R23- HONOR COURSE STRUCTURE – ECE

S. No	Course Code	Course Title	Contact hours/week			Credits
			L	T	P	
1	23ECH1	Advanced Communications	3	0	0	3
2	23ECH2	VLSI Signal Processing	3	0	0	3
3	23ECH3	CMOS Mixed Signal Design	3	0	0	3
4	23ECH4	Real Time Operating Systems	3	0	0	3
5	23ECH5	Image & Video Processing	3	0	0	3
6	23ECH6	Advanced Communications Lab	0	0	3	1.5
7	23ECH7	CMOS Mixed Signal Design Lab	0	0	3	1.5
8	23ECH8	Real Time Operating Systems Lab	0	0	3	1.5
9	23ECH9	Image & Video Processing Lab	0	0	3	1.5

23ECH1 – Advanced Communications

B. Tech. (Honor)

L	T	P	Cr.
3	0	0	3

Pre-Requisites: Analog and Digital Communications

Course Educational Objective: This course aims to provide comprehensive understanding of wireless communication systems including spread spectrum, channel modeling, and MIMO. It enables learners to explore SDR design, wireless networks (e.g., IEEE 802.11, 802.16), and evaluate advanced standards like 5G. Emphasis is placed on real-world applications, emerging technologies, and evolving wireless architectures beyond 5G.

Course Outcomes (COs): At the end of the course, student will be able to

CO1	**Explain** the principles of spread spectrum techniques, multiple access methods, and speech source coding used in wireless communication systems.
CO2	**Analyze** wireless channel behavior and fading models across various frequency bands including microwave, mmWave, and terahertz.
CO3	**Evaluate** the performance of MIMO systems and Software Defined Radio (SDR) architectures in wireless communications.
CO4	**Summarize** modern wireless network technologies and 5G communication systems, including spectrum technologies, waveforms, and future enablers

UNIT I:

SPREAD SPECTRUM AND MULTIPLE ACCESS TECHNIQUES: Introduction, Pseudo noise sequence, DS spread spectrum with coherent binary PSK, processing gain, FH spread spectrum, multiple access techniques wireless communication, TDMA and CDMA in wireless communication systems, source coding of speech for wireless communications.

UNIT II:

Wireless channel modeling (microwave, mmWave, and teraHertz): Propagation mechanism, reflection, refraction, diffraction and scattering. Fading channels- Multipath and small-scale fading Doppler shift, statistical multipath channel models, narrowband and wideband fading models, coherence bandwidth, and coherence time.

UNIT III:

Multiple-Input, Multiple-Output (MIMO) wireless communication: Basic MIMO model, MIMO capacity in fading channels, Diversity multiplexing trade off, Space-time code for MIMO wireless communication.

Software Define Radio (SDR): Characteristics and benefits of a software radio, design principles of software radio, enhanced flexibility with software radios, receiver design challenges.

UNIT IV:

Wireless Networks Introduction to wireless Networks, Advantages and disadvantages of Wireless Local Area Networks, WLAN Topologies, WLAN Standard IEEE 802.11, IEEE 802.11 Medium Access Control, Comparison of IEEE 802.11 a,b,g and n standards, IEEE 802.16 and its enhancements, Wireless PANs, HiperLan, WLL

UNITV:

5G Communication: 5G spectrum landscape and requirements, Spectrum access modes and sharing scenarios, 5G spectrum technologies. 5G CHANNEL MODEL: The 5G wireless Propagation Channels: Channel modeling requirements, propagation scenarios and challenges in

the 5G modeling. 5G USE CASES AND SYSTEM CONCEPT: Use cases and requirements, 5G system concept.5G waveforms, OFDM, OTFS, OFDMA, carrier aggregation, dual connectivity. Beyond 5G key enablers: Intelligent reflecting surfaces (IRS), wireless energy harvesting, SWIPT, integrated sensing and communication

Text Books:

1. Theodore, S. Rappaport, "Wireless Communications, Principles, Practice, PHI, 2nd Ed., 2002.
2. S. Haykin and M. Moher, "Modern Wireless Communication", Pearson Education, 2005.
3. Jeffrey H. Reed, "Software Radio: A Modern Approach to Radio Engineering", Prentice Hall, May 2002

References Books:

1. C. Oestges and B. Clerckx, "MMIO Wireless Communications", 1st Ed, 2007.
2. Paul Burns, "Software Defined Radio for 3G", Artech House Inc., 2003.
3. AfifOsseiran, Jose F Monserrat, Patrick Marsch, "5G Mobile and Wireless Communications Technology", Cambridge University Press, 2016
4. Feng Zhao, Leonidas Guibas , "Wireless Sensor Networks: An Information Processing Approach", 1st edition, , Elsevier Science imprint, Morgan Kauffman Publishers, 2009.

