platform
4. To develop and Debug the drivers in Embedded Linux

#### **UNIT I**

**9 hours**

**Introduction:** Need of Embedded Linux, Embedded Linux versus Desktop Linux, Embedded Linux Distributions Embedded Linux Architecture, Kernel Architecture: Hardware Abstraction Layer (HAL), Memory Manager, Scheduler, File System, IO Subsystem, Networking Subsystems, IPC; User Space, Linux Start-Up Sequence.

#### **UNIT II**

**9 hours**

**Board Support Package:** Inserting BSP in Kernel Build Procedure, the Boot Loader Interface, Memory Map, Interrupt Management, the PCI Subsystem, Timers, UART, and Power Management. **Embedded Storage:** Flash Map, Memory Technology Device, MTD Architecture, Embedded File Systems.

#### **UNIT III**

**9 hours**

**Embedded Drivers:** Linux Serial Driver, Ethernet Driver, and I2C Subsystem on Linux, USB Gadgets, Watchdog Timer, and Kernel Modules. Porting Applications: Architectural Comparison, Application Porting Roadmap.

#### **UNIT IV**

**9 hours**

**Real-Time Linux:** Linux and Real-Time: Building and Debugging: Building the Kernel, Building the Root File System, Integrated Development Environment, Elementary Concepts of Debugging. **Embedded Graphics:** Graphics System, Introduction to Display Hardware.

#### **UNIT V**

**9 hours**

**uClinux:** Linux on MMU - Less Systems, Program Load and Execution, Memory Management, File/ Memory Mapping.

#### **Course Outcomes:**

Upon successful completion of the course, students will be able to

CO1: Understand the importance of Embedded Linux in system design

CO2: Explain the Linux BSP for a hardware platform

CO3: Implement device drivers for embedded hardware peripherals.

CO4: Develop and deploy embedded applications on Linux-based platforms.

CO5: Explore features of uClinux-based embedded systems.

**Text Book(s)**

1. Derek Molloy, “Exploring Beagle Bone: Tools and Techniques for Building with Embedded Linux”, Wiley, 1st Edition, 2014.
2. Christopher Hallinan, “Embedded Linux Primer: A Practical Real-World Approach”, Prentice Hall, 2nd Edition, 2010.

**Reference Books**

1. P Raghvan, Amol Lad, Sriram Neelakandan, “Embedded Linux System Design and Development”, Auerbach Publications, 2005.
2. Karim Yaghmour, “Building Linux Systems”, O’Reilly & Associates, 2008.

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

**Professional Elective – IV****24VESP412 PHYSICAL DESIGN AUTOMATION**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Pre-requisite** Computer Architecture, Digital Logic Design

**Course Objectives:**

This course enables students to

1. To understand relation between automation algorithms and constraints posed by VLSI technology.
2. To adopt algorithms to meet critical design parameters.
3. To design area efficient logics by employing different routing algorithms and shape functions.
4. To simulate and synthesis different combinational and sequential logics.

**UNIT I** **9 hours**

**VLSI Design Automation Tools:** Algorithms and system design, Structural and logic design, Transistor level design, Layout design, Verification methods, Design management tools. Design styles: full custom, standard cell, gate arrays, field programmable gate arrays, sea of gates and comparison, system packaging styles, multi-chip modules

**UNIT II** **9 hours**

**Layout:** Compaction, placement and routing, Design rules, symbolic layout, Applications of compaction. Formulation methods, Algorithms for constrained graph compaction, Circuit representation, Wire length estimation, Placement algorithms, Partitioning algorithms.

**UNIT III** **9 hours**

**Floor planning and routing:** Floor planning concepts, Shape functions and floor planning sizing, Local routing, Area routing, Channel routing, global routing and its algorithms. Interconnection analysis, interconnection optimization

**UNIT IV** **9 hours**

**Simulation and Logic Synthesis:** Gate level and switch level modeling and simulation, Introduction to combinational logic synthesis, clock tree synthesis, ROBDD principles, implementation, construction and manipulation, two level logic syntheses.

**UNIT V** **9 hours**

**High-Level Synthesis:** Hardware model for high level synthesis, internal representation of input algorithms, Allocation, assignment and scheduling, scheduling algorithms, Aspects of assignment.

**Course Outcomes:**

Upon successful completion of the course, students will be able to

CO1: Understand relation between automation algorithms and constraints posed by VLSI technology.

