KERALA TECHNOLOGICAL UNIVERSITY
(PALAKKAD CLUSTER)

PROPOSED DRAFT OF SCHEME AND SYLLABI FOR
M.Tech
in
COMMUNICATION ENGINEERING AND SIGNAL PROCESSING
(ELECTRONICS AND COMMUNICATION ENGINEERING)

(2015 Admission onwards)
M.Tech Programme
In
Communication Engineering and Signal Processing
(Electronics and Communication Engineering)

Program Overview:

M. Tech. Communication Engineering and Signal Processing programme aims at equipping the students with knowledge of communication engineering and signal processing. The technical skills and ability to pursue high end research in the field of communication and signal processing are also provided.

Programme Educational Objectives:

- The graduates will become eminent communication engineers capable of playing significant role in their relevant field or carrying out related research activities at academic and research institutions.
- The graduates will become the experts of digital signal processing in the areas like Speech, Image and Biomedical signals along with relevant processor architectures.
- The graduates will apply their knowledge and skills of communication engineering and signal processing with an understanding of realistic constraints for the overall benefit of the society.
- The graduates will work and communicate effectively in inter-disciplinary environment, either independently or in a team, and demonstrate leadership qualities.
- The graduates will engage in life-long learning and professional development through self-study, continuing education or professional and doctoral level studies.
Programme Outcomes:

Upon completion of the programme, students will be able to:

• Apply advanced level knowledge, techniques, skills and modern tools of communication engineering and signal processing.

• Design advanced level communication systems, components, or processes to meet identified needs within economic, environmental and social constraints.

• Design advanced level signal processing systems in the areas of speech, image, biomedical signals, etc.

• Demonstrate the knowledge of communication engineering in various fields like signal processing, high performance networks, digital communication, etc.

• Identify, formulate, and solve communication engineering and signal processing related problems using advanced level computing techniques.

• Manage projects related to communication engineering and signal processing in multidisciplinary environments.

• Recognize the need to engage in lifelong learning through continuing education and research.

• Communicate effectively by oral, written, computing and graphical means.

• Function on multidisciplinary teams, working cooperatively, respectfully, creatively and responsibly as a member of a team.
# Scheme of M.Tech Programme in Communication Engineering and Signal Processing
(Electronics and Communication Engineering)

## SEMESTER-I

<table>
<thead>
<tr>
<th>SL NO</th>
<th>Exam Slot</th>
<th>Course Code</th>
<th>Subject</th>
<th>Hours/Week</th>
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L-Lecture; T-Tutorial; P-Practical; ICA-Internal Continuous Assessment; ESE-End Semester Examination

**ELECTIVE I**

08 EC 6251 (A): Information Theory
08 EC 6251 (B): Adaptive Signal Processing
08 EC 6251 (C): VLSI Circuits for Signal Processing
08 EC 6251 (D): Digital Image Processing

**Note:** 9 hours/week is meant for departmental assistance by students.
SEMESTER-II

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L-Lecture; T-Tutorial; P-Practical; ICA-Internal Continuous Assessment; ESE-End Semester Examination

ELECTIVE II

08 EC 6242 (A): Multirate Signal Processing and Filter Banks
08 EC 6242 (B): Spectral Analysis of Signals
08 EC 6242 (C): Spread Spectrum and CDMA Systems
08 EC 6242 (D): Markov Modeling and Queuing Theory

ELECTIVE III

08 EC 6252 (A): Communication Switching Theory
08 EC 6252 (B): Wavelets
08 EC 6252 (C): Communication Networks
08 EC 6252 (D): System Design Using Embedded Processors

Note: 9 hours/week is meant for departmental assistance by students.
### SEMESTER-III

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<th>Course Code</th>
<th>Subject</th>
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L-Lecture; T-Tutorial; P-Practical; ICA-Internal Continuous Assessment; ESE-End Semester Examination

**ELECTIVE IV**

08 EC 7211 (A): Signal Compression – Theory and Methods
08 EC 7211 (B): Speech and Audio Processing
08 EC 7211 (C): Biomedical Signal Processing
08 EC 7211 (D): DSP Algorithms and Architectures

**ELECTIVE V**

08 EC 7221 (A): Linear Systems Theory
08 EC 7221 (B): Linear and Nonlinear Optimization
08 EC 7221 (C): Transform Theory
08 EC 7221 (D): Information Hiding and Data Encryption

Note: The student has to undertake the departmental work assigned by HOD
## SEMESTER-IV

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L-Lecture; T-Tutorial; P-Practical; ICA-Internal Continuous Assessment; ESE-End Semester Examination

Note: The student has to undertake the departmental work assigned by HOD

## GRAND TOTAL FOR ALL SEMESTERS

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Course Objectives:
This course is intended to provide the necessary Mathematical foundation needed for the subjects to be dealt with in the program. After the completion of the course, the student should have a thorough understanding of Linear Algebra, Random Processes and their applications.

Course Outcomes:
Upon completion of the course, the student will be able to
- Apply algebraic equations and method of solving them.
- Apply special functions and processes, and solve problems associated with Engineering applications

Module I (7 hours)
Linear Algebra: Vector spaces, subspaces, Linear dependence, Basis and Dimension, Inner product spaces, Gram-Schmidt Orthogonalization Procedure

Module II (7 hours)
Linear transformations, Kernels and Images, Matrix representation of linear transformation, Change of basis, Eigen values and Eigen vectors of linear operator, Quadratic form.

Module III (12 hours)

Module IV (9 hours)

Module V (6 hours)
Continuous Time Markov Chains: General pure Birth processes and Poisson processes, Birth and death processes, Finite state continuous time Markov chains

Module VI (13 hours)


References:


Internal continuous assessment: 40 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

End semester Examination: 60 marks
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<tr>
<th>Module I (12 hours)</th>
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<th>Module IV (7 hours)</th>
<th>Module V (7 hours)</th>
<th>Module VI (14 hours)</th>
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References:


Internal continuous assessment: 40 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

End semester Examination: 60 marks
Course Objectives:
This is an extension of the principles of Digital Signal Processing, introduced in the undergraduate level. Upon completion of the course, the student must be able to design and implement various systems like filter banks, implement different means of spectral estimation and apply Digital Signal Processing principles to process speech and Radar signals.

Course Outcomes:
Upon completion of the course, the student will be able to
- Design digital filters and familiar with spectral estimation
- Get exposure to multirate signal processing.
- Apply DSP to speech and radar signal processing.

Module I (9 hours)

Module II (9 hours)
Design of IIR Digital Filters- Butterworth, Chebyshev and Elliptic Approximations; Lowpass, Bandpass, Bandstop and High pass filters

Module III (9 hours)
Multirate system fundamentals: Basic multirate operations – up-sampling and down sampling, Time domain and frequency domain analysis– Identities of multirate operations– Interpolator and decimator design– Rate conversion–Polyphase representation. Multirate filter banks.

Module IV (9 hours)
Parametric and non-parametric spectral estimation: Estimation of the Autocorrelation and power spectrum of random signals: periodogram- DFT in power spectrum estimation

Module V (9 hours)

Module VI (9 hours)
Application of DSP to Speech and Radar signal processing: Fourier analysis of non-stationary signals-speech and radar signals. Fourier analysis of stationary signals using Periodogram.
References:


Internal continuous assessment: 40 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

End semester Examination: 60 marks
08 EC 6241

DESIGN OF DIGITAL SIGNAL PROCESSING SYSTEMS

Hours/Week: Lecture – 3 hours

Credits – 3

Course Objectives:
Upon completion of this course, the student will be able to design systems using the popular Digital Signal Processor Family TMS 320 C64X.

