M. Tech. (Electronics and Telecommunication) Curriculum Structure
Specialization: Signal Processing
(w.e.f. 2019-20)

List of Abbreviations

Abbreviation	Title	No of courses	Credits	% of Credits
PSMC	Program Specific Mathematics Course	1	4	5.88%
PSBC	Program Specific Bridge Course	1	3	4.41%
DEC	Department Elective Course	3	9	13.24%
MLC	Mandatory Learning Course	2	0	0%
PCC	Program Core Course	5	15	22.06%
LC	Laboratory Course	7	9	13.24%
IOC	Interdisciplinary Open Course	1	3	4.41%
LLC	Liberal Learning Course	1	1	1.47%
SLC	Self Learning Course	2	6	8.82%
SBC	Skill Based Course	2	18	26.47%
Total		25	68	100%

PG Program [M. Tech. Electronics and Telecommunication – Signal Processing] Curriculum Structure

Semester I

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1.	PSMC	ETC-19005	Linear Algebra and Probability Theory	3	1	--	4
2.	PSBC	ESP-19001	DSP Algorithms	3	0	--	3
3.	PCC	ESP-19002	Digital Audio Processing	3	--	--	3
4.	PCC	ESP-19003	Digital Image and Video Processing	3	--	--	3
5.	DEC	ESP(DE)-19001 ESP(DE)-19002 ETC(DE)-19011	Department Elective I – a) Biomedical Signal Processing b) Voice and Data Networks c) Modeling, Simulation and Optimization	3	--	--	3
6.	MLC	ML-19011	Research Methodology and Intellectual Property Rights	2	--	--	--
7.	MLC	ML-19012	Effective Technical Communication	1	--	--	--
8.	LC	ESP-19004	Digital Audio Processing Lab	--		2	1
9.	LC	ESP-19005	Digital Image and Video Processing Lab	--	1	2	2
10.	LC	ESP-19006	Signal Processing Lab	--	1	2	2
11.	LC	ESP-19007	Seminar	--	--	2	1
	Total hrs and Credits			**18**	**3**	**8**	**22**

Semester II

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1.	IOC	ETC-19006	Interdisciplinary Open Course	3	--	--	3
2.	PCC	ESP-19009	Machine Learning	3	--	--	3
3.	PCC	ESP-19010	Adaptive Signal Processing	3	--	--	3
4.	DEC	ESP(DE)-19004 ESP(DE)-19005 ESP(DE)-19006	Department Elective –II a) Remote Sensing and Multispectral Signal Analysis b) Artificial Intelligence c) Signal processing for Communication Systems	3	--	--	3
5.	DEC	ETC(DE)-19010 ESP(DE)-19007	Department Elective –III a) Joint Time Frequency	3	--	--	3

		ESP(DE)-19008	Analysis b) Signal Acquisition devices and Systems c) Signal Processing for Surveillance Systems				
6.	LLC	LL-19001	Liberal Learning Course	1	--	--	1
7.	PCC	ESP-19008	DSP Architecture	3	--	--	3
8.	LC	ESP-19011	DSP Architecture Lab	--	--	2	1
9.	LC	ESP-19012	Machine Learning Lab	--	--	2	1
10.	LC	ESP-19013	Adaptive Signal Processing Lab	--	--	2	1
Total hrs and Credits				**19**		**6**	**22**

Interdisciplinary Open Course on "Broadband Communication" is offered to students of other departments.

Semester-III

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1.	SBC	ESP-20001	Dissertation Phase – I	--	--	18	9
2.	SLC	ESP-20002	Massive Open Online Course –I	3	--	--	3
Total hrs and Credits				**3**		**18**	**12**

Semester-IV

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1.	SBC	ESP-20003	Dissertation Phase – II	--	--	18	9
2.	SLC	ESP-20004	Massive Open Online Course –II	3	--	--	3
	Total hrs and Credits			**3**		**18**	**12**

Semester I

(PSMC) [ETC-19005] - Linear Algebra and Probability Theory

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week Tutorial : 1hr/week	T1, T2 – 20 marks each End-Semester Exam - 60

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Solve linear system of equations having numbers of unknowns equal to, less or more than number of equations.
2. Factorize matrix into components such as LU, QR, SVD.
3. Characterize random variables and its functions with probability distributions and cumulative distributions.
4. Specify and apply standard distributions to various applications in engineering

Syllabus Contents:

Linear Algebra

Vectors and Linear Combinations, Dot Products

Solving Linear Equations: Elimination, Elimination Matrices, Inverse Matrices, LU Factorization

Vector Spaces and Subspaces: Solving A.**x**= **0**, Nullspace of A, Rank, Row Reduced Form, Complete solution of A.**x** = **b**, Independence, Basis and Dimension, Dimensions of Four subspaces

Orthogonality: Orthogonality of Four Subspaces, Projections, Least Squares Approximations, Orthogonal bases, Gram-Schmidt – QR Factorization

Eigenvalues and Eigenvectors: Diagonalizing a Matrix, Symmetric Matrices, Positive Definite Matrices, Singular Value Decomposition

Probability and Statistics

Definitions, conditional probability, Bayes Theorem and independence.

Random Variables: Discrete, continuous and mixed random variables, probability mass, probability density and cumulative distribution functions, mathematical expectation, moments, moment generating function, Chebyshev inequality.

Special Distributions: Discrete uniform, Binomial, Geometric, Poisson, Exponential, Gamma, Normal distributions.

Pseudo random sequence generation with given distribution, Functions of a Random Variable

Joint Distributions: Joint, marginal and conditional distributions, product moments, correlation, independence of random variables, bi-variate normal distribution.

Stochastic Processes: Definition and classification of stochastic processes, Poisson process

References:

1. Gilbert Strang, “Introduction to Linear Algebra”, Wellesley Cambridge Press, 4th Edition
2. William W. Hines, Douglas C. Montgomery, David M. Goldsman, Connie M. Borror, “Probability and Statistics in Engineering”, Wiley, 4th Edition
3. Henry Stark, John W. Woods, “Probability and Random Process with Applications to Signal

Processing", Pearson Education, 3rd Edition
4. B. A. Ogunnaike, "Random Phenomena: Fundamentals of Probability and Statistics for Engineers", CRC Press, 2010.

(PSBC)[ESP-19001]- DSP Algorithms

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week	T1, T2 – 20 marks each End-Semester Exam - 60

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Interpret, represent and process discrete/digital signals and systems
2. Understand frequency domain analysis of discrete time signals.
3. Design & analyze DSP systems like FIR and IIR Filter, etc.

Syllabus Contents:

Introduction to DSP: Overview: Signals, systems and signal processing, classification of signals, elements of digital signal processing system, concept of frequency in continuous and discrete time signals, Periodic Sampling, Frequency domain representation of sampling, Reconstructions of band limited signals from its samples, Hilbert algorithm

Discrete-Time Signals and Systems (Frequency Domain analysis): Z-transform & Inverse z-transform, Linear convolution and its properties, Linear Constant Coefficient Difference equations, Frequency domain representation of Discrete-Time Signals & Systems, Representation of sequences by discrete time Fourier Transform, (DTFT), Properties of discrete time Fourier Transform, and correlation of signals, Fourier Transform Theorems.