23ECH2 – VLSI Signal Processing

B. Tech. (Honor)

L	T	P	Cr.
3	0	0	3

COURSE OUTCOMES: At the end of the course, student will be able to
CO1: Understand Pipelining, parallel processing and digital filters.
CO2: Optimize VLSI architectures for basic DSP algorithms
CO3: Analyze various parallel processing algorithms
CO4: Implement basic architectures for DSP using CAD tools

UNIT-I:
Introduction to DSP: Typical DSP algorithms, DSP algorithms benefits, Representation of DSP algorithms. **Pipelining and Parallel Processing:** Introduction, Pipelining of FIR Digital filters, Parallel Processing, Pipelining and Parallel Processing for Low Power. **Retiming:** Introduction – Definitions and Properties – Solving System of Inequalities – Retiming Techniques

UNIT-II:
Folding: Introduction -Folding Transform - Register minimization Techniques – Register minimization in folded architectures – folding of multirate systems
Unfolding: Introduction – An Algorithm for Unfolding – Properties of Unfolding – critical Path, Unfolding and Retiming – Applications of Unfolding

UNIT-III:
Systolic Architecture Design: Introduction – Systolic Array Design Methodology – FIR Systolic Arrays – Selection of Scheduling Vector – Matrix Multiplication and 2D Systolic Array Design – Systolic Design for Space Representations contain Delays

UNIT-IV:
Fast Convolution: Introduction – Cook-Toom Algorithm – Winograd algorithm – Iterated Convolution – Cyclic Convolution – Design of Fast Convolution algorithm by Inspection

UNIT-V:
Low Power Design: Scaling Vs Power Consumption –Power Analysis, Power Reduction techniques – Power Estimation Approaches Programmable DSP: Evaluation of Programmable Digital Signal Processors, DSP Processors for Mobile and Wireless Communications, Processors for Multimedia Signal Processing.

TEXT BOOKS:
1. VLSI Digital Signal Processing- System Design and Implementation – Keshab K. Parhi, 1998, Wiley Inter Science.
2. VLSI and Modern Signal Processing – Kung S. Y, H. J. While House, T. Kailath, 1985, Prentice Hall.

REFERENCE BOOKS:
1. Design of Analog – Digital VLSI Circuits for Telecommunications and Signal Processing – Jose E. France, YannisTsividis, 1994, Prentice Hall.
2. VLSI Digital Signal Processing – Medisetti V. K, 1995, IEEE Press (NY), USA.

23ECH3 – CMOS Mixed Signal Design

B. Tech. (Honor)

L	T	P	Cr.
3	0	0	3

COURSE OUTCOMES: At the end of the course, student will be able to
CO1: Understand the design methodology for mixed signal IC design
CO2: Analyze the design of PLL and operational amplifiers
CO3: Design the CMOS digital circuits and implement its layout.
CO4: Design the Switched Capacitor Circuits for different applications.

UNIT-I: Switched Capacitor Circuits: Introduction to Switched Capacitor circuits- basic building blocks, Operation and Analysis, Non-ideal effects in switched capacitor circuits, Switched capacitor integrators first order filters, Switch sharing, biquad filters.

UNIT-II: Phased Lock Loop (PLL): Basic PLL topology, Dynamics of simple PLL, Charge pump PLLs-Lock acquisition, Phase/Frequency detector and charge pump, Basic charge pump PLL, Non-ideal effects in PLLs-PFD/CP non-idealities, Jitter in PLLs, Delay locked loops, applications.

UNIT-III: Data Converter Fundamentals: DC and dynamic specifications, Quantization noise, Nyquist rate D/A converters- Decoder based converters, Binary-Scaled converters, Thermometer-code converters, Hybrid converters

UNIT-IV: Nyquist Rate A/D Converters: Successive approximation converters, Flash converter, Two-step A/D converters, Interpolating A/D converters, Folding A/D converters, Pipelined A/D converters, Time-interleaved converters.