CO2: Adopt algorithms to meet critical design parameters.

CO3: Design area efficient logics by employing different routing algorithms and shape functions.

CO4: Simulate and synthesis different combinational and sequential logics.

CO5: Develop hardware model for high level synthesis.

**Text Book(s)**

1. S. H. Gerez, Algorithms for VLSI Design Automation, John Wiley, 1998.
2. N. A. Sherwani, Algorithms for VLSI Physical Design Automation, (3/e), Kluwer, 1999

**Reference Books**

1. S. M. Sait, H. Youssef, VLSI Physical Design Automation, World scientific, 1999.
2. M. Sarrafzadeh, Introduction to VLSI Physical Design, McGraw Hill (IE), 1996.

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

# **Audit Courses**

**Audit Course - I****24AUP901 DISASTER MANAGEMENT**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>2</b>	<b>0</b>	<b>0</b>	<b>0</b>

**Course Objectives:**

Upon the completion of subject student will be able to-

1. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. Critically understand the strengths and weaknesses of disaster management approaches,
5. Planning and programming in different countries, particularly their home country or the countries they work in

**UNIT-I DISASTER CLASSIFICATION****6 hours**

Disaster: definition, factors and significance; difference between hazard and Disaster; natural disaster: earthquakes, volcanisms, cyclones, tsunamis, floods, droughts and famines, landslides and avalanches; man-made disasters: nuclear reactor meltdown, industrial accidents, oil slicks and spills, outbreaks of disease and epidemics, war and conflicts

**UNIT-II REPERCUSSIONS OF DISASTERS****6 hours**

Economic damage, loss of human and animal life, destruction of ecosystem. **Disaster Prone Areas in India:** Study of seismic zones; areas prone to floods and droughts, landslides and Avalanches; areas prone to cyclonic and coastal hazards with special reference to tsunami.

**UNIT-III DISASTER PREPAREDNESS AND MANAGEMENT****6 hours**

Preparedness: monitoring of phenomena triggering a disaster or hazard; Evaluation of risk: application of remote sensing, data from meteorological and Other agencies, media reports: governmental and community preparedness.

**UNIT-IV RISK ASSESSMENT****6 hours**

Disaster risk: concept and elements, disaster risk reduction, global and national disaster risk situation. Techniques of risk assessment, global co-operation in risk assessment and warning.

**UNIT-V DISASTER MITIGATION****6 hours**

Meaning, concept and strategies of disaster mitigation, emerging trends in Mitigation. Structural mitigation and non-structural mitigation, programs of Disaster mitigation in India.

**Course outcomes:**

After the completion of the subject following outcomes can be achieved-

CO1: Students will be able to understand disaster and its types in general.

CO2: They will understand the post disaster damage in terms of both like and commodity.

CO3: They will have clear picture of disaster-prone zones.

CO4: They will be able to understand the pre and post disaster preparedness needed to mitigate the disaster impact in large scale.

CO5: Student will also understand to quantify the risk in terms of monetary for both commodity and life.

CO6: Student will also learn the structural and non-structural measures for risk mitigation

**Reference Books:**

1. Ghosh G.K., 2006, Disaster Management, APH Publishing Corporation
2. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies" "New Royal book Company.
3. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences and Reflections", Prentice Hall Of India, New Delhi.
4. Goel S. L., Disaster Administration And Management Text and Case Studies" ,Deep&Deep Publication Pvt. Ltd., New Delhi

**Mode of Evaluation:** Assignments, Mid Term Tests

**Audit Course - I****24AUP902 CONSTITUTION OF INDIA**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>2</b>	<b>0</b>	<b>0</b>	<b>0</b>

**Course Objectives:**

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.
4. To get knowledge about the Indian Federal System and Center – State Relations
5. To Understand the Election Commission functions and administration system

**UNIT-I: INTRODUCTION** **6 hours**

Historical Background – Drafting Committee (Composition & Working) – Philosophical foundations of the Indian Constitution – Preamble – Fundamental Rights – Directive Principles of State Policy – Fundamental Duties – Citizenship – Constitutional Remedies for citizens.

**UNIT-II: STRUCTURE AND FUNCTION OF CENTRAL GOVERNMENT** **6 hours**

Union Government – Structures of the Union Government and Functions – President – Vice President – Prime Minister – Cabinet – Parliament – Supreme Court of India – Judicial Review.

