SEMESTER -III

ELECTIVE IV

08 EC 7211 (A)	SIGNAL COMPRESSION – THEORY AND METHODS *Hours/Week: Lecture – 3 hours*	Credits – 3

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)

Huffman Coding - Optimality of Huffman codes - Extended Huffman Coding – Adaptive Huffman Coding - Arithmetic Coding - Adaptive Arithmetic coding, Run Length Coding, Dictionary Techniques - Lempel-Ziv coding, Applications - Predictive Coding - Prediction with Partial Match - Burrows Wheeler Transform, Dynamic Markov Compression.

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.

Image Compression standards: JBIG, GIF, JPEG & JFIF, SPIHT, EZW, JPEG 2000. Video Compression Standards: MPEG, H.261, H.263 & H264.

References:

1. Khalid Sayood, "Introduction to Data Compression", Morgan Kaufmann Publishers., Second Edn.,
2. David Salomon, "Data Compression: The Complete Reference", Springer Publications, 4th Edn.,
3. Thomas M. Cover, Joy A. Thomas, "Elements of Information Theory," John Wiley & Sons, Inc.
4. N. S Jayant, Peter Noll, Digital Coding of Waveforms: Principles and Applications to Speech and Video, Prentice Hall Inc.
5. Toby Berger, Rate Distortion Theory: A Mathematical Basis for Data Compression, Prentice Hall, Inc.
6. K.R.Rao, P.C.Yip, "The Transform and Data Compression Handbook", CRC Press.
7. R.G.Gallager, "Information Theory and Reliable Communication", John Wiley & Sons, 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

08 EC 7211 (B)	**SPEECH & AUDIO PROCESSING** *Hours/Week: Lecture – 3 hours*	**Credits – 3**

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)

Digital models for the speech signal - mechanism of speech production - acoustic theory - lossless tube models - digital models - linear prediction of speech - auto correlation - formulation of LPC equation - solution of LPC equations - Levinson Durbin algorithm - Levinson recursion - Schur algorithm – lattice formulations and solutions - PARCOR coefficients

Module II (6 Hours)

Spectral analysis of speech - Short Time Fourier analysis - filter bank design. Auditory Perception : Psychoacoustics- Frequency Analysis and Critical Bands – Masking properties of human ear :

Module III (14 Hours)

Speech coding -subband coding of speech - transform coding - channel vocoder - formant vocoder – cepstral vocoder - vector quantizer coder- Linear predictive Coder. Speech synthesis - pitch extraction algorithms - Gold Rabiner pitch trackers - autocorrelation pitch trackers - voiced/unvoiced detection - homomorphic speech processing - homomorphic systems for convolution - complex cepstrums - pitch extraction using homomorphic speech processing. Sound Mixtures and Separation - CASA, ICA & Model based separation.

Module IV (13 Hours)

Speech Transformations - Time Scale Modification - Voice Morphing. Automatic speech recognition systems - isolated word recognition - connected word recognition -large vocabulary word recognition systems - pattern classification - DTW, HMM - speaker recognition systems - speaker verification systems – speaker identification Systems.

Module V (8 Hours)

Audio Processing : Non speech and Music Signals - Modeling -Differential, transform and subband coding of audio signals and standards - High Quality Audio coding using Psychoacoustic models - MPEG Audio coding standard.

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:

1.Rabiner L.R. & Schafer R.W., “Digital Processing of Speech Signals”, Prentice Hall

Inc.
2.O'Shaughnessy, D. "Speech Communication, Human and Machine". Addison-Wesley.
3.Thomas F. Quatieri , "Discrete-time Speech Signal Processing: Principles and Practice" Prentice Hall, Signal Processing Series.
4.Deller, J., J. Proakis, and J. Hansen. "Discrete-Time Processing of Speech Signals." Macmillan.
5.Ben Gold & Nelson Morgan , " Speech and Audio Signal Processing", John Wiley & Sons, Inc.
6.Owens F.J., "Signal Processing of Speech", Macmillan New Electronics
7.Saito S. & Nakata K., "Fundamentals of Speech Signal Processing", Academic Press, Inc.
8.Papamichalis P.E., "Practical Approaches to Speech Coding", Texas Instruments, Prentice Hall
9.Rabiner L.R. & Gold, "Theory and Applications of Digital Signal Processing", Prentice Hall of India
10.Jayant, N. S. and P. Noll. "Digital Coding of Waveforms: Principles and Applications to Speech and Video. Signal Processing Series", Englewood Cliffs: Prentice-Hall
11.Thomas Parsons, "Voice and Speech Processing", McGraw Hill Series
12.Chris Rowden, "Speech Processing", McGraw-Hill International Limited
13.Moore. B, "An Introduction to Psychology of hearing" Academic Press, London, 1997
14.E. Zwicker and L. Fastl, "Psychoacoustics-facts and models", Springer-Verlag., 1990