UNIT-V: Oversampling Converters: Noise shaping modulators, Decimating filters and interpolating filters, Higher order modulators, Delta sigma modulators with multibit quantizers, Delta sigma D/A

TEXT BOOKS:

1. Analog Integrated Circuit Design- David A. Johns, Ken Martin, Wiley Student Edition, 2016
2. CMOS Analog Circuit Design - Philip E. Allen and Douglas R. Holberg, Oxford University Press, International Second Edition/Indian Edition, 2010.
3. Design of Analog CMOS Integrated Circuits- Behzad Razavi, TMH Edition, 2002

REFERENCE BOOKS:

1. CMOS Integrated Analog-to- Digital and Digital-to-Analog converters-Rudy Van De Plassche, Kluwer Academic Publishers, 2003
2. Understanding Delta-Sigma Data converters-Richard Schreier, Wiley Interscience, 2005.
3. CMOS Mixed-Signal Circuit Design - R. Jacob Baker, Wiley Interscience, 2009.

23ECH4 – Real Time Operating Systems

B. Tech. (Honor)

L	T	P	Cr.
3	0	0	3

COURSE EDUCATIONAL OBJECTIVES:

The course aims to equip students with knowledge of RTOS concepts, programming with various real-time kernels, case-based modeling of embedded systems, Linux-based development and image creation, and RT Linux programming, enabling them to design and implement reliable, real-time embedded applications.

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

CO1: Understand Resource Sharing and dependencies for Scheduling Real-time tasks in multiprocessor and distributed systems

CO2: Apply the fault tolerance techniques, evaluation of reliability.

CO3: Analyze the working of real time operating systems and real time database.

CO4: Create mathematical model of the system and to develop real time algorithm for task scheduling.

UNIT-I: Introduction

OS Services, Process Management, Timer Functions, Event Functions, Memory Management, Device, File and IO Systems Management, Interrupt Routines in RTOS Environment and Handling of Interrupt Source Calls, Real-Time Operating Systems, Basic Design Using an RTOS, RTOS Task Scheduling Models, Interrupt Latency and Response of the Tasks as Performance Metrics, OS Security Issues.

UNIT-II: RTOS Programming

Basic Functions and Types of RTOS for Embedded Systems, RTOS mCOS-II, RTOS Vx Works, Programming concepts of above RTOS with relevant Examples, Programming concepts of RTOS Windows CE, RTOS Linux 2.6.x and RTOS RT Linux.

UNIT-III: Program Modeling – Case Studies

case study of digital camera hardware and software architecture, Case Study of Embedded System for an Adaptive Cruise Control (ACC) System in Car, Case Study of Embedded System for a Smart Card, Case Study of Embedded System of Mobile Phone Software for Key Inputs.

UNIT-IV: Target Image Creation & Programming in Linux

Operating System Software, Target Image Creation for Window XP Embedded, Porting RTOS on a Micro Controller based Development Board. Overview and programming concepts of Unix/Linux Programming, Shell Programming, System Programming

UNIT-V: Programming in RT Linux

Overview of RT Linux, Core RT Linux API, Program to display a message periodically, semaphore management, Mutex, Management, Case Study of Appliance Control by RT Linux System

TEXT BOOKS:

1. Rajkamal: "Embedded Systems-Architecture, Programming and Design", Tata McGraw Hill Publications, Second Edition, 2008.

2. Dr. K.V.K.K. Prasad: "Embedded/Real-Time Systems" Dream Tech Publications, 2005 Edition, Black pad book.

REFERENCES:

1. Labrosse, "Embedding system building blocks ", CMP publishers.
2. Rob Williams," Real time Systems Development", Butterworth Heinemann Publications.

23ECH5 – Image & Video Processing

B. Tech. (Honor)

L	T	P	Cr.
3	0	0	3

COURSE OUTCOMES:

CO1: Understand the image processing fundamentals

CO2: Apply filtering operations on images both in spatial and frequency domain; describe image restoration in presence of noise and degradation.

CO3: Analyze various segmentation techniques and compression methods on digital images.

CO4: Describe the fundamental steps in video processing

CO5: Summarize various methods for two-dimensional motion estimation

Unit – I

Introduction to Image Processing, applications of Digital Image Processing, Fundamental steps in digital image processing, components of an image processing system, Image sensing and acquisition, image sampling and quantization, Basic relationships between pixels.

Image Transforms: Need for image transforms, Image transforms: Fourier Transform, 2D Discrete Fourier Transform and its properties, Walsh Transform, Hadamard transform, Haar Transform, Slant transform, Discrete Cosine transform, KL Transform, Singular Value Decomposition.

