ECE - (4 Year B.TechProgramme) - COURSE CURRICULUM R-19												
IV Year Course structure												
Semester - I												
Course Code	**Title of the course**	**CAT**	**Periods**						**Sessionals Marks**	**Semester end Exam marks**	**Total Marks**	**Credits**
			L	**T**	**P**	**E**	**O**	**Total**				
ECE411	**Open Elective- III**	**OE**	**3**	**0**	**0**	**1**	**2**	**6**	**40**	**60**	**100**	**3**
ECE412	**Engineering Economics and Management**	**HS**	**3**	**0**	**0**	**0**	**2**	**5**	**40**	**60**	**100**	**3**
ECE413	**Professional Elective –4**	**PE**	**3**	**0**	**0**	**1**	**4**	**8**	**40**	**60**	**100**	**3**
ECE414	**Professional Elective -5**	**PE**	**3**	**0**	**0**	**1**	**3**	**7**	**40**	**60**	**100**	**3**
ECE415	**Microwave and Radar Engineering**	**PC**	**3**	**0**	**0**	**1**	**5**	**9**	**40**	**60**	**100**	**3**
ECE416	**Microwave Engineering Laboratory**	**PC**	**0**	**0**	**3**	**0**	**1**	**4**	**50**	**50**	**100**	**1.5**
ECE417	**DSP Lab**	**PC**	**0**	**0**	**3**	**0**	**1**	**4**	**50**	**50**	**100**	**1.5**
ECE418	**Industrial Training**	**PR**	**0**	**0**	**0**	**0**	**1**	**1**	**100**	**0**	**100**	**1**
ECE419	**Project Phase – I**	**PR**	**0**	**0**	**4**	**0**	**4**	**8**	**100**	**0**	**100**	**2**
Total			**15**	**0**	**10**	**4**	**23**	**52**	**500**	**400**	**900**	**21**
Semester - II												
Course Code	**Title of the course**	**Cate gory**	**Periods**						**Sessionals Marks**	**Semester end Exam marks**	**Total Marks**	**Credits**
			L	**T**	**P**	**E**	**O**	**Total**				
ECE411	**Open Elective- IV**	**OE**	**3**	**0**	**0**	**1**	**2**	**6**	**40**	**60**	**100**	**3**
ECE422	**Professional Elective-6**	**PE**	**3**	**0**	**0**	**1**	**2**	**6**	**40**	**60**	**100**	**3**
ECE423	**Project Phase – II**	**PR**	**0**	**0**	**16**	**0**	**16**	**32**	**100**	**100**	**200**	**8**
Total			**6**	**0**	**16**	**2**	**20**	**44**	**180**	**220**	**400**	**14**

Professional Elective 4
1. Cellular and Mobile Communications
2. Real time operating systems (RTOS)
3. Speech Processing

Professional Elective 5
1. Digital Image Processing
2. Satellite communications & GPS
3. Low power VLSI

Professional Elective 6
1. VLSI Signal processing
2. Data Communications
3. Phased Array systems

ENGINEERING ECONOMICS AND MANAGEMENT

ECE 412 **Credits:3**

Instruction: 3 Periods & 1 Tut/week Sessional Marks:40

End Exam: 3 Hours End Exam Marks:60

Prerequisites: Nil

Course Outcomes:

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

1. Understand the concepts of Economics.
2. Gain basic understanding of management and manage organizations effectively and to relate concepts of management with industrial organizations and manage organizations iciently
3. Have the basic knowledge of production management and make decisions proficiently
4. Understand the basic concepts of accounting, finance and marketing management.

CO-PO –PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	2	3	-	2	1
CO2	-	-	-	-	-	-	-	2	3	-	2	1
CO3	-	-	-	-	-	-	-	2	3	-	2	1
CO4	-	-	-	-	-	-	-	2	3	-	2	1

Correlation levels 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS

UNIT I 10 Periods

Fundamentals of Economics: Wealth, Welfare and Scarce Definitions of Economics; Micro and Macro Economics; Demand- Law of Demand, Elasticity of Demand, Types of Elasticity and Factors determining price elasticity of Demand: Utility- Law of Diminishing Marginal Utility, its limitations and exceptions.

UNIT II 10 Periods

Forms of Business Organizations: Features, merits and demerits of Sole Proprietorship, Partnership and Joint Stock Company- Public Enterprises and their types.

UNIT III 20 Periods

UNIT IV 10 Periods

Financial Management: Types of Capital: Fixed and Working Capital and Methods of Raining Finance; Final Accounts- Trading Account, Statement of Profit and Loss and Balance Sheet (simple problems)

UNIT V 10 Periods

Marketing Management and Entrepreneurship: Marketing Management: Functions of marketing and Distribution Channels. **Entrepreneurship**:Definition, Characteristics and Functions of an Entrepreneur

TEXT BOOKS:

1. A.R. AryaSri, Managerial Economics and Financial Analysis, TMH Publications, new Delhi, 2014**(UNIT–I,II,IV &V)**
2. S.C. Sharma and Banga T. R., Industrial Organization & Engineering Economics,khanna Publications, Delhi-6, 2006**(UNIT– III &IV)**
3. S.N.Maheswari, SK Maheswari, Financial Accounting Fifth Edition, Vikas Publishing House Pvt. Ltd., New Delhi, 2012 **(UNIT-V)**

CELLULAR AND MOBILE COMMUNICATIONS

ECE 413(a) **Credits:3**

Instruction : 3 periods & 1 Tutorial/Week Sessional Marks:40

End Exam : 3 Hours End Exam Marks:60

Prerequisites: Communication Systems Engineering**,** Digital Communications

Course Outcomes:

By the end of the course, students will be able to

Solve problems related to	
1.	Principle of operation of cellular mobile systems and their interferences.
2.	Mobile radio propagation & mobile multipath channels.
3.	Handoff, dropped calls and Frequency management and channel assignment strategies.
Analyze and design	
4.	forward and reverse channels of various Multiple access techniques in wireless communications
5.	The changes in implementation of receiver circuitry with the integration of mobile satellites.

