NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL



Minor in

Electronics and Communication Engineering

(for B.Tech. students of EEE and CSE)

(w.e.f. 2021-22)

Department of

Electronics and Communication Engineering

SCHEME OF INSTRUCTION

S.No	Course Code	Course Title	L	T	P	Credits	Sem
1	ECM11	Analog and Digital Communications	3	0	0	3	2 - 1
2	EC254	CMOS VLSI Design	3	0	0	3	2 - 2
3	EC304	Advanced Microcontrollers	3	0	0	3	3 - 1
4	EC354	Embedded and Real Time Operating Systems	3	0	0	3	3 - 2
5	EC423	Image and Video Processing	3	0	0	3	4 - 1
6	EC471	Wireless Sensor Networks	3	0	0	3	4 - 2
		Total				18	

Course Code : ECM11	Analog and Digital Communications	Credits 3-0-0 : 3

Pre requisites: NIL

Course Outcomes: After the completion of the course the student will be able to:

CO1	Compare the performance of AM, FM schemes
CO2	Model a Digital Communication System
CO3	Convert Analog signal to Digital Signal
CO4	Compare different digital modulation schemes.

Detailed Syllabus:

INTRODUCTION: Introduction to communication system, Communication Channels, Need for modulation, Analog vs Digital, Review of Signals and Systems.

AMPLITUDE MODULATION: Definition, Time domain and frequency domain description - AM, DSB- SC, single tone modulation, power relations in AM waves, Generation of AM waves (square law, Switching), Envelop detector, Generation of DSBSC Waves (Balanced, Ring), Coherent detection of DSB-SC Modulated waves, COSTAS Loop.

SSB MODULATION: Time domain, Frequency domain description, Frequency discrimination, Demodulation of SSB Waves, Frequency Division Multiplexing, Vestigial side band modulation- Time domain, Frequency description, Envelope detection of a VSB Wave pulse Carrier, Comparison of AM Techniques, Applications of different AM Systems.

ANGLE MODULATION: Basic concepts, Frequency Modulation: Single tone frequency modulation, Spectrum Analysis of Sinusoidal FM Wave, Narrow band FM, Wide band FM, Constant Average Power, Transmission bandwidth of FM Wave – Generation and Demodulation of FM Waves; Comparison of FM and AM, Super heterodyne Receiver.

PULSE MODULATION TECHNIQUES: Pulse Analog and Pulse Digital Modulation Schemes–Pulse Amplitude Modulation, Pulse width modulation, PPM, TDM, Pulse Code Modulation, Differential PCM systems (DPCM), Delta modulation, adaptive Delta modulation, comparison of PCM and DM systems, noise in PCM and DM systems.

DETECTION AND ESTIMATION: Model of Digital Communication Systems, Gram-Schmidt Orthogonalization, Geometric interpretation of signals, detection of known signals in noise, probability of error, matched filter receiver, correlation receiver

BASE BAND SHAPING FOR DATA TRANSMISSION: Requirements of a line encoding format, various line encoding formats- Unipolar, Polar, Bipolar, Discrete

PAM signals, Inter symbol interference, Nyquist's criterion, Raised cosine filter, Eye pattern.

DIGITAL MODULATION TECHNIQUES: Digital Modulation formats, Coherent binary modulation techniques (BPSK, BFSK), Coherent quadrature modulation techniques (QPSK), Non-Coherent binary modulation techniques (DPSK), QAM, M-ary modulation techniques (PSK, FSK, QAM), Comparison of M-ary digital modulation techniques, power spectra, bandwidth efficiency; BER for BPSK

Reading:

1. S. Haykin,"Communication Systems", John Wiley and Sons, 2001
2. B.P. Lathi, "Modern Digital & Analog Communications Systems", Oxford University Press
3. J. G. Proakis, M. Salehi, "Communication Systems Engineering", Pearson Education, 2002
4. H. Taub, D.L. Schilling, "Principles of Communication Systems", Tata McGraw Hill, 2001
5. Behrouz A. Forouzan, "Data communication and Networking", Tata McGraw Hill, 2007
6. Leon W.Couch II., Digital and Analog Communication Systems, 6th Edition, Pearson Education Inc., New Delhi, 2001.
7. A Bruce Carlson, PB Crilly, JC Rutledge, Communication Systems, 4th Edition, McGraw Hill New York, 2002.