Unit – II

Image Enhancement:

Spatial domain methods: Histogram processing, Fundamentals of Spatial filtering: Smoothing spatial filters, sharpening spatial filters.

Filtering in frequency domain: Basics of filtering in frequency domain, image smoothing, image sharpening.

Image Restoration:

Image degradation model, Noise models, restoration in the presence of noise: Spatial Filtering, Periodic Noise Reduction by frequency domain filtering, Estimation of degradation function, Inverse filtering, Minimum mean square error (Wiener) filtering.

Unit – III

Image segmentation: Point, line and edge detection, thresholding, and Region based segmentation.

Image compression: Image compression model, Basic compression methods: Huffman coding, Golomb coding, Arithmetic coding, LZW coding, Run-Length coding, Block Transform coding, Predictive coding.

Unit – IV

Basic Steps of Video Processing:

Analog Video, Digital Video. Time-Varying Image Formation models: Three-Dimensional Motion Models, Geometric Image Formation, Photometric Image Formation, Sampling of Video signals, Filtering operations.

Unit – V

2-D Motion Estimation:

Optical flow, General Methodologies, Pixel Based Motion Estimation, Block- Matching Algorithm, Mesh based Motion Estimation, Global Motion Estimation, Region based Motion Estimation, Multi resolution motion estimation

TEXT BOOKS:

1. Digital Image Processing – Gonzaleze and Woods, 3rd Ed., Pearson.
2. Digital Video Processing – M. Tekalp, Prentice Hall International.
3. Video Processing and Communication – Yao Wang, Joem Ostermann and Ya–quin Zhang. 1st Ed., PH Int.

REFRENCE BOOKS:

1. Fundamentals of Digital Image Processing – Anil K. Jain, Prentice Hall of India, 9th Edition, Indian Reprint, 2002.
2. Digital Image Processing –S. Jayaraman, S. Esakkirajan, and T. Veerakumar, McGraw-Hill Education, 2018.

23ECH6 – Advanced Communications Lab

B. Tech. (Honor)

L	T	P	Cr.
0	0	3	1.5

Pre-Requisites: Analog Communications, Signals and Systems

Course Educational Objective: This Course provides practical exposure on different aspects of analog and digital communications. It demonstrates the importance of different modulation techniques in analog and digital communication systems.

Course Outcomes (COs): At the end of the course, student will be able to

CO1	**Analyze** and implement various error control coding techniques including linear block, cyclic, and convolutional codes. ***(Analyze – L4)***
CO2	**Demonstrate** understanding of optical communication components and measure optical losses and LASER diode characteristics. ***(Understand – L2)***
CO3	**Evaluate** satellite communication systems and performance parameters like SNR and C/N ratio using practical setups. ***(Apply – L3)***
CO4	**Examine** spread spectrum and wireless channel models including DSSS, FHSS, and path loss models. ***(Apply – L3)***
CO5	**Adopt** effective communication, presentation and report writing skills **(Apply – L3).**

List of Experiments :(Minimum of Twelve Experiments has to be performed)

1. Implementation of Linear Block Code Encoder and Decoder
2. Implementation of Binary Cyclic Codes Encoder and Decoder
3. Implementation of Convolution Encoder- Decoder
4. Determination of Losses in Optical Fiber
5. Characteristics of LASER Diode.
6. Study of Satellite Communication System, uplink transmitter, down link receiver and transponder
7. Signal to noise ratio and Link Failure operations in satellite communication
8. Carrier to Noise Ratio in Satellite Communication
9. Study of Direct Sequence Spread Spectrum Modulation & Demodulation using CDMA-DSS BER Trainer
10. Efficiency of DS Spread- Spectrum Technique
11. Simulation of Frequency Hopping (FH) system
12. Generation of PN sequence and Gold Sequence
13. Outdoor propagation model - Okumura model and Hata model
14. Free space propagation – path loss model
15. Study of WLAN / network topologies

23ECH7 – CMOS Mixed Signal Design Lab

B. Tech. (Honor)

L	T	P	Cr.
0	0	3	1.5

Course Outcomes: At the end of the course, student will be able to
CO1: Demonstrate the compensation techniques
CO2: Design various analog and digital circuits
CO3: Create the layout for various designed circuits
CO4: Adapt effective communication, presentation and report writing skills

List of Experiments:

Cycle 1:
1) Fully compensated op-amp with resistor and miller compensation
2) High speed comparator design
i. Two stage cross coupled clamped comparator
ii. Strobed Flip-flop
3) Data converter

Cycle 2:
1) Switched capacitor circuits i. Parasitic sensitive integrator ii. Parasitic insensitive integrator
2) Design of PLL
3) Design of VCO
4) Band gap reference circuit
5) Layouts of All the circuits Designed and Simulated

Lab Requirements:

- **Software:** Mentor Graphics/ Cadence/ Tanner/Industry Equivalent Standard Software Tools
- **Hardware:** Personal Computer with necessary peripherals, configuration and operating System.