Analysis of Linear Time Invariant System: Analysis of LTI systems in time domain and stability considerations. Frequency response of LTI system, System functions for systems with linear constant-coefficient Difference equations, Freq. response of rational system functions relationship between magnitude & phase, All pass systems, inverse systems, Minimum/Maximum phase systems, systems with linear phase.

A Digital Signal-Processing System, The Sampling Process, Discrete Time Sequences, Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT), Linear Time-Invariant Systems, Digital Filters, Decimation and Interpolation.

Detailed Designing and analysis of FIR Filters, IIR Filters, Interpolation and Decimation Filters, An FFT Algorithm for DFT Computation, Overflow and Scaling

References:

1. Digital Signal Processing: A Practical approach, Ifeachor E.C. , Jervis B.W Pearson-Education, PHI/2002.
2. "Digital Signal Processing", B. Venkataramani and M. Bhaskar TMH, 2002

(PCC)[ESP-19002]- Digital Audio Processing	
Teaching Scheme Lectures: 3 hrs/week	**Examination Scheme** T1, T2 – 20 marks each End-Semester Exam - 60

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Understand different characteristics of Audio signals
2. Analyze different speech analysis and synthesis systems.
3. Design models and algorithms for audio and speech processing applications.

Syllabus Contents:

- Audio Signal Characteristics, Production model, Hearing and Auditory model, Acoustic characteristic of speech, Speech production models, Linear Separable equivalent circuit model, Vocal Tract and Vocal Cord Model
- Audio signal acquisition, Representation and Modelling, Enhancement of audio signals: Spectral Subtraction, Weiner based filtering, Neural nets
- Audio/ Speech Analysis and Synthesis Systems: Digitization, Sampling, Quantization and coding, Spectral Analysis, Spectral structure of speech, Autocorrelation and Short Time Fourier transform, Window function, Sound Spectrogram, Mel frequency Cepstral Coefficients, Filter bank and Zero Crossing Analysis, Analysis –by-Synthesis, Pitch Extraction., Linear Predictive Coding Analysis.
- Psychoacoustics, Multi-microphone audio processing: Room acoustics, Array beamforming. Acoustic sound source localization and tracking
- Applications: Principles of Automatic Speech Recognition (ASR),Theory and implementation of Hidden Markov Model (HMM) for ASR, Speaker Recognition, Evolution of Speech APIs, Natural Language Processing, Sound source separation models.

References:

1. Sen, Soumya, Dutta, Anjan Dey, Nilanjan, Audio Processing and Speech Recognition,1st edition, 2019, Springer
2. Gold, B.; Morgan, N.; Ellis, D. Speech and audio signal processing: processing and perception of speech and music. 2nd rev. ed. Wiley-Blackwell, 2011.
3. Sadaoki Furui, "Digital Speech Processing, Synthesis and Recognition" 2/e.
4. Rabiner and Schafer, "Digital Processing of Speech Signals", Pearson Education

(PCC) [ESP-19003] Digital Image and Video Processing	
Teaching Scheme Lectures: 3 hrs/week	**Teaching Scheme** Lectures: 3 hrs/week

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand and apply knowledge of various transforms and probability theory in image processing
2. Understand digital image processing fundamentals like enhancement, encoding, feature extraction, and segmentation.
3. Learn the concepts of motion in video processing
4. Analyze, apply and critically evaluate various image and video processing algorithms appropriate for practical applications

Syllabus Contents:

Introduction to image processing: Applications and fields of image processing, Fundamental steps in Digital image processing, Elements of visual perception, Image sensing and acquisition, Basic Concepts in Sampling and Quantization, representing digital images.

Image Enhancement: Some basic gray level transformations, Histogram Processing, Sharpening Spatial filters, Image Enhancement in the spatial and Frequency domain, Pseudocolouring

Segmentation : Some Basic Relationships between pixels, point, Edge based segmentation, Boundary detection, extraction and representation, Threshold based segmentation, Region based segmentation, Texture based segmentation.
Morphological operations, Use of motion in segmentation.

Image Compression: Data redundancies Variable-length coding, Quantizers, Predictive coding, Transform coding, Image compression standards.

Stereoscopic vision : Depth perception from stereo

Video processing : Basics of video processing, Motion analysis, video compression, video compression standards
Case studies: Watermarking, Biometrics, Document analysis, Moving object detection

References:

1. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, Pearson , 4rd Edition
2. Anit K. Jain, Fundamentals of Digital Image Processing, Prentice Hall.
3. Digital Video Processing by A. Murat Tekalp, first edition, Prentice Hall

(DEC) [ESP(DE)-19001] Department Elective I –
a) Biomedical Signal Processing

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week	T1, T2 – 20 marks each End-Semester Exam - 60

Course Outcomes:
At the end of the course, students will demonstrate the ability to:
1. Understand different types of biomedical signal.
2. Identify and analyze different biomedical signals.

3. Apply biomedical signal processing concepts to relevant domain.

Syllabus Contents:

Acquisition, Generation of Bio-signals, Origin of bio-signals, Types of bio-signals, Study of diagnostically significant bio-signal parameters Electrodes for bio-physiological sensing and conditioning, Electrode-electrolyte interface, polarization, electrode skin interface and motion artefact, biomaterial used for electrode,

Types of electrodes (body surface, internal, array of electrodes, microelectrodes), Practical aspects of using electrodes, Acquisition of bio-signals (signal conditioning) and Signal conversion (ADC's DAC's) Processing, Digital filtering,

Biomedical signal processing by Fourier analysis, Biomedical signal processing by wavelet (time-frequency) analysis, Analysis (Computation of signal parameters that are diagnostically significant),Classification of signals and noise, Spectral analysis of deterministic, stationary random signals and non-stationary signals

Coherent treatment of various biomedical signal processing methods and applications.

Principle component analysis, Correlation and regression, Analysis of chaotic signals Application areas of Bio–Signals analysis

References:

1. Biomedical Digital Signal Processing by W. J. Tompkins, Prentice Hall
2. Biomedical Signal Processing and Signal Modeling by Eugene N Bruce, John Wiley & Son's publication
3. Biomedical Engineering and Design Handbook by Myer Kutz, McGraw Hill
4. Biomedical signal processing by D C Reddy, McGraw Hill
5. Practical Biomedical Signal Analysis using MATLAB (Series in Medical Physics and Biomedical Engineering) 2011 by Katarzyn J. Blinowska (Author), JaroslawZygierewicz CRC Press; 1 edition

(DEC) [ESP(DE)-19002] Department Elective I –
b) Voice and Data Networks

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	T1, T2 – 20 marks each End-Semester Exam - 60

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Understand switching and routing protocols used in data communication system.