CO-PO –PSO Mapping

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	1	2*						1*				2		
CO2	2	2	2*						1*				2	2	
CO3	3	1							1*				2		
CO4	2	2							1*				2		
CO5	2	1							1*				1		

Correlation levels 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS

UNIT I 10 Periods

Introduction to Cellular Systems: Basic Cellular Systems, Uniqueness of mobile radio environment, Concept of Frequency reuse Channels, Cochannel interference Reduction factor, Desired C/I from a normal case in an Omnidirectional Antenna system, Non Co-channel interference, Cell splitting.

UNIT II 10 Periods

Mobile Radio Propagation: Large scale path loss - Reflection, Diffraction, Scattering, Outdoor and Indoor Propagation models, **Mobile Radio Propagation: small scale fadingand multi path** - small scale Multi path measurements, parameters of mobile multi path channels, Types of small scale fading.

UNIT III 10 Periods

Frequency Management and Channel Assignment: Frequency management, Fixed Channels assignment, Non Fixed Channel assignment, Traffic and Channel Assignment. **Hand Off, Dropped Calls:** Why Hand-Off, Types of Hand-Off and their characteristics, dropped call rates and their evaluation.

UNIT IV 10 Periods

Multiple access techniques for wireless communications: FDMA, TDMA, Spread spectrum techniques, SDMA, Packet Radio, CSMA , Capacity of cellular CDMA with multiple cells and capacity of SDMA, Details of forward and reverse CDMA channels

UNIT V 10 Periods

Personal access communication systems, personal Mobile satellite communications, Integrating GEO, LEO, MEO satellite and terrestrial mobile systems, Rake receiver and Advanced Rake receiver.

Note- Additional topics that can be introduced during the course but are out of the prescribed syllabus – **Performance of Fading channels**

TEXT BOOKS:

1. William C.Y.Lee, Wireless & Cellular Telecommunications, Third Edition,McGraw Hill, International Edition. **[UNIT- I ,II,III]**
2. Theodore S.Rappaport, Wireless communications Principles and Practice, Second Editions, Pearson Publications. **[UNIT- IV ,V]**

REFERENCE BOOKS:

1. GottapuSasibhushanaRao, Mobile Cellular Communication, PEARSON International, 2012.
2. Wayne Tomasi, Electronic Communication system, Pearson.

REAL TIME OPERATING SYSTEMS

ECE 413(b) **Credits:3**

Instruction: 3 Periods & 1 Tut/week Sessional Marks:40

End Exam: 3 Hours End Exam Marks:60

Prerequisites: CAO, MP & MC, OS

Course Objectives:

The objective of the course is to introduce the principles shared by many real-time operating systems, and their use in the development of embedded multitasking application software.

Course Outcomes:

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

1. Organize the hardware in computer organization, BIOS
2. Develop a broad understanding of the technologies and applications for the emerging and exciting domain of real-time systems
3. Illustrate the Process management such as threads, scheduling etc.
4. Manage the inter-process communications and memory
5. Address kernel issues with case studies.

CO-PO –PSO Mapping

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	1													1
CO2	3	2													1
CO3	3	3													1
CO4	3	3	1												1
CO5	2	3	3		2						2				1

Correlation levels 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS

UNIT I 10 Periods

INTRODUCTION:

Introduction to Operating System: Computer Hardware Organization, BIOS and Boot Process, Multi-threading concepts, Processes, Threads, Scheduling

UNIT II 10 Periods

BASICS OF REAL-TIME CONCEPTS: Terminology: RTOS concepts and definitions, real-time design issues, examples, Hardware Considerations: logic states, CPU, memory, I/O, Architectures, RTOS building blocks, Real-Time Kernel

UNIT III 10 Periods

PROCESS MANAGEMENT: Concepts, scheduling, IPC, RPC, CPU Scheduling, scheduling criteria, scheduling algorithms Threads: Multi-threading models, threading issues, thread libraries, synchronization Mutex: creating, deleting, prioritizing mutex, mutex internals

UNIT IV 10 Periods

INTER-PROCESS COMMUNICATION:

Messages, Buffers, mailboxes, queues, semaphores, deadlock, priority inversion,

PIPES MEMORY MANAGEMENT: - Process stack management, run-time buffer size, swapping, overlays, block/page management, replacement algorithms, real-time garbage collection

UNIT V 10 Periods

CASE STUDIES:

Case study Linux POSIX system, RTLinux / RTAI, Windows system,

Vxworks, uItron Kernel Design Issues: structure, process states, data structures, inter-task communication mechanism, Linux Scheduling

TEXT BOOKS:

1. J. J Labrosse, "MicroC/OS-II: The Real –Time Kernel", Newnes, 2002.
2. Jane W. S. Liu, *"Real-time systems"*, Prentice Hall, 2000

REFERENCE BOOKS:

1.W. Richard Stevens, *"Advanced Programming in the UNIX® Environment"*, 2nd Edition, Pearson Education India, 2011.
2. Philips A. Laplante, *"Real-Time System Design and Analysis"*, 3rd Edition, John Wley& Sons, 2004
3. Doug Abbott, *"Linux for Embedded and Real-Time Applications",* Newnes, 2nd Edition, 2011.

