M. Tech.

IN

COMMUNICATION SYSTEMS

SYLLABUS
FOR
CREDIT BASED CURRICULUM
(For students admitted in 2018-19)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY
TIRUCHIRAPPALLI – 620 015
TAMIL NADU, INDIA
CURRICULUM

The total minimum credits required for completing the M.Tech. Communication Systems Programme in Electronics and Communication Engineering is 66

SEMESTER I

<table>
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SEMESTER II

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<td>Optical Communication Systems</td>
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SEMESTER III

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### SEMESTER IV

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### LIST OF ELECTIVES

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<td>Detection and Estimation</td>
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<td>DSP Architecture</td>
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<td>EC614</td>
<td>Spectral Analysis of Signal</td>
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<td>WDM Optical Networks</td>
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<td>Advanced Techniques for Wireless Reception</td>
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<td>Digital Communication Receivers</td>
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<td>Analysis methods for passive MIC</td>
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<td>Substrate Integrated Waveguide Technology: Design and Analysis</td>
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<td>Pattern recognition and computational intelligence</td>
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<td>EC632</td>
<td>Foundations of Artificial Intelligence</td>
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<td>Introduction to Soft Computing and Machine Learning</td>
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<td>EC656</td>
<td>Design of ASICs</td>
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<td>Modeling and Synthesis with Verilog HDL</td>
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<td>Optimization of Digital Signal Processing structures for VLSI</td>
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**LIST OF OPEN ELECTIVES**

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<td>High Speed Communication Networks</td>
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M.Tech. (Communication Systems)  Department of Electronics and Communication Engineering

Course Code : EC601
Course Title : Linear Algebra and Stochastic Processes
Number of Credits : 3
Course Type : Core

COURSE OBJECTIVE
- The subject introduces the probability, random process and the linear algebra that are required for the theoretical analysis of the communication systems.

COURSE CONTENT


Text Books

Reference Books
5. Recent literature in Linear Algebra and Stochastic Processes.

COURSE OUTCOMES
Students are able to
CO1: solve the problems associated with Linear algebra
CO2: solve the problem associated with transformation of random variables
CO3: summarize the concepts associated with multiple random variables and to solve the problems associated with Multivariate Gaussian random vector
CO4: summarize the concepts associated with random process and to compute the power spectral density of the output of the system.
CO5: recognize the usage of random process in telecommunication engineering and to solve the corresponding problems.
COURSE OBJECTIVE
- To provide rigorous foundations in multirate signal processing, power spectrum estimation and adaptive filters.

COURSE CONTENT
Review of sampling theory. Sampling rate conversion by integer and rational factors. Efficient realization and applications of sampling rate conversion.


Text Books

Reference Books

COURSE OUTCOMES
Students are able to
CO1: apply multirate DSP for applications and design efficient digital filters & construct multi-channel filter banks.
CO2 select linear filtering techniques to engineering problems.
CO3: describe the most important adaptive filter generic problems.
CO4: describe the various adaptive filter algorithms.
CO5: describe the statistical properties of the conventional spectral estimators.
M.Tech. (Communication Systems)  
Department of Electronics and Communication Engineering

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COURSE OBJECTIVE
- To make the students familiarize with ABCD parameters, S parameters, Applications of planar transmission lines in the practical microwave circuits, Design and layout of all Microwave Integrated Circuit Design components and then systems.

COURSE CONTENT
Two-port network characterization. Scattering matrix representation of microwave components.

Planar transmission lines: Characteristics, properties, design parameters and applications. Design and realization of MIC Components. 3 dB hybrid design. Backward Directional Coupler, Hybrid ring and Power dividers.


Microwave oscillator design. One – port and two – port negative resistance oscillators. Oscillator design using large – signal measurements.

Text Books

Reference Books
4. Recent literature in Microwave Circuits.

COURSE OUTCOMES
Students are able to
CO1: understand the basics of Scattering matrix and two port characterization.
CO2: analyze the design principles of passive microwave components such as couplers and power dividers.
CO3: distinguish between the different types of MIC filters and their implementation.
CO4: understand the complexities of microwave amplifier design and its stability features.
CO5: identify the suitable microwave power sources of given specification for the selected application.
CO6: appreciate the design principles of microwave oscillators.
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**List of Experiments:**

1. Characteristics of Reflex Klystron
2. Characteristics of Gunn diode
3. Impedance Measurement
4. Frequency and Wavelength Measurement
5. Characteristics of Branch line directional coupler
6. Study of 3dB power divider
7. Study of Rat-race Hybrid ring
8. Study of Filters
9. Antenna Measurements
10. Study of 50Ω Microstrip Line
11. Study of Parallel line directional coupler
Course Code : EC602
Course Title : Advanced Digital Communication
Number of Credits : 3
Course Type : Core

COURSE OBJECTIVE
- This subject gives an in-depth knowledge and advancement in digital communication systems. It introduces some of the upcoming technologies like Multiuser - communication, Multi channel and Multicarrier communication technologies.

COURSE CONTENT
Baseband data transmission- Nyquist criterion for zero ISI, Correlative level coding, Optimum design of transmit and receive filters, Equalization.

Passband Digital transmission- Digital modulation schemes, Carrier synchronization methods, Symbol timing estimation methods.

Error control coding - Linear block codes, cyclic codes-encoding and decoding, Non-binary codes, Convolutional codes, Decoding of convolutional codes, Trellis coded modulation, Interleaver, Turbo coding, Performance measures.

Spread spectrum communication- D S and F H spread spectrum, CDMA system based on FH and DS spread spectrum signals, Applications, Synchronization of spread spectrum signals.

Multichannel and Multicarrier communication Systems, Multi user communication systems.