2. Analyze network design issues and learned queuing models of networks.
3. Acquire the knowledge about next generation network architecture.

Syllabus Contents:

Network Design Issues: Network Performance Issues, Network Terminology, centralized and distributed approaches for networks design, Issues in design of voice and data networks. Layered and Layer less Communication, Cross layer design of Networks

Switching in Networks: Voice Networks (wired and wireless) and Switching, Circuit Switching and Packet Switching, Statistical Multiplexing,

Data Link in Networks and their Design: Link layer design, Link adaptation, Link Layer Protocols, Retransmission Mechanisms (ARQ), Hybrid ARQ (HARQ), Go Back N, Selective Repeat protocols and their analysis.

Queuing Models of Networks: Traffic Models, Little's Theorem**,** Markov chains, M/M/1 and other Markov systems.

Multiple Access Protocols: Aloha System, Carrier Sensing, Examples of Local area networks, Internetworking , Bridging, Global Internet

Routing and Congestion Control in Internet:-IP protocol and addressing , Subnetting, Classless Interdomain Routing (CIDR) , IP address lookup , End to End Protocols, TCP and UDP. Congestion Control , Additive Increase/Multiplicative Decrease , Slow Start, Fast Retransmit/ Fast Recovery , Congestion avoidance , RED TCP Throughput Analysis, Quality of Service in Packet Networks. Network Calculus, Packet Scheduling Algorithms.

References:

1. Data Networks by D. Bertsekas and R. Gallager, Prentice Hall
2. Computer Networks: A Systems Approach by L. Peterson and B. S. Davie, Morgan Kaufman.
3. Communication Networking: An analytical approach by Kumar, D. Manjunath and J. Kuri, Morgan Kaufman.
4. Communications Network: A First Course by Walrand, McGraw Hill
5. Queueing Systems: Theory by Leonard Kleinrock, Volume I, John Wiley and Sons.
6. Telecommunication Network Design Algorithms by Aaron Kershenbaum, McGraw Hill

(DEC)[ETC(DE)-19011] Department Elective I –
c) Modeling, Simulation and Optimization

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	T1, T2 – 20 marks each End-Semester Exam - 60

Course Outcomes

At the end of the course, students will demonstrate the ability to:

1. Understand the steps of modeling and experimenting simulation.
2. Apply statistical knowledge and modeling techniques to construct simulation models
3. Interpret and analyze and simulation results
4. Identify, understand, formulate, and solve optimization problems
5. Understand the concepts of stochastic optimization algorithms

Syllabus Contents:

Introduction to Computer Simulation: Principle of Computer Modeling and Simulation - Monte Carlo Simulation - Nature of Computer Modeling and Simulation, , types of simulation, Simulation as a decision making tool.

Random Numbers and Random Variables: Pseudo Random Numbers - Techniques for Generating Random Numbers - Tests for Random Numbers - Inverse transform technique - exponential distribution - uniform distribution - Weibull distribution.

Distributions: Empirical Discrete Distribution - Discrete Uniform Distribution - Poisson Distribution - Geometric Distribution - Acceptance - Rejection Technique for Poison Distribution - Gamma Distribution.
Verification and Validation: Variance reduction technique, Verification and Validation of Simulation models, Discrete Event Simulation - Concepts in Discrete - Event Simulation, Manual Simulation using event Scheduling, Single Channel Queue, two server queue.

Continuous and Discrete event modeling and simulation: Representing complex behavior through computer program framework using core concepts of entities, events, resources, queues and time.
Introduction to Simulation Languages: Development of simulation models using simulation languages like GPSS – SIMSCRIPT. Agent based modeling methodologies.

Introduction to Optimization: Statement of an Optimization Problem: Design Vector, Design Constraints, Constraint Surface, Objective Function, Objective Function Surfaces
Classical Optimization Techniques: Single-Variable Optimization, Multivariable Optimization with No Constraints (Semi-definite case, Saddle point).
Particle Swarm Optimization

References:

1. Jerry Banks and John S.Carson, Barry L. Nelson, David M. Nicol, "Discrete Event System Simulation", Prentice Hall, India, 3rd Edition 2002. 2. Narsingh Deo, "System Simulation with Digital Computer", PHI, 2001.
2. B.P. Zeigler, H. Praehofer, T.G. Kim, "Theory of Modeling and Simulation"
3. Engineering Optimization: Theory and Practice, 3rd Edition Singiresu S Rao, New Age International, 2000

(MLC) [ML-19011] Research Methodology and Intellectual Property Rights

Teaching Scheme	Examination Scheme
Teaching Scheme Lectures: 2 hrs/week	**Examination Scheme** T1, T2 – 20 marks each End-Semester Exam - 60

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Understand research problem formulation.
2. Analyze research related information
3. Follow research ethics

Syllabus Contents:

- Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem.
- Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations
- Effective literature studies approaches, analysis
- Plagiarism , Research ethics,
- Effective technical writing, how to write report, Paper
- Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

References:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. "Research Methodology: A Step by Step Guide for beginners", by Ranjit Kumar, 2nd Edition

(MLC)[ML-19012] Effective Technical Communication Skills

Teaching Scheme	Examination Scheme
Lectures: 1 hr/week	

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Produce effective dialogue for business related situations
2. Use listening, speaking, reading and writing skills for communication purposes and attempt tasks by using functional grammar and vocabulary effectively
3. Analyze critically different concepts / principles of communication skills
4. Demonstrate productive skills and have a knack for structured conversations
5. Appreciate, analyze, evaluate business reports and research papers

Syllabus Contents:

Fundamentals of Communication
7 Cs of communication, common errors in English, enriching vocabulary, styles and registers

Aural-Oral Communication
The art of listening, stress and intonation, group discussion, oral presentation skills

Reading and Writing
Types of reading, effective writing, business correspondence, interpretation of technical reports and research papers

References:

1. Raman Sharma, "Technical Communication", Oxford University Press.
2. Raymond Murphy "Essential English Grammar" (Elementary & Intermediate) Cambridge University Press.
3. Mark Hancock "English Pronunciation in Use" Cambridge University Press.
4. Shirley Taylor, "Model Business Letters, Emails and Other Business Documents" (seventh edition), Prentise Hall
5. Thomas Huckin, Leslie Olsen "Technical writing and Professional Communications for Non-native speakers of English", McGraw Hill.