SPEECH PROCESSING

ECE 413(c) **Credits:3**

Instruction : 3 periods & 1 Tutorial/Week Sessional Marks:40

End Exam : 3 Hours End Exam Marks:60

Prerequisites: Basic of Optics, Electromagnetic Theory, Communication systems, and Computer networks.

Course Objectives:

- Understand the anatomy and Physiology of Speech Production system and perception model and to design an electrical equivalent of Acoustic model for Speech Production.
- Analyze speech signals in time and frequency domain.
- Analyze linear predictive coding techniques for speech signal

To study about the process of Man-Machine communication

Course Outcomes:

By the end of the course, students will be able to

1.	Create an electrical representation of the Speech Production system.
2.	Analyze the time domain and frequency domain representation of speech signal
3.	Design the Homomorphic Vocoder
4.	Apply Linear Predictive Coding (LPC) to speech synthesis system
5.	Build a complete speech recognition system

CO-PO –PSO Mapping

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2											2		
CO2	2	2											2		
CO3	2	2	2										2		
CO4	2	2											2		
CO5	2	2	2										2		

Correlation levels 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS

UNIT I 10 Periods

Fundamentals of Digital Speech Processing: Anatomy & Physiology of Speech Organs, The process of Speech Production, Acoustic Phonetics, Articulatory Phonetics, The Acoustic Theory of Speech Production- Uniform lossless tube model, effect of losses in vocal tract, effect of radiation at lips, Digital models for speech signals.

UNIT II 10 Periods

Time domain methods for speech processing: Time domain parameters of Speech signal, short time energy and average magnitude, Short time average zero crossing rate, Speech Vs Silence discrimination using energy and zero crossing, Pitch period estimation using a parallel processing approach, Short Time Auto Correlation Function, The short time average magnitude difference function, Pitch period estimation using Auto Correlation Function.

UNIT III 12 Periods

Frequency domain method for speech processing: Short Time Fourier analysis: Fourier transform and linear filtering interpretations, Filter bank summation method for short-time synthesis- Spectrographic displays - Pitch detection - Analysis by Synthesis - Analysis synthesis systems: Phase vocoder, Channel Vocoder.

Homomorphic speech analysis:

Homomorphic Systems for Convolution, The Complex Cepstrum of Speech, Pitch detection, Formant Estimation, Homomorphic Vocoders.

UNIT IV 8 Periods

Linear predictive analysis of speech: Basic Principles of linear predictive analysis: Auto correlation method, Covariance method, Solution of LPC equations: Cholesky method, Durbin's Recursive algorithm, Comparison between the Methods of Solution of the LPC Analysis Equations, Application of LPC parameters: Pitch detection using LPC parameters, Formant analysis using LPC Parameters.

UNIT V 10 Periods

Man-Machine Communication: Speaker Recognition System: Speaker Verification Systems, Speaker Identification Systems, Speech Recognition System: Isolated Digit Recognition System, Continuous Digit Recognition System, LPC Distance Measures, Large Vocabulary Word Recognition System.

TEXT BOOKS:

1. L.R. Rabiner and R.E Schafer, "Digital Processing of Speech Signals", Pearson Education, 2008,
2. Human & Machine, Douglas O'Shaughnessy, Speech Communications, 2nd Edition., Wiley India, 2000.

REFERENCE BOOKS:

1. Discrete-Time Speech Signal Processing, Thomas F, Quatieri, Prentice Hall /Pearson Education, 2004.
2. Speech and Audio Signal Processing, Ben Gold and Nelson Morgan, John Wileyand Sons Inc., Singapore, 2004
3. Fundamentals of Speech Recognition, L.R. Rabiner and B. H. Juang, PrenticeHall, 1993.

DIGITAL IMAGE PROCESSING

ECE 414(a) **Credits:3**

Instruction : 3 periods & 1 Tutorial/Week Sessional Marks:40

End Exam : 3 Hours End Exam Marks:60

Prerequisites: Signal & System (ECE 214), Digital Signal Processing (ECE 322)

Course Outcomes:

By the end of the course, students will be able to

1.	Describe the basic components of digital image processing system and transform techniques (FFT, DCT and Hadamard transform).
2.	Analyze image enhancement in spatial domain using smoothing and sharpening operators.
3.	Analyze image enhancement in frequency domain using High pass and low pass filters.
4.	Describe image restoration using Weiner filtering and image segmentation using thresholding and region growing techniques.
5.	Compare and contrast image compression techniques (Variable length coding, LZW coding, Bit plane coding, Lossless predictive coding, Lossy prediction, transform coding).

