E.G.S. PILLAY ENGINEERING COLLEGE

(Autonomous)

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NAGAPATTINAM – 611002

M.E. COMMUNICATION SYSTEMS

REGULATION -2021

Second Year – Third Semester

Course Category	Course Code	Course Name	L	T	P	C	Maximum Marks		
							CA	ES	Total
Theory Course									
PCC	2102CO301	Advanced Digital Communication	3	0	0	3	40	60	100
PEC		Programme Elective –V	3	0	0	3	40	60	100
OEC		OpenElective	3	0	0	3	40	60	100
Laboratory Course									
EEC	2104CO302	Project Work –Phase - I	0	0	20	10	50	50	100
Total			**9**	**0**	**20**	**19**	**170**	**230**	**400**

2102CO301	ADVANCED DIGITAL COMMUNICATION	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand the role of the communication in the design approaches for coding and modulation techniques.
2. To know the trade-offs involved in the design of basic and advanced coding and modulation techniques.
3. To learn the advanced baseband signal conditioning methods evolved for exploiting the channel and user application characteristics
4. To familiarize on modern coding techniques

Unit I	REVIEW OF ANALOG AND DIGITAL MODULATION TECHNIQUES	9 Hours

Review of PSK, FSK, and ASK, Base band and band pass communication; Signal space representation, Linear and nonlinear modulation techniques, M-ary modulation techniques; Spectral characteristics of digital modulation, Spread spectrum modulation techniques.

Unit II	RECEIVERS FOR AWGN AND FADING CHANNELS	9 Hours

Optimum receivers for AWGN channel -Correlation demodulator, matched filter, maximum likelihood sequence detector, envelope detectors for M-ary signals; Characterization of fading multipath channels, RAKE demodulator, Multiuser detection techniques-Digital transmission over Fading channel.

Unit III	ADVANCED MODULATION TECHNIQUES ANDMULTICARRIER SYSTEMS	9 Hours

Modulation techniques in MIMO system, Cognitive radio modulation technique, OFDM- Generation of sub-carriers using the IFFT; Guard Time and Cyclic Extension; Windowing; Peak to Average Power reduction schemes; Multicarrier CDMA- System design, Performance parameters.

Unit IV	CONVOLUTIONAL CODED DIGITAL COMMUNICATION	9 Hours

Representation of codes using Polynomial, State diagram, Tree diagram, and Trellis diagram – Decoding techniques using Maximum likelihood, Viterbi algorithm, Sequential and Threshold methods – Error probability performance for BPSK and Viterbi algorithm, Turbo Coding

Unit V	TRELLIS CODED MODULATION	9 Hours

Coded modulation for bandwidth-constrained channels-Trellis coded modulation; Set Partitioning, Four –state Trellis-coded modulation with 8-PSK signal constellation, Eight-state Trellis code for coded 8-PSK modulation, Eight-state Trellis for rectangular QAM signal constellations, Decoding methods and implementation issues.

	Total:	45 Hours

Further Reading: **MODERN CODING TECHNIQUES**

Introduction-Turbo Encoder, Turbo Decoder, Iterative Turbo Decoding Principles; Modifications of the MAP Algorithm-The Soft-Output Viterbi Algorithm(SOVA); Turbo Coding for AWGN channels, Turbo Coding for Rayleigh Channels, LDPC Codes, Space time coding and Reed Solomon codes.

Course Outcomes:

After completion of the course, Student will be able to

1. Demonstrate an understanding of the trade-offs involved in the design of basic and advanced coding and modulation techniques and the advanced baseband signal conditioning methods evolved for exploiting the channel and user application characteristics.
2. Demonstrate an understanding of the trade-offs involved in the design of basic and advanced coding and modulation techniques and the advanced baseband signal conditioning methods evolved for exploiting the channel and user application characteristics.
3. Analyze the user requirements and the type of channel over which the system has to function.
4. Apply the knowledge for designing the baseband signaling waveforms that would address the channel impairments. Examine advanced networking techniques

References:

1. Bernard Sklar., _Digital Communications‘, second edition, Pearson Education,2001.
2. John G. Proakis., Digital Communication‘, 4 th edition, McGraw Hill Publication, 2001
3. Richard Van Nee &Ramjee Prasad., OFDM for Multimedia Communications‘ Artech House
4. Publication,2001.
5. Theodore S. Rappaport., Wireless Communications‘, 2nd edition, Pearson Education, 2002.
6. Heinrich Meyer, Mare Moeneclacy, Stefan. A. Fechtel, "Digital communication receivers", Vol I &Vol II, John Wiley, New York, 1997.
7. Sergio Verdu, Multiuser Detection, Cambridge University Press, 1998
8. Andrea Goldsmith , Wireless Communication , Cambridge Univ. Press, 2006

ER – III, ELECTIVE V

2103CO021	NETWORK ON CHIP DESIGN	L	T	P	C
		3	0	0	3

Course Objectives:

1. To assess peer to peer interconnection network, shared bus based design, and Network on chip (NoC) based architectures.
2. To assess the issues of scalability of on chip connectivity and inter processor communication.

Module I	**INTRODUCTION TO INTERCONNECTION NETWORKS**	**9 Hours**

Uses of Interconnection Networks, Network Basics, A Simple Interconnection Network, Network Specifications and Constraints, Topology, Routing, Flow Control, Router Design, Performance Analysis

Module II	**TYPES OF NETWORKS**	**9 Hours**

Butterfly Networks, Torus Networks Mesh Networks, Non-blocking networks, Non-interfacing networks, Crossbarnetworks Clos Networks, Bene˘s Networks, Sorting Networks

Module III	**ROUTING & FLOW CONTROL**	**9 Hours**

Routing Basics, Deterministic Routing, Dimension-Order Routing, Adaptive Routing, Adaptive Routing Basics, Minimal Adaptive Routing, Fully Adaptive Routing, Flow control basics, Butter flow control, Buffer Management and Back pressure, A flit reservation flow control, Deadlock and live lock avoidances, Deadlock and live lock avoidances in adaptive routing

Module IV	**QUALITY OF SERVICE & ROUTER**	**9 Hours**

Guaranteed services, Best-Effort services, Router Data path Components, Input Buffer organization, Switches,Output Organization, Arbitration, waveform allocator, Processor-Network Interface, Shared-Memory Interface.

