JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India
DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

IV Year – ISemester

S. No.	Course	Category	L	T	P	Credits
1	Microwave and Optical Communication Engineering	PC	3	0	0	3
2	Data Communications & Computer networks	PC	3	0	0	3
3	Digital Image and Video Processing	PC	3	0	0	3
4	Professional Elective (PE3)	PE	3	0	0	3
5	Professional Elective (PE4)	PE	3	0	0	3
6	Internet of Things Lab	LC	0	0	3	1.5
7	Microwave and Optical Communication Engineering LAB	LC	0	0	3	1.5
8	Project - Part I	PR	0	0	6	3
			Sub-Total			**21**

IV Year – II Semester

S. No.	Course	Category	L	T	P	Credits
1	Professional Elective (PE5)	PE	3	0	0	3
2	Open Elective (OE2)	OE	3	0	0	3
3	Project - Part II	PR	0	0	18	9
			Sub-Total			**15**
			Total			**160**

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IV Year - I Semester		L	T	P	C
		3	0	0	3

MICROWAVE and OPTICAL COMMUNICATION ENGINEERING

Course Objectives:
The student will able to

- Understand fundamental characteristics of waveguides and Micro strip lines through electromagnetic fieldanalysis.
- Understand the basic properties of waveguide components and Ferrite materials composition
- Understand the function, design, and integration of the major microwave components oscillators, poweramplifier.
- Understand a Microwave test bench setup formeasurements.

UNIT I
MICROWAVE TUBES (Qualitative treatment only): Cavities**,** Re-entrant Cavities, Two Cavity Klystrons-Structure, Velocity Modulation and Bunching process, Reflex Klystrons-Structure, principle of working.
HELIX TWTS: Significance, Types and Characteristics of Slow Wave Structures; Structure of TWT.
M-TYPE TUBES
Introduction, Cross-field effects, Magnetrons – 8-Cavity Cylindrical Travelling Wave Magnetron.
MICROWAVE SOLID STATE DEVICES: Introduction, Classification, Applications. TEDs – Introduction, Gunn Diode – Principle, RWH Theory, Characteristics, LSA Mode of operation

UNIT II
WAVEGUIDE COMPONENTS AND APPLICATIONS- I (Qualitative treatment only): Waveguide Attenuators – Resistive Card, Rotary Vane types, Scattering matrix parameters: Definition, Properties, Salient Features -S- parameters of two port, three port, four port networks. 2 Hole, Bethe Holetypes.

UNIT III Over view of optical fiber communication, Total Internal Reflection, Numerical Aperture, Graded index fibers, Cut off wavelength.
OPTICAL FIBER CONNECTORS-Connector types, Single mode fiber connectors, Connector return loss, Fiber Splicing- Splicing techniques, Splicing single mode fibers, Multimode fiber joints, single mode fiber joints.

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UNIT I V

OPTICAL SOURCES and Detectors: Qualitative treatment, Structures, Materials, Quantum efficiency, Physical principles and comparison of: Optical sources and detectors, Related problems.

Optical system design- Point to point links – Component Choice and considerations, Link power budget, Line coding in Optical links, WDM, Necessity, Principles, Eye pattern.

UNIT –V: MEASUREMENTS:

a. MICROWAVE MEASUREMENTS: Description Of Microwave Bench- Different Blocks, Microwave Power Measurement- Bolometer Method. Measurement of Attenuation by Reflection Method, VSWR, ImpedanceMeasurement

b. OPTICAL MEASUREMENTS: OTDR, Attenuation, DetectorCharacteristics

TEXT BOOKS :

1. Microwave Devices and Circuits – Samuel Y. Liao, PHI, 3rdEdition,1994.
2. Foundations for Microwave Engineering – R.E. Collin, IEEE Press, John Wiley,2nd Edition,2002.
3. Optical Fiber Communications – Gerd Keiser, Mc Graw-Hill International edition,3rd Edition,2000.

REFERENCES :

1. Microwave Engineering- Annapurna Das and Sisir K.Das, Mc Graw HillEducation, 3rdEdition,2014.
2. Microwave Engineering – G S N Raju , I K International Publishing House Pvt. Limited,2008.
3. Fiber Optic Communication Systems – Govind P. Agarwal , John Wiley, 3rd Ediition, 2004.

Course Outcomes: After going through this course the student will be able to

- Design different modes in waveguidestructures
- Calculate S-matrix for various waveguide components and splitting the microwave energy in a desireddirection
- Distinguish between Microwave tubes and Solid State Devices, calculation of efficiency devices.
- Measure various microwave parameters using a Microwave testbench

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		3	0	0	3

DATA COMMUNICATIONS & COMPUTER NETWORKS

Course Objectives:

- To introduce the Fundamentals of data communicationnetworks
- To demonstrate the Functions of various protocols of Data linklayer.
- To demonstrate Functioning of various Routingprotocols.
- To introduce the Functions of various Transport layer protocols.
- To understand the significance of application layerprotocols

UNIT I:

Introduction to Data Communications: Components, Data Representation, Data Flow, Networks-Distributed Processing, Network Criteria, Physical Structures, Network Models, Categories of Networks Interconnection of Networks, The Internet - A Brief History, The Internet Today, Protocol and Standards - Protocols, Standards, Standards Organizations, Internet Standards. Network Models, Layered Tasks, OSI model, Layers in OSI model, TCP/IP Protocol Suite, Addressing Introduction, Wireless Links and Network Characteristics, WiFi: 802.11 Wireless LANs -The 802.11 Architecture,

UNIT II:

Data Link Layer: Links, Access Networks, and LANs- Introduction to the Link Layer, The Services Provided by the Link Layer, Types of errors, Redundancy, Detection vs Correction, Forward error correction Versus Retransmission Error-Detection and Correction Techniques, Parity Checks, Check summing Methods, Cyclic Redundancy Check (CRC) , Framing, Flow Control and Error Control protocols , Noisy less Channels and Noisy Channels, HDLC, Multiple Access Protocols, Random Access ,ALOHA, Controlled access, Channelization Protocols. 802.11 MAC Protocol, IEEE 802.11 Frame.