CO-PO –PSO Mapping

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	2	-	-	-	-	-	-	-	-	1	2	-	-
CO2	2	2	2	-	-	-	-	-	-	-	-	2	2	-	-
CO3	2	2	2	-	-	-	-	-	-	-	-	2	2	-	-
CO4	2	2	2	-	-	-	-	-	-	-	-	1	2	-	-
CO5	2	2	2	-	-	-	-	-	-	-	-	1	2	-	-

Correlation levels 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS

UNIT I 10 Periods

Digital Image Fundamentals: Fundamental steps in digital image processing, Components of an image processing system, Elements of visual perception, Image sensing and acquisition, Image sampling and quantization, Basic relationship between pixels

Image Transforms: Two-dimensional FFT properties, Discrete cosine transform &Hardmard transform

UNIT II 10 Periods

Image Enhancement (Spatial Domain): Introduction, Basic gray level transformation, Histogram processing, Enhancement using arithmetic/logic operations, Basics of spatial filtering: Smoothing and sharpening spatial filter

UNIT III 10 Periods

Image Enhancement (Frequency Domain): Introduction to Fourier transform and the frequency domain, Smoothing and sharpening frequency domain filters, Homomorphic filtering

UNIT IV 10 Periods

Image Restoration: Introductionto image degradation, Noise model, Restoration in presence of noise only, Inverse filtering, Wiener filtering,

Image Segmentation: Detection of discontinuities, Edge linking and boundary detection, Thresholding (global and adaptive), Region based segmentation

UNIT V 10 Periods

Image Compression: Redundancy, Fidelity criteria, Image compression models, Error free compression: Variable length coding, LZW coding, Bit plane coding, Lossless predictive coding, Lossy prediction, transform coding, image compression standards

Fundementals of morphological processing - Dilation, Erosion, Opening, Closing

TEXT BOOKS:

1. TRafael C Gonzalez, Richard E Woods, “Digital Image Processing,” PHI, Second edition, 2004. **(UNITS I, II, III, IV, V)**
2. Jayaraman S, Esakkirajan S, Veerakumar T, “Digital Image Processing,” Tata McGraw Hill, 2010 **(UNIT-I)**

REFERENCE BOOKS:

1. Anil Kumar Jain, “Fundamentals of Digital Image Processing,” PHI, 2002.

SATELLITE COMMUNICATIONS & GPS

ECE 414(b) **Credits:3**

Instruction : 3 periods & 1 Tutorial/Week Sessional Marks:40

End Exam : 3 Hours End Exam Marks:60

Prerequisites: Analog Communication **and** Digital Communications

Course Outcomes:

By the end of the course, students will be able to

1.	Describe and justify communication satellite subsystem with specifications.
2.	Analyze C/N ratio for satellite single link budgets in air and rain.
3.	Classify, analyze and estimate the capacity of each multiple access technique required for satellite communication.
4.	Illustrate the working principle of GPS and determine GPS receiver position using satellites in 2D & 3D.
5.	Illustrate GPS system segments, GPS signals & signal structures using PRN codes.

CO-PO –PSO Mapping

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	1												2	
CO2	3	2												2	
CO3	3	2												2	
CO4	3	1		1										2	
CO5	2	2		1										2	

Correlation levels 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS

UNIT I 12 Periods

Introduction: Types of satellites, Satellite constellation, orbital mechanics, look angle determination, Orbital effects in Communication System Performance, Satellite sub systems, Communication subsystems, Overview of launching procedures and launch vehicles.

UNIT II 10 Periods

Propagation Impairments And Space Link: Introduction, atmospheric loss, ionospheric effects, rain attenuation, other impairments.

Space link: Introduction, EIRP, transmission losses, link power budget, system noise, CNR, uplink, down link, effects of rain, combined CNR

UNIT III 10 Periods

Multiple Access: Frequency division multiple access (FDMA) Intermodulation, Calculation of C/N. Time division Multiple Access (TDMA) Frame structure, Examples. Satellite Switched TDMA Onboard processing, DAMA, Code Division Multiple access (CDMA),Spread spectrum transmission and reception.

UNIT IV 10 Periods

Introduction To Global Navigation Satellite Systems(GNSS): The History of GPS, The Evolution of GPS, Development of NAVSTAR GPS, Block I, Block II satellites, Block IIA, Block IIR and Block II R-M satellites. Introduction to IRNSS, GPS working principle, Trilateration, Determination of where the satellites are, Determination of how far the satellites are, Determining the receiver position in 2D or XY Plane, Determining the receiver position in 3D or X-Y-Z Plane

UNIT V 10 Periods

GPS Satellite Constellation And Signals: GPS system segments, Space segment, Control segment, User segment, GPS Signals, GPS signal generation, Generation of Codes- C/A code , P code and Navigation data.

***Note-** Additional topics that can be introduced during the course but are out of the prescribed syllabus –**The working of a satellite phone**

TEXT BOOKS:

1. T. Pratt and C.W. Boastian, "Satellite Communication", 2 nd edition, John Wiley & Sons, 2002**.(UNIT-I,II,III)**
2. G S RAO, Global Navigation Satellite Systems, McGraw-Hill Publications, New Delhi, 2010**(UNIT-IV,V)**

REFERENCE BOOKS:

1. D. Roddy, "Satellite Communications", Prentice Hall, 4 th edition, copyright, 2008.
2. K.N. Raja Rao, "Satellite Communication: Concept and Application", 2nd edition, PHI, 2013

LOW POWER VLSI

ECE 414(c) **Credits:3**

Instruction : 3 periods & 1 Tutorial/Week Sessional Marks:40

End Exam : 3 Hours End Exam Marks:60

Prerequisites: Digital Electronics, VLSI design

Course objectives:

- To make students familiar with power dissipation, power optimization techniques and power estimation in VLSI circuits.
- To make student design the power efficient VLSI systems by applying low power design techniques.