Module V	**PERFORMANCE ANALYSIS**	**9 Hours**

Throughput, Latency, Fault Tolerance, Common Measurement Pitfalls Queuing Theory, Probabilistic Analysis, Application-Driven Workloads, Synthetic Workloads, Virtual Channels, Network Size, Injection Processes, Prioritization, Stability, Fault tolerance.

Total:	**45 Hours**

Course Outcomes:

After completion of the course, Student will be able to

1. Outline different types of inter connection networks
2. Summarize various routing, flow control methods
3. Compute performance and QOS in NOC

References:

1. William James Dally and Brian Patrick Towles, “Principles and Practices of Interconnection Networks”, TheMorgan Kaufmann Series in Computer Architecture and Design, 2004.

2. Sudeep Pasricha and Nikil Dutt, On-Chip Communication Architectures - System on Chip Interconnect, Elsevier,2008.

3. Jih-Sheng Shen and Pao-Ann Hsiung, “Dynamic Reconfigurable Network-on-Chip Design: Innovations for Computational Processing and Communication” IGI global, Copyright © 2010

2103CO022	COMMUNICATION NETWORK SECURITY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To make the student understand the importance and goals of communication network andinformation security and introduce him to the different types of attacks.
2. To expose the student to the different approaches to handling security and the algorithms inuse for maintaining data integrity and authenticity.
3. To enable the student to appreciate the practical aspects of security features design and theirimplementation in wired and wireless internetworking domains.

Module I	INTRODUCTION ON SECURITY	9 Hours

Security Goals, Types of Attacks: Passive attack, active attack, attacks on confidentiality, attacks on Integrity and availability. Security services and mechanisms, Techniques: Cryptography, Substitution Ciphers, Transposition Ciphers, Stream and Block Ciphers- Steganography- Revision on Mathematics for Cryptography.

Module II	SYMMETRIC & ASYMMETRIC KEY ALGORITHMS	9 Hours

Data Encryption Standards (DES), Advanced Encryption Standard (AES), RC4, principle of asymmetric key algorithms, RSA Cryptosystem

Module III	INTEGRITY, AUTHENTICATION AND KEY MANAGEMENT	9 Hours

Message Integrity, Hash functions: **SHA 512, Whirlpool**, Digital signatures: Digital signature standards. Authentication: Entity Authentication: Biometrics, Key management Techniques.

Module IV	NETWORK SECURITY, FIREWALLS AND WEB SECURITY	9 Hours

Introduction on Firewalls, Types of Firewalls, Firewall Configuration and Limitation of Firewall. IP Security Overview, IP security Architecture, authentication Header, Security payload, security associations, Key Management. E-mail security: PGP, MIME,S/MIME. Web security requirement, Secure Socket Layer

Module V	WIRELESS NETWORK SECURITY	9 Hours

Security Attack issues specific to Wireless systems: Worm hole, Tunneling, DoS. WEP for Wi-Fi network, Security for Broadband networks: Secure Ad hoc Network, Secure Sensor Networks.

	Total:	45 Hours

Course Outcomes:

After completion of the course, Student will be able to

1. Demonstrate the ways in which communication network security may get compromised.
2. Understand the basic principles of security algorithm design
3. Implement and analyse the different algorithms and compare their performances.
4. Apply his knowledge for designing or modifying existing algorithms and implementing thematleast by simulation.

References:

1. Behrouz A. Forouzan ,‖ Cryptography and Network security‖ McGraw- Hill, 2011
2. William Stallings, "Cryptography and Network security: principles and practice", 2ndEdition, Prentice Hall of India,New Delhi, 2002
3. Atul Kahate ,‖ Cryptography and Network security‖, 2nd Edition, Tata McGraw-Hill, 2008.
4. R.K.Nichols and P.C. Lekkas ,‖ Wireless Security: Models , threats and Solutions‖, McGraw- Hill, 2001.
5. H. Yang et al., Security in Mobile Ad Hoc Networks: Challenges and Solution, IEEE Wireless Communications, Feb. 2004.
6. Securing Ad Hoc Networks," IEEE Network Magazine, vol. 13, no. 6, pp. 24-30, December 1999.
7. "Security of Wireless Ad Hoc Networks," http://www.cs.umd.edu/~aram/wireless/ survey.pdf
8. David Boel et.al ―Securing Wireless Sensor Networks – Security Architecture ― Journal of networks , Vol.3. No. 1. pp. 65 -76, Jan 2008
9. Perrig, A., Stankovic, J., Wagner, D., ―Security in Wireless Sensor Networks‖,Communications of the ACM, 47(6), 53-57, (2004).

2103CO023	MACHINE LEARNING ALGORITHMS	L	T	P	C
		3	0	0	3

Course Objectives:

1. Illustrate dimension reduction techniques
2. Explain various machine learning and deep learning architectures

Module I	DIMENSIONALITY REDUCTION AND EVOLUTIONARY MODELS	9 Hours

Dimensionality Reduction – Linear Discriminant Analysis – Principal Component Analysis – Factor Analysis – Independent Component Analysis – Locally Linear Embedding – Isomap – Least Squares Optimization – Evolutionary Learning – Genetic algorithms – Genetic Offspring: - Genetic Operators – Using Genetic Algorithms – Reinforcement Learning – Overview – Getting Lost Example – Markov Decision Process

Module II	LEARNING MODELS	9 Hours

Learning – Types of Machine Learning – Supervised Learning – The Brain and the Neuron – Design a Learning System – Perspectives and Issues in Machine Learning – Concept Learning Task – Concept Learning as Search – Finding a Maximally Specific Hypothesis – Version Spaces and the Candidate Elimination Algorithm – Linear Discriminants – Perceptron – Linear Separability – Linear Regression.