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

- Implement real time digital filters.
- Apply DSP to various systems.

Module I (14 Hours)
Introduction to a popular DSP from Texas Instruments, CPU Architecture, CPU Data Paths and Control, Timers, Interrupts, Internal Data/Program Memory, External Memory Interface, pipelining

Module II (7 Hours)
Programming : Instruction Set and Addressing Modes ,TMS 320C64X CPU Simple programming examples using C and assembly.

Module III (7 Hours)
Typical DSP development system, support tools and files , compiler, assembler, Code composer studio, CODECs

Module IV (7 Hours)

Module V (6 Hours)
Real Time Implementation: Implementation of Real Time Digital filters using DSP ,Implementation of FFT applications using DSP , DTMF Tone Generation and Detection

Module VI (13 Hours)
DSP Application examples in CODEC : PLL ,Image processing, FSK modems, Voice detection and reverse playback, Multirate filters, PID controllers.
Current Trends in Digital Signal Processors , DSP Controllers

References:
1. Digital Signal Processing and Application with C6713 and C6416 DSK, Rulph Chassaing, Worcester Polytechnic Institute, A Wiley-Interscience Publication
2. Digital Signal Processing Implementation using the TMS320C6000 DSP Platform, 1st Edition; Naim Dahnoun
6. DSP Applications using 'C' and the TMS320C6X DSK, 1st Edition; Rulph Chassaing

**Internal continuous assessment: 40 marks**
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

**End semester Examination: 60 marks**
ELECTIVE I

08 EC 6251 (A) INFORMATION THEORY

Credits – 3

Hours/Week: Lecture – 3 hours

Course Objectives:
Gives detailed concepts in Information Theory. Upon completion of this course, the student will have a deep understanding of
- Information and its measurement
- Various source coding schemes
- Concept of Channel capacity for both discrete and continuous channels and Shannon’s theorems
- Rate distortion theory and its applications

Course Outcomes:
Upon completion of the course, the student will be able to
- Analyze the importance of entropy calculation.
- Design channels with different channel capacity.
- Analyze the rate distortion properties.

Module I (13 hours)

Module II (7 hours)
Source Coding: Uniquely decodable codes- Instantaneous codes- Kraft’s inequality – McMillan’s inequality-Average length of a code- Optimal codes- Shannon codes- Fano codes-

Module III (6 hours)
Huffman Coding –Optimality of Huffman Codes-Lempel Ziv codes- Shannon’s source coding theorem–Arithmetic coding.

Module IV (14 hours)
Channel Capacity: Properties-Data transmission over Discrete Memoryless Channels-Capacity of Binary symmetric and Binary Erasure channels-Computing channel capacity- Arimoto-Blahut algorithm- Fano’s inequality- Shannon’s Channel Coding Theorem

Module V (7 hours)
Continuous Sources and Channels: Information measure for Continuous sources and channels-Differential Entropy- Joint, relative and conditional differential entropy- Mutual information

Module VI (7 hours)
Waveform channels- Gaussian channels- Mutual information and Capacity calculation for
Band limited Gaussian channels- Shannon limit.

Rate Distortion Theory: Rate Distortion Function - Properties – Calculation of Rate Distortion Function for binary source Gaussian

References:

- T. Cover and Thomas, “Elements of Information Theory”, John Wiley & Sons
- T. Bergu, “Rate Distortion Theory a Mathematical Basis for Data Compression” PH Inc.

Internal continuous assessment: 40 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

End semester Examination: 60 marks
**Course Objectives:**
This course is intended to impart to the students the principles of
- Adaptive signal processing,
- different algorithms used for design of Adaptive Filters,
- Performance evaluation of systems
- Modelling systems like multipath communication channel
- Synthesis of filters.

**Course Outcomes:**
Upon completion of the course, the student will be able to
- Analyze the convergence issues, computational complexities and optimality of different filters
- develop adaptive systems for various applications

**Module I (8 Hours):**
Adaptive systems - definitions and characteristics - applications - properties- examples - adaptive linear combiner-input signal and weight vectors - performance function-gradient and minimum mean square error

**Module II (6 Hours):**
Introduction to filtering- smoothing and prediction - linear optimum filtering-orthogonality - Wiener - Hopf equation-performance surface

**Module III (14 Hours):**

**Module IV (13 Hours):**
LMS algorithm convergence of weight vector-LMS/Newton algorithm - properties - sequential regression algorithm - adaptive recursive filters - random-search algorithms - lattice structure - adaptive filters with orthogonal signals

**Module V (7 Hours):**
Applications-adaptive modelling and system identification-adaptive modelling for multipath communication channel, geophysical exploration, FIR digital filter synthesis

**Module VI (6 Hours):**
Inverse adaptive modelling, equalization, and deconvolution-adaptive equalization of telephone channels-adapting poles and zeros for IIR digital filter synthesis

**References:**
2. Simon Haykin, Adaptive Filter Theory, Pearson Education.
4. S. Thomas Alexander, Adaptive Signal Processing - Theory and Application,
Springer-Verlag.

**Internal continuous assessment: 40 marks**
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

**End semester Examination: 60 marks**
08 EC 6251 (C)  

VLSI CIRCUITS FOR SIGNAL PROCESSING

Hours/Week: Lecture – 3 hours

Credits – 3

Course Objectives:

Provides a detailed theory of the VLSI implementation of circuits used in Signal processing. Upon completion of the course, the student will have a thorough understanding of

- Modelling a MOS transistor at low and high frequencies
- Analysis and design of CMOS amplifiers, Opamps and switches
- Theory, application and implementation of switched capacitor circuits.

Course Outcomes:

Upon completion of the course, the student will be able to

- Design and analyze different configurations of CMOS Amplifier
- Design CMOS differential amplifier and CMOS Op-Amp.
- Design the Switched capacitor circuits.

Module I (12 Hours)

Analog, Digital and Sampled analog signals and systems, Transformation methods, Design of Sampled data filters from Continuous time models. The MOS transistor, small signal equivalent, short channel effects, Low frequency and High frequency models.

Module II (7 Hours)

Analog CMOS sub circuits: MOS switch, Current sinks and sources, Current mirrors, Current and Voltage references, Bandgap references,

Module III (7 Hours)

CMOS Amplifiers: Inverters, Differential amplifiers, Cascode amplifiers, Current amplifiers, Output amplifiers, High gain amplifier architectures.

Module IV (14 Hours)


Module V (7 Hours)

Switched Capacitor Circuits: Switched Capacitor Filters, Integrated Filters, Switched Capacitor Integrators, Stray insensitive integrators, Second order sections; cascade filter design

Module VI (7 Hours)

Switched capacitor filter design, Switched Capacitor Amplifiers and Integrators. Application of Switched Capacitor circuits in Data modems/Digital voice transmission systems.

References:

2. CMOS Analog Circuit Design; Phillip E. Allen, Douglas R. Holberg; Oxford University Press
3. Analysis and Design of Analog Integrated Circuits; Gray, Hurst, Lewis and Meyer; Wiley, India.