UNIT III:

The Network Layer: Introduction, Forwarding and Routing, Network Service Models, Virtual Circuit and Datagram Networks-Virtual-Circuit Networks, Datagram Networks, Origins of VC and Datagram Networks, Inside a Router-Input Processing, Switching, Output Processing, Queuing, The Routing Control Plane, The Internet Protocol(IP):Forwarding and Addressing in the Internet-Datagram format, Ipv4 Addressing, Internet Control Message Protocol(ICMP), IPv6

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UNIT IV:

Transport Layer: Introduction and Transport Layer Services : Relationship Between Transport and Network Layers, Overview of the Transport Layer in the Internet, Multiplexing and Demultiplexing, Connectionless Transport: UDP -UDP Segment Structure, UDP Checksum, Principles of Reliable Data Transfer-Building a Reliable Data Transfer Protocol, Pipelined Reliable Data Transfer Protocols, Go-Back-N(GBN), Selective Repeat(SR), Connection Oriented Transport: TCP - The TCP Connection, TCP Segment Structure, Round-Trip Time Estimation and Timeout, Reliable Data Transfer, Flow Control, TCP Connection Management, Principles of Congestion Control - The Cause and the Costs of Congestion, Approaches to CongestionControl

UNIT V:

Application Layer: Principles of Networking Applications – Network Application Architectures, Processes Communicating, Transport Services Available to Applications, Transport Services Provided by the File Transfer: FTP,- FTP Commands and Replies, Electronic Mail in the Internet-STMP, Comparison with HTTP, DNS-The Internet's Directory Service – Service Provided by DNS, Overview of How DNS Works, DNS Records andmessages.

TEXT BOOKS:

1. Computer Networking A Top-Down Approach – Kurose James F, Keith W, 6thEdition , Pearson,2017.
2. Data Communications and Networking Behrouz A.Forouzan4th Edition McGraw Hill Education,2017.

REFERENCES:

1. Data communication and Networks - Bhusan Trivedi, Oxford university press,2016
2. Computer Networks -- Andrew S Tanenbaum, 4th Edition, PearsonEducation,2003.
3. Understanding Communications and Networks,3rdEdition,W.A.Shay,CengageLearning,2003.

Course Outcomes:

Upon completing this course, the student will be able to

- Know the Categories and functions of various Data communication Networks
- Design and analyze various error detectiontechniques.
- Demonstrate the mechanism of routing the data in networklayer
- Know the significance of various Flow control and Congestion controlMechanisms
- Know the Functioning of various Application layerProtocols.

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		3	0	0	3

DIGITAL IMAGE and VIDEO PROCESSING

Course Objectives:

- To study the image fundamentals and mathematical transforms necessary for image Processing.
- To study the image enhancement techniques
- To study image restoration procedures.
- To study the image compression procedures.
- To study the basics of Video processing and 2-D Motion estimation

UNIT I:

Fundamentals of Image Processing and Image Transforms:

Introduction, Image sampling, Quantization, Resolution, Image file formats, Elements of image processing system, Applications of Digital image processing. Introduction, Need for transform, image transforms, Fourier transform, 2 D Discrete Fourier transform and its transforms, Importance of phase, Walsh transform, Hadamard transform, Haar transform, slant transform Discrete cosine transform, KL transform, singular value decomposition, comparison of different image transforms.

UNIT II:

Image Enhancement:

Spatial domain methods: point processing techniques, Histogram processing, Fundamentals of Spatial filtering, smoothing spatial filters, sharpening spatial filters. Frequency domain methods: Basics of filtering in frequency domain, image smoothing, image sharpening, Selective filtering.

Image Restoration:

Introduction to Image restoration, Image degradation, Types of image blur, Classification of image restoration techniques, Image restoration model, Linear and Nonlinear image restoration techniques, Blind de-convolution.

UNIT III:

Image Segmentation:

Introduction to image segmentation, Point, Line and Edge Detection, Region based segmentation., Classification of segmentation techniques, Region approach to image segmentation, clustering techniques, Image segmentation based on thresholding, Edge based segmentation, Edge detection and linking, Hough transform.

Image Compression:

Introduction, Need for image compression, Redundancy in images, Classification of redundancy in images, image compression scheme, Classification of image compression schemes, Fundamentals of information theory, Run length coding, Shannon – Fano coding, Huffman coding, Arithmetic coding, Predictive coding, Transformed based compression, Image

compression standard, Wavelet-based image compression, JPEG Standards.

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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:

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, Waveform based coding, Block based transform coding, Predictive coding, Application of motion estimation in Videocoding.

TEXT BOOKS

1. Digital Image Processing – Gonzaleze and Woods, 3rd Ed,Pearson,2008.
2. Digital Video Processing – M. Tekalp, Prentice Hall International.2nd Ed.2015.

REFERENCE BOOKS

1. Digital Image Processing – S.Jayaraman, S.Esakkirajan, T.Veera Kumar – TMH,2009.
2. Video Processing and Communication – Yao Wang, JoemOstermann and Ya–quin Zhang.1st Ed., PH Int,2017
3. Digital Image Processing and Analysis-Human and Computer Vision Applicationwith CVIP Tools – ScotteUmbaugh, 2nd Ed, CRC Press,2011.