Module III	ARTIFICIAL NEURAL NEWORKS	9 Hours

Multi-layer Perceptron – Going Forwards – Going Backwards: Back Propagation Error – Multi-layer Perceptron in Practice – Examples of using the MLP – Overview – Deriving Back-Propagation – Radial Basis Functions and Splines – Concepts – RBF Network – Curse of Dimensionality – Interpolations and Basis Functions – Support Vector Machines

Module IV	TREE AND PROBABILISTIC MODELS	9 Hours

Learning with Trees – Decision Trees – Constructing Decision Trees – Classification and Regression Trees – Ensemble Learning – Boosting – Bagging – Different ways to Combine Classifiers – Probability and Learning – Datainto Probabilities – Basic Statistics – Gaussian Mixture Models – Nearest Neighbour Methods – Unsupervised Learning – K means Algorithms – Vector Quantization – Self Organizing Feature Map

Module V	DEEP LEARNING NETWORKS	9 Hours

Introduction to Deep neural networks – Convolution neural networks – Deep Belief Networks -Recurrent neural networks

	Total:	45 Hours

Course Outcomes:

After completion of the course, Student will be able to

1. Examine different feature extraction and dimensionality reduction techniques
2. Distinguish between, supervised, unsupervised and semi-supervised learning
3. Make use of different neural network architectures
4. Assess various type of tree and probabilistic models
5. Articulate various Deep neural network architectures

References:

1. Stephen Marsland, ―Machine Learning – An Algorithmic Perspective‖, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.

2. Tom M Mitchell, ―Machine Learning‖, First Edition, McGraw Hill Education, 2013.

3. Peter Flach, ―Machine Learning: The Art and Science of Algorithms that Make Sense of Data‖, First Edition, Cambridge University Press, 2012

4. Jason Bell, ―Machine learning – Hands on for Developers and Technical Professionals‖, First Edition, Wiley, 2014

5. Ethem Alpaydin, ―Introduction to Machine Learning 3e (Adaptive Computation and Machine Learning Series)‖, Third Edition, MIT Press, 2014

6. Kevin P. Murphy, "Machine Learning - A Probabilistic Perspective", The MIT Press, Cambridge, 2012

7. Josh Patterson and Adam Gibson, "Deep Learning - A Practitioner's Approach", O'Reilly Media, Inc, 2017

2103CO024	ADVANCED DISPLAY SYSTEM	L	T	P	C
		3	0	0	3

Course Objectives:

4. To illustrate the concept of Theory of Light
5. To Understand Display technologies, LED and LCD Display System
6. To know about low power displays and micro display technologies

Module I	THEORY OF LIGHT AND DISPLAY	9 Hours

Properties of light-Geometric optics-optical modulation-vision and perception-Light detection and sensitivity-Spatial vision and pattern perception- Binocular vision and depth perception-Driving display: Direct drive-Multiplex and Passive matrix –Active matrix driving- Panel interface – Graphic controller- Signal Processing Mechanism-Power supply -Fundamentals- Power supply sequencing

Module II	DISPLAY TECHNOLOGIES	9 Hours

Display Glasses- Inorganic Semiconductor- TFT technology-Organic TFT Technology-Transparent Conductors-Patterning processes- Photolithography for Thin Film LCD-Wet Etching-Dry Etching-TFT signal processing techniques-Touch screen technologies: Introduction –Coatings- adhesive-Interfaces with computer mechanism.

Module III	LED AND LCD DISPLAY SYSTEM	9 Hours

LED Display Panels-Inorganic Electroluminescent Displays-Organic Electroluminescent displays-OLEDs-Active matrix for OLED Displays-Liquid crystal Displays-Properties of Liquid crystals-Optics and modeling of Liquid crystals- LCD Device technology - Bistable LCDs-LCD addressing- LCD Backlight and Films- LCD Production – Flex o electro – Optical LCDs

Module IV	PAPER LIKE AND LOW POWER DISPLAYS	9 Hours

Colorant Transposition Displays- MEMs Based Displays-3-D Displays -3-D Technologies-Mobile displays-Trans-reflective displays for mobile devices- Liquid crystal optics for mobile displays- Energy aspects of mobile display technology

Module V	MICRO DISPLAY TECHNOLOGIES	9 Hours

Liquid crystals on Silicon Reflective Microdisplay-Tran missive liquid crystal micro display- MEMS Micro display-DLP Projection Technology- Micro display applications-Projection systems-Head worn displays- Display metrology-Display technology dependent issues-Standards and Patterns -Green Technologies in Display engineering

	Total:	45 Hours

Course Outcomes:

After completion of the course, Student will be able to

1. Explain the concept of Theory of Light
2. Have the knowledge on Display technologies, LED and LCD Display
3. Understand the concept in Low power displays
4. Explain the concepts of Micro display technologies
5. Illustrate the concepts of advanced display techniques

References:

1. Video and Television Engineering", Jerry C. Whitaker, McGraw-Hill Companies, Fourth Edition,2003

2. Introduction to Micro Displays", David Armitage, lan underwood, Wiley Publications, September, 2006

2103CO025	MEDICAL IMAGE PROCESSING	L	T	P	C
		3	0	0	3

Course Objectives:

1. Know information about various medical imaging modalities
2. Understand the basic concepts of image enhancement, image restoration, morphologicalimage processing, image segmentation, feature recognition in medical images
3. Restate information about classification and image visualization in medical image processingprojects
4. Discuss image processing facilities in MATLAB and its equivalent open source tools

Module I	FUNDAMENTALS OF IMAGE PROCESSING	9 Hours

Image perception, MTF of the visual system, Image fidelity criteria, Image model, Image sampling and quantization – two dimensional sampling theory, Image quantization, Optimum mean square quantizer, Image transforms – 2D-DFT and other transforms

Module II	BIO-MEDICAL IMAGE PREPROCESSING	9 Hours

Image Enhancement operations – Image noise and modeling, Image restoration – Image degradation model, Inverse and Weiner filtering, Geometric transformations and correction