(LC)[ESP-19004]- Digital Audio Processing Lab	
Teaching Scheme Lectures: 2 hrs/week	**Examination Scheme** Term work/Practical:100 marks

Course Outcomes:

At the end of the lab course, the students will demonstrate the ability to:

1. Analyze audio signal characteristics using softwares.
2. Process audio signals and implement various speech analysis techniques in MATLAB
3. Implement any audio processing application in MATLAB.

ab Assignments:

1. Audio signal analysis and introduction to various parameters of audio signal using PRAAT, Audacity.
2. Writing MATLAB code or function for:
   - Finding energy of an audio frame
   - Detection and removal of silence region in audio
   - Plotting spectrogram for given audio signal
3. Extraction of Mel Frequency Cepstral Coefficients (MFCCs) from an audio signal in MATLAB.
4. Extraction of Linear Predictive Coding (LPC) coefficients from an audio signal in MATLAB.
5. Calculation of minimum edit distance between two strings using Dynamic Programming algorithm in MATLAB.
6. Designing a codebook as stated in VQ method using K-means clustering algorithm in MATLAB.
7. Evaluation of probabilities using HMM and Viterbi algorithm for a given sequence in MATLAB.
8. Estimation of DOA.
9. Source separation using ICA

(LC) [ESP-19005] Digital Image and Video Processing Lab	
Teaching Scheme Lab: 2 hrs/week	**Examination Scheme** Term work/Practical 100 marks

Course Outcomes:

At the end of the lab course, the students will demonstrate the ability to:

1. Implement various image processing and image enhancement techniques in MATLAB and identify their application areas.
2. Execute various image segmentation techniques.
3. Implement image and video compression techniques.

Lab Assignments:

1. Obtaining row profile of a given row of an image in MATLAB
2. Plotting histogram of an image in MATLAB

3. Adjusting the brightness of an image using a constant value in MATLAB
4. Calculating mean and variance of an image in MATLAB
5. Histogram Equalization of an image in MATLAB
6. Spatial Filtering: Applying low pass, high pass and median filters on an image in MATLAB
7. Pseudo Coloring an image using sinusoidal transforms in MATLAB
8. Detection of edges of an image using Canny Edge Detection algorithm in MATLAB.
9. Image Thresholding using OTSU Thresholding algorithm in MATLAB.
10. Region-based Image Segmentation using region growing in MATLAB.
11. Apply Discrete Cosine Transform (DCT) on an image in MATLAB.
12. Motion Estimation for video sequence using full search algorithm.
13. Tutorial: Presentation of some topics in Digital Image and Video Processing.

(LC) [ESP-19006] Signal Processing Lab

Teaching Scheme	**Examination Scheme**
Lab: 3 hrs/week	Term work/Practical 100 marks

Course Outcomes:

At the end of laboratory course students will demonstrate the ability to

1. Simulate and analyze digital signal processing systems in MATLAB
2. Generate and Analyze analog and digital signals with the help Labview.

Lab Assignments:

Experimentation using Matlab

To find the FFT/IDFT of given signal.
Design and Implementation of FIR Filter
Design and Implementation of IIR Filter
Implementation of Interpolation /Decimation Process
FFT and its Applications

Experimentation using Labview

Acquisition of signal in lab view
Generating signal with Lab view
To find the FFT/IDFT of given signal
Spectral analysis,STFT
Design and Implementation of FIR Filter
Design and Implementation of IIR Filter

(LC) [ESP-19007] Seminar	
Teaching Scheme Lab: 2 hrs/week	**Examination Scheme**

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Guidelines:

- Each student is expected to give a seminar on a topic of current relevance in Signal Processing area.
- Students have to refer published papers from standard journals.
- The seminar report must not be the reproduction of the original papers but it can be used as reference.

Semester II

(IOC)[ETC-19006]- Interdisciplinary Open Course

Broadband Communication

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week	T1, T2 – 20 marks each End-Semester Exam - 60

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Distinguish Cellular Communication Systems from 2G to 5G
2. Compare Optical Fiber Communication and Wireless Communication on the basis of Bandwidth, Cost, Security, and Durability requirements.
3. Understand the operating principles of Wi-Fi and Wi-MAX systems, fixed wireless systems and Quality of services in broadband.
4. Evaluate the parameters related to orbital motion and link budget for the satellite.

Syllabus Contents:

Mobile Communication: Introduction, Concepts of coverage area and dead zones, Cellular system design, Frequency reuse, Co channel and adjacent channel interference, Interference reduction techniques, Fixed and Dynamic Channel Assignment Strategies, concepts of cell splitting, Handoff Process, Factors affecting Handoff Process, Handoff Strategies, Microcell Zone concept, GSM architecture, Call Flows in GSM, Multiple access techniques.

Satellite Communication: Introduction, Kepler laws, apogee and perigee heights, Orbital equations, LEO, MEO, GEO satellites, Orbit perturbations, Satellite Sub-Systems, Solar eclipse on satellite, Sun transit outage phenomena, Doppler frequency shift, Satellite Link Budget- Flux density, EIPR and received signal power equations, Calculation of system noise temperature for satellite receiver, noise power calculation, C/N ratio calculations in clear air and rainy conditions.

Fixed Wireless Systems: Microwave links, Private unlicensed links (Spread spectrum), MMDS (Multi-channel Multi-point Distribution Service), LMDS (Local Multipoint Distribution Service).

Wi-Fi and Wi-MAX Technologies: Introduction to Wi-Fi and Wi-MAX, Principles and parameters for Wireless LAN (IEEE 802.11 standards), Operating principles for Wi-MAX (IEEE 802.16 standard), Comparison of Wi-Fi and Wi-MAX.

Optical Fiber Communication: Principles of optical fiber communication, advantages and disadvantages of optical fiber communication, Optical Spectral bands, Basic optical laws and definitions, Single-mode fiber, Graded-index fiber, Signal Degradation in optical fiber: Attenuation, Dispersion.

Quality-of-Service (QoS) in Broadband: QoS issues in broadband communication, A case study of broadband service regulations for maintaining QoS by telecom regulatory bodies such as TRAI.

References:

1. Theodore S. Rappaport, “Wireless Communications-Principles and Practice”,2nd edition, PHI,2010

2. Louis E. Frenzel, "Principles of Electronic Communication Systems",3rd edition, Tata McGraw Hill, 2012
3. Timothy Pratt and Others, "Satellite Communications", Wiley India, 2nd edition, 2002
4. Recent QoS regulations released by TRAI (available on website of TRAI).

(PCC) [ESP-19009]- Machine Learning

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week	T1, T2 – 20 marks each End-Semester Exam - 60

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Design and implement machine learning solutions to a) Classification b) Regression c) Clustering problems
2. Evaluate and interpret the results of the machine learning algorithms
3. Build rapid prototypes and for actual deployment.

Syllabus Contents:

Review of Probability Theory and Linear algebra

Regression: Linear Regression, Multivariate Regression, Subset Selection, Shrinkage Methods, Principal Component Regression, Logistic Regression, Partial Least Squares Classification: Linear Classification, LDA

Introduction to Perceptron and SVM Neural Networks: Introduction, Early Models, Perceptron Learning, Back-propagation, Initialization of neural network, Training and Validation, Parameter Estimation

Decision Trees - Stopping Criterion and Pruning, Loss function, Categorical Attributes, Multiway Splits, Missing values, Instability, Regression Trees. Bootstrapping and Cross Validation, Class Evaluation, Measures, ROC curve, MDL, Ensemble methods, Committee Machines and Stacking.