**UNIT-III: STRUCTURE AND FUNCTION OF STATE GOVERNMENT** **6 hours**

State Government – Structure and Functions – Governor – Chief Minister – Cabinet – State Legislature – Judicial System in States – High Courts and other Subordinate Courts.

**UNIT-IV CONSTITUTION FUNCTIONS** **6 hours**

Indian Federal System – Center – State Relations – President's Rule – Constitutional Amendments – Constitutional Functionaries - Assessment of working of the Parliamentary System in India.

**UNIT-V: ELECTION COMMISSION** **6 hours**

Central Election Commission - Role and functioning – Chief Election Commissioner and Election Commissioners – State Election Commission – Institute and Bodies for the welfare of SC/ST/OBC and Women

**Course Outcomes:**

Upon completion of the course, students will be able to:

CO1: Know about Human rights protection by Indian Constitution.

CO2: Understand the functions of the Indian government

CO3: Understand and abide the rules of the Indian constitution.

CO4: Role of Constitution in Socio-economic development and welfare activities of the Country.

**Textbooks:**

1. Durga Das Basu, "Introduction to the Constitution of India", Prentice Hall of India, New Delhi.
2. R.C. Agarwal, (1997) "Indian Political System", S.Chand and Company, New Delhi.

**References Books:**

1. The Constitution of India, 1950 (Bare Act), Government Publication
2. Dr. S.N. Basu, Dr. B.R. Ambedkar framing of Indian Constitution, 1<sup>st</sup> Edition, 2015
3. M.P. Jain, Indian Constitution Law, 7<sup>th</sup> Edn., Lexis Nexis, 204
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015

**Mode of Evaluation:** Assignments, Mid Term Tests

**Audit Course -II****24AUP903 ENGLISH FOR RESEARCH PAPER WRITING**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>2</b>	<b>0</b>	<b>0</b>	<b>0</b>

**Course objectives:**

Students will be able to:

1. Understand that how to improve your writing skills and level of readability
2. Learn about what to write in each section
3. Understand the skills needed when writing a Title
4. Ensure the good quality of paper at very first-time submission

**UNIT I: SCIENTIFIC WRITING: AN INTRODUCTION** **6 hours**

What is scientific writing – Language in scientific writing – Use and miss-use of English – Elements of scientific writing - Paraphrasing and Plagiarism - Hedging and Criticizing – How to identify research problem

**UNIT II: WRITING TITLE AND ABSTRACT** **6 hours**

Strategies for writing effective title –Planning and preparing your abstract - Things to consider while writing abstract – Useful phrases for writing abstract

**UNIT III: ORGANISING THE LITERATURE; METHODS OF DATA COLLECTION AND DATA ANALYSIS** **6 hours**

What is review of the literature - Techniques of reading and citing various studies relevant to the study – Things to consider while organising review of the literature – useful phrases while writing review of the literature. Introduction to various methods of data collection –Preparing tools and describing them - How to interpret and analyse data.

**UNIT IV: WRITING FINDINGS, DISCUSSION AND CONCLUSION** **6 hours**

Useful vocabulary while writing findings, discussion, and conclusion –elaboration of the findings - Preparing and describing charts and graphs –how to organise your discussion section – Discussing the findings of your study with the literature available

**UNIT V: PREPARING REFERENCES, APPENDICES AND PROOFREADING THE PAPER** **6 hours**

Various styles of referencing and bibliography (APA, MLA, Oxford, Harvard, Chicago), – Organising and preparing Appendixes – Various strategies of proofreading

**Course Outcomes:**

At the end of the course the learners will be able to:

- CO1: Become aware of various components of academic writing
- CO2: Improve and use academic vocabulary while writing a research papers
- CO3: Plan and write quality research papers in their respective field

**References:**

1. Adrian Wallwork, (2011). English for Writing Research Papers. Springer New York
2. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
3. Day, R. (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
4. Highman, N. (1998), Handbook
5. Research Papers, Springer New York Dordrecht
6. Kate L. Turabian, (2007).A Manual for Writers of Research Papers, Theses, and Dissertations, Seventh Edition: Chicago Style for Students and Researchers [*7th ed.*]Chicago Guides to Writing, Editing, and Publishing

**Mode of Evaluation:** Assignments, Mid Term Tests

**Audit Course-II****24AUP904 VALUE EDUCATION****Course Prerequisite:** NIL

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>2</b>	<b>0</b>	<b>0</b>	<b>0</b>

**Course Objectives:**

Students will be able to:

1. Understand value of education
2. Understand value of self- development
3. Imbibe personality development
4. Imbibe spiritual development and to about the importance of character
5. Incorporate good emotional intelligence with self-control

**UNIT-I****6 hours**

Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgements.