Course Outcomes:

By the end of the course, students will be able to

1.	Explain the sources of power dissipation in CMOS
2.	Classify the special techniques to mitigate the power consumption in VLSI circuits
3.	Summarize the power optimization and trade-off techniques in digital circuits.
4.	Illustrate the power estimation at logic and circuit level
5.	Explain the software design for low power in various level

CO-PO –PSO Mapping

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	1													1
CO2	3	2													1
CO3	3	3													1
CO4	3	3	1												1
CO5	2	3	3		2						2				1

Correlation levels 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS

UNIT I 12 Periods

Power Dissipation in CMOS : Sources of power dissipation – Physics of power dissipation in MOSFET devices: The MIS structure, long channel MOSFET, Submicron MOSFET, gate induced drain leakage– Power dissipation in CMOS: short circuit dissipation, dynamic dissipation, load capacitance– Low power VLSI design: Limits – principles of low power design, hierarchy of limits, fundamental limit, material limit, device limit, system limit.

UNIT II 10 Periods

Power Optimization Using Special Techniques : Power Reduction in Clock Networks: Clock Gating, Reduced Swing Clock, Oscillator Circuit for Clock Generation, Frequency Division and Multiplication, Other Clock Power Reduction Techniques - CMOS Floating Node: Tristate Keeper Circuit, Blocking Gate, Low Power Bus: Low Swing Bus, Charge Recycling Bus, Delay Balancing - Low Power Techniques for SRAM: SRAM Cell, Memory Bank Partitioning, Pulsed Word line and Reduced bit line Swing

UNIT III 10 Periods

Design of Low Power Circuits: Transistor and Gate Sizing : Sizing an Inverter Chain, Transistor and Gate Sizing for Dynamic Power Reduction, Transistor Sizing for Leakage Power Reduction - Network Restructuring and Reorganization : Transistor Network Restructuring, Transistor Network Partitioning and Reorganization - Special Latches and Flip-flops : Self-gating Flip-flop, Combinational Flip-flop, Double Edge Triggered Flip-flop - Low Power Digital Cell Library : Cell Sizes and Spacing, Varieties of Boolean Functions, Adjustable Device

Threshold Voltage

UNIT IV 10 Periods

Power Estimation: Modelling of signals - signal probability calculation - Statistical techniques - estimation of glitching power- Sensitivity Analysis-Power estimation using input vector compaction, power dissipation in Domino logic, circuit reliability, power estimation at the circuit level, Estimation of maximum power: test generation based approach, steepest descent, generic based algorithm based approach

UNIT V 10 Periods

Software Design for Low Power: Sources of software power dissipation - software power estimation: Gate level, architecture level, bus switching activity, instruction level power analysis - software power optimization: minimizing memory access costs, instruction selection and ordering, power management - Automated low power code generation – Co-design for low power.

TEXT BOOKS:

1.Kaushik Roy, S.C.Prasad,"LowpowerCMOSVLSIcircuitdesign",Wiley,2000
2.A.P. Chandrasekaran, R.W. Broadersen,"Low power digital CMOS design", Kluwer,1995
3.Gary Yeap,"PracticallowpowerdigitalVLSIdesign",Kluwer,1998

REFERENCE BOOKS:

1. Dimitrios Soudris, Christians Pignet, Costas Goutis, "Designing CMOS Circuits for Low Power", Kluwer,2002
2. J.B. Kulo, J.H Lou, "Low Voltage CMOS VLSI Circuits", Wiley1999.

MICROWAVE & RADAR ENGINEERING

ECE 415 **Credits:3**

Instruction : 3 periods & 1 Tutorial/Week Sessional Marks:40

End Exam : 3 Hours End Exam Marks:60

Prerequisites: Electromagnetic Field Theory

Course Objectives:

- To explain the theoretical principles underlying in the operation of microwave devices and circuits
- To understand the principles behind the measurement of various microwave parameters and required bench setup
- To understand different microwave sources and amplifiers
- To understand the basics of the Radar Engineering

Course Outcomes:

By the end of the course, students will be able to

1.	Apply Electromagnetic field theory to rectangular waveguides and analyze waveguides
2.	Analyze the working of passive microwave components using S-matrix.
3.	Apply the operating principles in generating/amplifying microwave signals using microwave tubes and solid state devices.
4.	Analyse the working of RADAR and its range equation.
5.	Apply the principles of Radar to identify different radars

CO-PO –PSO Mapping

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3												3	3
CO2	3	3	1											3	3
CO3	2	3												3	2
CO4	2	3	2											3	2
CO5	2	3												3	2

Correlation levels 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS

UNIT I 12 Periods

Microwave Components:

Introduction to Microwaves, advantages and applications; Theory of Guided Waves- Waves in between parallel plates, Wave Guide – Derivation of Field Equations, Modes of Propagations, and their parameters, Types of Wave-guides; Excitation methods for different TE modes, Wave impedance in waveguide;Attenuators; Cavity Resonators, Re-entrant Cavities, Wave-meters, Microwave Filters, Detectors.