Course Outcomes:

- Defining the digital image, representation of digital image, importance of image resolution, applications in imageprocessing.
- Know the advantages of representation of digital images in transform domain, application of various imagetransforms.
- Know how an image can be enhanced by using histogram techniques, filtering techniques etc
- Understand image degradation, image restoration techniques using spatial filtersand frequencydomain
- Know the detection of point, line and edges in images, edge linking through local processing, globalprocessing.
- Understand the redundancy in images, various image compressiontechniques.
- Know the video technology from analog color TV systems to digital video systems,how video signal is sampled and filtering operations in videoprocessing.
- Know the general methodologies for 2D motion estimation, various coding used invideo processing.

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IV Year - I Semester		L	T	P	C
		3	0	0	3

COMMUNICATION STANDARDS and PROTOCOLS
(Professional Elective 3)

Objective:

- Acquire knowledge about transferring data into cloud using variousWired/Wireless communicationtechnologies.

Prerequisites:

Basic knowledge on Digital numbering system; Micro Controller Peripheral Programming, interfacing different types of sensors using I2C,SPI, UART ; wired and wireless communications.

Unit-I:

Introduction to Communication and Networking : Communications**,** Signal Types and its characteristics (Analog/Digital), Data Transmission Types (Serial/Parallel), Communication Techniques (Asynchronous, Synchronous),Data Transmission Modes (Simplex, Half/Full Duplex), Network Topologies (Star, Ring, Mesh, Point to Point, Tree, Bus, Daisy chain, Multi drop) and its applications, Modulation need and types.

Unit-II:

OSI Layers: Communication Layers and its applications, Communication media (Twisted Pair, Coaxial, Fiber Optics), Introduction to Errors (Error types, Detection, Correction) and Flow Control and its applications.

Unit-III:

Wired Communication Protocols: Ethernet (Types, Socket, MAC, IP, ARP, ICMP, TCP, UDP, DHCP), CAN, Mod-bus(RTU, ASCII), UART (RS485,RS232), OFC and Advantages, Disadvantages and its applications, Introduction to Dial up Modems, Leased line modems.

Unit-IV:

Wireless Communication Protocols: Zigbee, Bluetooth, Wi-Fi, GPRS, GSM , NFC , IR, Satellite Communication. Advantages, Disadvantages and its applications.

Unit-V:

Network Types: Introduction to LAN,WAN,PAN, Internet and Intranet, sensor networks (wired/wireless) and its applications.

Network Security : Introduction to NAT, PAT, DNS, Network Routing algorithms, Introduction to Switch, Hub, Bridges and its working, Network Security and Introduction to Firewall and its applications.

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Text books:

1. Introduction to data communication and networking by Wayne Tomasi, PearsonPrentice Hall,2005
2. Introduction to data communication and networking by Behrouz Forouzan ,4th Edition McGraw HillEducation,2017.
3. Basics of data communications by WilliamStallings.

Reference books:

1. Basics of computer networking by Thomas Robertazzi Stony BrookUniversity,2011
2. Wireless Networking Absolute Beginner's Guide by MichaelMiller:
3. Designing and Deploying 802.11n Wireless Networks by Jim Geier 2nd Edition, Kindle Edition.
4. CAN System Engineering from Theory to Practical Applications,2nd Edition,Springer,2013

Course Outcomes:

- Able to develop sensornetworks
- Able to communicate data via Wired/Wirelesscommunication
- Configure and test communicationtechnologies

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IV Year - I Semester		L	T	P	C
		3	0	0	3

ANALOG IC DESIGN
(Professional Elective 3)

Course Objectives:

The student will be able to

- Understand the behavior of MOS Devices and Small-Signal & Large-Signal Modeling of MOS Transistor and AnalogSub-Circuits.
- Learn and understand CMOS Amplifiers like Differential Amplifiers, Cascode Amplifiers, Output Amplifiers, and OperationalAmplifiers.
- Design and Develop the Analog CMOS Circuits for different Analogoperations.
- Learn and understandthe concepts of Open-Loop Comparators and Different Types of Oscillators like Ring Oscillator, LC Oscillatoretc.

UNIT -I:

MOS Devices and Modelling: The MOS Transistor, Passive Components- Capacitor & Resistor, Integrated circuit Layout, CMOS Device Modelling - Simple MOS Large-Signal Model, Other Model Parameters, Small-Signal Model for the MOS Transistor, Computer Simulation Models, Sub-threshold MOSModel.

UNIT -II:

Analog CMOS Sub-Circuits: MOS Switch, MOS Diode, MOS Active Resistor, Current Sinks and Sources, Current Mirrors-Current mirror with Beta Helper, Degeneration, Cascode current Mirror and Wilson Current Mirror, Current and Voltage References, Band gap Reference.

UNIT -III:

CMOS Amplifiers: Inverters, Differential Amplifiers, Cascode Amplifiers, Current Amplifiers, Output Amplifiers, High Gain Amplifiers Architectures.

CMOS Operational Amplifiers: Design of CMOS Op Amps, Compensation of Op Amps, Design of Two-Stage Op Amps, Power- Supply Rejection Ratio of Two-Stage Op Amps, Cascode Op Amps, Measurement Techniques of OP Amp.

UNIT -IV:

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

UNIT -V:

Oscillators & Phase-Locked Loops: General Considerations, Ring Oscillators, LC Oscillators, Voltage Controlled Oscillators.

Simple PLL, Charge Pump PLLs, Non-Ideal Effects in PLLs, Delay Locked Loops, Applications.

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TEXT BOOKS:

1. Design of Analog CMOS Integrated Circuits- Behzad Razavi, TMH Edition,SecondEdition.
2. CMOS Analog Circuit Design - Philip E. Allen and Douglas R. Holberg, Oxford University Press, International Second Edition/Indian Edition,2010.