**UNIT-II****6 hours**

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline

**UNIT-III****6 hours**

Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance. True friendship.

Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature.

**UNIT-IV****6 hours**

Character –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message.

**UNIT-V****6 hours**

Competence- Emotional Intelligence- Mind your Mind, Self-control, Honesty, Studying effectively

**Course Outcomes:**

Students will be able to

1. Knowledge of self-development
2. Learn the importance of Human values
3. Developing the moral personality
4. Development of spiritual personality
5. Development of emotional personality for efficiency in work

**Text/Reference Books:**

1. Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi

**Mode of Evaluation:** Assignments, Mid Term Tests

**Audit Course - II****24AUP905 STRESS MANAGEMENT BY YOGA****Course Prerequisite:** None**Course Objectives**

Students will be able to:

1. To know the human psyche: Yogic and modern concepts
2. To have the importance for mental health
3. To know the relationship between mind and body
4. To understand the concept of stress according to modern science and yoga
5. To achieve overall health of mind through yoga

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>2</b>	<b>0</b>	<b>0</b>	<b>0</b>

**UNIT-I SCIENTIFIC FOUNDATIONS OF STRESS** **6 hours**

Concept of stress – Sources of stress - Types of Stress – Personality factors and Stress – Stress and the college student

**UNIT-II CONSEQUENCES OF STRESS ON HUMAN MIND** **6 hours**

Human Psyche: Yogic and Modern concepts, behavior and consciousness – Frustration – Conflicts – Psychosomatic Disorders

**UNIT-III MENTAL HYGIENE AND YOGA** **6 hours**

Mental health: A Yogic Perspective – Mental hygiene and role of Yoga in mental hygiene – Yogic principles for the management of stress (Prayer and meditation for mental health)

**UNIT-IV ASHTANGA YOGA INTRODUCTION** **6 hours**

Introduction to Ashtanga Yoga – Concepts and techniques of stress management in Ashtanga yoga of Patanjali Yoga sutra (i.e. Benefits of Meditation for stress management)

**UNIT-V YOGIC MANAGEMENT OF STRESS** **6 hours**

Specific practices for stress management: Yogasana, breath awareness, shavasana, yoganidra, pranayama and meditation

**Course Outcomes:**

Students will be able to:

1. Understand the role of yoga in stress management
2. Understanding the role of yoga in life management
3. Understanding the role of yoga in mental hygiene
4. To Develop strong mental health
5. To Develop healthy mind and there by improve efficiency

**Text/Reference Books:**

1. ‘Certification of yoga professionals, Official guide book for Level 1 and Level 2” Excel books private limited, Noida
2. “Rajayoga or conquering the Internal Nature” by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

**Mode of Evaluation:** Assignments, Mid Term Tests

# Open Elective

## Open Elective

24CSEP303 ADVANCED DATA VISUALIZATION TECHNIQUES

L T P C  
3 0 0 3

### **Course Description:**

Advanced Data Visualization is about the art and science of visualizing data. Three themes (what, why, and how) will run alongside each other as we cycle through the course. In “what” we focus on specific types of visualizations for a particular purpose, “how” we focus on the process – each visualization starts with and “why” we discuss the theory that ties the “how” and the “what” together, often focusing on the grammar of graphics.

## **Course Objectives:**

1. To understand the various types of data, apply and evaluate the principles of data visualization.
2. Acquire skills to apply visualization techniques to a problem and its associated dataset.
3. To apply structured approach to create effective visualizations from the massive dataset using various visualization tools.

## **UNIT I      BASICS OF DATA VISUALIZATION**

9 hours

Overview of data visualization - Data Abstraction - Task Abstraction - Dimensions and Measures - Analysis: Four Levels for Validation. Statistical charts (Bar Chart - stacked bar chart – Line Chart - Histogram - Pie chart - Frequency Polygon - Box plot - Scatter plot - Regression curves.) Information visualization – effective data analysis – traits of meaningful data – visual perception – making abstract data visible – building blocks of information visualization – analytical interaction – analytical navigation – optimal quantitative scales – reference lines and regions – trellises and crosstabs – multiple concurrent views – focus and context – details on demand – over-plotting reduction – analytical patterns – pattern examples.