Gradient Boosting, Random Forests, Multi-class Classification, Naïve Bayes, Bayesian Networks, Undirected Graphical Models, HMM, Variable elimination, Belief Propagation, Partitional clustering, Hierarchical Clustering, Birch Algorithm, CURE Algorithm, Density- Based Clustering, Gaussian Mixture Models, Expectation Maximization, Learning Theory, Re-enforcement Learning

Convolutional Neural Networks - CNN Operations, CNN architectures, Training, Transfer Learning.

Recurrent Neural Networks - RNN, LSTM, GRU, Applications.

Introduction to Deep learning

References:

1. Bengio, Courville, “Deep learning by Good Fellow”, - MIT Press, 2016.
2. Bishop “Pattern Recognition and Machine Learning” Springer, 2009.
3. Chollet,” Deep learning with Python”, Manning Publications, 2017.
4. Ethem Alpaydin, “Introduction to Machine Learning”, PHI, 2005
5. Bishop Christopher, “Neural Networks for Pattern Recognition”, New York, NY: Oxford University Press, ISBN: 9780198538646
6. Mitchell Tom, “Machine learning”, New York, NY: McGraw-Hill, ISBN:9780070428072
7. Hastie, T. R. Tibshirani, and J. G. Friedman, “The Elements of Statistical Learning: Data Mining, Inference and Prediction”, New York, NY: Springer, ISBN:9780387952840
8. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani “Introduction to Statistical Learning”, Springer, 2013

(PCC) [ESP-19010]- Adaptive Signal Processing

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	T1, T2 – 20 marks each End-Semester Exam - 60

Course Outcomes: At the end of the course, students will demonstrate the ability to:

1. Evaluate the performance of various methods for designing adaptive filters through estimation of different parameters of stationary random process.
2. Ability to experiment and identify merits and demerits of various adaptive algorithms.
3. Design and implement filtering solutions for various applications.

Syllabus Contents:

Introduction to Adaptive Filters.

1. Adaptive filter structures, issues and examples.
2. Applications of adaptive filters.

a. Channel equalization, active noise control.
b. Echo cancellation, beamforming

Discrete time stochastic processes.

1. Re-visiting probability and random variables.
2. Discrete time random processes.
3. Power spectral density - properties.
4. Autocorrelation and covariance structures of discrete time random processes.
5. Eigen-analysis of autocorrelation matrices.

Wiener filter, search methods and the LMS algorithm.

1. Wiener FIR filter (real case).
2. Steepest descent search and the LMS algorithm.
3. Extension of optimal filtering to complex valued input.

The Complex LMS algorithm.

Convergence and Stability Analyses.

1. Convergence analysis of the LMS algorithm.
2. Learning curve and mean square error behaviour.
3. Weight error correlation matrix.
4. Dynamics of the steady state mean square error (mse).

Misadjustment and stability of excess mse.

Variants of the LMS Algorithm.

1. The sign-LMS and the normalized LMS algorithm.
2. Block LMS.
3. Review of circular convolution.
4. Overlap and save method, circular correlation.

FFT based implementation of the block LMS Algorithm.

Vector space framework for optimal filtering.

1. Axioms of a vector space, examples, subspace.
2. Linear independence, basis, dimension, direct sum of subspaces.
3. Linear transformation, examples.
4. Range space and null space, rank and nullity of a linear operator.
5. Inner product space, orthogonality, Gram-Schmidt orthogonalization.
6. Orthogonal projection, orthogonal decomposition of subspaces.

The lattice filter and estimator.

1. Forward and backward linear prediction, signal subspace decomposition using forward and backward predictions.
2. Order updating the prediction errors and prediction error variances, basic lattice section.
3. Reflection coefficients, properties, updating predictor coefficients.
4. Lattice filter as a joint process estimator.
5. AR modeling and lattice filters.

Gradient adaptive lattice.

RLS lattice filter.

1. Least square (LS) estimation, pseudo-inverse of a data matrix, optimality of LS estimation.
2. Vector space framework for LS estimation.
3. Time and order updating of an orthogonal projection operator.
4. Order updating prediction errors and prediction error power.
   Time updating PARCOR coefficients.

References:

1. "Adaptive Filter Theory" by S. Haykin, Prentice Hall, Englewood Cliffs, NJ, 1991 (end Ed.).
2. "Adaptive Filters â€“ Theory and Applications", by B. Farhang-Boroujeny, John Wiley and Sons, 1999

(PCC)[ESP-1900] DSP Architecture	
Teaching Scheme	**Examination Scheme**

Lectures: 3 hrs/week	T1, T2 – 20 marks each End-Semester Exam - 60

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Identify and formalize architectural level characterization of P-DSP hardware
2. Ability to design, programming, and testing code for DSP applications using Code Composer Studio environment in simulation mode and using starter kits
3. Deployment of DSP hardware for Control, Audio and Video Signal processing applications

Syllabus Contents:

Programmable DSP Hardware: Processing Architectures (von Neumann, Harvard), DSP core algorithms (FIR, IIR, Convolution, Correlation, FFT), IEEE standard for Fixed and Floating Point Computations, Special Architectures Modules used in Digital Signal Processors (like MAC unit, Barrel shifters), On-Chip peripherals, DSP benchmarking.

Structural and Architectural Considerations: Parallelism in DSP processing, Texas Instruments TMS320 Digital Signal Processor Families, Fixed Point TI DSP Processors: TMS320C1X and TMS320C2X Family, TMS320C25 –Internal Architecture, Arithmetic and Logic Unit, Auxiliary Registers, Addressing Modes (Immediate, Direct, and Indirect, Bit-reverse Addressing), Basics of TMS320C54x and C55x Families in respect of Architecture improvements and new applications fields, TMS320C5416 DSP Architecture, Memory Map, Interrupt System, Peripheral Devices, Illustrative Examples for assembly coding.

VLIW Architecture: Current DSP Architectures, GPUs as an alternative to DSP Processors, TMS320C6X Family, Addressing Modes, Replacement of MAC unit by ILP, Detailed study of ISA, Assembly Language Programming, Code Composer Studio, Mixed C and Assembly Language programming, on-chip peripherals, Simple applications developments as an embedded environment.

Multi-core DSPs: Introduction to Multi-core computing and applicability for DSP hardware, Concept of threads, introduction to P-thread, mutex and similar concepts, heterogeneous and homogenous multi-core systems, Shared Memory parallel programming – OpenMP approach of parallel programming, PRAGMA directives, OpenMP Constructs for work sharing like for loop, sections, TI TMS320C6678 (Eight Core subsystem).

FPGA based DSP Systems: Limitations of P-DSPs, Requirements of Signal processing for Cognitive Radio (SDR), FPGA based signal processing design- case study of a complete design of DSP processor, High Performance Computing using P-DSP: Preliminaries of HPC, MPI, OpenMP, multicore DSP as HPC infrastructure.