UNIT II 12 Periods

Microwave Circuits& Measurements:

S Matrix and its Properties. S Matrix of E Plane Tee, H plane Tee and Magic Tee, Directional coupler. S Matrix of Ferrite Devices and applications. Microwave Bench Setup - Introduction and its features, Measurement of Frequency, Wavelength, VSWR, Unknown impedance, attenuation, Coupling, Isolation and Directivity measurements of Directional coupler

UNIT III 12 Periods

Microwave Tubes & Solid State Devices:

Resonant Cavity Devices, Reflex Klystron, Two – Cavity Klystron, Multi – Cavity Klystron, Slow – Wave Devices, TWT, Magnetrons;PIN Diode, Tunnel Diodes, Gunn Diode, IMPATT, TRAPATT Diodes, Crystal Diode.

UNIT IV 12 Periods

Fundamentals of Radar:

Radar Range Equation, Radar Block Diagram and Operation, Prediction of Range, Minimum Detectable Signal, Receiver Noise, Radar Cross-section, Transmitter Power, PRF and Range Ambiguities, Radar Antenna Parameters, System Losses and Propagation Effects.

UNIT V 12 Periods

Types of Radars:

Doppler effect,FMCW Radar, MTI Radar – Block Diagram &Principle, Delay line cancellers, Blind speeds, Range gated Doppler filters, MTI delay lines, limitations, Pulse Doppler Radar, Tracking Radar –Sequential Lobing, Conical scan; Monopulse tracking radar.

TEXT BOOKS:

1. M. Kulakarni, " *Microwave & Radar Engineering* ", 5th ed., Umesh Publication, 2014.
2. M.I. Skolnik, "*Introduction to Radar Systems*", McGraw Hill, 2007.
3. G.S.N. Raju, "*Microwave Engineering*",1st ed., IK International Publishers, 2008
4. G.S.N Raju, "*Radar Engineering and Fundamentals of Navigational Aids*", 1st ed. IK International Publishers, 2008

REFERENCE BOOKS:

1. D.M.Pozar, "*Microwave Engineering*", 2nd ed., McGraw Hill.2015.
2. G. SasibhushanRao, "*Microwave & Radar Engineering*" ,1st ed., Pearson Education,2014.

MICROWAVE EINGINEERING LABORATORY

ECE 416 **Credits:1.5**

Instruction: 3 Practical's/week Sessional Marks:50

End Exam: 3 Hours End Exam Marks:50

Prerequisites: Antennas and propagation, Microwave engineering

Course Objectives:

- The main objective of the course is to make the students get the exposure to various microwave sources, microwave passive components and bench setup in this lab. Also, get the opportunity to measure various parameters related to components, and characterize microwave devices with the microwave bench setup.

Course Outcomes:

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

1.	Find the bench set up before start of the experiment, identifying the required apparatus and procedure of doing the experiment.
2.	Measure various parameters of the signal, load & characterize various microwave sources using microwave bench setup.
3.	Plot the radiation pattern of horn antenna and other antennas using antenna trainer system.
4.	Design the antenna with given specification using simulation tools.
5.	Measure and record the experimental data, plot it and analyse the results, and prepare a formal laboratory report.

CO-PO –PSO Mapping

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	-	1	2	1	-	-	-	-	2	-	-		1	2	2
CO2	-	2	1	3	-	-	-	-	2	-	-	2	2	2	2
CO3	-	2	2	1	-	-	-	-	2	3	-	1	1	1	1
CO4	-	3	3	3	-	-	-	-	2		-	3	1	2	2
CO5	-	-	-	3	-	-	-	-	2	3	-		1	2	3

Correlation levels 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS

List of Experiments

1. Study of microwave components.
2. Determine the Characteristics of the GUNN diode.
3. Determination of Mode Characteristics of reflex klystron.
4. Measurement of the frequency and wavelength of a given signal.
5. Determine the VSWR of a given load.
6. Determine the Unknown Load Impedance of a given load.
7. Determine the Attenuation characteristics of a given load .
8. Determine the scattering parameters of E-Plane tee junction.
9. Determine the scattering parameters of H-Plane tee junction.
10. Determine the scattering parameters of Magic Tee Junction.
11. Determine the characteristics of a given Directional Coupler.
12. Determining the radiation pattern of the Horn Antenna.
13. Study of Antenna Trainer Systems.

14. Determining the radiation pattern of a 3 element Yagi- Uda antenna with folded dipole.
15. Determining the radiation pattern of a 5 element Yagi- Uda antenna with folded dipole.
16. Determining the radiation pattern of a $\lambda/2$ phased array antenna.
17. Design of a Rectangular Microstrip Patch Antenna using HFSSsoftware.
18. Design of a Circular Microstrip Patch Antenna using HFSS software.
19. Design of a Rectangular waveguide using HFSS software.

Note: A student has to complete 12 experiments as decided by the instructor.

DIGITAL SIGNAL PROCESSING LAB

ECE 417 **Credits:1.5**

Instruction: 3 Practical's /Week Sessional Marks:50

End Exam: 3 Hours End Exam Marks:50

Prerequisites: Signals and systems, Digital signal Processing, Digital Image Processing

Course Outcomes:

By the end of the course, students will be able to

1.	Illustrate the importance of circular convolution of two finite length sequences.
2.	Compute and analyze signal spectrum of discrete system using DFT/FFT algorithms in MATLAB.
3.	Implement the digital filter in MATLAB programming environments.
4.	Program a DSP chip with a variety of real-time signal processing algorithms.
5.	Analyze the sampling rate conversion process using decimation and interpolation.