Course Code: EC254	CMOS VLSI Design	Credits 3-0-0 : 3

Pre-requisites: EC131 - Basic Electronic Engineering

Course Outcomes: At the end of the course the student will be able to:

CO1	Explain the fabrication, operation and characteristics MOSFET
CO2	Analyze the performance of CMOS inverter
CO3	Design digital circuits using CMOS gates
CO4	Design analog circuits using CMOS gates
CO5	Outline the latest trends in CMOS technology

Detailed syllabus:

INTRODUCTION to MOSFETs: Unit process steps of CMOS technology, Fabrication process flow: NMOS, PMOS, Twin well CMOS; Structure and operation of the MOS transistor, I-V and C-V characteristics, MOSFET capacitances, layout, design rules, Scaling and Short channel effects.

MOS INVERTERS: Inverters with resistive, MOSFET load; CMOS inverter: Voltage transfer characteristics, Noise margins, switching characteristics, calculation of delay times; effect of load on switching characteristics and driving large loads, logical effort of paths

Digital circuits using CMOS: Pseudo NMOS, Pass transistor, transmission gates, Dynamic logic, Domino logic, Differential cascode voltage switch logic, design of combinational circuits, design of sequential circuits, timing requirements.

Analog circuits: Second order effects in MOSFETs. Single stage Amplifiers: Common-source stage, Source follower, Common-gate, Cascode stage, Differential Amplifiers, Passive and Active current mirrors, CMOS operational amplifier, gain boosting techniques.

Trends in CMOS technology: SOI, FinFET and multi-gate FET, 2D materials based FETs, On-chip interconnects.

Reading:

1. Sung-Mo Kang, Yusuf Leblebici Chulwoo kim, Digital Integrated Circuits: Analysis and Design, 4th Edition, McGraw Hill Education, 2016.
2. Behzad Razavi, Design of Analog CMOS Integrated Circuits, 2nd Edition, McGraw Hill Education, 2016.
3. Jan M RABAEY, Digital Integrated Circuits, 2nd Edition, Pearson Education, 2003.
4. Neil H.E. Weste and David Harris, CMOS VLSI Design: A circuits and systems perspective, 4th Edition, Pearson Education, 2015.

Course Code: EC304	Advanced Microcontrollers	Credits : 3-0-0 : 3

Pre-requisites: Digital system Design

Course Outcomes: After the completion of the course the student will be able to:

CO1	Understand the evolution of microprocessors and microcontrollers and its architectures
CO2	Understand the evolution and architectures of ARM processors.
CO3	Analyze and understand the instruction set and development tools of ARM
CO4	Understand the architectural features of ARM cortex M4 microcontrollers.
CO5	Understand the exception, interrupts and interrupt handling schemes
CO6	Understand the hardware and interfacing peripheral devices to ARM cortex M4

Detailed Syllabus:

Introduction to Microprocessors and Microcontrollers:
Evolution and introduction of 80X86 microprocessor, Architecture of 8086, Memory organization, 8086 system connections and timing. Overview of 8051 microcontroller, Architecture, Instruction set and addressing modes, programming of I/O Ports, Interrupts, timer/ counter and serial communication.

Introduction to ARM Processors:
Introduction to ARM processors, Evolution of ARM processors, pipeline organization, ARM Processor cores and CPU cores. Introduction to ARM Cortex-M Processors, ARM Cortex-M4 processor's architecture, Programmer's model, Special registers, Operation Modes.

ARM Cortex-M4 programming: Assembly basics, Instruction set, Data transfer, Data processing, conditional and branch instructions, barrier and saturation operations, Cortex-M4-specific instructions,Thumb2 instructions, Keil Microcontroller Development Kit for ARM, Typical program compilation flow, Sample arithmetic and logical assembly language programs

ARM cortex-M4 Memory Systems and interrupts: Overview of memory system features, Memory map, Memory access attributes and permissions, Data alignment and unaligned data access support, Bit-band operations, Overview of exceptions and interrupts, Exception types, Overview of interrupt management, Definitions of priority, Vector table and vector table relocation, Software interrupts, Exception Handling.