References:

1. Digital Signal Processors Architecture, Programming and Applications by B. Venkatramani , M. Bhaskar
2. Introduction to Parallel Processing by M. Sasikumar, D. Shikhare, Ravi Prakash, PHI
3. Algorithms and Parallel Computing by Fayez Gebali, Wilely
4. Parallel Programming in OpenMP by Rohit Chandra, L. Dagun, Memon- Morgan Kaufman
5. Multicore Embedded systems- GeorgiousKormaros, CRC Press
6. High Performance Embedded Computing: Architectures , applications-- Wayne Wolf, Morgan Kaufman
7. Algorithmic Collections for Digital Signal Processing Applications- E.S. Gopi

(DEC) Departmental Elective -II

a) [ESP(DE)-19004]- Remote Sensing and Multispectral Analysis

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week	T1, T2 – 20 marks each End-Semester Exam - 60

Course Outcomes:

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

1. Understand the basic principles of remote sensing
2. Apply various corrections required in processing remote sensed images
3. Analyse remote sensing images to solve problems in different areas like LULC, change detection, image fusion
4. Apply acquired knowledge and critical thinking skills to solve a real-world problem with appropriate remote sensing data and processing methods

Concepts and Foundations of Remote Sensing

Introduction, energysourcesandradiation principles, energyinteractionsinthe atmosphere, energyinteractionswith earthsurface features, anidealremotesensingsystem, characteristicsofrealremotesensing systems, energy sources and electromagnetic spectrum, different resolutions for remote sensing images, successful application of remote sensing.

Correcting and Registering images

Sources of distortions and correction in remote sensing images, georeferencing.

Visual ImageInterpretation

Fundamentals of visual image interpretation, basic visual image interpretation equipment, land use/land cover mapping, geologic and soil mapping, agricultural applications, forestry applications, rangeland applications, water resource applications, urban and regional planning applications, wetland mapping wildlife ecology applications, archaeological applications, environmental assessment, natural disaster assessment, principles of landform identification and evaluation.

Different types of remote sensors

Across-track scanning, along-track scanning, operating principles of across-track multispectral scanners, example along-track multispectral scanner and data, across-track thermal scanning, thermal radiation principles, interpreting thermal scanner imagery, geometric characteristics of across-track scanner imagery, geometric characteristics of along-track scanner imagery, radiometric calibration of thermal scanners, temperature mapping with thermal scanner data, FLIR systems, hyperspectral sensing, microwave remote sensing – synthetic aperture radar, radar image characteristics, radar image interpretation, examples of multispectral, panchromatic and SAR sensors.

Digital Image Processing of remote sensing images.

Image file formats (BSQ, BIP, BIL), image rectification and restoration, image enhancement, multi-image manipulation, image fusion-PCA and wavelet-based techniques. image classification, post-classification smoothing, classification accuracy assessment, data merging and GIS integration, hyperspectral image analysis, biophysical modelling, scale effects, image transmission and compression.

References:

1. 'Remote Sensing and Image Interpretation', T.M. Lillesand and R.W. Kiefer, John Wiley & Sons, Singapore, 7th edition, 2015.
2. ‘Remote Sensing Digital Image Analysis - An Introduction’, John A. Richards, Springer, 5th edition, 2013.
3. 'Remote Sensing - Models and Methods for Image Processing', R.A. Schowengerdt, Elsevier India Pvt. Ltd., New Delhi, 2006

(DEC) Departmental Elective -II

b) [ESP(DE)-19005] Artificial Intelligence

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	T1, T2 – 20 marks each End-Semester Exam - 60

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Identify and formalize a given problem in the framework of solution by AI methods
2. Design Fuzzy Logic based system for engineering applications including AN Network methods
3. Deploy inconsistent information systems
4. Understand major areas and challenges in evolutionary computing and Chaotic systems

Syllabus Contents:

Knowledge Representation: Prepositional Logic, Inference Rules in Prepositional Logic, Knowledge representation using Predicate logic, Predicate Calculus, Semantic net, Frames Inconsistent Information Systems: Basic Concepts of Rough Sets, Equivalence Class and Discernibility Relations, Lower and Upper approximations, Information Systems Framework using Rough Sets, Reducts and Core, Introduction to Rough Set Software ROSE, Rules extractions, Information Gain and applications Evolutionary Computing: Genetic algorithms, Introduction to Genetic Programming Dynamical Systems and Chaos: 1-D Maps, Chaotic orbits, Fixed Points, Chaotic attractors, Bifurcations, Fractals, Mandlebrot set, Time Series analysis Representation and Manipulation of Imprecision and Uncertainty: Type-I Fuzzy Sets, Membership Functions – Triangular, Trapezoidal, PI, T-Norm, S-Norm Operations, Fuzzy Hedges, Fuzzy Relations & Composition, Type-II Fuzzy sets introduction Engineering Adaptations of Fuzzy Systems: Fuzzy Object Class, Fuzzy Logic IC chips, Fuzzy Inference Engine, Rule based fuzzy expert systems, Fuzzy Controllers, case studies Neural Networks: Introduction to neural networks and perception, Neural net Architecture and applications Term Paper: Students in a group will prepare a review term paper on the current topics related to study units in IEEE format and present it in the classes.

References:

1. Toshinori Munakata, “Fundamentals of the New Artificial Intelligence”, Springer, Second Ed
2. Elaine Rich, Kevin Knight, B. Nair, “Artificial Intelligence”, Tata Mc Graw-Hill, Third Ed
3. K.T. Alligood, T.D. Sauer, J.A. Yorke, “Chaos-An introduction to Dynamical Systems”Springer
4. D. K. Chaturvedi, “Soft Computing- Techniques and its Applications in Electrical Engg.” Springer
5. Melanai Mitchell, “An Introduction to Genetic Algorithms (Complex Adaptive Systems)”
6. Time Series Analysis Paper by Elizabeth Bradley and Videos by Bradley

(DEC) Departmental Elective -II

c) [ESP(DE)-19006] Signal Processing for Communication

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week	T1, T2 – 20 marks each End-Semester Exam - 60

Introduction: The Discrete-Time Abstraction, Basic Signals Digital Frequency, Elementary Operators, The Reproducing Formula, Energy and Power, Classes of Discrete-Time Signals, Finite-Length Signals, . Infinite-Length Signals.

Signals and Hilbert Spaces: Euclidean Geometry: Review, From Vector Spaces to Hilbert Spaces: The Recipe for Hilbert Space , Examples of Hilbert Spaces, Inner Products and Distances, Subspaces , Bases, Projections, Fourier Analysis.

Discrete Time Filters: Linear Time-Invariant Systems, Filtering in the Time Domain, Filtering in the Frequency Domain: LTI “Eigen functions”, The Convolution and Modulation Theorems, Properties of the Frequency Response, Ideal Filters, Realizable Filters, Constant-Coefficient Difference Equations, The Algorithmic Nature of CCDEs, Filter Analysis and Design.

Stochastic Signal Processing: Random Variables, Random Vector , Random Processes , Spectral Representation of Stationary Random Processes: Power Spectral Density, PSD of a Stationary Process, White Noise , Stochastic Signal Processing.

Interpolation and Sampling, A/D and D/A Conversions.