Text Books

Reference Book
1. S.Lin & D.J.Costello, Error Control Coding (2/e) Pearson, 2005
2. Recent literature in Advanced Digital Communication.

COURSE OUTCOMES
Students are able to
- CO1: understand the operation, theoretical analysis and design of baseband, pass band data transmission systems.
- CO2: design and implement various digital encoders and decoders.
- CO3: summarize spread spectrum technology and its application.
- CO4: compare single carrier and multicarrier communication systems.
- CO5: do research in the digital communication systems.
M.Tech. (Communication Systems)  Department of Electronics and Communication Engineering

**Course Code**: EC604  
**Course Title**: Broadband Wireless Technologies  
**Number of Credits**: 3  
**Course Type**: Core

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### COURSE OBJECTIVE
- To expose the students to understand mobile radio communication principles and to study the recent trends adopted in cellular systems and wireless standards.

### COURSE CONTENT

**Introduction to Wireless Communication.** The Cellular concept, System design, Capacity improvement in cellular systems, Co channel interference reduction. Intelligent cell concept and applications. Technical Challenges.


Multiuser Systems: CDMA- Principle, Network design, Link capacity, Power control. WCDMA-Network planning, MC-CDMA, OFDM, Cellular mobile communication beyond 3G.


### Text Books

### Reference Books
5. Recent literature in Broadband Wireless Technologies.

### COURSE OUTCOMES

Students are able to

CO1: discuss the cellular system design and technical challenges.

CO2: analyze the Mobile radio propagation, and practical link budget design.

CO3: analyze fading, diversity concepts, channel models, and design parameters.

CO4: analyze Multiuser Systems, CDMA, WCDMA network planning and OFDM Concepts.

CO5: summarize the principles and applications of wireless systems and standards, smart antenna, beam forming and MIMO systems.
M.Tech. (Communication Systems)  Department of Electronics and Communication Engineering

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**COURSE OBJECTIVES**

- To prepare the students understand the various process and subsystems involved in the optical communication.
- To enable the students appreciate the different multiplexing technologies in the fiber optic communication.
- To design optical communication systems to serve a defined purpose

**COURSE CONTENT**


Semiconductor optical amplifiers. EDFA and Raman amplifiers – modeling and analysis. Analysis and digital transmission with high power fiber amplifiers.

Multichannel systems: WDM light wave systems. TDM and code division multiplexing.

Advances in wavelength division multiplexing / demultiplexing technologies.


Soliton systems: Nonlinear effects. Soliton – based communication. High speed and WDM soliton systems

**Text Books**


**Reference Books**

5. Recent literature in Optical Communication Systems.

**COURSE OUTCOMES**

Students are able to

- CO1: understand the modulation and demodulation schemes in the coherent optical systems.
- CO2: understand the various types of the optical amplifiers
- CO3: analyse various multiplexing techniques used and evaluate the recent advances in this field
- CO4: compare the merits and demerits, potential applications of microwave semiconductor devices.
- CO5: analyse the operating principle of WDM solutions systems.
List of Experiments

1. Measurement of Numerical Aperture
2. Measurement of Attenuation and Bending Loss
3. Study of Analog Link
4. Proximity Sensor
5. Study of BER and Q-factor estimation in the optical system simulation
6. EDFA design for DWDM link
7. Study the Characteristics of a Communication channels
   AWGN
   BSC
8. Analog and Digital Modulation
   Frequency Modulation and Demodulation
   QPSK Modulation and Demodulation
9. Conventional Encoder and Decoder
10. OFDM-802.11a
11. Study of network simulators
EC610  Digital signal and Image Processing Laboratory  (L-T-P) C
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List of Experiments:
1. Generation of spatially correlated multivariate Gaussian process with desired mean vector and the required co-variance matrix.
2. Forward linear predictor and backward linear predictor
3. Design and Realization of the adaptive filter using LMS algorithm and RLS algorithm
4. Noise cancellation using Winner filter and adaptive filter
5. Performance study of periodogram power spectrum estimator and modified periodogram estimator
6. Nonparametric and methods of power spectrum estimator (Bartlett’s and Welch’s methods)
7. AR method of power spectrum estimation
8. (A) Transmultiplexer
   (B) Quadrature–mirror filter
9. Representation of the 2D image signal as the linear combinations of PCA (Eigen faces)
10. Image compression using discrete cosine transformation (DCT).
11. Discrete Multitone Transmission (DMT)
12. Orthogonal Frequency-division multiplexing (OFDM)
13. Implementation of Multiple-input Multiple output (MIMO)
COURSE OBJECTIVE
- The objective of this course is to make the students conversant with those aspects of statistical decision and estimation which are indispensable tools required for the optimal design of digital communication systems.

COURSE CONTENT
Binary hypothesis testing: Bayes, mini-max and Neyman-Pearson tests. Composite hypothesis testing.


Signal detection in continuous time: Detection of deterministic signals in Gaussian noise. Coherent detection in white Gaussian noise.

Text Books

Reference Books
4. Recent literature in Detection and Estimation.

COURSE OUTCOMES
Students are able to
- CO1: summarize the fundamental concept on Statistical Decision Theory and Hypothesis Testing
- CO2: summarize the various signal estimation techniques with additive noise
- CO3: summarizer with Bayesian parameter estimation (minimum mean square error (MMSE), minimum mean absolute error (MMAE), maximum a-posterior probability (MAP) estimation methods).
- CO4: compare optimal filtering, linear estimation, and Wiener/Kalman filtering.
- CO5: construct Wiener and Kalman filters (time discrete) and state space models.
COURSE OBJECTIVES

- To give an exposure to the various fixed point and floating point DSP architectures and to implement real time applications using these processors.