**Internal continuous assessment: 40 marks**
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

**End semester Examination: 60 marks**
Course Objectives:
Upon completion of this course, the student will have an understanding of various Monochrome and Colour Image processing methods, Image enhancement, Image segmentation, and image compression methods. The students are exposed to popular image compression standards like JPEG and JPEG 2000.

Course Outcomes:
Upon completion of the course, the student will be able to
- Analyze various techniques for image representation
- Analyze the image enhancement techniques.
- Analyze the colour image processing and image compression

Module I  (10 Hours)
Fundamental steps in digital image processing, Components of an image processing system, Image sampling and quantization, Some basic relationships between pixels, Linear and nonlinear operations, 2D convolution- 2D FFT, 2D-wavelet, contourlet transforms.

Module II  (9Hours)
Image enhancement techniques : Some basic gray level transformations, Histogram processing, Smoothing and Sharpening spatial filters, Image enhancement in frequency domain- Smoothing, and Sharpening frequency domain filters,

Module III  (8 Hours)
Homomorphic filtering, Image restoration: Noise models, Restoration in the presence of noise only-spatial filtering, Estimating the degradation functions, Inverse filtering.

Module IV  (9 Hours)
Colour image processing: colour models, pseudo-colour processing, image compression: image compression models, loss-less and lossy compression, JPEG and JPEG 2000

Module V  (8 Hours)
Morphological image processing: dilation and erosion, opening and closing, some basic morphological algorithms.

Module VI  (10 Hours)
Image segmentation: Detection of discontinuities, Edge linking and boundary detection, Thresholding, Region based segmentation, applications of digital image processing in medical, recent developments, Image fusion, pseudo colouring.

References:
1. R. C. Gonzalez and R.E. Woods - Digital Image Processing, Pearson
   Processing, Pearson Education

**Internal continuous assessment: 40 marks**

Internal continuous assessment is in the form of periodical tests,
assignments, seminars or a combination of these. There will be a
minimum of two tests in each subject.

**End semester Examination: 60 marks**
Course Objectives

The main objective of the course is to provide a familiarization with research methodology and to induct the student into the overall research process and methodologies. This course addresses:
The scientific research process and the various steps involved formulation of research problem and research design, design of experiments, thesis preparation and presentation, research proposals, publications and ethics; Important research methods in engineering.
As a tutorial type course, this course is expected to be more learner centric and active involvement from the learners are expected which encourages self-study and group discussions. The faculty mainly performs a facilitator’s role.

Syllabus:

Course Outcome:
At the end of course, the student will be able to:
Discuss research methodology concepts, research problems, research designs, thesis preparations, publications and research methods.
Analyze and evaluate research works and to formulate a research problem to pursue research
Prepare a thesis or a technical paper, and present or publish them
Apply the various research methods followed in engineering research for formulation and design of own research problems and to utilize them in their research project.

Reference Books:
Research Methodology, Integration of principles”, Methods and Techniques, Pearson Education

COURSE PLAN

MODULE: 1
Overview of Research Methodology: Research concepts – meaning – objectives – motivation - types of research –research process – criteria for good research – problems encountered by Indian researchers - scientific method - research design process

MODULE: 2

MODULE: 3

MODULE: 4
MODULE: 5

MODULE: 6
Research Methods – Measurement, sampling and Data acquisition: Measurement design – errors - validity and reliability in measurement - scaling and scale construction - sample design - sample size determination - sampling errors - data collection procedures - sources of data – data collection methods - data preparation and data analysis

Internal continuous assessment: 100 marks
Course Objectives:
This course is intended for
- Increasing the breadth of knowledge
- Enhancing the ability of self study
- Improving presentation and communication skills
- Augmenting the skill of Technical Report Writing.

Students have to register for the seminar and select a topic of their interest from Communication / Signal Processing or related topics from outside the syllabus in consultation with any faculty member offering courses for the programme. A detailed write-up on the topic of the seminar is to be prepared in the prescribed format given by the Department. The seminar shall be of 30 minutes duration and a committee with the Head of the department as the chairman and two faculty members from the department as members shall evaluate the seminar based on the coverage of the topic, presentation and ability to answer the questions put forward by the committee.

Internal continuous assessment: 100 marks
Course Objectives:
This course enables the students to explore the concepts of designing and implementing various systems using DSP kits, Simulate and study various systems using MATLAB.

Course Outcomes:
Upon completion of the course, the student will be able to
- Design and implement various filters and systems
- Simulate various systems using MATLAB

Tools:
Numerical Computing Environments – GNU Octave or MATLAB or any other equivalent tool, DSP Kits.

List of Experiments:
1. Generation of waveforms and observation of the output using the graphical display utility of integrated Development Environment (IDE)
2. Generation of a sine function and sampling of generated sine waveform. Observation of the spectrum and windowing effect.
3. Implementation of linear convolution on 1D and 2D signals.
4. Implementation of circular convolution on 1D and 2D signal
5. Implementation of FIR filter (Filter coefficients may be obtained from MATLAB)
6. Implementation of FIR filter (Filter coefficients may be obtained from MATLAB)
7. Verification of FIR and IIR filters by inputting a signal from the signal generator (configure the codec in the DSP development board)
8. Implementation of simple algorithms in audio and image processing
9. Real time data exchange between MATLAB and IDE to transfer the data from computer to Development kit.
10. Assembly language programming
   i) Implementation of linear convolution
   ii) Implementation of circular convolution

Internal continuous assessment: 100 marks
Practical Records/Outputs: 40%
Regular Class Viva Voce: 20%
Final Test: 40%
SEMESTER-II
CORE SUBJECTS

08 EC 6212  WIRELESS COMMUNICATION  Hours/Week: Lecture – 3 hours  Credits – 3

Course Objectives:
This course gives a thorough treatment of the principles of Wireless Mobile communication.
Upon completion of the course, the student will have knowledge about
• Different types of fading in wireless channels and their mitigation
• Diversity schemes and MIMO channels
• Cellular communication systems – GSM and CDMA
• Cellular communication standards

Course outcomes
Upon completion of the course, the student will be able to
• Analyze the Different types of fading in wireless channels and their mitigation
• Analyze the Diversity schemes and MIMO Channels
• Analyze the multiple access techniques.
• Analyze the cellular communication systems – GSM and CDMA

Module I (6 hours)
Fading: Wireless Channel Models- path loss and shadowing models- statistical fading models- Narrow band and wideband fading models- Review of performance of digital modulation schemes over wireless channels

Module II (7 hours)

Module III (13 hours)
Fading Channel Capacity: Capacity of Wireless Channels- Capacity of flat and frequency selective fading channels- Multiple Input Multiple output (MIMO) systems- Narrow band multiple antenna system model- Parallel Decomposition of MIMO Channels- Capacity of MIMO Channels.

Module IV (13 hours)
Module V (7 hours)


Module VI (8 hours)

Cellular Wireless Communication Standards-Second generation cellular systems: Brief discussion specifications on GSM, CDMA, Wideband CDMA, Wi-Fi, Wi-max
Introduction to multicarrier Communication: OFDM, MCCDMA

References:


Internal continuous assessment: 40 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

End semester Examination: 60 marks
**Course Objectives:**
Upon completion of this course, the students will have an understanding of the different criteria and methods used in detection theory, Methods and measures of estimation, Properties and characteristics of estimators and principles of state estimation.