Module III	MEDICAL IMAGE RECONSTRUCTION	9 Hours

Mathematical preliminaries and basic reconstruction methods, Image reconstruction in CT scanners, MRI, FMRI, Ultra sound imaging., 3D Ultra sound imaging Nuclear, Medical Imaging modalities – SPECT,PET, Molecular Imaging

Module IV	IMAGE ANALYSIS AND CLASSIFICATION	9 Hours

Image segmentation- pixel based, edge based, region based segmentation. Active contour models and Level sets for medical image segmentation, Image representation and analysis, Feature extraction and representation, Statistical, Shape, Texture, feature and statistical image classification

Module V	IMAGE REGISTRATIONS AND VISUALIZATION	9 Hours

Rigid body visualization, Principal axis registration, Interactive principal axis registration, Feature based registration, Elastic deformation based registration, Image visualization – 2D display methods, 3D display methods, virtual reality based interactive visualization

	Total:	45 Hours

Course Outcomes:

After completion of the course, Student will be able to

1. Discuss basic medical image processing algorithms
2. Describe the use of MATLAB and its equivalent open source tools
3. Paraphrase image processing applications that incorporates different concepts of medicalImage Processing
4. Review different approaches in medical domain
5. Explore the possibility of applying Image processing concepts in modern hospitals

References:

1. Atam P. Dhawan, ―Medical Image Analysis‘, Wiley Interscience Publication, NJ S.Sridhar, Digital Image Processing‖, Oxford University Press, 2011, New Delhi
2. Rafael C. Gonzalez and Richard E. Woods, ―Digital Image Processing‖, Third Edition, Pearson Education, 2008, New Delhi
3. Geoff Dougherty, ― Digital Image Processing for Medical Applications‖, Cambridge University Press, 2010
4. Alasdair McAndrew, ― Introduction to Digital Image Processing with Matlab ‖, Cengage Learning 2011, India
5. Anil J Jain, ―Fundamentals of Digital Image Processing‖, PHI, 2006
6. Alfred Horowitz, _MRI Physics for Radiologists – A Visual Approach‘, Second edition Springer Verlag Network, 1991
7. Kavyan Najarian and Robert Splerstor,‖ Biomedical signals and Image processing, CRC – Taylor and Francis, New York, 2006
8. John L. Semmlow, ‖ Biosignal and Biomedical Image Processing Matlab Based applications‖ Marcel DekkerInc., New York,2004

OPEN ELECTIVE

2103CO026	DATA CONVERTERS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To explain the basic operational and design principles of CMOS Analog to Digital and Digitalto Analog converter architectures
2. To introduce the design calculations for developing the various blocks associated with atypical CMOS AD or DA converter
3. To make students decide the dimensions and bias conditions of all the MOS transistors involved in the design

Module I	**SAMPLE AND HOLD CIRCUITS**	**9 Hours**

Sampling switches, Conventional open loop and closed loop sample and hold architecture, Open loop architecture with miller compensation, multiplexed input architectures, recycling architecture switched capacitor architecture.

Module II	**SWITCH CAPACITOR CIRCUITS AND COMPARATORS**	**9 Hours**

Switched-capacitor amplifiers, switched capacitor integrator, switched capacitor common mode feedback. Single stage amplifier as comparator, cascaded amplifier stages as comparator, latched comparators.

Module III	**DIGITAL TO ANALOG CONVERSION**	**9 Hours**

Performance metrics, reference multiplication and division, switching and logic functions in AC, Resistor ladder DAC architecture, current steering DAC architecture.

Module IV	**ANALOGTODIGITALCONVERSION**	**9 Hours**

Performance metric, Flash architecture, Pipelined Architecture, Successive approximation architecture, Time interleaved architecture

Module V	**PRECISION TECHNIQUES**	**9 Hours**

Comparator offset cancellation, Op Amp off set cancellation, Calibration techniques, range overlap and digital correction

Total:	**45 Hours**

Course Outcomes:

After completion of the course, Student will be able to

1. Discuss about Sample and hold circuits
2. Express importance of Capacitors and comparators
3. Summarize of Digital to analog conversion techniques
4. Outline basics of Analog to digital conversion
5. Review various Precision techniques

References:

1. Behzad Razavi, “Principles of data conversion system design”, S. Chandand company Ltd, 2000
2. Franco Maloberti, “Data Converters”, Springer, 2007.
3. Rudy Van de Plassche, “CMOS Integrated Analog-to-Digital and Digital-to-Analog Converters”, Kluwer Acedamic Publishers, Boston, 2003

2103CO027	SMART ANTENNAS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To learn the fundamentals of smart Antennas
2. To learn the fundamentals of Beam forming
3. To explore the concepts of Space time Processing

Unit I	INTRODUCTION TO SMART ANTENNAS	9 Hours

Introduction - Need for Smart Antennas, Smart Antenna Configurations, Switched-Beam Antennas, Adaptive Antenna Approach, Space Division Multiple Access (SDMA), Architecture of a Smart Antenna System, Receiver, Transmitter, Benefits and Drawbacks, Mutual Coupling Effects

Unit II	DOA ESTIMATION FUNDAMENTALS	9 Hours

Introduction The Array Response Vector, Received Signal Model, The Subspace-Based Data Model, Signal Auto covariance Matrices ,Conventional DOA Estimation Methods, Conventional Beam forming Method, Capon's Minimum Variance Method, Subspace Approach to DOA Estimation ,The MUSIC Algorithm, The ESPRIT Algorithm, Uniqueness of DOA Estimates

Unit III	BEAMFORMING FUNDAMENTALS	9 Hours

The Classical Beam former-Statistically Optimum Beam forming Weight Vectors, The Maximum SNR Beam former, The Multiple Side lobe Canceller and the Maximum, SINR Beam former-Minimum Mean Square Error (MMSE),Direct Matrix Inversion (DMI), Linearly Constrained Minimum Variance (LCMV) , Adaptive Algorithms for Beam forming ,The Least Mean-Square (LMS) Algorithm, The Recursive Least-Squares (RLS) Algorithm