Multirate Signal Processing: Downsampling, Upsampling, Oversampling

Design of a Digital Communication System: The Communication Channel(The AM Radio Channel, The Telephone Channel), Modem Design: The Transmitter (Digital Modulation and the Bandwidth Constraint, Signaling Alphabets and the Power Constraint), Modem Design: The Receiver (Hilbert Demodulation, The Effects of the Channel) , Adaptive Synchronization (Carrier Recovery, Timing Recovery)

References

1. Signal Processing for Communications, by P.Prandoni and M. Vetterli, 2008, EPFL Press

(DEC III)- Department Elective III

a) [ETC(DE)-19010] Joint Time Frequency Analysis

Teaching Scheme Lectures: 3 hrs/week	**Examination Scheme** T1, T2 – 20 marks each End-Semester Exam - 60

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Understand the limitations of Fourier Transform and the significance of Wavelets Time-Frequency.
2. Analysis and study of techniques for Time-Frequency Analysis and Multi-Resolution Analysis.
3. Understand applications of Time-Frequency and Multi-Resolution Analysis techniques.

Syllabus Contents:

Piecewise constant approximation - the Haar wavelet, Building up the concept of dyadic Multiresolution Analysis (MRA),

Relating dyadic MRA to filter banks, review of discrete signal processing, Elements of multirate systems and two-band filter bank design for dyadic wavelets,

Families of wavelets: Orthogonal and biorthogonal wavelets, Daubechies' family of wavelets in detail, Vanishing moments and regularity, Conjugate Quadrature Filter Banks (CQF) and their design, Dyadic MRA more formally, Data compression – fingerprint compression standards, JPEG-2000 standards,

The Uncertainty Principle and its implications: the problem and the challenge that Nature imposes, The importance of the Gaussian function: the Gabor Transform and its generalization; time, frequency and scale - their interplay, The Continuous Wavelet Transform (CWT), Condition of admissibility and its implications, The Uncertainty Principle: and its implications: the fundamental issue in this subject - the problem and the challenge that Nature imposes, The importance of the Gaussian function: the Gabor Transform and its generalization; time, frequency and scale - their interplay, The Continuous Wavelet Transform (CWT), Condition of admissibility and its implications, Application of the CWT in wideband correlation processing,

Variants of the wavelet transform and its implementational structures, The wavepacket transform, Computational efficiency in realizing filter banks - Polyphase components, The lattice structure, The lifting scheme,

An exploration of applications: Transient analysis; singularity detection; Biomedical signal processing applications; Geophysical signal analysis applications; Efficient signal design and realization: wavelet based modulation and demodulation; Applications in mathematical approximation; Applications to the solution of some differential equations; Applications in computer graphics and computer vision; Relation to the ideas of fractals and fractal phenomena.

References:

1. Wavelet Analysis: The Scalable Structure of Information by Howard L. Resnikoff, Raymond O. Wells, Springer
2. Wavelet Transforms: Introduction by Raghuveer M. Rao, Ajit S. Bopardikar
3. Insight Into Wavelets - From Theory to Practice by K. P. Soman, K. I. Ramachandran, Prentice Hall
4. An Introduction to Wavelets Through Linear Algebra by Michael W. Frazier, Springer
5. Multirate Systems and Filter Banks by P. P. Vaidyanathan, Pearson Education

(DEC III)- Department Elective III

b) [ESP(DE)-19007] Signal Acquisition Devices and Systems

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week	T1, T2 – 20 marks each End-Semester Exam - 60

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Understands the elements of data acquisition techniques
2. Evaluate and select appropriate techniques and devices for realising a data acquisition system.
3. Design and implement a data acquisition solution for a particular application

Syllabus Contents:

Concepts of data acquisition systems, sample signals that measure real physical conditions and convert the resulting samples into digital, numeric values to be analyzed

Problem-solving approach to data acquisition, sensors that convert physical parameters to electrical signals, signal conditioning circuitry to convert sensor signals into a form that can be converted to digital values and analog-to-digital converters, which convert conditioned sensor signals to digital values. hands-on approach, culminating with data acquisition projects

Fundamental principles of measurement, sensors and signal conditioning. software packages related to data acquisition

References:

1. Data Acquisation systems from Fundamentals To Applied Design Hardcover-March

22,2013 byMaurizio Di Paolo EmilioSpringer; 2013 edition (March 22, 2013)
2. Data Acquisition for Sensor SystemsPaperback– December 3, 2010 by H.R. TaylorSpringer; Softcover reprint of hardcover 1st ed. 1997 edition (December 3,2010).

(DEC III)- Department Elective III

c) [ESP(DE)-19008] Signal Processing for Surveillance Systems

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	T1, T2 – 20 marks each End-Semester Exam - 60

Course Outcomes: At the end of the course, students will demonstrate the ability to:

1. Understand and analyze various computer vision techniques for object segmentation, localization, recognition and tracking
2. Apply various state-of-the-art techniques for object localization, recognition and tracking in autonomous vehicles
3. Apply and implement various recent deep learning based techniques for object localization, recognition and tracking in autonomous vehicles

Syllabus Contents:

Study of various methods for shape representation and segmentation: Deformable curves and Snakes, Fourier and Wavelet descriptors
Introduction to various object recognition methods: Hough Transform, Shape correspondence, Shape Matching , Principal Component Analysis etc.
Study of image formation models, camera model and camera calibration
Introduction to various computer vision algorithms for segmentation, recognition and tracking
State-of-the-art methods for object representation such as HoG, Texture features, Bag-of-Words, Sparse Representation, Haar like features.
Can include some state-of-the-art techniques for object localization: Various Object proposal methods
Study of state-of-the-art classifiers: KNN, SVM, Adaboost, ANN
Introduction to CNN as the recent emerging classifier for signal processing applications in Autonomous vehicles
Familiarity with recent deep learning based algorithms for object localization and recognition : RCNN, FAST RCNN, FASTER RCNN, YOLO
Intelligent Transport Systems (ITS): Communication standards in IOT for ITS like, MQTT, DDS, AMQP, BLUETOOTH, ZIGBEE, WIFI, Security and surveillance systems
Advanced driver assistance systems (ADAS): ADAS domain controller, Automotive thermal camera, Camera module without processing, Conditionally automated drive controller, Drive assist ECU, Driver monitoring, Driver vital sign monitoring, Front/Rear camera, advance features.
Internet of vehicles and VANET: Types of IOV, Benefits of IOV, Difference between IOV and VANET, Connected cars IoT Transportation, Activity Monitoring.

References:

1. Computer Vision: Models, Learning, and InferencebySimon J. D. Prince, Cambridge University Press
2. Computer Vision- A Reference Guide by Ikeuchi and Katsushi , Springer
3. Pattern Recognition and Machine Learning by Christopher Bishop,Mcgraw-Hill
4. Digital Signal Processing for in-vehicle system and processing, Springer
5. Practical Convolutional Neural Networks by M. Sewak, Md. R. Karim and P. Pujari

(LLC)- Liberal Learning Course

Teaching Scheme	**Examination Scheme**
Lectures:1 hr/week	Term Work -100 Marks

Course Outcomes:

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Exhibit self learning capabilities and its use in effective communication.
2. Inculcate impact of various areas to relate with society at large.