**Course Outcomes:**
Upon completion of the course, the student will be able to
- Analyze the Signal detection in the presence of noise
- Apply the concepts of estimation and detection in various signal processing applications.

**Module I (8 hours)**
Detection theory: Binary decisions - Single observation. Maximum likelihood decision criterion; Neymann-Pearson criterion; Probability of error criterion

**Module II (9 hours)**
Bayes risk criterion; Minimax criterion; Robust detection; Receiver operating characteristics. Binary decisions - Multiple observations

**Module III (9 hours)**
Vector observations- The general Gaussian problem
Waveform observation in additive Gaussian noise; The integrating optimum receiver; Matched filter receiver.

**Module IV (10 hours)**
Estimation theory: Methods
Maximum likelihood estimation; Bayes cost method Bayes estimation criterion - Mean square error criterion; Uniform cost function; absolute value cost function
Linear minimum variance - Least squares method; Estimation in the presence of Gaussian noise - Linear observation; Non-linear estimation.

**Module V (9 hours)**
Properties of estimators: Bias, Efficiency, Cramer Rao bound Asymptotic properties; Sensitivity and error analysis.
State estimation: Prediction; Kalman filter

**Module VI (9 hours)**
Sufficient statistics and statistical estimation of parameters: Concept of sufficient statistics; Exponential families of distributions; Exponential families and Maximum likelihood estimation; Uniformly minimum variance unbiased estimation.
References:


Internal continuous assessment: 40 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

End semester Examination: 60 marks
Course Objectives:
Provides a thorough understanding of the theory and design of Channel codes for error control. The course begins with an introduction to the basic Mathematical concepts and develops systematically through Linear block codes to the Convolutional Codes.

Course Outcomes:
Upon completion of the course, the student will be able to
- Analyze the channel coding methods
- Apply various coding and evaluate their performance.

Module I (9 hours)
Introduction to algebra: Groups- Rings- Fields- Binary Field arithmetic-Arithmetic of Galois Field- Integer Ring- Finite Field based on Integer Ring- Polynomial Rings- Finite Field based on Polynomial Rings-Primitive elements- Construction and basic properties of Finite Fields- Computations using Galois Field arithmetic

Module II (9 hours)
Vector spaces- Vector subspaces- Linear independence. Linear Block Codes Matrix description of Linear Block codes- Minimum Distance of a Block code-- Error detecting and correcting capabilities of a Block code- Standard Array and Syndrome decoding

Module III (9 hours)
Hamming codes- Perfect and Quasi-perfect codes- Extended codes- Hadamard codes- Binary Golay codes- BCH codes-Performance- Decoding of BCH codes, Reed Solomon codes- Encoding and Decoding

Module IV (9 hours)
Cyclic Codes: Polynomial description-Minimal polynomial and conjugates- Generator and parity-Check matrices of cyclic codes- Encoding of cyclic codes- Syndrome computation- Error detection - decoding of cyclic codes- Cyclic Hamming codes

Module V (9 hours)
Convolutional Coding: Structural properties-Encoders for convolutional coding – State representation and the state diagram- The Tree diagram – The Trellis diagram- Transfer function of a Convolutional code – Systematic and Non-systematic Convolutional codes – Catastrophic error propagation in Convolutional codes

Module VI (9 hours)
Maximum likelihood decoding of Convolutional codes – Hard versus Soft decision decoding - The Viterbi Algorithm – Sequential decoding – Concept of interleaving – Block interleaving –Convolutional interleaving – Concatenated codes-Turbo codes – Basic concepts – Encoding with recursive systematic codes.
References:

2. R.E. Blahut, “Theory and Practice of Error Control Coding”, MGH.

Internal continuous assessment: 40 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

End semester Examination: 60 marks
ELECTIVE II

08 EC 6242 (A) MULTIRATE SIGNAL PROCESSING AND FILTER BANKS

Credits – 3

Course Objectives:
Upon completion this course, the student will have deep understanding of the theory, design and applications of
- QMF banks
- Perfect Reconstruction filters
- Cosine modulated Filter banks.

Course Outcomes:
Upon completion of the course, the student will be able to
- Design various filter banks
- Apply various filter banks

Module I  (9 Hours)
Fundamentals of Multirate Theory: The sampling theorem - sampling at sub- Nyquist rate - Basic Formulations and schemes - Basic Multirate operations- Decimation and Interpolation - Digital Filter Banks- DFT Filter Bank- Identities

Module II  (9 Hours)
Maximally decimated filter banks: Polyphase representation - Errors in the QMF bank- Perfect Reconstruction (PR) QMF Bank - Design of an alias free QMF Bank

Module III  (9 Hours)
M-channel perfect reconstruction filter banks: Uniform band and non uniform filter bank - tree structured filter bank- Errors created by filter bank system- Polyphase representation- perfect reconstruction systems

Module IV  (8 Hours)
Perfect reconstruction (PR) filter banks: Para-unitary PR Filter Banks- Filter Bank Properties induced by paraunitarity- Two channel FIR paraunitary QMF Bank-

Module V  (8 Hours)
Linear phase PR Filter banks- Necessary conditions for Linear phase property- Quantization Effects: -Types of quantization effects in filter banks. - coefficient sensitivity effects, dynamic range and scaling.

Module VI  (11 Hours)

References:
1. P.P. Vaidyanathan. “Multirate systems and filter banks.” Prentice Hall. PTR.

**Internal continuous assessment: 40 marks**
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

**End semester Examination: 60 marks**
Course Objectives:
This course deals with the different methods for Power Spectrum Estimation. Upon completion of this course, students will be well versed with

- Power and Energy spectral density of signals
- Parametric and non parametric methods of estimation of PSD
- Filter bank methods of spectral analysis.

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

- Analyze the Power and Energy spectral density of signals
- Analyze the Filter bank methods of spectral analysis.

Module I   (12 Hours)
Power Spectral Density: Energy spectral density of deterministic signals, Power spectral density of random signals, Properties of PSD.

Module II   (7 Hours)
PSD Estimation - Non-parametric methods : Estimation of PSD from finite data, Non-parametric methods : Periodogram properties, bias and variance analysis, Blackman-Tuckey method

Module III   (7 Hours)
Window design considerations, time-bandwidth product and resolution - variance trade-offs in window design, Refined periodogram methods : Bartlet method, Welch method.

Module IV   (8 Hours)

Module V   (7 Hours)

Module VI   (13 Hours)
Filterbank methods: Filterbank interpolation of periodogram, Slepia base-band filters, refined filterbank method for higher resolution spectral analysis, Capon method, Introduction to higher order spectra.

References:
1. Introduction to Spectral Analysis, Stoica , R.L. Moses, Prentice Hall
Internal continuous assessment: 40 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

End semester Examination: 60 marks
Course Objectives:
Upon completion of this course, students will have deep insight on spread spectrum communication systems. The course imparts knowledge about principle of spread spectrum and use of orthogonal codes, performance of CDMA systems under AWGN and fading channels, use of CDMA systems in cellular communication and important CDMA standards.

Course Outcomes:
Upon completion of the course, the student will be able to
- Generate various spreading sequences and codes.
- Comment about the feasibility of given Spread Spectrum system from its performance analysis.
- Provide solutions to various issues present in Spread Spectrum systems.