COURSE CONTENT


Digital Media Processors. Video processing sub systems. Multi-core DSPs. OMAP. CORTEX, SHARC, SIMD, MIMD Architectures.

Text Books

Reference Books
4. Recent literature in DSP Architecture.

COURSE OUTCOMES

Students are able to

CO1: learn the architecture details fixed and floating point DSPs
CO2: infer about the control instructions, interrupts, and pipeline operations, memory and buses.
CO3: illustrate the features of on-chip peripheral devices and its interfacing with real time application devices.
CO4: learn to implement the signal processing algorithms and applications in DSPs.
CO5: learn the architecture of advanced DSPs.
COURSE OBJECTIVE
To impart the students a thorough exposure to the layered architecture of communication network and to analyse the protocols adopted for traffic management, routing and QOS provisioning.

COURSE CONTENT
The need for a protocol architecture, The TCP/IP protocol architecture, Internetworking, Packet switching networks, Frame relay networks, Asynchronous Transfer mode (ATM) protocol architecture, High speed LANs.

Application of queuing theory to the analysis of performance of communication networks, Transport layer services-Principles of Reliable data transfer, Congestion control and flow control mechanism.

Virtual circuits and datagrams, Router architecture, Forwarding and addressing in the internet, Interior routing protocols, Exterior routing protocols and multicast.

IEEE 802.11 architecture and services, medium access control and physical layer, Wi-Fi protected access, IEEE 802.15 protocol architecture, Blue tooth and Personal Area Networks.

Quality of service in IP networks, Integrated and differentiated services, Protocols for QOS support-Resource reservation protocol, Multiprotocol label switching, Real time transport protocol.

Text Books

Reference Books

COURSE OUTCOMES
Students are able to
CO1: compare and analyse the fundamental principles of various high speed communication networks and their protocol architectures
CO2: examine the performance modeling, congestion control issues and traffic management in IP networks
CO3: compare and analyse the various routing protocols in IP networks
CO4: study of various wireless LAN standards, Blue tooth and high data rate personal area networks
CO5: examine quality of service in IP networks.
## COURSE OBJECTIVE
- To give an exhaustive survey of methods available for power spectrum estimation.

## COURSE CONTENT


## Text Books

## Reference Book
2. Recent literature in Spectral Analysis of signals.

## COURSE OUTCOMES
Students are able to

CO1: derive and analyse the statistical properties of the conventional spectral estimators, namely the periodogram, averaged & modified periodogram and Blackman-Tukey methods.

CO2: formulate modern, parametric, spectral estimators based upon autoregressive (AR), moving average (MA), and autoregressive moving average (ARMA) models, and detail their statistical properties. Describe the consequence of the term resolution as applied to a spectral estimator.

CO3: define techniques for calculating moments in spectral and temporal domains; Analyze filter bank method, capon methods for spectrum estimation.

CO4: demonstrate knowledge and understanding of the principles of parametric and non-parametric array processing algorithms.

CO5: select an appropriate array processing algorithms for frequency estimation and sonar, radar applications.
M.Tech. (Communication Systems)  Department of Electronics and Communication Engineering

Course Code : EC615
Course Title : Digital Image Processing
Number of Credits : 3
Course Type : Elective

COURSE OBJECTIVES

- To explore various techniques involved in Digital Image Processing.

COURSE CONTENT


Feature Extraction from the Image: Boundary descriptors, Regional descriptors, Relational descriptors. Dimensionality reduction techniques, Discriminative approach and the Probabilistic approach for image pattern recognition.

Text Books

Reference Books

COURSE OUTCOMES

Students are able to

- CO1: Reproduce the need for image transforms, different types of image transformation and their properties.
- CO2: Compare different techniques employed for the enhancement of images.
- CO3: Compare various spatial and frequency domain techniques of image processing.
- CO4: Summarize various morphological operations and segmentation techniques.
- CO5: Summarize various pattern recognition concepts and demonstrate the image pattern classifier.
**Course Code**: EC616  
**Course Title**: RF MEMS  
**Number of Credits**: 3  
**Course Type**: Elective

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**COURSE OBJECTIVE**
- To impart knowledge on basics of MEMS and their applications in RF circuit design.

**COURSE CONTENT**


Micro-machined transmission lines. Coplanar lines. Micro-machined directional coupler and mixer.


**Text Books**

**Reference Books**
3. Recent literature in RF MEMS.

**COURSE OUTCOMES**
Students are able to
- CO1: learn the Micromachining Processes
- CO2: learn the design and applications of RF MEMS inductors and capacitors.
- CO3: learn about RF MEMS Filters and RF MEMS Phase Shifters.
- CO4: learn about the suitability of micro-machined transmission lines for RF MEMS
- CO5: learn about the Micro-machined Antennas and Reconfigurable Antennas
Course Code: EC617
Course Title: Smart Antennas
Number of Credits: 3
Course Type: Elective

COURSE OBJECTIVE

- To gain an understanding and experience with smart antenna environments, algorithms and implementation.

COURSE CONTENT


Optimal spatial filtering – adaptive algorithms for CDMA. Multitarget decision – directed algorithm.

DOA estimation – conventional and subspace methods. ML estimation techniques. Estimation of the number of sources using eigen decomposition. Direction finding and true ranging PL systems. Elliptic and hyperbolic PL systems. TDOA estimation techniques.