## UNIT II DATA VISUALIZATION TOOLS

9 hours

Introduction to various data visualization tools - Scalar and point techniques - vector visualization techniques - multidimensional techniques - visualizing cluster analysis – K-means and Hierarchical Cluster techniques. Time Series data visualization – Text data visualization – Spatial Data Visualization

## UNIT III      NETWORK VISUALIZATION

9 hours

Networks and Trees - Heat Map – Tree Map - Map Color and Other Channels Manipulate View - Visual Attributes- Multivariate data visualization – Geometric projection techniques - Icon-based techniques - Pixel-oriented techniques - Hierarchical techniques - Scatterplot matrix - Hyper box - Trellis display - Parallel coordinates.

**UNIT IV INTRODUCTION TO DASHBOARDS** **9 hours**  
Dashboard – Introduction– Taxonomies- User Interaction- Organizational Functions-Dashboard Design – Worksheets - Workbooks – Workbook Optimization - Protection and common mistakes. Dashboard creation using visualization tool use cases: Finance-marketing-insurance-healthcare.

**UNIT V PLOTTING GEOSPATIAL VISUALIZATION** **9 hours**  
Plotting Geospatial Data: Introduction to Geoplotlib, Design Principles of Geoplotlib, Geospatial Visualizations, Plotting Geospatial Data on a Map Web-Based Visualizations: Concepts of Bokeh, Interfaces-Plotting and Model Interfaces, Output, Bokeh Server, Presentation, Integrating – HTML Document and Bokeh Applications.

### **Course Outcomes:**

After completing this Unit, students will be able to

- CO1: Understand the different data types, visualization types to bring out the insight
- CO2: Demonstrate the analysis of large dataset using various visualization techniques and tools
- CO3: Relate the visualization towards the problem based on the dataset to analyse and bring out valuable insight on large dataset.
- CO4: Design visualization dashboard to support the decision making on large scale data.
- CO5: Apply visualization techniques for various Geospatial data analysis tasks

### **Text Book(s)**

1. Ben Fry, "Visualizing data: Exploring and explaining data with the processing environment", O'Reilly, 2008.
2. Tamara Munzer, Visualization Analysis and Design, 1st edition, CRC Press, United States, 2015.

### **Reference Books**

1. Mario Dobler, Tim Grobmann, "Data Visualization with Python", O'Reilly, First Edition, 2019
2. Michael Fry, Jeffrey Ohlmann, Jeffrey Camm, James Cochran, Data Visualization: Exploring and Explaining with Data, South-Western College Publishing, 2021

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

## Open Elective

24CSEP304 ENTERPRISE CLOUD COMPUTING

L T P C  
3 0 0 3

## Pre-requisite NIL

## Course Objectives:

1. Understand the foundational concepts, terminologies, and models of cloud computing, including cloud characteristics, delivery models, and deployment models, to build a strong theoretical base.
2. Explore the technologies underpinning cloud computing such as broadband networks, data center infrastructure, service oriented architecture & virtualization, and evaluate their impact on cloud service delivery and performance.
3. Gain hands-on experience with cloud infrastructure mechanisms including virtual servers, cloud storage, and resource replication, and learn to manage and monitor cloud resources effectively.
4. Develop skills to manage cloud environments through the use of remote administration systems, resource management, SLA management, and billing systems, and apply these skills to real-world case studies.
5. Understand the implications of cloud computing for enterprise strategies, including the transition to cloud-centric operations, and learn to design and implement cloud solutions that enhance business continuity and operational efficiency.

## UNIT I

9 hours

**Understanding Cloud Computing:** Origins and influences, Basic Concepts and Terminology, Goals and Benefits, Cloud Characteristics, Risks and Challenges.

**Fundamental Concepts and Models:** Roles and Boundaries, Cloud Characteristics, Cloud Delivery Models, Cloud Deployment Models.

## UNIT II

9 hours

**Cloud-Enabling Technology:** Broadband Networks and Internet Architecture, Data Center Technology, Service Oriented Architecture, Virtualization Technology.

## Cloud Computing Mechanisms

**Cloud Infrastructure Mechanisms:** Logical Network Perimeter, Virtual Server, Cloud Storage Device, Cloud Usage Monitor, Resource Replication.