Module I (7 Hours)
Introduction to spread spectrum communication, pulse noise jamming, low probability of detection, direct sequence spread spectrum, frequency-hopping and time-hopping spread spectrum systems, correlation functions

Module II (7 Hours)
Spreading sequences- maximal-length sequences, gold codes, Walsh orthogonal codes-properties and generation of sequences Synchronization and Tracking: delay lock and tau-dither loops, coarse synchronization- principles of serial search and match filter techniques.

Module III (13 Hours)
Performance of spread spectrum system under AWGN, multi-user Interference, jamming and narrow band interferences Low probability of intercept methods, optimum intercept receiver for direct sequence spread spectrum, Error probability of DS-CDMA system under AWGN and fading channels, RAKE receiver

Module IV (8 Hours)
Basics of spread spectrum multiple access in cellular environments, reverse Link power control, multiple cell pilot tracking, soft and hard handoffs, cell coverage issues with hard and soft handoff, spread spectrum multiple access outage, outage with imperfect power control, Erlang capacity of forward and reverse links.

Module V (6 Hours)

Module VI (13 Hours)
General aspects of CDMA cellular systems, IS-95 standard, Downlink and uplink, Evolution to Third Generation systems, WCDMA and CDMA-2000 standards, Principles of Multicarrier communication, MCCDMA and MC-DS-CDMA.

References:
2. A. J. Viterbi, “CDMA - Principles of Spread Spectrum Communications,”
Addison-Wesley.

**Internal continuous assessment: 40 marks**
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

**End semester Examination: 60 marks**
Course Objectives:
This course is a thorough treatment of Markov chains and Markov models of systems. It also deals with the essential queuing theory and application of Markov models in the analysis of queuing networks.

Course Outcomes:
Upon completion of the course, the student will be able to
- Analyze the Markov chains and Markov models of systems
- Apply Markov models in the analysis of queuing networks.

Module I (14 Hours)
Stochastic Processes: Renewal Processes - Reward and Cost Models, Poisson Process; Point Processes; Regenerative Processes; Renewal Theorems.

Module II (7 Hours)
Markov Models: Discrete Time Markov Chain - Transition Probabilities, Communication Classes, Irreducible Chains

Module III (7 Hours)
Continuous Time Markov Chain - Pure-Jump Continuous-Time Chains, Regular Chains, Birth and Death Process, Semi-Markov Processes

Module IV (7 Hours)
Single Class & Multi-class Queuing Networks: Simple Markovian queues; M/G/1 queue; G/G/1 queue; Open queuing networks; Closed queuing networks

Module V (6 Hours)
Mean value analysis; Multi-class traffic model; Service time distributions; BCMP networks; Priority systems.

Module VI (13 Hours)
Time Delays and Blocking in Queuing Networks: Time delays in single server queue; Time delays in networks of queues; Types of Blocking; Two finite queues in a closed network; Aggregating Markovian states.

References:
   Academic press.

**Internal continuous assessment: 40 marks**  
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

**End semester Examination: 60 marks**
Course Objectives:
Upon completion of this course, the students will have a deep knowledge about the Communication switching methods, blocking in switching networks, traffic analysis and multiplexing systems.

Course Outcomes:
Upon completion of the course, the student will be able to
- Analyze the communication switching methods
- Analyze the traffic and lost calls
- Analyze the blocking in switching networks, traffic analysis and multiplexing systems.

Module I  (8 Hours)

Module II  (6 Hours)

Module III  (9 Hours)
Types of blocking for a packet switch- Output conflicts- HOL blocking.
Traffic analysis: Traffic measurements, arrival distributions, Poisson process, holding/service time distributions, loss systems, lost calls cleared – Erlang-B formula, lost calls returning and lost calls held models, lost calls cleared and held models with finite sources, delay systems, Little’s theorem, Erlang-C formula , M/G/1 model.

Module IV  (5 Hours)

Module V  (13 Hours)

Module VI  (13 Hours)
Statistical multiplexing: blocking analysis in circuit multiplexed networks, with single rate or Multirate traffic- Models for performance analysis of integrated packet networks; deterministic models, worst case analysis; stochastic models, large deviations analysis. The effective Bandwidth approach for Admission control - Models for traffic flow in packet networks, long range dependence and self similar processes.

References:
1. A. Kumar, D. Manjunath, J. Kuri, Communication Networking: An Analytical

**Internal continuous assessment: 40 marks**
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

**End semester Examination: 60 marks**
Course Objectives:
This course provides the students with a thorough foundation of Wavelet theory, construction of wavelets and their applications in signal analysis.

Course Outcomes:
Upon completion of the course, the student will be able to
- Use Fourier tools to analyze signals
- Analyze the MRA and representation using wavelet bases
- Analyze the various wavelet transforms and design wavelet transform

Module I (7 Hours)
Fourier and Sampling Theory, Generalized Fourier theory, Fourier transform, Short-time (windowed) Fourier transform, Time-frequency analysis, Fundamental notions of the theory of sampling.

Module II (7 Hours)
Theory of Frames: Bases, Resolution of unity, Definition of frames, Geometrical considerations and the general notion of a frame, Frame projector, Example – windowed Fourier frames.

Module III (7 Hours)
Wavelets: The basic functions, Specifications, Admissibility conditions, Continuous wavelet transform (CWT), Discrete wavelet transform (DWT). The multiresolution analysis, MRA axioms, Construction of an MRA from scaling functions - The dilation equation and the wavelet equation

Module IV (7 Hours)
Compactly supported orthonormal wavelet bases - Necessary and sufficient conditions for orthonormality.
Regularity and selection of wavelets: Smoothness and approximation order - Analysis in Soboleve space, Criteria for wavelet selection with examples.

Module V (13 Hours)
Splines, Cardinal B-spline MRA, Subband filtering schemes, Compactly supported orthonormal wavelet bases. Wavelet decomposition and reconstruction of functions in $L^2(\mathbb{R})$. Fast wavelet transform algorithms - Relation to filter banks, Wavelet packets – Representation of functions, Selection of basis.

Module VI (13 Hours)
Biorthogonality and biorthogonal basis, Biorthogonal system of wavelets - construction, The Lifting scheme.

References:
Wellesley- Cambridge Press.
11. Ingrid Daubechies, “Ten lectures on wavelets” SIAM.

**Internal continuous assessment: 40 marks**
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

**End semester Examination: 60 marks**
Course Objectives:
This course provides a deep knowledge on Internet architecture, Quality of service issues in broadband networks, and Statistical multiplexing of communication networks.

Course Outcomes:
Upon completion of the course, the student will be able to
- Identify the type of networks and protocols for a given network scenario.
- Estimate the performance and throughput of a given network.
- Design a network aimed at optimum performance.

Module I (10 Hours)

Module II (10 Hours)
Data link layer: ARQ schemes, multiple access, LANs. Broadband services and QoS issues: Quality of Service issues in networks- Integrated service architecture- Queuing Disciplines- Weighted Fair Queuing- Random Early Detection

Module III (8 Hours)

Module IV (10 Hours)
Introduction to Queuing theory: Markov chain- Discrete time and continuous time Markov chains- Poisson process- Queuing models for Data gram networks- Little’s theorem- M/M/1 queuing systems- M/M/m/m queuing models- M/G/1 queue- Mean value analysis.

Module V (8 Hours)
Statistical Multiplexing in Communication Networks: Multiplexing: Network performance and source characterization; Stream sessions in packet networks -

Module VI (8 Hours)
Statistical Multiplexing in Communication Networks: deterministic analysis, stochastic analysis, circuit multiplexed networks.