Text Books


Reference Book

2. Recent literature in Smart Antennas.

COURSE OUTCOMES

Students are able to

- CO1: compare the performances of digital radio receivers and software radios.
- CO2: study the CDMA spatial processors to analyze the multi-cell systems.
- CO3: analyze the channel models for smart antenna systems.
- CO4: study the environmental parameters for signal processing of smart antenna systems.
- CO5: evaluate the requirements for the design and implementation of smart antenna systems.
M.Tech. (Communication Systems)  
Department of Electronics and Communication Engineering

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**COURSE OBJECTIVE**
- To analyse the various design issues and challenges in the layered architecture of Ad hoc wireless networks

**COURSE CONTENT**

Design goals of a MAC protocol, Contention based protocols; Contention based protocols with reservation mechanisms and scheduling mechanisms, MAC protocols using directional antennas.

Table driven routing protocols, On demand routing protocols, hybrid routing protocols, Hierarchical routing protocols, Power aware routing protocols, Tree based and mesh based multicast routing protocols

Network security requirements-Issues and challenges, network security attacks, key management, secure routing protocols

Energy management schemes-Battery management, transmission power management, system power management schemes. Quality of service solutions in ad hoc wireless networks.

**Text books**
2. Stefano Basagni, Marco Conti, “Mobile ad hoc networking”, Wielyinterscience 2004

**References books**
2. George Aggelou,"Mobile ad hoc networks-From wireless LANs to 4G networks, McGraw Hill publishers, 2005
3. Recent literature in Ad Hoc Networks.

**COURSE OUTCOMES**
Students are able to
- CO1: compare the differences between cellular and ad hoc networks and the analyse the challenges at various layers and applications
- CO2: summarize the protocols used at the MAC layer and scheduling mechanisms
- CO3: compare and analyse types of routing protocols used for unicast and multicast routing
- CO4: examine the network security solution and routing mechanism
- CO5: evaluate the energy management schemes and Quality of service solution in ad hoc networks
M.Tech. (Communication Systems)  
Department of Electronics and Communication Engineering

<table>
<thead>
<tr>
<th>Course Code</th>
<th>EC619</th>
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<tbody>
<tr>
<td>Course Title</td>
<td>Wavelet Signal Processing</td>
</tr>
<tr>
<td>Number of Credits</td>
<td>3</td>
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<tr>
<td>Course Type</td>
<td>Elective</td>
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</table>

**COURSE OBJECTIVE**

- To expose the students to the basics of wavelet theory and to illustrate the use of wavelet processing for data compression and noise suppression.

**COURSE CONTENT**


Wavelet methods for image processing. Burt-Adelson and Mallat’s pyramidal decomposition schemes. 2D-dyadic wavelet transform.

**Text Books**


**Reference Books**

1. A.Teolis, Computational Signal Processing with Wavelets, Birkhauser, 1998
4. Recent literature in Wavelet Signal Processing.

**COURSE OUTCOMES**

Students are able to

- CO1: understand about windowed Fourier transform and difference between windowed Fourier transform and wavelet transform.
- CO2: understand wavelet basis and characterize continuous and discrete wavelet transforms
- CO3: understand multi resolution analysis and identify various wavelets and evaluate their time-frequency resolution properties
- CO4: implement discrete wavelet transforms with multirate digital filters
- CO5: understand about wavelet packets
- CO6: design certain classes of wavelets to specification and justify the basis of the application of wavelet transforms to different fields.
**Course Code**: EC620  
**Course Title**: WDM Optical Networks  
**Number of Credits**: 3  
**Course Type**: Elective

### COURSE OBJECTIVES
- To prepare the students understand the building blocks of optical network architecture.
- To enable the students appreciate the different routing networks in the WDM technology.
- To design optical network topology and routing to serve a defined application.

### COURSE CONTENT


Virtual topology design problem, light path routes, implementation in broadcast and select networks.

### Text Books
1. R.Ramaswami & K.N.Sivarajan, Optical Networks, A Practical Perspective (3/e), Elsevier, 2010

### Reference Books
4. Recent literature in WDM Optical Networks.

### COURSE OUTCOMES
Students are able to
- CO1: understand the structure of the first generation networks and SONET.
- CO2: understand the salient features of WDM network architecture of the optical amplifiers
- CO3: analyse various methods of optical nodal design and routing.
- CO4: compare the merits and demerits of various wavelength networks.
- CO5: design the virtual topology and routing for the select optical networks.
**Course Code** : EC621
**Course Title** : Advanced Techniques for Wireless Reception
**Number of Credits** : 3
**Course Type** : Elective

**COURSE OBJECTIVE**
- To get an understanding of signal processing techniques for emerging wireless systems.

**COURSE CONTENT**

Robust multiuser detection for non Gaussian channels; asymptotic performance, implementation aspects.

Adaptive array processing in TDMA systems. Optimum space-time multiuser detection. Turbo multiuser detection for synchronous and turbo coded CDMA.


**Text Books**

**Reference Books**
4. Recent literature in Advanced Techniques for Wireless Reception.

**COURSE OUTCOMES**
Students are able to
- CO1: discuss the Wireless signaling environment and Performance issues.
- CO2: analyze the channel modeling and multiuser detection.
- CO3: analyze the Adaptive array processing and turbo coded CDMA.
- CO4: analyze Linear and nonlinear predictive techniques.
- CO5: analyze the Signal Processing Techniques for wireless reception.
M.Tech. (Communication Systems)  
Department of Electronics and Communication Engineering

<table>
<thead>
<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>Course Title</td>
<td>Error Control Coding</td>
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<tr>
<td>Number of Credits</td>
<td>3</td>
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<tr>
<td>Course Type</td>
<td>Elective</td>
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</tbody>
</table>

**COURSE OBJECTIVE**

- To explain the importance of modern coding techniques in the design of digital communication systems.

**COURSE CONTENT**


Space-time codes. MIMO systems. Space-time codes. MIMO systems. Space-time block codes (STBC) – decoding of STBC.