REFERENCES:

1. Analysis and Design of Analog Integrated Circuits- Paul R. Gray, Paul J. Hurst, S. Lewis and R. G. Meyer, Wiley India, Fifth Edition,2010.
2. Analog Integrated Circuit Design- David A.Johns, Ken Martin, Wiley Student Edn,2013.

Course Outcomes:

After going through this course, the student will be able to

- Model and simulate different MOS Devices using small signalModel.
- Design and analyze any Analog Circuits in real timeapplications.
- Apply the concepts Analog Circuit Design to develop various Applications in RealTime.
- Analyze and comparedifferentOpen-Loop Comparators andOscillators.

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IV Year - I Semester		L	T	P	C
		3	0	0	3

SMART SENSORS
(Professional Elective 3)

OBJECTIVE:
To make student to acquire the knowledge on types of sensors/transducers, working principles, selection procedure, applications of sensing systems

UNIT – I
Introduction to Measurement: Measurement units, applications, elements, choosing appropriate measuring instruments. Instrument Types and Performance Characteristics: Review of instrument types, Static characteristics, dynamiccharacteristics
Error during measurement process: Sources of systematic error, reduction and quantification of systematic errors, random errors, aggregation of measurement system errors.
Calibration: Calibration of measuring instruments, Primary calibration, secondary calibration and field calibration. Calibration methods for different parameters (temperature, pressure, humidity, flow...etc.). Automatic Calibration mechanisms.

UNIT – II
Temperature Sensors: Thermo-resistive, Resistance Temperature Detectors, Silicon Resistive, Thermistors, Semiconductor, Optical, Acoustic, Piezoelectric
Humidity and Moisture Sensors: Capacitive, Electrical Conductivity, Thermal Conductivity, Optical Hygrometer, Time Domain Reflectometer.
Pressure and Force Sensors: Mercury Pressure, Bellows, Membranes, and Thin Plates, Piezoresistive, Capacitive, Optoelectronic, Vacuum, Strain Gauges, Tactile, Piezoelectric Force
Applications: Case studies in processing industries, indoor environment monitoring in offices, cold storages

UNIT – III
Occupancy and Motion Detectors: Ultrasonic, Microwave Motion, Capacitive Occupancy, Visible and Near-Infrared Light, Far-Infrared Motion, PIR Motion, Position, Displacement, and Level Sensors: Potentiometric, Gravitational, Capacitive, Inductive and Magnetic, Optical, Ultrasonic, Radar
Velocity and Acceleration Sensors: Capacitive Accelerometers, Piezoresistive Accelerometers, Piezoelectric Accelerometers, Thermal Accelerometers, Heated-Plate Accelerometer, Heated-Gas Accelerometer, Gyroscopes, Piezoelectric Cables
Applications: Case studies in manufacturing industries, robotics

UNIT – IV
Flow Sensors: Pressure Gradient Technique, Thermal Transport, Ultrasonic, Electromagnetic, and Micro flow, Coriolis Mass Flow, Acoustic Sensors: Resistive Microphones, Fiber-Optic, Piezoelectric, Solid-State microphone, Light & Radiation Sensors: Photodiodes, Phototransistor, Photo resistors, Thermal detectors

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Chemical Sensors: Metal-Oxide Chemical, ChemFET, Electro-chemical, Potentiometric, Conduct metric, Amperometric, Optical Chemical, Mass Detector
Applications: Case studies in processing industries, oil and gas industries, water SCADA, pharmaceutical industries

UNIT – V
Introduction to wireless sensor networks, Challenges for wireless sensor networks, Applications for wireless sensor networks, enabling technologies for wireless sensor networks.
Single node architecture – Hardware components, Energy consumption of Sensor nodes (only Operation states with different power consumption, Relationship between computation and communication, Power consumption of sensor and actuators is included), Deployment environments
Sensor Network Architecture - Sensor Network Scenarios, Optimization goals and figures of merit, Design principles of WSN, Service interfaces of WSNs, Gateway-concepts.

TEXT BOOKS:
1. Measurement and Instrumentation Principles - Morris, AlanS
2. An Introduction to Error Analysis by John R.Taylor
3. Sensor Technology Handbook, John S.Wilson
4. Holger Karl & Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks" John-Wiley,First-Edition-2014.

REFERENCE BOOKS
1. Mechanical Measurements – Beckwith, Marangoni,Lienhard
2. Measurement of Systems - Application and design - Earnest O.Doeblin
3. Electronic Instrumentation and Measurement Technique - Albert DHelfrick
4. Kazem Sohraby, Daniel Minoli, &Taieb Znati, "Wireless Sensor Networks- Technology, Protocols, AndApplications", John Wiley,2007.

Course Outcomes : The student will be able to
- Understand measuring parameters, measuring systems, effects ofenvironment, characteristics and parameters to be considered for designing aninstrument
- Understand different types of sensors/transducers, working principles,selection procedure, applications of sensingsystems
- Understand Challenges and applications of sensors and sensornetworks
- Select a sensor/sensing system for arequirement
- Test, install and collect the data from a group ofsensors.
- Derive sensor-based solution for differentapplications.

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		3	0	0	3

ADVANCED DIGITAL SIGNAL PROCESSING
(Professional Elective 3)

Course Objectives:
The main objectives of the course are

- To study about discrete time systems and to learn about FFTalgorithms.
- To study the design techniques for FIR and IIR digitalfilters
- To study the finite word length effects in signalprocessing
- To study the properties of random signal, Multirate digital signal processing andabout QMFfilters

UNIT –I: Review of DFT, FFT, IIR Filters and FIR Filters: Introduction to filter structures (IIR & FIR). Implementation of Digital Filters, specifically 2nd Order Narrow Band Filter and 1st Order All Pass Filter. Frequency sampling structures of FIR, Lattice structures, Forward prediction error, Back ward prediction error, Reflection coefficients for lattice realization, Implementation of lattice structures for IIR filters, Advantages of lattice structures.