Unit IV	SPACE–TIME PROCESSING	9 Hours

Introduction, Discrete Space–Time Channel and Signal Models, Space–Time beam forming, Inter symbol and Co-Channel Suppression, ISI Suppression, CCI Suppression, Joint ISI and CCI Suppression, Space–Time Processing for DS-CDMA, Capacity and Data Rates in MIMO Systems,

Unit V	MOBILE STATIONS' SMART ANTENNAS	9 Hours

Introduction -Multiple-Antenna MS Design, Combining Techniques, Selection (Switched) Diversity, Maximal Ratio Combining, Adaptive Beamforming or Optimum Combining ,RAKE Receiver Size, Mutual Coupling Effects, Dual - Antenna Performance Improvements ,Downlink Capacity Gains

	Total:	45 Hours

Further Reading:

Single-User Data Rate Limits, Multiple-Users Data Rate Limits, Data Rate Limits Within a CellularSystem, MIMO in Wireless Local Area Networks

Course Outcomes:

After completion of the course, Student will be able to

1. Know basics of smart antennas
2. Understand beam forming and its fundamentals
3. Illustrate space time processing
4. Understand mobile station antennas

References:

1. Constantine A. Balanis, Panayiotis I. Ioannides, Introduction to Smart Antennas Morgan& Claypool Publishers
2. Ahmed El Zooghby, Smart Antenna Engineering, Artech House
3. M.J. Bronzel, Smart Antennas, John Wiley, 2004
4. T.S. Rappaport & J.C. Liberti, Smart Antennas for Wireless Communication, Prentice Hall (PTR) , 1999
5. R. Janaswamy, Radio Wave Propagation and Smart Antennas for wireless communication, Kluwer 2001

2103CO028	ADVANCED DIGITAL IMAGE PROCESSING	L	T	P	C
		3	0	0	3

Course Objectives: At the end of this course, the student will learn

1. Learn different techniques for image enhancement, video and image recovery
2. Understand techniques for image and video segmentation
3. Study techniques for image and video compression and object recognition

Module I	Digital Image and Video Fundamentals	9 Hours

Digital image and video fundamentals and formats, 2-D and 3-D sampling and aliasing, 2-D / 3-Dfiltering, image decimation/interpolation, video sampling and interpolation, Basic imageprocessing operations, Image TransformsNeed for image transforms, DFT, DCT, Walsh, Hadamard transform, Haar transform, Wavelet transform

Module II	Image and Video Enhancement and Restoration	9 Hours

Histogram, Point processing, filtering, image restoration, algorithms for 2-D motion estimation, change detection, motion-compensated filtering, frame rate conversion, deinterlacing, videoresolution enhancement, Image and Video restoration (recovery).

Module III	Image and Video Segmentation	9 Hours

Discontinuity based segmentation- Line detection, edge detection, thresholding, Region basedsegmentation, Scene Change Detection, Spatiotemporal Change Detection, Motion Segmentation,Simultaneous Motion Estimation and Segmentation Semantic Video Object Segmentation,Morphological image processing.

Module IV	Colour image Processing	9 Hours

Colour fundamentals, Colour models, Conversion of colour models, Pseudo colour imageprocessing, Full colour processing

Module V	Object recognition	9 Hours

Image Feature representation and description-boundary representation, boundary descriptors,regional descriptors, feature selection techniques, introduction to classification, supervised andunsupervised learning, Template matching, Bayes classifier

	Total:	45 Hours

Course Outcomes:

After completion of the course, Student will be able to

1. Explain the Digital image and Video fundamentals.
2. Choose a efficient Image and video enhancement and restoration techniques.
3. Examine the different image and video segmentation.
4. Model a colour image process for the particular application.
5. Dissect the object in the image using different boundary techniques.

References:

1. Ed. Al Bovik ,"Handbook of Image and Video Processing", 2nd Edition, AcademicPress, 2000.
2. J. W. Woods, "Multidimensional Signal, Image and Video Processing and Coding",2nd Edition, Academic Press, 2011.
3. Rafael C. Gonzalez and Richard E. Woods," Digital Image Processing", 3rd Edition,Prentice Hall, 2008.
4. A. M. Tekalp, "Digital Video Processing", 2nd Edition, Prentice Hall, 2015. A. M. Tekalp, "Digital Video Processing", 2nd Edition, Prentice Hall, 2015.
5. S. Shridhar, "Digital Image Processing", 2nd Edition, Oxford University Press, 2016.

2103CO029	EMBEDDED SYSTEM DESIGN USING MSP430	L	T	P	C
		3	0	0	3

Course Objectives:

1. Explain serial and parallel protocols and busses
2. Assess various wireless protocols and apply it in hardware

Module I	COMMUNICATION PROTOCOLS	9 Hours

Serial/Parallel Communication – Serial communication protocols -RS232 standard – RS485 – Synchronous Serial Protocols -Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I2C) – PC Parallel port programming - ISA/PCI Bus protocols – Firewire.

Module II	USB AND CAN BUS	9 Hours

USB bus – Introduction – Speed Identification on the bus – USB States – USB bus communication: Packets –Data flow types –Enumeration –Descriptors –PIC Microcontroller USB Interface – CAN Bus – Introduction - Frames –Bit stuffing –Types of errors –Nominal Bit Timing – PIC microcontroller CAN Interface –A simple application with CAN.