References:
Internal continuous assessment: 40 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

End semester Examination: 60 marks
Course Objectives:
Upon completion of this course, the students will be able to program and interface PIC microcontroller, design and implement systems using PIC microcontrollers, development of embedded systems, gain knowledge about real time operating systems.

Course Outcomes:
Upon completion of the course, the student will be able to
- Program PIC microcontroller
- Design and implement systems using PIC microcontrollers
- Develop embedded systems
- Design real time operating systems

Module I (8 hours)
Microcontroller: Brief history of the PIC microcontroller - PIC18 features and block diagram-PIC18 Architecture and assembly language Programming, SFRs, RISC architecture in the PIC, Branch, Call, Time delay loop, PIC I/O Port programming, addressing modes, look-up table and table processing, Bank switching in the PIC18,

Module II (6 hours)
Data types and time delays in C, I/O Port programming in C, Bit-addressable I/O programming, logic operations in C, Data conversion programs in C.

Module III (14 hours)
PIC Peripherals and Interfacing: PIC18 timer programming in assembly and C, Serial Port programming in assembly and C, Interrupt programming in assembly and C, ADC and DAC interfacing, CCP and ECCP programming, DC Motor interfacing and PWM.

Module IV (6 hours)
Introduction to Embedded Systems: Characteristics of Embedded systems, Software embedded into a system- Device Drivers and Interrupt Servicing mechanisms.

Module V (7 hours)
Inter-process Communication and Synchronisation of Processes, Tasks and Threads: Multiple Processes in an Application - Data sharing by multiple tasks and routines- Inter Process Communication

Module VI (13 hours)
Real Time Operating Systems:
Operating System Services, I/O Subsystems - Network Operating Systems - Real Time and Embedded System Operating systems
Interrupt routines in RTOS Environments - RTOS Task Scheduling models, Interrupt Latency and response Times - Standardization of RTOS - Ideas of Embedded Linux. Case study using ARM processor/PIC microcontroller
References:
1. PIC Microcontroller and Embedded Systems using assembly and C for PIC18 –
   Muhammad Ali Mazidi, Roind D. Mckinay, Danny Causey; Pearson Education.
2. Design with PIC microcontroller – John Peatman; Prinice Hall
   Publications.
4. Real-time Systems - Jane Liu, PH 2000
   Laplante
6. Embedded Software Primer - Simon, David E.
7. Tornado API Programmers guide

Internal continuous assessment: 40 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

End semester Examination: 60 Marks
Course Objectives:
To develop project as per the detailed problem formulation. Perform analytical and comparative analysis of the developed system. Submit a report at the end of the semester covering details of all the phases of project preliminaries, project work and result.

Guidelines:
1. Students are expected to take up any industry defined problem or research oriented definition as a Mini project.
2. Detail study of existing solutions for the selected topic must be done.
3. Students are required to implement/simulate existing solutions (algorithms/techniques/methods) for their selected topic.
4. Post-implementation work would include preparing a report including comparative study of implemented/simulated solutions and their results.

Evaluation:
Department will constitute an Evaluation Committee to review the project work. The concerned head of the department shall be the chairman of this committee. It shall have two senior faculty members from the same department and the project supervisor.

Internal continuous assessment: 100 marks

Progress evaluation by the project supervisor : 40 Marks
Presentation & evaluation by committee : 60 Marks
Course Objectives:
Upon completion, the students will

- Be able to design enlisted experiments and implement using hardware
- Acquire sufficient expertise in simulating these systems using MATLAB
- Be able to design and implement self standing systems of their choice with sufficient complexity.

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

- Implement and compare various modulation schemes
- Simulate various systems using MATLAB
- Simulate and implement signal processing techniques.

Tools:
Numerical Computing Environments – GNU Octave or MATLAB or any other equivalent tool

List of Experiments:
1. Implementation of digital modulation schemes – BASK, BFSK, BPSK. Plot BER vs $\frac{E_b}{N_0}$ in AWGN channels.
2. Performance comparison of QPSK, DPSK, MSK & GMSK.
4. Comparison of diversity combining techniques – SC, EGC & MRC.
5. Simulation of CDMA systems.
8. Carrier recovery and bit synchronization.
9. Implementation of multicarrier communication.
11. Constellation diagram of various digital modulation schemes.

Internal continuous assessment: 100 marks
Practical Records/Outputs: 40%
Regular Class Viva Voce: 20%
Final Test: 40%
Course Objectives:
Upon completion of this course, the students will get a deep understanding about the various source coding techniques used for signal compression. The course also provides knowledge about important data, audio, image and video compression standards.

Course Outcomes:
Upon completion of the course, the student will be able to
- Analyze the various source coding techniques used for signal compression
- Calculate rate distortion for different sources.
- Analyze the compression standards of data, audio, image and video.

Module I (7 Hours)
Review of Information Theory: The discrete memoryless information source - Kraft inequality; optimal codes Source coding theorem. Compression Techniques - Lossless and Lossy Compression - Mathematical Preliminaries for Lossless Compression

Module II (7 Hours)

Module III (7 Hours)
Rate distortion theory: Rate distortion function R(D),Properties of R(D); Calculation of R(D) for the binary source and the Gaussian source, Rate distortion theorem, Converse of the Rate distortion theorem

Module IV (6 Hours)
Quantization - Uniform & Non-uniform - optimal and adaptive quantization, vector quantization and structures for VQ, Optimality conditions for VQ, Predictive Coding - Differential Encoding Schemes

Module V (13 Hours)
Mathematical Preliminaries for Transforms: Karhunen Loeve Transform, Discrete Cosine and Sine Transforms, Discrete Walsh Hadamard Transform, Lapped transforms - Transform coding - Subband coding - Wavelet Based Compression - Analysis/Synthesis Schemes

Module VI (14 Hours)
Data Compression standards: Zip and Gzip, Speech Compression Standards: PCM, ADPCM, SBC, CELP, MPC-MLQ, MELP, LPC. Audio Compression standards: MPEG.
References:
5. Toby Berger, Rate Distortion Theory: A Mathematical Basis for Data Compression, Prentice Hall, Inc.

Internal continuous assessment: 40 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

End semester Examination: 60 marks
Course Objectives:
This course imparts a detailed knowledge of modelling of speech signals, subband coding of speech, vocoders, Homomorphic speech processing, Voice morphing, speaker identification and speaker recognition systems, and processing of music.

Course Outcomes:
Upon completion of the course, the student will be able to
- Analyze the digital representation of speech waveform.
- Represent the homomorphic speech processing.
- Analyze the speech enhancement and synthesis techniques.

Module I (7 Hours)

Module II (6 Hours)

Module III (14 Hours)

Module IV (13 Hours)

Module V (8 Hours)

Module VI (6 Hours)
Music Production - sequence of steps in a bowed string instrument - Frequency response measurement of the bridge of a violin. Audio Data bases and applications - Content based retrieval.

References:

**Internal continuous assessment: 40 marks**

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

**End semester Examination: 60 marks**
Course Objectives:
Upon completion of this course, students will have thorough understanding of the various biomedical signals, their processing using standard signal processing tools, cardio vascular and neurological applications of signal processing, modeling of EEG, EEG segmentation and Medical image formats.