UNIT - II: Non-Parametric Methods: Estimation of spectra from finite duration observation of signals, Nonparametric Methods: Bartlett, Welch & Blackman-Tukey methods, Comparison of all Non-Parametricmethods

UNIT – III: Parametric Methods: Autocorrelation & Its Properties, Relation between auto correlation & model parameters, AR Models – Yule-Walker & Burg Methods, MA & ARMA models for power spectrum estimation, Finite word length effect in IIR digital Filters – Finite word-length effects in FFT algorithms.

UNIT –IV: Multi Rate Signal Processing: Introduction, Decimation by a factor D, Interpolation by a factor I, Sampling rate conversion by a rational factor I/D, Multistage Implementation of Sampling Rate Conversion, Filter design & Implementation for sampling rate conversion. Examples of up-sampling using an All Pass Filter.

UNIT –V: Applications of Multi Rate Signal Processing: Design of Phase Shifters, Interfacing of Digital Systems with Different Sampling Rates, Implementation of Narrow Band Low Pass Filters, Implementation of Digital Filter Banks, Sub-band Coding of Speech Signals, Quadrature Mirror Filters, Transmultiplexers, Over Sampling A/D and D/AConversion.

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TEXT BOOKS:

1. J.G.Proakis & D. G. Manolakis, "Digital Signal Processing: Principles, Algorithms & Applications", 4th Edition,PHI,2008.
2. Alan V Oppenheim & Ronald W Schaffer, "Discrete Time signal processing ", PHI. 2nd Edition,1999.
3. Emmanuel C. Ifeacher, Barrie. W. Jervis, "DSP – A Practical Approach", 2nd Edition, PearsonEducation,2000.

REFERENCE BOOKS:

1. S. M .Kay, "Modern spectral Estimation: Theory & Application ", 1988,PHI.
2. P.P.Vaidyanathan, "Multi Rate Systems and Filter Banks", PearsonEducation.
3. Kaluri V. Rangarao, Ranjan K. Mallik, "Digital Signal Processing: A Practitioner's Approach", ISBN: 978-0-470-01769-2, 210 pages, November 2006 JohnWeley.
4. S.Salivahanan, A.Vallavaraj, C.Gnanapriya, "Digital Signal Processing",2000,TMH

Course Outcomes:

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

- Comprehend the DFT, FFT and IIRfilters.
- To study the modern digital signal processing algorithms andapplications.
- Have an in-depth knowledge of use of digital systems in real timeapplications
- Acquire the basics of multi rate digital signal processing and apply the algorithms for wide area of recentapplications.
- Analyze the power spectrum estimation and Comprehend the Finite word length effects in Fixed point DSPSystems.

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		3	0	0	3

AUGMENTED REALITY
(Professional Elective 3)

OBJECTIVE:
The course is designed to impart the fundamentals of augmented reality (AR), and teach how to build an AR experience.

UNIT – I:
Introduction to Augmented Reality: Definition and Scope, a brief history of Augmented Reality, Examples, Other related fields: Virtual Reality, Mixed Reality Continuum, Ubiquitous Computing.
Understanding Virtual Space: Defining visual space and content, defining position and orientation in three dimensions, navigation

UNIT – II:
Understanding human senses and their relationship to Output/Input Devices: The mechanics of sight – visual pathway, spatial vision and depth cues, The mechanics of hearing, mechanics of feeling, Multimodal displays, Visual perception, Requirements and Characteristics, Spatial display model, Visual displays

UNIT – III:
Sensors for tracking position, orientation and motion – Tracking, calibration and registration, coordinate systems, characteristics of tracking technology, Stationary tracking systems, Mobile sensors, optical tracking, sensor fusion, Computer vision for augmented reality – market tracking, multiple-camera infrared tracking, natural feature tracking by detection, incremental tracking, simultaneous localization and mapping, outdoortracking
Devices to enable navigation and interaction – 2D versus 3D interaction and navigation, the importance of a manual interface, hand and gesture tracking, whole body tracking, gaming and entertainment interfaces, navigating with mind.

UNIT – IV:
Software architectures – AR application requirements, software engineering requirements, Distributed object systems, dataflow, scene graphs, developer support.
Applications of Augmented and Virtual Reality: Gaming and Entertainment, Architecture and construction, Health and medicine, Aerospace and defence, education, information control and big data visualization, Tele-robotics and telepresence.

UNIT – V:
Human factors, legal and social considerations – human factor considerations, legal and social considerations, The future of AR – what may drive business cases, an AR developer's wish list, taking AR outdoors, interfacing with smart objects, confluence of VR and AR, augmented humans, AR as dramatic medium, AR as social computing platform.

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TEXTBOOKS:

1. Augmented Reality – Principles and Practice, Dieter Schmalstieg and Tobias Höllerer, 1st Edition,Addison-Wesley
2. Practical Augmented Reality – A guide to the technologies, applications, and human factors for AR and VR, Steve Aukstakalnis, 1st Edition,Addison-Wesley
3. Understanding Augmented Reality, Concepts and Applications, Alan B. Craig,1st Edition, Morgan Kaufman

REFERENCE BOOKS:

1. Handbook of Virtual Environments: Design, Implementation, and Applications, Kelly S. Hale and Kay M. Stanney, 2nd Edition, CRCPress
2. Designing Virtual Systems: The Structured Approach, Gerard Jounghyun Kim,Springer
3. Spatial Augmented Reality: Merging Real and Virtual Worlds, Oliver Bimber and Ramesh Raskar, 1st Edition, A K Peters/CRC press.