## UNIT III

9 hours

**Cloud Management Mechanisms:** Remote Administration System, Resource Management System, SLA Management System, Billing Management System, Case Study Example

# Cloud Computing Architecture

**Fundamental Cloud Architectures:** Workload Distribution Architecture, Resource Pooling Architecture, Dynamic Scalability Architecture, Elastic Resource Capacity Architecture, Service Load Balancing Architecture, Cloud Bursting Architecture, Elastic Disk Provisioning Architecture, Redundant Storage Architecture, Case Study Example

## UNIT IV

9 hours

## **Cloud-Enabled Smart Enterprises:** Introduction, Revisiting the Enterprise Journey, Service-Oriented Enterprises, Cloud Enterprises, Smart Enterprises, The Enabling Mechanisms of Smart Enterprises

**M. Tech VLSI Design and Embedded Systems**

**Cloud-Inspired Enterprise Transformations:** Introduction, The Cloud Scheme for Enterprise Success, Elucidating the Evolving Cloud Idea, Implications of the Cloud on Enterprise Strategy, Establishing a Cloud-Incorporated Business Strategy

**UNIT V** **9 hours**

**Transitioning to Cloud-Centric Enterprises:** The Tuning Methodology, Contract Management in the Cloud

**Cloud-Instigated IT Transformations**

Introduction, Explaining Cloud Infrastructures, A Briefing on Next-Generation Services, Service Infrastructures, Cloud Infrastructures, Cloud Infrastructure Solutions, Clouds for Business Continuity, The Relevance of Private Clouds, The Emergence of Enterprise Clouds

**Course Outcomes:**

At the end of this course students will demonstrate the ability to

- CO1: Explain cloud computing concepts, models, and characteristics relevant to modern IT environments.
- CO2: Analyze cloud-enabling technologies like networks, data centers, and virtualization.
- CO3: Set up and manage cloud infrastructure for high availability and reliability.
- CO4: Apply cloud management techniques for resource, SLA, and billing optimization.
- CO5: Design cloud solutions to enhance business continuity and operational efficiency.

**Text Books:**

1. Erl Thomas, Puttini Ricardo, Mahmood Zaigham, Cloud Computing: Concepts, Technology & Architecture 1st Edition,
2. Pethuru Raj, Cloud Enterprise Architecture, CRC Press.

**Reference Books:**

1. James Bond, The Enterprise Cloud, O'Reilly Media, Inc.
2. Gautham Shroff, "Enterprise Cloud Computing: Technology, Architecture, Applications", Cambridge press, 2010.
3. John Rhoton and Risto Haukiojal, "Cloud Computing Architectured: Solution Design Handbook", Recursive Press, 2013.

**Mode of Evaluation:** Assignments, Mid Term Tests and End Semester Examination.

**Open Elective****24MEP302 AUTOMATION AND ROBOTICS**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Pre-requisite:** **NIL****Course Objectives:**

This course is designed to:

1. To introduce the fundamental principles of automation and robotic systems.
2. To provide a detailed understanding of sensors, actuators, and embedded hardware used in robotic automation.
3. To explore the role of IoT in enhancing robotic applications with cloud and network-based control.
4. To study different robotic control strategies including path planning and wireless communication.
5. To analyze application domains of automation and robotics in industries, smart environments, and assistive technologies.

**UNIT I INTRODUCTION TO AUTOMATION AND ROBOTICS 9 hours**

Historical evolution of automation and robotics, Elements of automation systems: sensors, actuators, controllers, communication. Types and classifications of robots: industrial, mobile, service, collaborative. Levels of automation and hierarchy in automated systems. Role of AI and ML in modern robotics (overview).

**UNIT II SENSORS, ACTUATORS, AND MICROCONTROLLER SYSTEMS 9 hours**

Overview of sensing technologies: ultrasonic, IR, LDR, temperature, gas, motion, force. Actuation mechanisms: electrical, hydraulic, pneumatic; types of motors and control. Interfacing sensors with microcontrollers (theory): ADC, PWM, GPIO. Microcontroller platforms overview: Arduino, ESP32, Raspberry Pi (architecture, features). Importance of timing, signal conditioning, and data acquisition systems.

**UNIT III IOT INTEGRATION IN ROBOTICS 9 hours**

Architecture of IoT: perception, network, and application layers. IoT protocols: MQTT, CoAP, HTTP/REST, WebSocket – comparison and use cases. Cloud platforms for IoT-enabled robotics: ThingSpeak, Blynk, Google Firebase (functional overview). Edge vs Cloud computing in robotics. Data logging, remote control, and device provisioning (theoretical framework).