Course Outcomes:
Upon completion of the course, the student will be able to
- Apply tools of science and engineering for biological processes.
- Analyze the signal processing and physiological signals through the application of digital signal processing methods to biomedical problems.

Module I     (14 Hours)
Introduction to Biomedical Signals - Examples of Biomedical signals - ECG, EEG, EMG - Tasks in Biomedical Signal Processing - Computer Aided Diagnosis. Origin of bio potentials - Review of linear systems - Fourier Transform and Time Frequency Analysis (Wavelet) of biomedical signals- Processing of Random & Stochastic signals - spectral estimation – Properties and effects of noise in biomedical instruments - Filtering in biomedical instruments

Module II     (13 Hours)

Module III     (6 Hours)
Cardio vascular applications : Basic ECG - Electrical Activity of the heart- ECG data acquisition – ECG parameters & their estimation - Use of multiscale analysis for ECG parameters estimation - Noise & Artifacts

Module IV     (7 Hours)

Module V     (7 Hours)
Neurological Applications : The electroencephalogram - EEG rhythms & waveform - categorization of EEG activity - recording techniques - EEG applications- Epilepsy, sleep disorders, brain computer interface.

Module VI    (7 Hours)
Modeling EEG- linear, stochastic models - Non linear modeling of EEG - artifacts in EEG & their characteristics and processing - Model based spectral analysis - EEG segmentation - Joint Time-Frequency analysis
- correlation analysis of EEG channels - coherence analysis of EEG channels. Medical Image format - DICOM, HL-7, PACS

References:
4. Semmlow, Marcel Dekker “Biosignal and Biomedical Image Processing”, 2004
5. Enderle, “Introduction to Biomedical Engineering,” 2/e, Elsevier, 2005

Internal continuous assessment: 40 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

End semester Examination: 60 marks
DSP ALGORITHMS AND ARCHITECTURES

Course Objectives:
Upon completion of this course, the students will have detailed knowledge of design of DSP algorithms, simulation of DSP systems in C and modeling using VHDL, VLSI implementation of algorithms, synthesis of DSP modules and modeling the synthesis in VHDL.

Course Outcomes:
Upon completion of the course, the student will be able to
- Design DSP algorithms
- Simulate DSP systems
- Model DSP systems using VHDL
- Synthesize DSP modules.

Module I  (14 Hours)

Module II  (7 Hours)
Circuits and DSP Architecture Design: Fast filtering algorithms (Winograd’s, FFT, short-length FIR), retiming and pipelining, block processing, folding, distributed arithmetic architectures

Module III  (7 Hours)
VLSI performance measures (area, power, and speed), structural modeling in VHDL, Analog signal processing for fast operation, Impact of nonideal characteristics of analog functional blocks on the system performance.

Module IV  (7 Hours)
DSP Module Synthesis: Distributed arithmetic (DA), Advantageous of using DA, Size reduction of look-up tables, Canonic signed digit arithmetic, Implementation of elementary functions Table-oriented methods, Polynomial approximation Random number generators, Linear feedback shift register

Module V  (6 Hours)
High performance arithmetic unit architectures (adders, multipliers, dividers), bit-parallel, bit-serial, digit-serial, carry-save architectures, redundant number system, modeling for synthesis in HDL, synthesis place-and-route.

Module VI  (13 Hours)
Parallel algorithms and their dependence: Applications to some common DSP algorithms, System timing using the scheduling vector, Projection of the dependence graph using a projection direction, The delay operator and z-transform techniques for mapping DSP algorithms onto processor arrays, Algebraic technique for mapping algorithms, The computation domain, The dependence matrix of a variable, The scheduling and projection functions, Data broadcast and pipelining, Applications using common DSP algorithms.
References:
3. Digital Signal Processing with Field Programmable Gate Array, Uwe Meyer-Baese, Springer-Verlag
7. Computer Arithmetic: Algorithms and Hardware Designs, Parhami, Behrooz, Oxford University Press,

Internal continuous assessment: 40 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

End semester Examination: 60 marks
ELECTIVE V

08 EC 7221 (A)  LINEAR SYSTEMS THEORY  
Hours/Week: Lecture – 3 hours  
Credits – 3

Course Objectives: 
Upon completion of this course, the students will have deep knowledge and insight on vector space representation of signals, bases, orthonormal bases, analysis of linear systems, eigen values and eigen vectors, infinite dimensional vector spaces and Hilbert spaces.

Course Outcomes: 
Upon completion of the course, the student will be able to
- Analyze vector space representation of signals
- Analyze linear systems.
- Analyze infinite dimensional vector spaces and Hilbert spaces.

Module I  (7 Hours) 
Finite Dimensional Signal Space: Vector Spaces :- Complex Numbers, Definition of Vector Space, Properties of Vector Spaces, Subspaces, Sums and Direct Sums, Span and Linear Independence, Bases

Module II  (7 Hours) 

Module III  (13 Hours) 

Module IV  (7 Hours) 

Module V  (6 Hours) 

Module VI  (14 Hours) 

References: 
1. Sheldon Axler, Linear Algebra Done Right, Springer 
3. Paul R. Halmos, Finite-Dimensional Vector Spaces, Springer
5. Arch W. Naylor and George R. Sell, Linear Operator Theory in Engineering and Science, Springer

**Internal continuous assessment: 40 marks**
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

**End semester Examination: 60 marks**
08 EC 7221 (B)  
LINEAR & NONLINEAR OPTIMIZATION  
Hours/Week: Lecture – 3 hours

Credits – 3

Course Objectives:
The objective of this course is to provide thorough Mathematical foundation for linear and non linear optimization techniques. Upon completion of this course, the student will have deep understanding of Vector spaces, linear transformation, linear optimization algorithms, sensitivity analysis, constrained and unconstrained optimization and Engineering applications of these methods.

Course Outcomes:
- Apply optimization in engineering design.
- Use optimization algorithms.

Module I  (8 Hours)

Module II  (6 Hours)

Module III  (14 Hours)
Linear Programming: Introduction -Optimization model, formulation and applications-Classical optimization techniques: Single and multi variable problems- Types of constraints. Linear optimization algorithms: The simplex method -Basic solution and extreme point -Degeneracy-The primal simplex method -Dual linear programs - Primal, dual, and duality theory - The dual simplex method - The primal-dual algorithm-Duality applications. Post optimization problems: Sensitivity analysis and parametric programming-

Module IV  (7 Hours)

Module V  (6 Hours)
Constrained optimization: Constrained optimization with equality and inequality constraints. Kelley’s convex cutting plane algorithm - Gradient projection method - Penalty Function methods.
Module VI  (13 Hours)
Constrained optimization: Lagrangian method - Sufficiency conditions - Kuhn-Tucker optimality conditions- Rate of convergence - Engineering applications Quadratic programming problems-Convex programming problems.

References:
1. David G Luenberger, .Linear and Non Linear Programming., 2nd Ed, Addison-Wesley.

Internal continuous assessment: 40 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

End semester Examination: 60 marks
Course Objectives:
The primary objective is to provide deep understanding of the various transforms used in signal analysis. Upon completion of this course, the student will have sound knowledge in the methods of Laplace transform, Z-transform, the Fourier transforms, Wavelet transform, DCT and other transforms, their applications in various fields like image compression. The course also introduces new transforms like CTT and WBCT.