**Text Books**


**Reference Books**

4. Recent literature in Error Control Coding.

**COURSE OUTCOMES**

Students are able to

- CO1: understand the need for error correcting codes in data communication and storage systems.
- CO2: identify the major classes of error detecting and error correcting codes and how they are used in practice. Construct codes capable of correcting a specified number of errors.
- CO3: use the mathematical tools for designing error correcting codes, including finite fields.
- CO4: explain the operating principles of block codes, cyclic codes, convolution codes, modulation codes, Turbo codes etc.
- CO5: design an error correcting code for a given application.
- CO6: understand the fundamental limits of error correction. Develop and execute encoding and decoding algorithms associated with the major classes of error detecting and error correcting codes.
Course Code : EC623  
Course Title : Digital Communication Receivers  
Number of Credits : 3  
Course Type : Elective

COURSE OBJECTIVE
- To expose the students to the latest trends in the design of digital communication receivers with particular emphasis on synchronization, channel estimation and signal processing aspects.

COURSE CONTENT
Baseband PAM. Clock recovery circuits. Error tracking and spectral – line generating synchronizers. Squaring and Mueller and Muller synchronizers.


ML synchronization algorithms – DD and NDA. Timing parameter and carrier phase estimation – DD and NDA.

Performance analysis of carrier and symbol synchronizers. Feedback and feed forward synchronizers. Cycle slipping Acquisition of carrier phase and symbol timing.


Text Books

Reference Books
3. Recent literature in Digital Communication Receivers.

COURSE OUTCOMES
Students are able to
- CO1: summarize baseband PAM and Synchronizers.
- CO2: model and distinguish the channels.
- CO3: interpret optimum receivers and matched filter receivers.
- CO4: summarize phase and carrier estimation methods.
- CO5: compare carrier and symbol synchronizers.
- CO6: distinguish various fading channels.
**Course Code**: EC624

**Course Title**: Analysis Methods for Passive MIC

**Number of Credits**: 3

**Course Type**: Elective

**COURSE OBJECTIVE**

- To make the students confident in designing M, I, C, components in any planar transmission line and also to familiarize multi layer structure.

**COURSE CONTENT**

Parameters of planar transmission line variants. Static and dynamic analysis methods for microstripline, coplanar waveguide, coplanar strips, striplines and slot line.

Spectral domain methods. Formulation of quasi static and dynamic spectral domain analyses. Galekin’s method.


Coplanar lines, quasi-static and full wave analysis. Design equations. Comparison with microstrip and slot lines.

General analysis of coupled lines. Design considerations for microstrip lines and coplanar waveguides.

**Text Books**


**Reference Book**

3. Recent literature in Passive MIC.

**COURSE OUTCOMES**

Students are able to

- CO1: analyze any planar transmission lines, usage of different planar transmissions lines for various frequencies and for various antennas.
- CO2: appreciate the features of different spectral domain methods.
- CO3: understand the hybrid mode analysis and its application in planar transmission lines
- CO4: understand the analysis and design equations of coplanar lines and
- CO5: appreciate the design considerations of microstrip and coplanar waveguides.
M.Tech. (Communication Systems)  
Department of Electronics and Communication Engineering

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<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>Course Title</td>
<td>Electromagnetic Metamaterials</td>
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<tr>
<td>Number of Credits</td>
<td>3</td>
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<td>Course Type</td>
<td>Elective</td>
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</table>

**COURSE OBJECTIVE**

- To understand the properties of metamaterials and MTM inspired structures for antenna performance improvement, microwave components.

**COURSE CONTENT**


An overview of different types of SRR and CSRR, Equivalent circuit model for MSRR, Labyrinth and spiral resonator, Parameters extraction using NRW approach.

LH-TL loaded antenna, Electrically small antenna, Thin wavelength resonator design , Partial metamaterial loading, Sub-wavelength antenna, Metamaterial substrate, Metamaterial superstrate , CSRR loaded antenna, OCSRR loaded monopole antenna, Bandwidth enhancement, Notch function using SRR in UWB antenna , MTM inspired antenna.


**Text Book**


**COURSE OUTCOMES**

Students are able to

- CO1: learn and understand the properties of metamaterials and the effect of properties on fundamental phenomena
- CO2: understand the theory of Transmission line theory of Metamaterials.
- CO3: discuss different types of SRR and to derive equivalent circuit
- CO4: discuss the metamaterial properties for performance enhancement of antenna.
- CO5: learn the design of microwave components using metamaterials.
M.Tech. (Communication Systems)  
Department of Electronics and Communication Engineering

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<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>Course Title</td>
<td>Bio MEMS</td>
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<tr>
<td>Number of Credits</td>
<td>3</td>
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<td>Course Type</td>
<td>Elective</td>
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COURSE OBJECTIVE
- To train the students in the design aspects of Bio MEMS devices and Systems. To make the students aware of applications in various medical specialists especially the Comparison of conventions methods and Bio MEMS usage.

COURSE CONTENT
Introduction-The driving force behind Biomedical Applications – Biocompatibility - Reliability Considerations-Regularity Considerations – Organizations - Education of Bio MEMS-Silicon Micro fabrication-Soft Fabrication techniques


SENSOR PRINCIPLES and MICRO SENSORS: Introduction-Fabrication-Basic Sensors-Optical fibers-Piezo electricity and SAW devices-Electrochemical detection-Applications in Medicine


Text Book

Reference Books
6. Recent literature in Bio MEMS.