**UNIT IV ROBOTIC CONTROL, NAVIGATION, AND COMMUNICATION 9 hours**

Basics of kinematics and control in mobile robots. Introduction to navigation: line following, obstacle avoidance, indoor localization. Wireless communication methods: Wi-Fi, BLE, LoRa, Zigbee – use in robotic control. Concepts of feedback, open-loop vs closed-loop control, PID (conceptual explanation). Control architectures: centralized, distributed, cloud-based.

**UNIT V APPLICATION DOMAINS AND FUTURE TRENDS 9 hours**

Industrial automation: pick-and-place robots, robotic arms, AGVs. Smart environments: home automation, surveillance bots, service robots. Assistive and healthcare robotics: autonomous wheelchairs, rehabilitation aids. Emerging trends: swarm robotics, human-robot collaboration (HRC), soft robotics. Ethical considerations, safety standards, and legal frameworks in automation.

**Course Outcomes:**

At the end of the course, the student will be able to:

- CO1: Define core automation and robotics terminologies and categorize various robotic systems. (L1)
- CO2: Explain the function and selection of sensors, actuators, and embedded controllers in robotic systems. (L2)
- CO3: Interpret IoT architectures and demonstrate their integration with robotic automation. (L3)
- CO4: Analyze wireless control, navigation algorithms, and data flow in IoT-based robotic systems. (L3)
- CO5: Evaluate the suitability of automation and robotics technologies in various real-world application domains. (L3)

**Text Books:**

- 1. Rajesh Singh, Anita Gehlot, "Internet of Things and Automation with ESP32", Wiley India, 2023
- 2. Debasis Samanta, "Fundamentals of Robotics and Intelligent Systems", Cengage Learning, 2024
- 3. S. R. Jankiraman, "Embedded Systems and Robotics with Open Source Tools", Universities Press, 2022

**Reference Books:**

- 1. Amit Kumar & Mahalik N. P., "IoT and Robotics Applications: Design, Development and Deployment", CRC Press, 2024
- 2. Jonathan Valvano, "Embedded Systems: Introduction to ARM Cortex-M Microcontrollers", CreateSpace, 2023
- 3. Rafael C. Gonzalez, "Robotics and Control: Principles and Practice", McGraw-Hill, 2022

**Mode of Evaluation:** Assignments, Mid Term Tests and End Semester Examination.

# **Skill Enhancement Course**

**Skill Oriented Course****24VES601 QNX EMBEDDED REAL TIME OPERATING SYSTEM**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>1</b>	<b>0</b>	<b>2</b>	<b>2</b>

**Pre-Requisite** Nil**Course Description:**

This laboratory course emphasizes to the students to understand the concepts of QNX Embedded Real time operating systems. This course covers the Micro Kernal OS, different types of policies, Process, Multi-threading multi-resource services for real time environment. It also covers the High availability and Reliability Design with commercial QNX Momentics IDE.

**Course Objectives**

By the end of this course, students will:

1. Understand the architecture and core concepts of the QNX RTOS and Learn to develop and debug applications using the QNX Momentics IDE. (L2)
2. Apply the knowledge of process and thread management, including synchronization techniques. (L3)
3. Construct inter-process communication (IPC) methods and their applications in QNX. (L3)
4. Understand hardware programming concepts, including interrupt handling and memory access. (L2)
5. Develop to build and configure QNX boot/OS images for embedded systems. (L6)

**UNIT I INTRODUCTION TO QNX OS ARCHITECTURE 6 hours**

Brief history of Embedded Systems and Real Time Systems, Overview of QNX OS architecture: microkernel, process manager, and standards, Protected address spaces, process/thread model, and scheduling, Introduction to inter-process communication (IPC) and synchronization, Resource managers and shared objects.

- Study of QNX Micro Kernal Operating System and QNX Momentics IDE
- Installation of QNX Momentics IDE 8.0, and Installation of QNX Operating System in Raspberry Pi 4
- Write a program for “Hello World” and using QNX Momentics IDE, execute on x86 and ARMx64 architecture.

**UNIT II PROCESSES, THREADS, AND SYNCHRONIZATION 6 hours**

Process management: creation, termination, and memory protection, Thread management: creation, termination, and synchronization, Synchronization techniques: mutexes, semaphores, and condition variables, Hands-on exercises: process/thread creation and synchronization.