Course Outcomes:
Upon completion of the course, the student will be able to
- Apply the various transforms.
- Analyze the relationship between various discrete versions of Fourier transform.
- Analyze the continuous and discrete wavelet transforms.

Module I  (7 Hours)
Introduction and Review: Introduction on the integral and discrete transforms and their applications- Need of reversibility- basis – Requirements of transforms- (Linear algebraic approach)

Module II  (7 Hours)
Review of Laplace Transform, Z transform, Continuous Fourier Transform, Discrete Time Fourier transform, Discrete transform-Relations between the transforms

Module III  (14 Hours)

Module IV  (7 Hours)
Discrete Transforms and Applications: Discrete Cosine transform and applications in JPEG - Discrete STFT (DSTFT) – Application of DSTFT in audio signal processing- Discrete Wavelet Transform (DWT) - lifting applied to DWT

Module V  (6 Hours)
Applications of DWT in audio signal processing - image compression (JPEG 2000) - At least one application of each transform in one dimensional, two-dimensional or three dimensional signals or multimedia signal processing (Example : compression, information security, watermarking , steganography, denoising, signal separation, signal classification).

Module VI  (13 Hours)
New Transforms and Applications: Limitations of DWT in image processing - Contourlet transform (CTT) – Applications of CTT in image processing - Ridgelet and Curvelet transforms - New developments in DWT and CTT such as wavelet Based Contourlet Transform(WBCT)

References:
2. Integral and Discrete transforms with applications and error analysis, Abdul Jerri, Marcel Dekker Inc.
3. Integral Transforms and Their Applications Lokenath Debnath, Dambaru Bhatta, Taylor & Francis Inc

**Internal continuous assessment: 40 marks**

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

**End semester Examination: 60 marks**
Course Objectives:
This course deals with the principles and implementation of secure communication. It extensively covers cryptography, steganography, their methods and applications.

Course Outcomes:
Upon completion of the course, the student will be able to
- Apply Cryptography, watermarking and Steg analysis
- Apply encryption techniques in data for various applications
- Analyze various Data Hiding techniques

Module I (7 Hours)
Information security – Digital rights management – copy right protection - Information integration - Digital watermarking and steganography- difference between watermarking and steganography – Classification, applications in content authentication

Module II (7 Hours)
Medical images, audio and video – requisites of watermarking and steganography – data hiding capacity, robustness and imperceptibility - Watermarking with side information - fragile watermark – benchmark for watermarking – data hiding in text

Module III (14 Hours)
Watermarking in spatial domain - Additive methods, spread spectrum based methods- Steganography in spatial domain - Information theoretic approach for watermarking - Watermarking and steganography in frequency domain – Based on Discrete cosine transform, Discrete Wavelet transform and Contourlet transform - different methods - Comparison between frequency domain and spatial domain methods

Module IV (7 Hours)
Watermark detection – detection theoretic and information theoretic approach – Operating characteristics - Recovery of embedded data - Blind and non blind methods – Quality evaluation of data hidden images, audio and video.

Module V (6 Hours)

Module VI (13 Hours)
Difference between steganography and cryptography - Encryption and decryption for Watermarks - Embedding and Extraction Procedures – Image hashing - Watermarking with Visual Cryptography - Analysis of different methods
References:

3. Fabien Petitcolas Stefan Katzenbeisser Information Hiding Techniques for Steganography and Digital Watermarking, Artech publishers

Internal continuous assessment: 40 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

End semester Examination: 60 marks
Course Objectives: This course is intended for
- Increasing the breadth of knowledge
- Enhancing the ability of self study
- Improving presentation and communication skills
- Augmenting the skill of Technical Report Writing.

Students have to register for the seminar and select a topic of their interest from Communication / Signal Processing or related topics from outside the syllabus in consultation with any faculty member offering courses for the programme. A detailed write-up on the topic of the seminar is to be prepared in the prescribed format given by the Department. The seminar shall be of 30 minutes duration and a committee with the Head of the department as the chairman and two faculty members from the department as members shall evaluate the seminar based on the coverage of the topic, presentation and ability to answer the questions put forward by the committee.

Internal continuous assessment: 100 marks
<table>
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<tr>
<th>08 EC 7241 (P)</th>
<th>PROJECT (PHASE-I)</th>
<th>Credits – 6</th>
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<td>Hours/Week: 8 hours</td>
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**Course Objectives:**
The main objective of the Project is to identify current issues in the area of Communication Engineering and Signal Processing. The ability of the student to address contemporary issues and to find practical solutions to the issues increases. Also, continued and self learning skill of the student is enhanced.

**Course Outcomes:**
This will help the students to identify their potential areas of research and to contribute their skills towards the field of Electronics and Communication engineering.

**Guidelines:**
The project work can be a design project/experimental project and/or computer simulation project on any of the topics in communication/signal processing area. The project work is allotted individually on different topics. Normally students are expected to do the project within the college. However they are permitted to do the project in an industry or in a government research institute under a qualified supervisor from that organization.

While students are expected to do their projects in their colleges, provision is available for them to do it outside the college either in an industry or in an institute of repute. This is only possible in the fourth semester and the topic of investigation should be in line with the project part planned in the 3rd semester. Student should apply for this through the project supervisor indicating the reason for this well in advance, preferably at the beginning of the 3rd semester. The application for this shall include the following:-

- **Topic of the Project:**
- **Project work plan in the 3rd Semester:**
- **Reason for doing the project outside:**
- **Institution/Organization where the project is to be done:**
- **External Supervisor –**
  - Name:
  - Designation:
  - Qualifications:
  - Experience:

This application is to be vetted by a departmental committee constituted for the same by the Principal and based on the recommendation of the committee the student is permitted to do the project outside the college. The same committee should ensure the progress of the work periodically and keep a record of this.
The student is required to undertake the master research project phase I during the 3rd semester and Phase II in the 4th semester. Phase I consists of preliminary thesis work, two reviews of the work and the submission of a preliminary report. First review would highlight the topic, objectives, methodology and expected results. Second review assesses the progress of the work, preliminary report and future plan of the work to be completed in the 4th semester. Progress of the project work is to be evaluated at the end of the third semester. For this a committee headed by the head of the department with two other faculty members in the area of the project, of which one shall be the project supervisor. If the project is done outside the college, the external supervisor associated with the student will also be a member of the committee.

**Internal continuous assessment: 50**

- Progress evaluation by the project supervisor : 20 Marks
- Presentation & evaluation by committee : 30 Marks
Project phase II is a continuation of project phase I started in the 3rd semester. There would be two reviews in the 4th semester, first in the middle of the semester and the second at the end of the semester. First review is to evaluate the progress of the work. Second review would be a pre-submission presentation before the evaluation committee to assess the quality and quantum of the work done. This would be a pre-qualifying exercise for the students for getting approval by the Departmental committee for the submission of the thesis. At least one technical paper is to be prepared for possible publication in journal or conferences. The technical paper is to be submitted along with the thesis.

The final evaluation of the project will be external evaluation. This shall be done by a committee constituted for the purpose by the Principal of the college. The concerned head of the department shall be the chairman of this committee. It shall have two senior faculty members from the same department, project supervisor and the external supervisor, if any, of the student and an external expert either from an academic/R&D organization or from Industry as members.

**Internal Continuous assessment: 100**
- Project evaluation by the supervisor/s: 30 Marks
- Evaluation by the External expert: 30 Marks
- Presentation & evaluation by committee: 40 Marks