23ECH8 – Real Time Operating Systems Lab

B. Tech. (Honor)

L	T	P	Cr.
0	0	3	1.5

COURSE EDUCATIONAL OBJECTIVES:

To provide hands-on experience through practical experimentation and simulation in real-time embedded system development using ARM-based processors and RTOS and enabling them to implement task management, synchronization, inter-process communication, device interfacing, and data communication for real-time applications.

COURSE EDUCATIONAL OBJECTIVES:

CO1:	**Develop** real-time applications on ARM-based platforms using various RTOS environments through task creation, synchronization, and resource sharing mechanisms.
CO2:	**Design** real-time embedded system architectures by modeling tasks, managing memory, and scheduling using RTOS principles.
CO3:	**Construct** embedded solutions for real-world applications through case studies and implement device interfacing, data communication, and system porting using Linux and RTOS tools.
CO4:	Adapt effective communication, presentation and report writing skills

- The Students are required to write the programs using C-Language according to the Experiment requirements using RTOS Library Functions and macros ARM-926 developer kits and ARM-Cortex.
- The following experiments are required to develop the algorithms, flow diagrams, source code and perform the compilation, execution and implement the same using necessary hardware kits for verification. The programs developed for the implementation should be at the level of an embedded system design.
- The students are required to perform at least SIX experiments from Part-I and TWO experiments from Part-II.

List of Experiments:

Part-I: Experiments using ARM-926 with PERFECT RTOS

1. Register a new command in CLI.
2. Create a new Task.
3. Interrupt handling.
4. Allocate resource using semaphores.
5. Share resource using MUTEX.
6. Avoid deadlock using BANKER'S algorithm.
7. Synchronize two identical threads using MONITOR.
8. Reader's Writer's Problem for concurrent Tasks.

Part-II: Experiments on ARM-CORTEX processor using any open source RTOS.
(Coo-Cox-Software-Platform)

1. Implement the interfacing of display with the ARM- CORTEX processor.
2. Interface ADC and DAC ports with the Input and Output sensitive devices.
3. Simulate the temperature DATA Logger with the SERIAL communication with PC.
4. Implement the developer board as a modem for data communication using serial port Communication between two PCs.

Lab Requirements:

Software:

- Eclipse IDE for C and C++ (YAGARTO Eclipse IDE), Perfect RTOS Library, COO-COX Software Platform, YAGARTO TOOLS, and TFTP SERVER.
- LINUX Environment for the compilation using Eclipse IDE & Java with latest version.

Hardware:

- The development kits of ARM-926 Developer Kits and ARM-Cortex Boards.
- Serial Cables, Network Cables and recommended power supply for the board.

23ECH9 – Image & Video Processing Lab

B. Tech. (Honor)

L	T	P	Cr.
0	0	3	1.5

Course Outcomes: At the end of the course, student will be able to
CO1: Demonstrate various operations on images
CO2: Perform filtering in spatial and frequency domain
CO3: Implement image compression and segmentation
CO4: Examine the fundamental operations on video signal
CO5: Adapt effective communication, presentation and report writing skills.

List of Experiments: (Minimum of ten experiments are to be performed)

1. Perform basic operations on images
2. Perform Pixel based operations (Point based operations) for Image enhancement
3. Demonstrate the histogram of an image and perform histogram equalization
4. Spatial Domain filtering
5. Computation of 2D-DFT and Perform filtering in Frequency domain
6. Implementation of Image Restoration methods
7. Implementation of JPEG compression Algorithm
8. Comparison of coding Techniques for image compression (Bit plane, Predictive,
9. Arithmetic, Huffman coding).
10. Detection of edges in an image (Prewitt, Sobel, Krisch and Laplacian of Gaussian
11. Operators, Canny operators)
12. Image Segmentation based on thresholding.
13. Basic operations on Video and identification of key frame
14. Computation of optical flow velocities for a moving object in a Video
15. Implementation of two-dimensional motion estimation