Module III	ETHERNET BASICS	9 Hours

Elements of a network – Inside Ethernet – Building a Network: Hardware options – Cables, Connections and network speed – Design choices: Selecting components –Ethernet Controllers – Using the internet in local and internet communications – Inside the Internet protocol

Module IV	EMBEDDED ETHERNET	9 Hours

Exchanging messages using UDP and TCP – Serving web pages with Dynamic Data – Serving web pages that respond to user Input – Email for Embedded Systems – Using FTP – Keeping Devices and Network secure

Module V	WIRELESS EMBEDDED NETWORKING	9 Hours

Wireless sensor networks – Introduction – Applications – Network Topology – Localization –Time Synchronization - Energy efficient MAC protocols –SMAC – Energy efficient and robust routing – Data Centric routing

Total:	45 Hours

Course Outcomes:

After completion of the course, Student will be able to

1. Summarize serial communication protocols
2. Develop embedded applications using USB and CAN Bus
3. Discuss Ethernet basics
4. Examine applications using UDP and TCP protocols
5. Appraise various wireless communication MAC protocols

References:

1. Frank Vahid, Tony Givargis, “Embedded Systems Design: A Unified Hardware/Software Introduction” - John & Wiley Publications, 2002

2. Jan Axelson, “Parallel Port Complete: Programming, interfacing and using the PCs parallel printer port” - Penram Publications, 1996.

3. Dogan Ibrahim, “Advanced PIC microcontroller projects in C: from USB to RTOS with the PIC18F series” - Elsevier 2008.

4. Jan Axelson, “Embedded Ethernet and Internet Complete”, Penram publications, 2003.

6. Bhaskar Krishnamachari, Networking, Wireless Sensors - Cambridge press 2005.

7. Olaf Pfeiffer, Andrew Ayre and Christian Keydel, “Embedded Networking with CAN and CAN open”, Second edition published by Copperhill Media Corporation, 2003

2103CO030	MICROWAVE REMOTE SENSING	L	T	P	C
		3	0	0	3

Course Objectives:

1. To learn the concepts of Radio telemetry
2. To have a knowledge of the basics of radar remote sensing
3. To study the airborne and space borne radar systems
4. To impart the knowledge of Microwave Remote sensing and its applications

Unit I	**FUNDAMENTALS AND RADIOMETRY**	**9 Hours**

Introduction and early history, Basic concepts, plane waves, antenna systems, radiometry, microwave interactions with atmospheric constituents, Earth's surface and vegetation, Radiometric systems,
Sensors, Data products and its applications.

Unit II	**RADAR REMOTE SENSING**	**9 Hours**

Radar Basics, Radar interaction with Earth surface and vegetation, Surface scattering theory. Radar equation , fading concept, Measurement and discrimination, Physical mechanisms and empirical models for scattering and emission, Geometry of Radar images, Radar return and image signature, Resolution concepts, SAR, Speckle in radar imagery, concept of roughness, geometry of targets, resonance, dielectric constant, surface and volume scattering, signal penetration and enhancement

Unit III	**AIRBORNE AND SPACE BORNE RADAR SYSTEMS**	**9 Hours**

Airborne, Space borne, different platforms and sensors, Data products and selection procedure, SEASAT,SIRA,SIRB,ERS,JERS,RADARSAT missions, Doppler radar, JASON,TOPEX/POSEIDON, Aircraft: Air SAR, C/X SAR, E-SAR, STAR-1

Unit IV	**APPLICATION OF RADAR REMOTE SENSING**	**9 Hours**

Applications in Agriculture, Forestry, Geology, Hydrology, ice studies, land use mapping and ocean related studies, military and surveillance applications, search and rescue operations, ground and air target detection and tracking.

Unit V	**SPECIAL TOPICS IN RADAR REMOTE SENSING**	**9 Hours**

SAR inter ferometry – Basics- differential SAR inter ferometry, Radar Polari metry-Radar gram metry and applications-Altimeter and its applications, scatter meter and its applications

	Total:	**45 Hours**

Further Reading:

RADAR Antennas, Transmitter, Receiver, Synthetic Aperture Radar; Aircraft, Air SAR, C/X SAR, E-SAR, STAR-1, Radar gram metry applications, Micro strip based broadband matching networks, Applications of Hydrology, Oceanography.

Course Outcomes:

After completion of the course, Student will be able to

1.Understand applications Radar systems

2.Knowledge of various techniques and aspects of Radar for remote sensing

3.Learn the problems in remote sensing

References:

1. Ulaby, F.T., Moore, K.R. and Fung, **Microwave remote sensing vol-1,vol-2 and vol- Addison**-Wesley Publishing Company,London,1986
2. Floyd. M. Handerson and Anthony, J .Lewis ,**Principles and applications of Imaging RADAR, Manual of Remote sensing**, Third edition, vol.2, ASPRS, Jhumurley and sons, Inc,1998
3. Philippe Lacomme, Jeancl and eMarchais, Jean-Philippe Hardarge and Eric Normant**, Air and space borne radar systems-An introduction**, Elsevier publications 2001
4. Iain H.woodhouse**, Introduction to microwave remote sensing**, 2004
5. Roger J Sullivan, Knovel**, Radar foundations for Imaging and Advanced Concepts**, SciTech Pub, 2004.
6. Eugene A. Sharkov, **Passive Microwave Remote Sensing of the Earth**: Physical Foundations, Published by Springer, 2003
7. Ian Faulcon bridge, **Radar Fundamentals,** Published by Argos Press, 2002

2103CO031	HIGH SPEED SWITCHING ARCHITECTURE	L	T	P	C
		3	0	0	3

Course Objectives: At the end of this course, the student will have a in-depth knowledge about

1. High Speed Networks
2. Synchronous and Asynchronous Networks
3. Switching Techniques

Module I	HIGH SPEED NETWORKS	9 Hours

Introduction- LAN, WAN, Network evolution through ISDN to B-ISDN, Transfer mode and control of B-ISDN, SDH multiplexing structure, ATM standard, ATM adaptation layers.

Module II	LAN SWITCHING TECHNOLOGY	9 Hours

Switching Concepts, switch forwarding techniques, switch path control, LAN Switching, cut through forwarding, store and forward, virtual LANs

Module III	ATM SWITCHING ARCHITECTURE	9 Hours

Switch model, ATM,QOS, Blocking networks - basic - and- enhanced banyan networks, sorting networks - merge sorting, re-arrangeable networks - full-and- partial connection networks, non blocking networks - Recursive network construction, comparison of non-blocking network, Switching with deflection routing - shuffle switch, tandem banyan

Module IV	QUEUES IN ATM SWITCHES	9 Hours

Internal Queuing -Input, output and shared queuing, multiple queuing networks – Combined Input, output and shared queuing - performance analysis of Queued switches.