Cortex-M4 Implementation and applications: Detailed block diagram, Bus interfaces on cortex-M4, External PPB interface, typical connections, reset types and signals. Getting started with µVision. Applications: Flashing of LEDS using Shift Register, Interfacing stepper motor, Interfacing temperature sensor, Interfacing ADC, Interfacing Real Time Clock, Interfacing of Analog Key pad

Readings:

1. Joseph Yiu, The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors, Newnes Publications; Third Edition, 2013.
2. Ata Elahi-Trever Arjeski, “ARM Assembly language with hardware experiment”, Springer Int. Publishing, 2015.
3. Steve Furber , “ARM system on chip Architecture”, Pearson Publications, Second Edition.
4. D. V. Hall. Microprocessors and Interfacing, TMGH. Second Edition 2006.
5. Wrox, “ Professional Embedded ARM Development”
6. William hohl and Christoper Hinds, “ARM assembly language fundamentals and Techniques”CRC, Second Edition, 2015.
7. M.A. Mazidi, J.G. Mazidi, R.D. Mckinlay, “The 8051 Microcontroller and Embedded Systems”, Pearson Second Edition.

Course Code : EC354	Embedded and Real Time Operating Systems	Credits 3–0–0 : 3

Prerequisites: Digital system design and familiar with any one programming language

Course Outcomes: At the end of the course the student will be able to:

CO1	Identify the applications, Design metrics and challenges of Embedded system
CO2	Design, implement and test an embedded system.
CO3	Write the programs for embedded system.
CO4	Describe the various components and operating systems used in real-time Embedded systems.
CO5	Identify Fundamental Issues, Computation models in Hardware-software co-design, and Hardware Software Trade-offs.

Detailed syllabus:

Introduction to Embedded Systems: Embedded systems Overview, Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification, Major Application Areas, Purpose of Embedded Systems, Characteristics of embedded computing applications, Design Challenges, Common Design Metrics

Embedded System Development: 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, Reset Circuit, Brown-out Protection Circuit, Oscillator Unit, Real Time Clock, Watchdog Timer Communication Interface: Onboard and External Communication Interfaces

Embedded System Programming: Embedded Firmware, ARM processor Architecture, pipeline, registers, instructions, thumb mode, exceptions Embedded Firmware Design Approaches and Development Languages.

Real-Time Operating Systems: Architecture of the kernel, Tasks and Task Scheduler, Scheduling algorithms, Interrupt Service Routines, Semaphores, Mutex, Mailboxes, Message queues, Event Registers, Pipes, Signals, Timers, Memory management, Priority Inversion problem. Overview of off-the shelf operating systems-MicroC OS II, Vxworks, RT Linux.

Overview of Hardware –Software Co-design: Fundamental Issues in Hardware-Software co-design, Computation models in embedded system design, Introduction to Unified Modelling Language (UML), Hardware Software Trade-offs

Reading:

1. Introduction to Embedded Systems -Shibu K.V, McGraw Hill
2. Embedded Systems Design –Santanu Chattopadhyay, PHI, 2013.
3. Embedded System Design -Frank Vahid, Tony Givargis, John Wiley
4. Embedded/Real-Time Systems: Concepts Design and Programming, K.V.K.K. Prasad Dreamtech, 2005
5. Embedded Systems –Lyla, Pearson, 2013
6. An Embedded Software Primer -David E. Simon, Pearson Education.

Course Code : EC423	Image and Video Processing	Credits 3-0-0 : 3

Course Outcomes:

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

CO1	Interpret, Analyze, model and Process the Image data using appropriate methods, algorithms
CO2	Interpret, Analyze, model and Process the Video data using appropriate methods, algorithms
CO3	Specify and design optimal image and video processing techniques for the given Imaging problem to efficiently use the available hardware and software tools.
CO4	Apply suitable tools to simulate and demonstrate the working of image processing systems as per the application needs.

Detailed Syllabus:

Image Processing Overview: Image Sensing and Acquisition, Digital Image Representation, Basic Relationships between Pixels, Image Enhancement, Intensity Transformations and Spatial Filtering, Histogram Processing, Smoothing Spatial Filters, Sharpening Spatial Filters.

Image Segmentation: Point, Line, and Edge Detection, First order derivative, Prewitt and Sobel operators, Second order derivative – LoG, DoG, Canny Operator, Edge linking, Hough Transform, Thresholding – Global, Adaptive, Otsu's Method, Region Growing, Region Splitting and Merging Algorithms.

Image Representation and Description: Chain codes, Signatures, Boundary Descriptors, Shape numbers, Fourier Descriptors, Statistical moments, Regional Descriptors – Topological, Texture, Principal Component Analysis.