Course Outcomes:

At the end of the course, students will

- Understand the basics of AugmentedReality
- Understand human senses and their relationship todevices
- Understand various application scenarios of AR
- Understand softwarearchitecture

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		3	0	0	3

SOFTWARERADIO
(Professional Elective4)

Pre-requisite(s): Basic knowledge of signal processing, concepts in wireless Communication and networks.

Course Objectives: This course enables the students to:

- Understand the basic components of software definedradio.
- Understand the distortion parameters and nonlinear Distortion in TransmittedSignals.
- Calculate power requirement in power amplifier forSDR.
- Understand Digital Pre-distortion Techniques for Linear/NonlinearDistortion.
- Appraise Digital Pre-distortionTechniques.

UNIT 1: Basic components of software defined radios, Software defined radio architectures Part A, Software defined radio architectures- Part B.

UNIT 2: Distortion parameters, Sources and metrics of distortion in a transceiver, Nonlinear distortion and nonlinearity specifications, Power amplifiers: Nonlinear Distortion in Transmitted Signals.

UNIT 3: Power amplifier Line-up for linearity & power requirement calculations, Linearization Techniques for nonlinear distortion in SDR.

UNIT 4: Predistortion Techniques for nonlinear distortion in SDR.

UNIT 5: Digital Predistortion Techniques for Linear/Nonlinear Distortion.

Textbook:

1. Jeffrey H. Reed “Software Radio: A Modern Approach to radio Engineering”, Pearson EducationAsia,2002

References:

1. Sanjay Kumar, “Wireless Communication the Fundamental and AdvancedConcepts” River Publishers, Denmark, 2015 (Indianreprint)
2. https://onlinecourses.nptel.ac.in/noc18_ec01/preview.

Course Outcomes: After the completion of this course, students will be to:

- Able to analyze the basic components of software definedradio.
- Demonstrate understanding about distortion parameters and nonlinear Distortionin TransmittedSignals
- Able to calculate power requirement in power amplifier forSDR
- Demonstrate understanding about Digital Pre-distortion Techniques forLinear/Nonlinear Distortion
- Design and analyze the various algorithms used for software definedradio.

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LOW POWER VLSI DESIGN
(Professional Elective 4)

Course Objectives:

- Known the low power low voltage VLSIdesign
- Understand the impact of power onsystemperformances.
- Known about differentDesignapproaches.
- Identify suitable techniques to reduce power dissipation in combinational and sequentialcircuits.

UNIT –I:

Fundamentals: Need for Low Power Circuit Design, Sources of Power Dissipation – Switching Power Dissipation, Short Circuit Power Dissipation, Leakage Power Dissipation, Glitching Power Dissipation, Short Channel Effects –Drain Induced Barrier Lowering and Punch Through, Surface Scattering, Velocity Saturation, Impact Ionization, Hot ElectronEffect.

UNIT –II:

Supply Voltage Scaling for Low Power: Device Feature Size Scaling, Constant-Field Scaling, Constant-Voltage Scaling, Architectural-Level Approaches: Parallelism for Low Power, Pipelining for Low Power, Combining Parallelism with Pipelining, Voltage Scaling Using High-Level Transformations: Multilevel Voltage Scaling Challenges in MVS Voltage Scaling Interfaces, Static Timing Analysis Dynamic Voltage and Frequency Scaling

UNIT -III

Low-Power Design Approaches: Low-Power Design through Voltage Scaling – VTCMOS circuits, MTCMOS circuits, Architectural Level Approach –Pipelining and Parallel Processing Approaches.Power Gating, Clock Gating Versus Power Gating, Power-Gating Issues, Isolation Strategy, State Retention Strategy, Power-Gating Controller, Power Management, Combining DVFS and PowerManagement.

UNIT –IV:

Low-Voltage Low-Power Adders: 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 Multipliers: Introduction, Overview of Multiplication, Types of Multiplier Architectures, Braun Multiplier, Baugh- Wooley Multiplier, Introduction to Wallace Tree Multiplier.

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UNIT –V:

Low-Voltage Low-Power Memories: Basics of ROM, Low-Power ROM Technology, Future Trend and Development of ROMs, Basics of SRAM, Memory Cell, Pre-charge and Equalization Circuit, Low-Power SRAM Technologies, Basics of DRAM, Self-Refresh Circuit, Future Trend and Development of DRAM.

TEXT BOOKS:

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 ProfessionalEngineering,1st edition,2004

REFERENCE BOOKS:

1. Introduction to VLSI Systems: A Logic, Circuit and System Perspective – Ming-BO Lin, CRCPress,2011
2. Low Power CMOS VLSI Circuit Design – Kaushik Roy, Sharat C. Prasad, John Wiley & Sons,2000.
3. Practical Low Power Digital VLSI Design – Gary K. Yeap, Kluwer Academic Press,2002.
4. Leakage in Nanometer CMOS Technologies– Siva G. Narendran, Anatha Chandrakasan,Springer,2005.

Course Outcomes:

Upon completing this course, the student will be able to

- Understand the need of Low power circuitdesign.
- Attain the knowledge of architecturalapproaches.
- Analyze and design Low-Voltage Low-Power combinationalcircuits.
- Known the design of Low-Voltage Low-PowerMemories

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EMBEDDED SYSTEMS
(Professional Elective 4)

Course Objectives:
The main objectives of this course are given below:

- The basic concepts of an embedded system areintroduced.
- The various elements of embedded hardware and their design principles areexplained.
- Different steps involved in the design and development of firmware for embedded systems iselaborated.
- Internals of Real-Time operating system and the fundamentals of RTOS based embedded firmware design isdiscussed.
- Fundamental issues in hardware software co-design were presented andexplained.
- Familiarize with the different IDEs for firmware development for different family of processors/controllers and embedded operatingsystems.
- Embedded system implementation and testing tools are introduced anddiscussed.