- Write a program that creates multiple child processes using fork() and print different messages in parent and child process. Terminate the parent after 5 seconds and print the pid from the child.
- Implement a multi-threaded application using POSIX threads (pthread\_create). Each thread should process a different part of an array and the main thread should wait for all threads to complete using pthread\_join.

- Write a program to create a process with 4 threads that update the portion of array of size 1000 bytes by updating 250 bytes each. Make the main thread to join on the 4 threads and print the completion. Use mutex to prevent data corruption while each thread is updating the array.
- Implementing a thread-safe bounded buffer (also known as a circular queue) that is shared between multiple producer threads and multiple consumer threads. The buffer has a fixed size (N slots). Producers add items to the buffer, and consumers remove items from the buffer.

**UNIT III INTER-PROCESS COMMUNICATION (IPC) 6 hours**

Overview of IPC methods in QNX: message passing, pulses, and shared memory, Comparing IPC methods: advantages and disadvantages, Practical implementation of IPC in QNX, Hands-on exercises: message passing and shared memory.

- Write a program to create a basic Client and Server model to send / receive data. If *MsgReply()* was removed from server what happens?, if the server's *MsgReceive()* returns a failure, should the program exit?
- Write a program to create a pulse and send from a process to another by keeping *pid* and *cid* in the pulse. Verify the exchange of messages and delivery of pulses
- Write a program to create a pulse and send from a process to another by use *name\_attach()*, and *name\_attach()* creates a channel with several channel flags turned on, your server should expect to receive kernel pulses on a disconnect pulse, release the scoid by calling *ConnectDetach()*
- Write a program to creates shared memory objects and handles, reads and updates the shared memory, finally release message and disconnect pulse with server client model.

**UNIT IV HARDWARE PROGRAMMING AND TIMING 6 hours**

Hardware access methods: IO-mapped and memory-mapped IO, Interrupt handling and DMA-safe memory allocation, Timing architecture: periodic timing, one-shot timing, and timeouts, Hands-on exercises: interrupt handling and timing mechanisms.

- Write a Program to Simple standard interrupt handling - Interrupt 1, works only on VM ware virtual machine
- Write a program to a timer function, it will wake up 5 seconds from the time it runs and then every 1500 milliseconds after that it will wake up by receiving a pulse.
- Implement two processes that communicate via shared memory using *shm\_open* and *mmap*. One process writes data, and the other reads and displays it.

**UNIT V BUILDING AND CONFIGURING QNX BOOT/OS IMAGES 6 hours**

Overview of QNX boot/OS image structure, Components of a boot image: startup code, kernel, drivers, and scripts, Building and loading boot images onto target hardware, Introduction to resource managers and their implementation.

- Create a new virtual machine image with a larger boot disk from Momentics IDE and VSCode and build the image directory on the target (x86\_64 virtualized)
- Create the Boot image using QNX BSP

## Course Outcomes:

At the end of the course, students will be able to:

1. Describe the QNX OS architecture and its microkernel-based design and Develop and debug QNX-based applications using appropriate tools.
2. Apply process/thread management and synchronization techniques in QNX.
3. Implement inter-process communication methods for real-time systems.
4. Configure and build QNX boot/OS images for specific hardware platforms.
5. Develop strong knowledge on the POSIX standards that help in System Application Development

## Text Book(s)

1. Amos, Brian. "*Hands-On RTOS with Microcontrollers: Building real-time embedded systems using FreeRTOS, STM32 MCUs, and SEGGER debug tools*". Packt Publishing Ltd, 2020.

2. Abraham Silberschatz, Peter B. Galvin, Greg Gagne, "*Operating System Concepts*", 9th Edition, Wiley, 2018

3. Barr, Michael, and Anthony Massa. *Programming embedded systems: with C and GNU development tools*. " O'Reilly Media, Inc.", 2006.

## Reference Book(s)

1. Kerrisk, Michael. *The Linux programming interface: a Linux and UNIX system programming handbook*. No Starch Press, 2010.
2. Tanenbaum, A. S., and A. S. Woodhull. "The minix book–operating systems." (2006). Online Resources:
  3. (a) QNX Neutrino RTOS User's Guide, QNX Software Systems.
  - (b) <https://blackberry.qnx.com/en/products/qnx-everywhere>
  - (c) <https://gitlab.com/qnx/projects>

**Mode of Evaluation:** Continuous Internal Evaluation, Assignments, Mid Term Tests and End Semester Examination