Module V	IP SWITCHING	9 Hours

Addressing model, IP Switching types - flow driven and topology driven solutions, IP Over ATM address and next hop resolution, multicasting, Photonic switching - Photonic switching architectures.

	Total:	45 Hours

Course Outcomes:

After completion of the course, Student will be able to

1. Explain evolution of high-speed networks.
2. Discuss different LAN Switching techniques.
3. Apply switching architecture solutions for different networks
4. Analyze performance of queued ATM switches
5. Distinguish between different IP switching solutions

References:

1. Achille Pattavina, “Switching Theory: Architectures and performance in Broadband ATM networks ", John Wiley & Sons Ltd, New York. 1998

2. Christopher Y Metz, “ Switching protocols & Architectures”, McGraw – Hill Professional Publishing, NewYork.1998.

3. Rainer Handel, Manfred N Huber, Stefan Schroder, “ATM Networks – Concepts Protocols, Applications”, III Edition, Addison Wesley, New York. 1999.

4. John A.Chiong, “ Internetworking ATM for the internet and enterprise networks”, McGraw Hill, New York, 1998.

5. S.Kar and T.Srinivas, “Optical fiber communications, Principles and Practice”, Tata Mc Graw Hill, 2002.

2103CO032	RFIC DESIGN	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand the basics of RFICs components and working principles.
2. To understand the technologies used in RFICs.
3. To introduce to the students the basics of Impedance matching in RFICs
4. To understand the role of Passive elements in RFIC Technology
5. To design of active circuits in RFICs

Unit I	RFIC BASICS	9 Hours

Low Frequency Analog design and Microwave design versus RFIC design- impedance levels for microwave and low frequency analog design- RFICs used in a communication transceiver. Issues in RFIC design- noise, noise power, noise figure-linearity and distortion in RF circuits- dynamic range filtering issues.

Unit II	TECHNOLOGY FOR RFICS	9 Hours

Transistor and Integrated circuit invention- charge transport in transistors- materials used- types of transistors used-MOSFET, MESFET, HEMT, BJT, HBT, BiCMOS. β Current dependence in BJT, small signal model and small signal parameters- high frequency effects-unity gain frequency-types of noises-thermal noise, shot noise, 1/f noise.

Unit III	IMPEDANCE MATCHING	9 Hours

Review of Smith chart- signal flow analysis- S parameters- parameter conversion- impedance matching- conversion between series and parallel RL and RC circuits- tapped capacitors and inductors- mutual inductance- matching using transformers- tuning a transformer- impedance transformation- bandwidth of impedance transformation network-quality factor of an LC resonator transmission lines.

Unit IV	PASSIVE CIRCUIT ELEMENTS IN RFIC TECHNOLOGY	9 Hours

Back end and metallization in IC technologies- sheet resistance and skin effect- parasitic capacitance-parasitic inductance- resistors and types- capacitors and types- varactors- design of inductors and transformers- Q factor and characterization of inductor- multilevel inductor- packaging signal pads- wiring- simple filters-combiners and dividers.

Unit V	ACTIVE CIRCUITS IN RFIC	9 Hours

Amplifiers- topologies- stabilization networks- bias supply- design strategies- narrowband and wideband design of LNA- power amplifier- choice of topology, current source based amplifiers, switched amplifiers- amplitude control and switches- attenuators and switches, variable gain amplifiers- phase shifters-reflective type and digitally adjustable phase shifters- vector modulators

	Total:	45 Hours

Course Outcomes:

After completion of the course, Student will be able to

1. Explain the application of RFICs.
2. Summarize various technologies used in RFICs
3. Measure impedance matchingand simulation of RFIC circuits using Optisim software
4. Correlate the applications of passive circuits and active circuits in RFICs.
5. Design aRFICs using active circuits

References:

1. John Rogers and Calvin Plett, “Radio Frequency Integrated Circuit Design”, Artech House, 2003. 2
2. T. H. Lee, The Design of CMOS Radio-Frequency Integrated Circuits, Cambridge, 2004
3. Franck Ellinger, “Radio Frequency Integrated Circuits and Technologies”, Springer, 2007.
4. Richard C. Li , RF Circuit Design John wiley & sons,2012
5. B. Razavi, RF Microelectronics, Prentice Hall, 1998

2103CO033	SPACE TIME COMMUNICATION	L	T	P	C
		3	0	0	3

Course Objectives:

1. To acquire the knowledge on various modulation and coding schemes for space-time wirelesscommunications
2. To understand transmission and decoding techniques associated with wireless communications
3. To understand multiple-antenna systems such as multiple-input multiple-output (MIMO) andspace-time codes

Module I	MULTIPLE ANTENNA PROPAGATION AND ST CHANNEL CHARACTERIZATION	9 Hours

Wireless channel, Scattering model in macro cells, Channel as a ST random field, Scattering functions, Polarization and field diverse channels, Antenna array topology, Degenerate channels, reciprocity and its implications, Channel definitions, Physical scattering model, Extended channel models, Channel measurements, sampled signal model, ST multiuser and ST interference channels, ST channel estimation

Module II	CAPACITY OF MULTIPLE ANTENNA CHANNELS	9 Hours

Capacity of frequency flat deterministic MIMO channel: Channel unknown to the transmitter, Channel known to the transmitter, capacity of random MIMO channels, Influence of ricean fading, fading correlation, XPD anddegeneracy on MIMO capacity, Capacity of frequency selective MIMO channels

Module III	SPATIAL DIVERSITY	9 Hours

Diversity gain, Receive antenna diversity, Transmit antenna diversity, Diversity order and channel variability, Diversity performance in extended channels, Combined space and path diversity, Indirect transmit diversity, Diversity of a space-time- frequency selective fading channel.