COURSE OUTCOMES
Students are able to
CO1: learn and realize the MEMS applications in Bio Medical Engineering
CO2: understand the Micro fluidic Principles and study its applications.
CO3: learn the applications of Sensors in Health Engineering.
CO4: learn the principles of Micro Actuators and Drug Delivery system
CO5: learn the principles and applications of Micro Total Analysis
Course Code: EC627
Course Title: Substrate Integrated Waveguide Technology: Design and Analysis
Number of Credits: 3
Course Type: Elective

COURSE OBJECTIVE
- To make the students familiar with Substrate Integrated Waveguide (SIW) Technology with emphasis on Circuits Analysis, Design and Layout of SIW components.

COURSE CONTENT


Even-Odd Mode Analysis of a Symmetrical Circuit, Half circuit with PMC symmetry wall, half circuit with PEC symmetry wall, Microstrip or planar transmission line to SIW Transition and Half Mode SIW.

Substrate Integrated Circuits (SICs) and components, Filters, couplers Mixers, Amplifiers and SIW antennas.

Numerical Technique for SIW analysis: Methods of line.

Reference Books
3. Recent literature in Substrate Integrated Waveguide Technology.

COURSE OUTCOMES
Students are able to
- Gain knowledge & will be employable in all the corporate and R&D sections deals with Microwave Integrated Circuits.
M.Tech. (Communication Systems)  
Department of Electronics and Communication Engineering

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<tr>
<th>Course Code</th>
<th>EC628</th>
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<tbody>
<tr>
<td>Course Title</td>
<td>Pattern recognition and computational intelligence</td>
</tr>
<tr>
<td>Number of Credits</td>
<td>3</td>
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<tr>
<td>Course Type</td>
<td>Elective</td>
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</table>

**COURSE OBJECTIVE**

- The subject aims to make the students to understand the mathematical approach for pattern recognition and computational intelligence

**COURSE CONTENT**


Linear models for regression and classification: Linear basis function models for regression - Bias variance decomposition-Bayesian linear regression-Discriminant functions - Fisher’s linear discriminant analysis (LDA) - Principal Component Analysis (PCA) - Probabilistic generative model - Probabilistic discriminative model- Independent Component Analysis (ICA)


Neural networks: Feed-forward Network functions-Network training - Error Back propagation - The Hessian Matrix - Regularization in Neural Network - Mixture density networks – Bayesian Neural Networks - Particle swarm optimization-Genetic algorithm-Ant colony optimization-Bacterial foroging-Simulated annealing – Fuzzy logic systems

**Text Books**


**Reference Books**

2. Recent literature in Pattern recognition and computational intelligence.

**COURSE OUTCOMES**

Students are able to

- CO1: summarize the various techniques involved in pattern recognition  
- CO2: identify the suitable pattern recognition techniques for the particular applications.  
- CO3: categorize the various pattern recognition techniques into supervised and unsupervised.  
- CO4: summarize the mixture models based pattern recognition techniques  
- CO5: summarize the various computational intelligence techniques for pattern recognition
Course Code: EC629
Course Title: Photonic Integrated Circuits
Number of Credits: 3
Course Type: Elective

COURSE OBJECTIVE
- The photonic integrated circuits course will introduce the basics of various integrated optical waveguides and devices used in optical communication applications.
- This course also covers materials and fabrication technology for optical integrated circuits.

COURSE CONTENT

Directional couplers, Coupled mode analysis of uniform and reverse delta-beta couplers. Applications as power splitters, Y-junction, optical switch; Phase and amplitude modulators, filters, A/D converters, Y-splitters, Mode splitters, polarization splitters; Mach-Zehnder interferometer based devices.

Acousto-optic waveguide devices. Arrayed waveguide devices, Nano-photonic-devices: Metal/dielectric plasmonic waveguides, long and short range surface Plasmon modes supported by thin metal films, applications in waveguide polarizers.


Nonlinear effects in integrated optical waveguides, Self-phase modulation, Cross-phase modulation, Four-wave mixing, Stimulated Brillouin Scattering, Stimulated Raman Scattering.

Reference Books
3. T. Tamir, Guided wave opto-electronics, Springer Verlag, 1990
7. Recent journals and conference proceedings.

COURSE OUTCOMES
Students are able to
- CO1: Summarize the fundamental concept of optical waveguides.
- CO2: Construct the different types of optical waveguides.
- CO3: Construct the couplers, modulators and devices for communication applications
- CO4: Summarize fabrication technologies for design of optical waveguides
- CO5: Describe the various nonlinear effects in integrated optical waveguides.
COURSE OBJECTIVE

- The objective of this course is to understand the basic concepts and working principles of various optical fibers based photonic sensors.
- This course will be useful to design and develop sensors for sensing various physical parameters in practical applications.

COURSE CONTENT

Review of propagation characteristics of single, multimode optical fibers and Photonic crystal fibers. Surface Plasmon modes supported by metal-dielectric interface.


Fiber optic SAGNAG interferometer sensors, SAGNAG effect, Fiber Optic gyros, Mach-Zehnder interferometer sensors. Fiber optic magnetic, current sensors.


Distributed optical fiber sensors, Optical scattering in fiber, Sensors based on Rayleigh, Raman and Brillouin scattering. Fiber sensors based on Surface Plasmon Resonance (SPR) and Surface Plasmon wave (SPW). Photonic crystal fiber sensors. Noise effects in sensors.

Reference Books
2. B.P.Pal, Guided Wave Optical Components and Devices, Elsevier, 2005
6. Recent journals publications and conference proceedings.

COURSE OUTCOMES

Students are able to
- CO1: Summarize the basic propagation principle in optical fibers.
- CO2: Construct the different types of modulators for optical fiber sensors.
- CO3: Construct the grating sensors and distributed sensors in fibers.
- CO4: Describe the theoretical principle of fiber sensors based on surface Plasmon effect.
- CO5: Describe the design of application specific fiber optic sensors.
Course Code: EC631
Course Title: Optical Wireless Communications
Number of Credits: 3
Course Type: Elective

COURSE OBJECTIVE
- This subject provides the in-depth knowledge in Optical Wireless Communication systems. It covers the emerging Optical wireless communication trends and their applications.