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 7211 (C)	**BIOMEDICAL SIGNAL PROCESSING** *Hours/Week: Lecture – 3 hours*	**Credits – 3**

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)

Concurrent, coupled and correlated processes - illustration with case studies - Adaptive and optimal filtering - Modeling of Biomedical signals - Detection of biomedical signals in noise - removal of artifacts of one signal embedded in another -Maternal-Fetal ECG - Muscle-contraction interference. Event detection - case studies with ECG & EEG - Independent component Analysis - Cocktail party problem applied to EEG signals - Classification of biomedical signals.

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)

ECG Signal Processing: Baseline Wandering, Power line interference, Muscle noise filtering – QRS detection - Arrhythmia analysis - Data Compression: Lossless & Lossy- Heart Rate Variability – Time Domain measures - Heart Rhythm representation - Spectral analysis of heart rate variability - interaction with other physiologicalsignals.

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:

1.Bruce, "Biomedical Signal Processing & Signal Modeling," Wiley, 2001
2.Sörnmo, "Bioelectrical Signal Processing in Cardiac & Neurological Applications", Elsevier
3.Rangayyan, "Biomedical Signal Analysis", Wiley 2002.
4.Semmlow, Marcel Dekker "Biosignal and Biomedical Image Processing", 2004
5.Enderle, "Introduction to Biomedical Engineering," 2/e, Elsevier, 2005
6.D.C.Reddy , " Biomedical Signal Processing: Principles and techniques" , Tata McGraw Hill,

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 7211 (D)	**DSP ALGORITHMS AND ARCHITECTURES** *Hours/Week: Lecture – 3 hours*	**Credits – 3**

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)

DSP Algorithm Design : DSP representations (data-flow, control-flow, and signal-flow graphs, block diagrams), fixed-point DSP design (A/D precision, coefficient quantization, round-off and scaling), filter structures (recursive, nonrecursive and lattice), algorithmic simulations of DSP systems in C , behavioral modeling in HDL System modeling and performance measures.

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:

1. Digital Signal Processors: Architectures, Implementations, and Applications Sen M.Kuo , Woon-Seng, S. Gan Prentice Hall

2. VLSI Signal Processing Systems, Design and Implementation.Keshab K. Parhi, John Wiley & Sons.

3. Digital Signal Processing with Field Programmable Gate Array, Uwe Meyer-Baese, Springer- Verlag

4. DSP Principles, Algorithms and Applications, John G. Proakis , Dimitris Manolakis K - Prentice Hall

5. Architectures for Digital Signal Processing, Pirsch, John Wiley and Sons.

6. DSP Integrated Circuits, Lars Wanhammar, Academic Press.

7. Computer Arithmetic: Algorithms and Hardware Designs, Parhami, Behrooz, Oxford University Press,

8. Computer Arithmetic Algorithms, Israel Koren, A. K. Peters, Natick, MA.

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)

Dimension Inner-Product Spaces :- Inner Products, Norms, Orthonormal Bases, Orthogonal Projections and Minimization Problems, Linear Functionals and Adjoints Some Important Bases :- Standard Ordered Bases, DFT Bases, DCT Bases.

Module III (13 Hours)

Linear Systems :Linear Maps :- Definitions and Examples, Null Spaces and Ranges, The Matrix of a Linear Map, Invertibility. Eigenvalues and Eigenvectors :- Invariant Subspaces, Polynomials Applied to Operators, Upper-Triangular Matrices, Diagonal Matrices, Invariant Subspaces on Real Vector Spaces

Module IV (7 Hours)

Linear Systems : Operators on Inner-Product Spaces :- Self-Adjoint and Normal Operators, The Spectral Theorem, Normal Operators on Real Inner-Product Spaces, Positive Operators, Isometries, Polar and Singular-Value Decompositions.

Module V (6 Hours)

Some Important Classes of Linear Systems :- Shift Invariant systems and Toeplitz matrices. Operators and square matrices. Self adjoint operators and Hermitian matrices. Projections and idempotent matrices. Rotations and unitary matrices.