UNIT-I
INTRODUCTION: Embedded system-Definition, history of embedded systems, classification of embedded systems, major application areas of embedded systems, purpose of embedded systems, the typical embedded system-core of the embedded system, Memory, Sensors and Actuators, Communication Interface, Embedded firmware, Characteristics of an embedded system, Quality attributes of embedded systems, Application-specific and Domain-Specific examples of an embedded system.

UNIT-II
EMBEDDED HARDWARE DESIGN: Analog and digital electronic components, I/O types and examples, Serial communication devices, Parallel device ports, Wireless devices, Timer and counting devices, Watchdog timer, Real time clock.

UNIT-III
EMBEDDED FIRMWARE DESIGN: Embedded Firmware design approaches, Embedded Firmware development languages, ISR concept, Interrupt sources, Interrupt servicing mechanism, Multiple interrupts, DMA, Device driver programming, Concepts of C versus Embedded C and Compiler versusCross-compiler.

UNIT-IV
REAL TIME OPERATING SYSTEM: Operating system basics, Types of operating systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Threads, Processes and Scheduling, Task communication, Task synchronization.

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HARDWARE SOFTWARE CO-DESIGN: Fundamental Issues in Hardware Software Co-Design, Computational models in embedded design, Hardware software Trade-offs, Integration of Hardware andFirmware.

UNIT-V:
EMBEDDED SYSTEM DEVELOPMENT, IMPLEMENTATION AND TESTING: The integrated development environment, Types of files generated on cross-compilation, Deassembler/Decompiler, Simulators, Emulators and Debugging, Target hardware debugging, Embedded Software development process and tools, Interpreters, Compilers and Linkers, Debugging tools, Quality assurance and testing of the design, Testing on host machine, Simulators, Laboratory Tools.

Text Books:
1. Embedded Systems Architecture- By Tammy Noergaard, Elsevier Publications,2013.
2. Embedded Systems-By Shibu. K.V-Tata McGraw Hill Education Private Limited,2013.

References:
1. Embedded System Design, Frank Vahid, Tony Givargis, John Wiley Publications,2013.
2. Embedded Systems-Lyla B.Das-Pearson Publications,2013.

Course Outcomes:
At the end of this course the student can able to:
- Understand the basic concepts of an embedded system and able to know an embedded system design approach to perform a specificfunction.
- The hardware components required for an embedded system and the design approach of an embeddedhardware.
- The various embedded firmware design approaches on embeddedenvironment.
- Understand how to integrate hardware and firmware of an embedded system using real time operatingsystem.

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		3	0	0	3

DSP PROCESSORS and ARCHITECTURES
(Professional Elective 4)

Course Objectives:

- To recall the various techniques of digital signalprocessing.
- To introduce the architectural features of programmable DSP Processors ofTexas Instruments (TI) and Analog devices(AD).
- To understanding the practical examples of DSP Processorarchitectures.
- To develop programming knowledge by using Instruction set of DSPProcessors.
- To know the interfacing techniques to I/O devices andmemory.

UNIT-I:

Introduction to Digital Signal Processing

Introduction, a Digital signal-processing system, the sampling process, discrete time sequences, Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT), Linear time-invariant systems, Digital filters, Decimation andinterpolation.

Computational Accuracy in DSPImplementations

Number formats for signals and coefficients in DSP systems, Dynamic Range and Precision, Sources of error in DSP implementations, A/D Conversion errors, DSP Computational errors, D/A Conversion Errors, Compensating filter.

UNIT-II:

Architectures for Programmable DSP Devices

Basic Architectural features, DSP Computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation UNIT, Programmability and Program Execution, Speed Issues, Features for External interfacing.

UNIT-III:

Programmable Digital Signal Processors

Commercial Digital signal-processing Devices, Data Addressing modes of TMS320C54XX DSPs, Data Addressing modes of TMS320C54XX Processors, Memory space of TMS320C54XX Processors, Program Control, TMS320C54XX Instructions and Programming, On-ChipPeripherals, Interrupts of TMS320C54XX Processors, Pipeline Operation of TMS320C54XX Processors.

UNIT-IV:

Analog Devices Family of DSP Devices

Analog Devices Family of DSP Devices – ALU and MAC block diagram, Shifter Instruction, Base Architecture of ADSP 2100, ADSP-2181 high performance Processor.

Introduction to Black fin Processor - The Black fin Processor, Introduction to Micro Signal Architecture, Overview of Hardware Processing Units and Register files, Address Arithmetic Unit, Control Unit, Bus Architecture and Memory, Basic Peripherals

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UNIT-V:
Interfacing Memory and I/O Peripherals to Programmable DSP Devices
Memory space organization, External bus interfacing signals, Memory interface, Parallel I/O interface, Programmed I/O, Interrupts and I/O, Direct memory access (DMA).

TEXT BOOKS:
1. Digital Signal Processing – Avtar Singh and S. Srinivasan, Thomson Publications,2004.
2. A Practical Approach To Digital Signal Processing - K Padmanabhan,R. Vijayarajeswaran, Ananthi. S, New Age International,2006/2009
3. Embedded Signal Processing with the Micro Signal Architecture: Woon-SengGan,Sen M.Kuo, Wiley-IEEE Press,2007

REFERENCE BOOKS:
1. Digital Signal Processors, Architecture, Prog and Applications-B.Venkataramani and M. Bhaskar, 2002,TMH.
2. DSP Processor Fundamentals, Architectures & Features – Lapsley et al. 2000, S. Chand &Co.
3. Digital Signal Processing App Using the ADSP-2100 Family by TheApplications Engineering Staff of Analog Devices, DSP Division, Edited by Amy Mar,PHI
4. The Scientist and Engineer's Guide to Digital Signal Processing bySteven W. Smith, Ph.D., California Technical Publishing, ISBN 0-9660176-3-3,1997.