COURSE CONTENT

Optical wireless communication theory - channel modeling - Indoor optical wireless communication channel-LOS propagation model-Spherical and Guassian wave model-outdoor channel- Attenuation-Beam Wander-Turbulence (Scintillation/Fading)-Turbidity (rain, fog, snow)-Cloud-free line of sight-log normal negative exponential- gamma-gamma turbulence model-modulation schemes for optical wireless- Analogue intensity modulation-Digital base band-pulse modulation-subcarrier intensity modulation -optical polarization shift keying- BER performance analysis

Free space optical communications: Introduction-operating principles-characteristics-Qos and availability--FSO OFDM communication-FSO underwater- Free space optical networks-laser satellite communication.

Coded modulation techniques for OWC- Coded MIMO for OWC- Indoor OWC MIMO channel-Point to point OW MIMO communications- MIMO FSO-Wireless optical CDMA Communication system-System description-indoor wireless optical CDMA-FSO CDMA

Visible light communications- VLC principle- VLC system model- system implementation-VLC applications

Reference Books
6. Recent literature in Optical Wireless Communication.

COURSE OUTCOMES
Students are able to

CO 1: interpret the principles of Optical wireless communication devices and systems.
CO 2: model the channel for indoor and outdoor OWC systems and analyze the impact of modulation techniques on bandwidth and power efficiency.
CO 3: summarizes the free space optical communication and Laser satellite communication.
CO 4: summarizes the coded modulation techniques for OWC, coded MIMO and CDMA techniques in FSO.
**Course Code**: EC632  
**Course Title**: Foundations of Artificial Intelligence  
**Number of Credits**: 3  
**Course Type**: Elective

**COURSE OBJECTIVE**
- Approaches to produce “intelligent” systems, Knowledge representation (both symbolic and neural network), search and machine learning.
- To learn the principles and fundamentals of designing AI programs.

**COURSE CONTENT**


Reasoning under Uncertainty: Review of basic probability, Random variables and probability distributions: Axioms of probability, Probabilistic inference, Bayes’ Rule, Conditional Independence, Knowledge representations using Bayesian Networks, Randomized sampling (Monte Carlo) methods (e.g. Gibbs sampling), Markov Networks, Relational probability models, Hidden Markov Models, Decision Theory Preferences and utility functions, Maximizing expected utility.

Agents: Definitions of agents, Agent architectures (e.g., reactive, layered, cognitive), Agent theory, Rationality, Game Theory Decision-theoretic agents, Markov decision processes (MDP), Software agents, Personal assistants, and Information access Collaborative agents, Information-gathering agents, Believable agents (synthetic characters, modelling emotions in agents), Learning agents, Multi-agent systems Collaborating agents, Agent teams, Competitive agents (e.g., auctions, voting), Swarm systems and Biologically inspired models. manifold learning. Game theory.

**Text Books**


**Reference Books**

2. Rainer Unland, Matthias Klusch, Monique Calisti,“Software agent based applications, platforms and development kits”, Whitestein series in software agent technologies, 2005

**COURSE OUTCOMES**

Students are able to
- CO1: To learn the concepts of artificial intelligence
- CO2: To study problem solving techniques
- CO3: To understand the representation of knowledge and reasoning mechanism
- CO4: To learn to construct plans of actions
- CO5: To study network models used for learning agents
Course Code : EC633
Course Title : Introduction to Soft Computing and Machine Learning
Number of Credits : 3
Course Type : Elective

COURSE OBJECTIVE
- Focus on fundamental concepts and techniques for approaching artificial intelligence.

COURSE CONTENT


Fuzzy logic control – Case studies: Inverted pendulum – Home heating system – Mountain car problem. Introduction, Building block hypothesis, working principle, Basic operators and Terminologies like individual, gene, encoding, fitness function and reproduction, Genetic modeling: Significance of Genetic operators, Inheritance operator, cross over, inversion & deletion, mutation operator, Bitwise operator, GA optimization problems, JSP (Job Shop Scheduling Problem), TSP (Travelling Salesman Problem), Differences & similarities between GA & other traditional methods, Applications of GA.


Text Books
2. N.P. Padhy, ”Artificial Intelligence and Intelligent Systems” Oxford University Press.

Reference Books
COURSE OUTCOMES
Students are able to
CO1: To explain theory underlying Soft computing
CO2: To construct algorithms to learn neural network models
CO3: To implement fuzzy logic algorithms
CO4: To construct algorithms to learn Genetic Algorithm models
CO5: To apply reinforcement learning techniques

Course Code : EC656
Course Title : Design of ASICs
Number of Credits : 3
Course Type : Elective

COURSE OBJECTIVES
- To prepare the student to be an entry-level industrial standard ASIC or FPGA designer.
- To give the student an understanding of issues and tools related to ASIC/FPGA design and implementation.
- To give the student an understanding of basics of System on Chip and Platform based design.
- To give the student an understanding of High performance algorithms

COURSE CONTENT
Semicustom Approach: Synthesis (RTL to GATE netlist) - Introduction to Constraints (SDC), Introduction to Static Timing Analysis (STA). Place and Route (Logical to Physical Implementation): Floorplan and Power-Plan, Placement, Clock Tree Synthesis (clock planning), Routing, Timing Optimization, GDS generation.
System-On-Chip Design - SoC Design Flow, Platform-based and IP based SoC Designs, Basic Concepts of Bus-Based Communication Architectures. High performance algorithms for ASICs/ SoCs as case studies – Canonic Signed Digit Arithmetic, KCM, Distributed Arithmetic, High performance digital filters for sigma-delta ADC.