Module VI (14 Hours)

Infinite Dimensional Signal Spaces : Metric Spaces :- Definition, Convergence and Completeness. Hilbert spaces :- Introduction [Ref 3, Appendix]. l2 and L2 spaces. Definition and some properties. Orthogonal Complements, Orthonormal Sets, Fourier Expansion. Conjugate Space, Adjoint of an Operator, Self Adjoint Operators, Normal and Unitary operators, Projections.

References:

1. Sheldon Axler, Linear Algebra Done Right, Springer
2. G. F. Simmons, Introduction to Topology and Modern Analysis, Tata McGraw Hill.

3. Paul R. Halmos, Finite-Dimensional Vector Spaces, Springer
4. Todd K. Moon and Wynn C. Stirling, Mathematical Methods and Algorithms for Signal Processing, Pearson
5. Arch W. Naylor and George R. Sell, Linear Operator Theory in Engineering and Science, Springer
6. Peter D. Lax, Linear Algebra, Wiley Students Edition.
7. Michael W. Frazier, An Introduction to Wavelets Through Linear Algebra, 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)

Mathematical Background: Sequences and Subsequences- Mapping and functions- Continuous functions- Infimum and Supremum of functions- Minima and maxima of functions- Differentiable functions. Vectors and vector spaces- Matrices- Linear transformation- Quadratic forms- Definite quadratic forms- Gradient and Hessian- Linear equations- Solution of a set of linear equations-Basic solution and degeneracy.

Module II (6 Hours)

Convex sets and Convex cones- Introduction and preliminary definition- Convex sets and properties- Convex Hulls- Extreme point- Separation and support of convex sets- Convex Polytopes and Polyhedra- Convex cones- Convex and concave functions- Basic properties- Differentiable convex functions- Generalization of convex functions.

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)

Nonlinear Programming: Minimization and maximization of convex functions- Local & Global optimum- Convergence-Speed of convergence. Unconstrained optimization: One dimensional minimization - Elimination methods: Fibonacci & Golden section search - Gradient methods - Steepest descent method.

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.
2. S.S.Rao, .Engineering Optimization.; Theory and Practice; Revised 3rd Edition, New Age International Publishers, New Delhi
3. S.M. Sinha, Mathematical programming: Theory and Methods, Elsevier.
4. Hillier and Lieberman Introduction to Operations Research, McGraw-Hill, 8th edition.
5. Saul I Gass, Linear programming, McGraw-Hill, 5th edition.
6. Bazarra M.S., Sherali H.D. & Shetty C.M., Nonlinear Programming Theory and Algorithms, John Wiley, New York.
7. Kalyanmoy Deb, Optimization for Engineering: Design-Algorithms and Examples, Prentice Hall (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

08 EC 7221 (C)	**TRANSFORM THEORY** *Hours/Week: Lecture – 3 hours*	**Credits – 3**

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 Lapalce transform, Z-transform, the Fourier transforms, Wavelet transform, DCT and other trsnsforms, 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)

Integral Transforms: Short Term Fourier Transform(STFT) – Limitations of STFT - Heisenbergs uncertainty principle - Continuous wavelet transform (CWT) - Hilbert Transforms - Radon Transform - Abel Transform - Sine transform – Cosine Transform - The Mellin Transform - Hankel Transform - Hartley Transform.

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:

1. The Transforms and Applications Handbook, Second Edition - Edited by Alexander D. Poularikas, CRC Press

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

08 EC 7221 (D)	INFORMATION HIDING AND DATA ENCRYPTION *Hours/Week: Lecture – 3 hours*	Credits – 3

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)

Quality evaluation with and without reference – Human visual system based methods - Weighted signal noise ratio for quality evaluation of stetgo data – Robustness measure of recovered data - steganalysis – statistical based techniques for steganalysis

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:

1. Ingemar Cox, Matthew Miller, Jeffrey Bloom, Jessica Fridrich, Ton Kalker "Digital Watermarking and Steganography, 2nd Ed., Morgan Kaufman Publishers
2. Fundamentals of Digital Image Watermarking Book Description, John Wiley & Sons Fernando Perez Gonzalez, Sviatoslav Voloshynovskiy
3. Fabien Petitcolas Stefan Katzenbeisser Information Hiding Techniques for Steganography and Digital Watermarking, Artech publihsers
4. Wang, F. Pan, J. Jain, L. C. Innovations in Digital Watermarking Techniques, 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 7231 (P)	**SEMINAR** *Hours/Week: 2 hours*	**Credits – 2**

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

08 EC 7241 (P)	PROJECT (PHASE-I) *Hours/Week: 8 hours*	Credits – 6

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