Course Outcomes:
Upon the completion of course, student able to
- Understand the basic concepts of Digital SignalProcessing.
- To differentiate the architectural features of General purpose processors and DSP processors.
- Understand the architectures of TMS320C54xx devices and ADSP 2100 DSPdevices.
- Write the simple assembly language programs by using instruction set ofTMS320C54xx.
- To interface the various devices to DSPProcessors.

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MULTI MEDIA COMMUNICATION
(Professional Elective 4)

Course objectives: This course will enable students to
- Define the Multimedia CommunicationModels
- Explain Multimedia Transport in WirelessNetworks
- Solve the Security issues in multimedianetworks
- Illustrate real-time multimedia networkapplications.
- Explain different network layer basedapplication.

Unit-I: Introduction and tools used for MM content development , Media interaction, bimodality of human speech, Lip reading, speech driven talking heads, Lip synchronization, Lip tracking, Audio to visual mapping.

Unit-II: Biomodal person verification, Joint AV coding, Multimedia processing, Digital media, Signal processing elements, Challenges in MM processing, Perceptual coding of Digital Audio.

Unit-III: Transform audio coders, Image coding, video coding, Water marking techniques, Organization, Storage and retrieval, ANNs for MMSP.

Unit-IV: Distributed MM systems, Multimedia processors, Multimedia OS, Multimedia communication standards, MPEG-1, MPEG-2, MPEG-4, MPEG-7.

Unit–V: Real time multimedia across Internet, packet audio/video multimedia transport across IP/ATM Network, Wireless multimedia, mobile multimedia access for internet, multimedia PCS.

Text Book:
1. Multimedia Communication Systems: Techniques and Standards, KR RAO et al, Pearson, 2002.
2. Insight into Mobile Multimedia Communication : D. BULL et al, Academic Press,1999
3. Multimedia Systems Design : PK ANDLEIGH , K. THAKKAR,PHI,2002
4. Multimedia, TAY VAUGHAN,5/e, TMH,2001

Course Outcomes:
- Develop the multimedia content using multimediatools
- Understand various audio, video and joint codingtechniques.
- Identify the requirements of real time multimedia transfer on IPnetworks.
- Study different types of multimediaprocessors

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		0	0	3	1.5

INTERNET OF THINGS LAB

List of Experiments:

1. Introduction to Raspberry Pi Board/ Arduino/NodeMCU.
2. Familiarization with ARM keil MDK for programming and debugging an application on the PSoC 4 BLE chip and perform necessary softwareinstallation.
3. To interface Push button/Digital sensor (IR/LDR) with ARM keil MDK on PSoC 4 BLE chip and write a program to turn ON LED when push button is pressed or at sensor detection.
4. Set up a Bluetooth Low Energy (namely Bluetooth Smart) connection between the PSoC BLE kit and a smart phone and use an app to send and receive data to and from the BLE Pioneerkit.
5. To interface capacitor sensor (touch sensor) with smart phone and write a program to turn RGB LED ON/OFF when '1'/'0' is received from smart phone usingBluetooth.
6. Automatic street light control to control the street light (Turn on and off based on the light) using Arduino/ Node MCU/RaspberryPi
7. Smoke Detection using MQ-2 GasSensor
8. Detecting obstacle with IR Sensor and Arduino/ Node MCU/RaspberryPi
9. Arduino board interfacing with the temperature and humidity sensor and prints theoutput on LCD / serialmonitor
10. Write an Arduino program for interfacing Arduino board with the Ultrasonicsound sensor and print the output on Serialmonitor.

Equipment required for Laboratories:

Arduino/Node MCU/Raspberry Pi + PSoC 4 BLE Bluetooth Low Energy Pioneer Kit + Hardware, MQ-2 Gas Sensor, Ultrasonic sound sensor.

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		0	0	3	1.5

MICROWAVE AND OPTICAL COMMUNICATION ENGINEERING LAB

Minimum Twelve Experiments to be conducted:

Part-A (Any 7 Experiments (8 & 9 Compulsory))

1. Reflex Klystron Characteristics.
2. Gunn DiodeCharacteristics.
3. AttenuationMeasurement.
4. Directional CouplerCharacteristics.
5. Impedance and FrequencyMeasurement.
6. Scattering parameters ofCirculator.
7. Scattering parameters of MagicTee.
8. Radiation Pattern of Horn and ParabolicAntennas.
9. Synthesis of Microstip antennas (Rectangular Structure) Using any Industrystandard SimulationSoftware.

Part – B (Any 5 Experiments) :

10. Characterization ofLED.
11. Characterization of LaserDiode.
12. Intensity modulation of Laser output through an opticalfiber.
13. Measurement of Data rate for Digital Opticallink.
14. Measurement ofNA.
15. Measurement of losses for Analog Opticallink.

Equipment required for Laboratories:

1. Regulated Klystron Power Supply, Klystronmount
2. VSWRMeter
3. MicroAmmeter
4. Multimeter
5. CRO
6. GUNN Power Supply, PinModulator
7. Crystal Diodedetector
8. Micro wave components(Attenuation)
9. FrequencyMeter
10. Slotted linecarriage
11. Probe detector
12. Wave guideshorts
13. SSTuner
14. DirectionalCoupler
15. E, H, MagicTees
16. Circulators, Isolator
17. MatchedLoads

18. Pyramidal Horn and ParabolicAntennas
19. Turntable for AntennaMeasurements
20. Fiber Optic Analog Trainer basedLED
21. Fiber Optic Analog & Trainer basedlaser
22. Fiber OpticTrainer
23. Fiber cables - (Plastic,Glass)