Module IV	MULTIPLE ANTENNA CODING AND RECEIVERS	9 Hours

Coding and interleaving architecture, ST coding for frequency flat channels, ST coding for frequency selective channels, Receivers(SISO,SIMO,MIMO),Iterative MIMO receivers, Exploiting channel knowledge at the transmitter: linear pre-filtering, optimal pre-filtering for maximum rate

Module V	ST OFDM, SPREAD SPECTRUM AND MIMO MULTIUSER DETECTION	9 Hours

SISO-OFDM modulation, MIMO-OFDM modulation, Signalling and receivers for MIMO OFDM,SISO-SS modulation, MIMO-SS modulation, Signalling and receivers for MIMO, Outage performance for MIMO-MU,MIMO-MU with OFDM,CDMA and multiple antennas

Total:	45 Hours

Course Outcomes:

After completion of the course, Student will be able to

1. Know antenna propagation systems
2. Understand multiple antenna channels
3. Illustrate different coding of Microwaves
4. Examine performance of OFDM techniques
5. Understand the concepts of spatial diversity

References:

1. A. Paulraj, Rohit Nabar, Dhananjay Gore., "**Introduction to Space Time Wireless Communication Systems**", Cambridge University Press, 2003

2. Sergio Verdu" **Multi User Detection**" Cambridge University Press, 1998

3. Andre Viterbi " **Principles of Spread Spectrum Techniques**" Addison Wesley 1995

2103CO034	COMMUNICATION PROTOCOL ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

1. To know basics of network and protocol models
2. To get knowledge about verification process of protocol's performance
3. To understand synthesis of implementation of protocols

Unit I	NETWORKREFERENCEMODEL	9 Hours

Communication model -software, subsystems, protocol, protocol development methods, Protocol engineering process, Layered architecture, Network services and Interfaces, Protocol functions, OSI model, TCP/IP protocol suite

Unit II	PROTOCOL SPECIFICATIONS	9 Hours

Components of protocol, Specifications of Communication service, Protocol entity, Interface, Interactions, Multimedia protocol, Internet protocol, SDL, SDL based protocol other. Protocol specification languages.

Unit III	PROTOCOLVERIFICATION/VALIDATION	9 Hours

Protocol verification, Verification of a protocol using finite state machines, Protocol validation, protocol design errors, Protocol validation approaches, SDL based protocol verification and validation

Unit IV	PROTOCOLCONFORMANCE/PERFORMANCE TESTING	9 Hours

Conformance testing methodology and framework, Conformance test architectures, Test sequence generation methods, Distributed architecture by localmethods, Conformance testing with TTCN, systems with semi controllable interfaces - RIP, SDL based tools for conformance testing, SDL based conformance testing of MPLS Performance testing,

Unit V	PROTOCOLSYNTHESISANDIMPLEMENTATION	9 Hours

Protocol synthesis, Interactive synthesis algorithm, Automatic synthesis algorithm, Automatic synthesis SDL from MSC, Protocol Re-synthesis; Requirements of protocol implementation, Object based approach to protocol implementation, Protocol Compilers, Tool for protocol engineering.

	Total:	45 Hours

Further Reading:

SDL based performance testing of TCP and OSPF, Interoperability testing, SDL based inter operability testing of CSMA / CD and CSMA / CA protocol using Bridge, Scalability testing

Course Outcomes:

After completion of the course, Student will be able to

1. Explain layered architecture and its protocol
2. Formulate protocol specifications
3. Analyze protocol used in any particular application.
4. Design the performance testing methodology for the designed protocol.
5. Explain various protocol synthesis algorithms and its implementation

References:

1. Pallapa Venkataram and Sunilkumar S. Manvi, **"Communication protocol Engineering"**, Eastern Economy edition,2004
2. Richard Lai and Jira chief pattana, **"Communication Protocol Specification and Verification"**, Kluwer Publishers, Boston,1998
3. Tarnay, K., **"Protocol Specification and Testing"**, Plenum, New York, 1991
4. Mohamed G. Gouda, **"Elements of Network Protocol Design"**, John Wiley &Sons, Inc. New York, USA, 1998
5. V. Ahuja, **"Design and Analysis of Computer Communication networks"**, Mc Graw- Hill, London,1982

2104CO302	PROJECTPHASE - I	L	T	P	C
		0	0	20	10

CourseObjectives:

1.Todevelopknowledgetoformulatearealworldproblemand project'sgoals
2.To identify thevarioustasksoftheprojectto determinestandardprocedures
3.Toidentifyandlearnnewtools,algorithmsandtechniques
4.Tounderstandthevariousproceduresforvalidation oftheproductandanalysisthecosteffectiveness
5.Tounderstand theguidelineto Preparereportfororaldemonstrations

Guidelines

The Project Work will start in semester III and should preferably be a problem with research potential and should involvescientific research, design, generation / collection and analysis of data, determining solution and must preferably bring outthe individual contribution. Seminar should be based on the area in which the candidate has undertaken the dissertationwork as per the common instructions for all branches of M. E. The examination shall consist of the preparation of reportconsisting of a detailed problem statement and a literature review. The preliminary results (if available) of the problemmay also be discussed in the report. The work has to be presented in front of the examiners panel set by Head and PGcoordinator.Thecandidatehastobeinregularcontactwithhisguideandthetopicofdissertationmustbemutually decidedbytheguideandstudent.

	Total:	30 Hours

CourseOutcomes:

Aftercompletionofthecourse, Studentwillbeableto

1. Studentswillbeexposedtoself-learningvarioustopics.
2. Studentswilllearntosurveytheliteraturesuchasbooks,national/internationalrefereedjournalsand contact resourcepersonsforthe selectedtopicof research.
3. Studentswilllearn towritetechnicalreports.
4. Studentswilldevelop oralandwrittencommunicationskillstopresentand defendtheirworkinfrontof technicallyqualifiedaudience.