CO-PO –PSO Mapping

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1			2	2								2		
CO2	1		2	2	2								2		
CO3	1			2	2								2		
CO4	1		1	2	2								2		
CO5	1			2	2								2		

Correlation levels 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS

CYCLE I Digital Signal Processing based Experiments

MATLAB based experiments

1. Perform (i) Circular convolution of the given two sequences(ii) Linear convolution using circular convolution.
2. Compute the DFT of a sequence and verify the properties of DFT.
3. Design analog Butterworth (i) low pass filter (ii) high pass filter for the given specifications.
4. Design an analog Chebyshev type-I and II (i) low pass filter (ii) high pass filter for the given specifications.
5. Design an IIR digital filter using Impulse invariant method
6. Design an IIR digital filter using Bilinear transformation
7. Design a FIR digital filter using (i) Rectangular and (ii) Hanning window techniques
8. Design a FIR digital filter using Kasier window techniques
9. Illustrate the effect of Decimation by an integer factor. Plot the magnitude spectrum
10. Illustrate the effect of Interpolation by an integer factor. Plot the magnitude spectrum

DSP Starter kits-based experiments:

11. Linear and circular convolution using CC Studio
12. IIR Filter design using TMS320C6713 DSP Processor

Experiments beyond syllabus

1.Write a program to compute the histogram of an input image and improve the appearance using histogram equalization technique.

2. Write a program to perform smoothing and sharpening operation of an image using spatial filtering

3. Write a program in MATLAB for edge detection using different edge detection mask

VLSI SIGNAL PROCESSING

ECE 422(a) **Credits:3**

Instruction : 3 periods & 1 Tutorial/Week Sessional Marks:40

End Exam : 3 Hours End Exam Marks:60

Prerequisites: VLSI Design, Digital IC Design and Digital signal Processing

Course Outcomes:

By the end of the course, students will be able to

1.	Represent the DSP algorithms and transforms as systems with block, signal flow and data flow diagrams.
2.	Design pipeline and parallel processed FIR filters.
3.	Perform retiming and minimize the registers and solve the systems of inequalities.
4.	Design systolic architecture using canonical mapping and generalized mapping
5.	Design and analyze parallel and pipeline IIR

CO-PO –PSO Mapping

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	1										2	2	1
CO2	3	3	3										2	2	1
CO3	3	2	2										2	3	1
CO4	3	2	3										2	2	1
CO5	3	2	3										3	2	1

Correlation levels 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS

UNIT I 10 Periods

Introduction to Digital Signal Processing Systems: Typical Signal Processing Algorithms, DSP Application Demands and Scaled CMOS Technologies, Representations of DSP Algorithms.

UNIT II 10 Periods

Pipelining and parallel processing: Iteration bound, Introduction, Pipelining of FIR filters, Parallel Processing, Pipelining and Parallel processing for low power.

UNIT III 10 Periods

Retiming: Definitions and Properties, Solving systems of inequalities, Retiming techniques.

Unfolding and Folding: Unfolding Algorithm, Properties of unfolding, Critical Path, Unfolding and Retiming, Folding Transformation, Register Minimization techniques.

UNIT IV 10 Periods

Systolic Architecture Design

Systolic Array Design Methodology, FIR Systolic Arrays, Selection of Scheduling Vector, Matrix Operations and 2D Systolic Array Design, Systolic Design for Space Representations Containing Delays.

UNIT V 10 Periods

Pipelined and Parallel IIR filters:

Pipeline Interleaving in Digital Filter, Pipelining in 1st Order IIR Digital Filters, Pipelining in Higher order IIR Digital Filters, Parallel Processing for IIR filters, Combined Pipelining and Parallel processing for IIR digital filters, Low-power IIR Filter Design Using Pipelining and Parallel Processing.

TEXT BOOKS:

1. K. K. Parhi, "VLSI Digital Signal Processing Systems, Design and Implementation", John Wiley, 1999**(UNIT-I,II,III,IV &V)**

REFERENCE BOOKS:

1. S.Y.Kung, "VLSI Array Processors", Prentice-Hall, 1988

DATA COMMUNICATIONS

ECE 422(b) **Credits:3**

Instruction : 3 periods & 1 Tutorial/Week Sessional Marks:40

End Exam : 3 Hours End Exam Marks:60

Prerequisites: Digital Electronics & Logic Design, Analog Communication, Digital communications

Course Outcomes:

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

1.	Familiarize with basic concepts related to communication systems.
2.	Compare different transmission medias.
3.	Identify the best suitable multiplexing technique as per the requirement.
4.	Detect and correct errors in data transmission.
5.	Compare different network switching techniques.

CO-PO –PSO Mapping

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2		2				2			1		2	
CO2	3	3	2		2				2			1		2	
CO3	3	3							1			1		3	
CO4	2	3	1						1			1		2	
CO5	1	2	1		2				1			1		2	

Correlation levels 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS

UNIT I 10 Periods

Data Transmission: Introduction to communication systems, Data, signal and Transmission: Analog and Digital, Transmission modes, Transmission Impairments, Performance criteria of a communication system Goals of computer Network, Networks: Classification, Components and Topology, Layered architecture of a Network software, OSI and TCP/IP model.