Syllabus Contents:

Identification of topic and resources, scope, and synthesize viewpoints for the areas such as performing arts, social sciences, business, philosophy, Agriculture sports and athletics, Fine Arts Medicine and Health Linguistics, defence studies and education

(LC)[ESP-19011]DSP Architecture Lab

Teaching Scheme	**Examination Scheme**
Lab: 3 hrs/week	Term work/Practical 100 marks

Course Outcomes: At the end of the lab course, the students will demonstrate the ability to:

1. Implement various digital signal processing algorithms using Code Composer Studio in simulation

mode.
2. Demonstrate various digital signal processing algorithms on DSP hardware.
3. Deploy DSP hardware using Code Composer Studio for various digital signal processing applications

. **Lab Assignments:**
1. Study of TMSC6713 DSK and introduction to Code Composer Studio 5.4.0.
2. Bit Reversal using TMSC6713 DSK
3. Signed Integer Division using TMSC6713 DSK
4. Signed Integer Division using TMSC6713 DSK
5. Unsigned Integer Division using TMSC6713 DSK
6. Convolution of 2 sequences using TMSC6713 DSK
7. Complex Number Multiplication using TMSC6713 DSK
8. Computation of Radix-2 and Radix-4 FFT using TMSC6713 DSK
9. Mini Project: Any Signal Processing Application using TMSC6713 DSK

(LC)[ESP-19012]- Machine Learning Lab

Teaching Scheme	**Examination Scheme**
Lectures: 2 hrs/week	Term work/Practical 100 marks

Course Outcomes:

At the end of the course the student should be able to

1. Learn application of AI in practical field
2. Apply ML concepts to find solution in problem domain.

Syllabus Contents:

- Overview of Python- Starting with Python
- Introduction to installation of Python
- Introduction to Python Editors & IDE's(Canopy, pycharm, Jupyter, Rodeo, Ipython etc.)
- Understand Jupyter notebook & Customize Settings
- Concept of Packages/Libraries - Important packages(NumPy, SciPy, scikit-learn, Pandas, Matplotlib, etc)
- Installing & loading Packages & Name Spaces
- Data Types & Data objects/structures (strings, Tuples, Lists, Dictionaries)
- List and Dictionary Comprehensions
- Variable & Value Labels – Date & Time Values
- Basic Operations - Mathematical - string - date
- Reading and writing data
- Simple plotting , Control flow & conditional statements, Debugging & Code profiling
- Algorithms for machine learning

(LC) [ESP-19013]- Adaptive Signal Processing Lab	
Teaching Scheme Lectures: 3 hrs/week	**Examination Scheme** Term work/Practical 100 marks

Course Outcomes: At the end of the lab course, the students will demonstrate the ability to:

1. Devise filtering solutions for various applications and appreciate the need for adaptation in design.
2. Analyse convergence and stability issues associated with adaptive filter design

Lab Assignments:

1. Convolution of two sequences in MATLAB.
2. Computation of Discrete Fourier Transform of a given sequence in MATLAB.
3. Implementations of Finite Impulse Response (FIR) filter in MATLAB.
4. Implementations of Infinite Impulse Response (IIR) filter in MATLAB.
5. Implementation of decimation in MATLAB.
6. Implementation of interpolation in MATLAB.
7. Implementation of adaptive filter using Least Mean Squares (LMS) algorithm in MATLAB.
8. Implementation of adaptive filter using Recursive Least Squares (RLS) algorithm in MATLAB.
9. Presentation: Any topic on recent areas of research in Multirate and Adaptive Signal processing.

Semester III and IV

(Dissertation) Dissertation Phase – I and Phase - II	
Teaching Scheme Lectures: 4 hrs/week	**Examination Scheme** Term work – 50 marks, Oral – 50

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Ability to synthesize knowledge and skills previously gained and applied to an in-depth study and execution of new technical problem.
2. Capable to select from different methodologies, methods and forms of analysis to produce a suitable research design, and justify their design.
3. Ability to present the findings of their technical solution in a written report.
4. Presenting the work in International/ National conference or reputed journals.

Syllabus Contents:

The dissertation / project topic should be selected / chosen to ensure the satisfaction of the urgent need to establish a direct link between education, national development and productivity and thus reduce the gap between the world of work and the world of study. The dissertation should have the following

- Relevance to social needs of society
- Relevance to value addition to existing facilities in the institute
- Relevance to industry need
- Problems of national importance
- Research and development in various domain

The student should complete the following:

- Literature survey Problem Definition
- Motivation for study and Objectives
- Preliminary design / feasibility / modular approaches
- Implementation and Verification
- Report and presentation

The dissertation stage II is based on a report prepared by the students on dissertation allotted to them. It may be based on:

- Experimental verification / Proof of concept.
- Design, fabrication, testing of Communication System.
- The viva-voce examination will be based on the above report and work.

Guidelines for Dissertation Phase – I and II at M. Tech. (Electronics):

- As per the AICTE directives, the dissertation is a yearlong activity, to be carried out and evaluated in two phases i.e. Phase – I: July to December and Phase – II: January to June.
- The dissertation may be carried out preferably in-house i.e. department‟s laboratories and centers OR in industry allotted through department‟s T & P coordinator.
- After multiple interactions with guide and based on comprehensive literature survey, the

student shall identify the domain and define dissertation objectives. The referred literature should preferably include IEEE/IET/IETE/Springer/Science Direct/ACM journals in the areas of Computing and Processing (Hardware and Software), Circuits-Devices and Systems, Communication-Networking and Security, Robotics and Control Systems, Signal Processing and Analysis and any other related domain. In case of Industry sponsored projects, the relevant application notes, while papers, product catalogues should be referred and reported.

- Student is expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation and phase wise work distribution, and submit the proposal within a month from the date of registration.
- Phase – I deliverables: A document report comprising of summary of literature survey, detailed objectives, project specifications, paper and/or computer aided design, proof of concept/functionality, part results, A record of continuous progress.
- Phase – I evaluation: A committee comprising of guides of respective specialization shall assess the progress/performance of the student based on report, presentation and Q & A. In case of unsatisfactory performance, committee may recommend repeating the phase-I work.
- During phase – II, student is expected to exert on design, development and testing of the proposed work as per the schedule. Accomplished results/contributions/innovations should be published in terms of research papers in reputed journals and reviewed focused conferences OR IP/Patents.
- Phase – II deliverables: A dissertation report as per the specified format, developed system in the form of hardware and/or software, A record of continuous progress.
- Phase – II evaluation: Guide along with appointed external examiner shall assess the progress/performance of the student based on report, presentation and Q & A. In case of unsatisfactory performance, committee may recommend for extension or repeating the work