Video Sampling and Indexing: Digital Video, Video Transmission, Spatiotemporal Sampling Structures, Sampling Structure Conversion, Image and Video Indexing and Retrieval

Video Enhancement: Introduction, Spatio Temporal Noise Filtering, Linear Filters, Order-Statistic Filters.

Motion Detection and Estimation: Hypothesis Testing, Markov Random Fields, MAP Estimation, Motion Detection, Motion Estimation, Motion Models, Region of Support, Estimation Criteria, Search Strategies, Practical Motion Estimation Algorithms, Global Motion Estimation, Block Matching, Phase Correlation.

Video Compression: Introduction, Application Requirements, Digital Video Signals and Formats, Digital Video Formats, Video Compression Techniques, Entropy and Predictive Coding, Block Transform Coding--The Discrete Cosine Transform, Motion Compensation and Estimation, Video Encoding Standards and H.261, spatial subband/wavelet transform (SWT), Motion Estimation, MC Temporal Filtering, Lifting Implementation, Directional IBLOCKs, Scalable Motion Vector Coding, Alphabet General Partition of Motion Vector Symbols, EZBC Coder, MPEG-1 Video Coding Standard, MPEG-1 Video Coding vs. H.261 MPEG-1 Video

Structure, Summary of the Major Differences between MPEG-1 Video and H.261 Coders, MPEG-4: Technical Description, Embedded Video Codec Design Requirements and Constraints, Embedded Video Codec Design Flow.

Reading:

Text Books:

1. Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", 4th Edition, - Pearson Education, 2015.
2. **ALAN C BOVIK,** "Hand Book of Image and Video Processing", 2nd Edition, Elsevier Academic Press, 2005.

Reference Books:

1. **Rafael C. Gonzalez, Richard E. Woods, and Steven L. Eddins**, "Digital Image Processing Using MATLAB", 2nd Edition, Tata McGraw Hill Publication, 2010.
2. **Oge Marques**, "Practical Image And Video Processing Using Matlab", John Wiley & Sons, Inc., 2011.
3. **Ranjan Parekh**, "Fundamentals Of Image, Audio, And Video Processing Using Matlab® With Applications To Pattern Recognition", CRC Press, 2021.

Course Code : EC471	Wireless Sensor Networks	Credits 3-0-0 : 3

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

CO1	understand the concept of Wireless Sensor Networks and its applications
CO2	understand various architectures of Wireless Sensor Networks, and its related hardware and protocols
CO3	Familiarised with deployment and configuration methods.
CO4	acquainted to Node-level Software Platforms

Detailed Syllabus:

Introduction and Overview of Wireless Sensor Networks: Background of Sensor Network Technology, Application of Sensor Networks, Challenges for Wireless Sensor Networks, Enabling Technologies for Wireless Sensor Networks.

Sensor Node Hardware and Network Architecture: Single-node Architecture: Hardware Components, Operating Systems and Execution Environments, Network Architecture: Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts.

Network Protocols: MAC Protocols: Requirement and design constraints for MAC Protocols, Important classes of MAC Protocols, MAC Protocols for Wireless Sensor Networks.

Routing Protocols: Classification of Routing Protocols, Energy-Efficient Routing, Geographic Routing.

Deployment and Configuration: Localization and Positioning, Single-hop Localization, Positioning in Multi-hop environments, Coverage and Connectivity, Naming and Addressing in Sensor Networks, Assignment of MAC addresses.

Sensor Network Platforms and Tools: Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level Software Platforms, Node-level Simulators

Reading:

Text Books:

1. Holger Karl and Andreas Willig, *Protocols and Architectures for Wireless Sensor Networks,* John Wiley, 2005.
2. Feng Zhao & Leonidas J.Guibas, *Wireless Sensor Networks - An Information Processing Approach,* Elsevier, 2007.

Reference Books:

1. Kazem Sohraby, Daniel Minoli, and Taieb Znati, *Wireless Sensor NetworksTechnology, Protocols and Applications,* John Wiley, (2007).
2. Raghavendra, Cauligi S, Sivalingam, Krishna M., Zanti Taieb, *Wireless Sensor Network*, Springer 1st Ed, (2004) (ISBN: 978-4020-7883-5).
3. Anna Hac, *Wireless Sensor Network Designs*, John Wiley, (2003).