Text Book

Reference Books
6. Recent literature in Design of ASICs

COURSE OUTCOMES
Students able to

CO1: demonstrate VLSI tool-flow and appreciate FPGA and CPLD architectures
CO2: understand the issues involved in ASIC design, including technology choice, design management and tool-flow.
CO3: understand the algorithms used for ASIC construction.
CO4: understand Full Custom Design Flow and Tool used
CO5: understand Semicustom Design Flow and Tool used - from RTL to GDS and Logical to Physical Implementation
CO6: understand about STA, LEC, DRC, LVS, DFM
CO7: understand the basics of System on Chip and on chip communication architectures appreciate high performance algorithms for ASICs

Course Code : EC662
Course Title : Modeling and Synthesis with Verilog HDL
Number of Credits : 3
Course Type : Elective

COURSE OBJECTIVES

- To design combinational, sequential circuits using Verilog HDL.
- To understand behavioral and RTL modeling of digital circuits
- To verify that a design meets its timing constraints, both manually and through the use of computer aided design tools
- To simulate, synthesize, and program their designs on a development board
- To verify and design the digital circuit by means of Computer Aided Engineering tools which involves in programming with the help of Verilog HDL.

COURSE CONTENT

Hardware modeling with the verilog HDL. Encapsulation, modeling primitives, different types of description.

Logic system, data types and operators for modeling in verilog HDL. Verilog Models of propagation delay and net delay path delays and simulation, inertial delay effects and pulse rejection.

Behavioral descriptions in verilog HDL. Synthesis of combinational logic.

HDL-based synthesis - technology-independent design, styles for synthesis of combinational and sequential logic, synthesis of finite state machines, synthesis of gated clocks, design partitions and hierarchical structures.

Synthesis of language constructs, nets, register variables, expressions and operators, assignments and compiler directives. Switch-level models in verilog. Design examples in verilog.

Text Books


Reference Books

3. Recent literature in Modeling and Synthesis with Verilog HDL.

COURSE OUTCOMES

Students are able to

CO1: understand the basic concepts of verilog HDL
CO2: model digital systems in verilog HDL at different levels of abstraction
CO3: know the simulation techniques and test bench creation.
CO4: understand the design flow from simulation to synthesizable version  
CO5: get an idea of the process of synthesis and post-synthesis

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<tr>
<th>Course Code</th>
<th>EC663</th>
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<tr>
<td>Course Title</td>
<td>Optimizations of Digital Signal Processing Structures for VLSI</td>
</tr>
<tr>
<td>Number of Credits</td>
<td>3</td>
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<tr>
<td>Course Type</td>
<td>Elective</td>
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## COURSE OBJECTIVE
- To understand the various VLSI architectures for digital signal processing.
- To know the techniques of critical path and algorithmic strength reduction in the filter structures.
- To enable students to design VLSI system with high speed and low power.
- To encourage students to develop a working knowledge of the central ideas of implementation of DSP algorithm with optimized hardware.

## COURSE CONTENT
An overview of DSP concepts, Pipelining of FIR filters. Parallel processing of FIR filters. Pipelining and parallel processing for low power, Combining Pipelining and Parallel Processing.

Transformation Techniques: Iteration bound, Retiming, Folding and Unfolding

Pipeline interleaving in digital filters. Pipelining and parallel processing for IIR filters. Low power IIR filter design using pipelining and parallel processing, Pipelined adaptive digital filters.

Algorithms for fast convolution: Cook-Toom Algorithm, Cyclic Convolution. Algorithmic strength reduction in filters and transforms: Parallel FIR Filters, DCT and inverse DCT, Parallel Architectures for Rank-Order Filters.

Synchronous pipelining and clocking styles, clock skew and clock distribution in bit level pipelined VLSI designs. Wave pipelining, constraint space diagram and degree of wave pipelining. Implementation of wave-pipelined systems, Asynchronous pipelining.

### Text Book

### Reference Books
7. Recent literature in Optimizations of Digital Signal Processing Structures for VLSI.

## COURSE OUTCOMES
Students are able to
- CO1: understand the overview of DSP concepts and design architectures for DSP algorithms.  
- CO2: improve the overall performance of DSP system through various transformation and optimization techniques.  
- CO3: perform pipelining and parallel processing on FIR and IIR systems to achieve high speed and low power.  
- CO4: optimize design in terms of computation complexity and speed.  
- CO5: understand clock based issues and design asynchronous and wave pipelined systems
# M.Tech. (Communication Systems)  
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<tr>
<th>Course Code</th>
<th>EC664</th>
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<tbody>
<tr>
<td>Course Title</td>
<td>Cognitive Radio</td>
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<tr>
<td>Number of Credits</td>
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<td>Course Type</td>
<td>Elective</td>
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## COURSE OBJECTIVE
- This subject introduces the fundamentals of multi rate signal processing and cognitive radio.

## COURSE CONTENT


## Text Books

## Reference Books
5. T. DarcChiueh, P. Yun Tsai,” OFDM baseband receiver design for wireless communications”, Wiley, 2007
6. Recent literature in Cognitive Radio.

## COURSE OUTCOMES
Students are able to
- CO1: gain knowledge on multirate systems.
- CO2: develop the ability to analyze, design, and implement any application using FPGA.
- CO3: be aware of how signal processing concepts can be used for efficient FPGA based system design.
- CO4: understand the rapid advances in Cognitive radio technologies.
- CO5: explore DDFS, CORDIC and its application.