UNIT II 10 Periods

Transmission Media: Transmission Line Characteristics, Transmission Line Characteristics in Time Domain, Cross talk, Metallic Transmission Media, Optical Fiber Base-band Transmission of Data Signals, Telephone Network, Long Distance Network

UNIT III 10 Periods

Multiplexing: Space Division Multiplexing- Frequency Division Multiplexing: Wave length Division Multiplexing - Time Division multiplexing: Characteristics, Digital Carrier system, SONET/SDH-Statistical time division multiplexing: Cable Modem - Code Division Multiplexing. Multiple Access– CDMA

UNIT IV 10 Periods

Error Detection and Correction Techniques: Asynchronous transmission, Synchronous transmission, Detecting and Correcting Errors-Types of Errors-Error Detection: Parity check, Cyclic Redundancy Check (CRC) - Error Control Error Correction: Forward Error Correction and Reverse error correction.

UNIT V 10 Periods

Basic principles of switching: Circuit Switched Networks, Structure of Circuit Switch – Packet Switching: Datagram Networks, Virtual Circuit Networks, Structure of packet switches.

TEXT BOOKS:

1.William Stallings, Data and Computer Communications, 10th Edition, PH/Pearson Edu. Inc., 2014

2.Praksh C. Gupta ‘DATA COMMUNICATIONS’ Prentice Hall of India 1996

REFERENCE BOOKS:

1.Behrouz A. Forouzan, Data Communications and Networking, 3rdEditionTMH,2004

2.William A. Shay, Understanding Data Communications & Networks, 2ndEdition Thomson-Brooks/Cole –Vikas Publishing House,1999

3.Michale A. Miller, Data & Network Communications, Thomson/Delmar –Vikas Pub. House, 2000

PHASED ARRAY SYSTEMS

ECE 422(c) **Credits:4**

Instruction : 4 periods & 1 Tutorial/Week Sessional Marks:40

End Exam : 3 Hours End Exam Marks:60

Prerequisites: Antenna and Wave Propagation

Course Outcomes:

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

1.	Apply the knowledge the engineering and science in understanding and differentiating various system requirements with phased arrays for radar and communication system.
2.	Analyze linear/planar array antennas with required side lobes, beam width, bandwidth etc., and determine their directivity & study various scanning techniques.
3.	Identify, formulate and analyze different antennas to form an array for a given application
4.	Formulate the array patterns using various synthesis techniques
5.	Apply different feeding mechanisms for resonant and travelling wave arrays & measure different parameters of the array

CO-PO –PSO Mapping

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	-	-	-	-	-	-	-	-	-	1	2	1
CO2	3	3	3	-	-	-	-	-	-	-	-	-	3	3	1
CO3	3	3	2	-	-	-	-	-	-	-	-	-	3	3	1
CO4	3	3	2	-	-	-	-	-	-	-	-	-	1	1	1
CO5	2	2	1	-	-	-	-	-	-	-	-	-	1	1	1

Correlation levels 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS

UNIT I 10 Periods

Phased Arrays in Radar and Communication Systems: System requirements for radar and communication antennas - Directive properties of Arrays, Array noise characterization, receiving antenna in polarized plane wave field, system considerations, Monopole beam splitting, Array characterization for radar and communication systems - Fundamental results from array theory, Array size determination, Time-delay compensation.

UNIT II 10 Periods

Array Characteristics : Characteristics of linear and planer arrays, Scanning to End-fire, **Scanning Technique:** Introduction Conventional Scanning, Mechanical versus Electronic scanning, Techniques of Electronic scanning, Frequency, Phase and Time Delay scanning principle, Hybrid scanning techniques, Thinned Arrays

UNIT III 10 Periods

Elements for phased array : Introduction , array elements, polarization characteristics of infinitesimal elements in free space; Electric current antenna elements - dipole and the monopole; Aperture antenna elements – slot elements, waveguide radiators, horn elements, microstrip patch element

UNIT IV 10 Periods

Phased Array Systems: Beam steering in Phased arrays; Phase Shifters and fundamentals of phase shifters. Parameters effecting the performance of Radar System including parameter management/ error analysis; operational scenario; Multifunctional operations; Transmit - Receive Modules; System Design Methodology, Integration and Testing and Evaluation of Radar Systems ; Introduction on existing PARs . Advances in Phased arrays.

UNIT V 10 Periods

Array Feeds & Measurements: Introduction**,** Series feeds: Resonant Arrays- Impedance and bandwidth, Resonant slot array Travelling Wave Arrays- Frequency Squint and Single Beam condition, Calculation of element conductance, TW slot array Frequency scanning, Phase

scanning; Shunt feeds: Corporate feeds, distributed feeds, Introduction - measurement of Low sidelobe patterns & scanning phenomena.

TEXT BOOKS:

1. Robert J. Mailloux, Phased Array Antenna Handbook, Third Edition, Artech House, 2017 **[UNIT- I ,II &III]**
2. R.C.Hansen, Phased Array Antennas, Second edition, John Wiley & Sons Publications 2009 **[UNIT - IV]**

REFERENCE BOOKS:

1. Peter J. Kahrilas, Electronics Scanning Radar Systems Desing Handbook, Artech House, 1976.
2. A. A. Olinar, G. H. Knittel, Phased Array Radar, Artech House, 1972
3. Skolnik, M.I., Radar Handbook, 3rd edn., The McGraw-Hill Companies, 2008