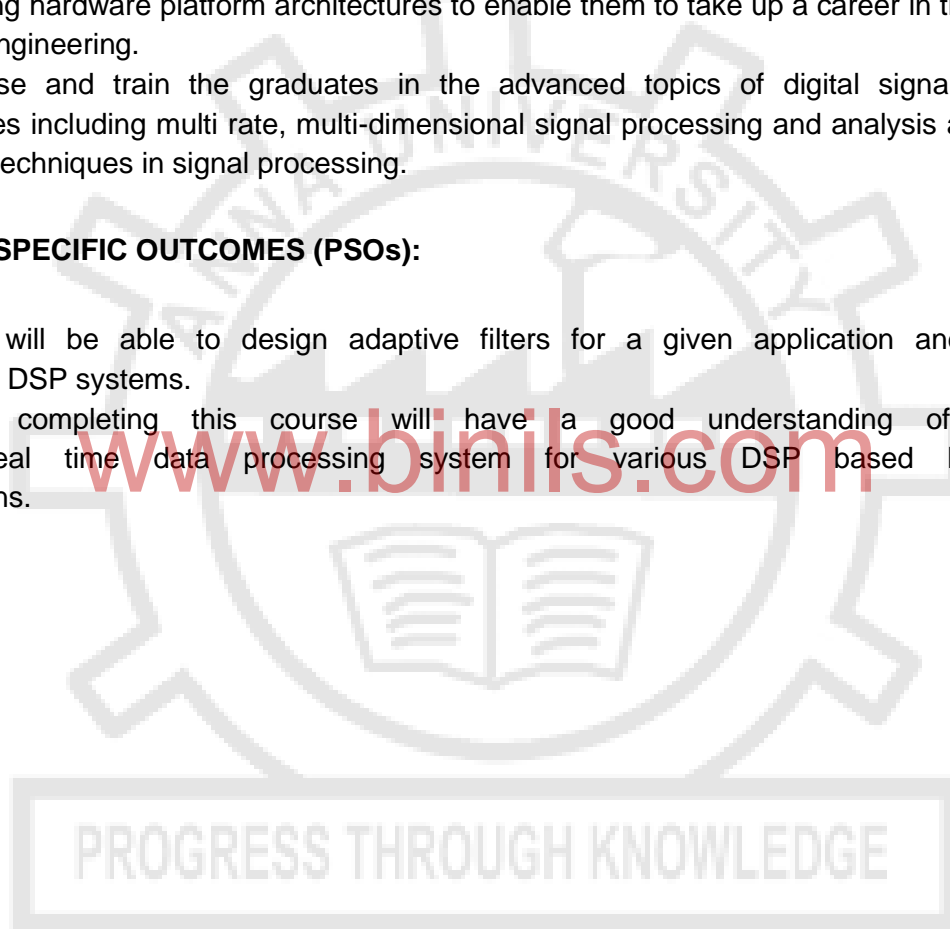**ANNA UNIVERSITY, CHENNAI**
NON - AUTONOMOUS COLLEGES AFFILIATED ANNA UNIVERSITY
M.E. DIGITAL SIGNAL PROCESSING
REGULATIONS – 2021
CHOICE BASED CREDIT SYSTEM

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

1. To provide theoretical and conceptual knowledge of digital signal processing in the areas like radar, VLSI, speech and image processing
2. To educate graduates in the field of signals and signal processing techniques adopted in various sectors like power/industrial/biomedical/optical/aerospace/energy along with relevant processing hardware platform architectures to enable them to take up a career in this important area of engineering.
3. To expose and train the graduates in the advanced topics of digital signal processing techniques including multi rate, multi-dimensional signal processing and analysis and machine learning techniques in signal processing.

PROGRAM SPECIFIC OUTCOMES (PSOs):

1. Students will be able to design adaptive filters for a given application and to design multi- rate DSP systems.
2. Students completing this course will have a good understanding of the DSP based real time data processing system for various DSP based high speed applications.

ANNA UNIVERSITY, CHENNAI
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M.E. DIGITAL SIGNAL PROCESSING
REGULATIONS – 2021
CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULA AND 1st SEMESTER SYLLABI
SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK L	T	P	TOTAL CONTACT PERIODS	CREDITS
THEORY								
1.	MA4102	Applied Mathematics For Signal Processing Engineers	FC	4	0	0	4	4
2.	RM4151	Research Methodology and IPR	RMC	2	0	0	2	2
3.	DS4151	Digital Image and Video Processing	PCC	3	0	2	5	4
4.	DS4152	Statistical Signal Processing	PCC	3	0	0	3	3
5.	DS4101	Modern Communication Systems	PCC	3	0	0	3	3
6.	DS4102	Speech and Audio Signal Processing	PCC	3	0	0	3	3
7.		Audit Course – I*	AC	2	0	0	2	0
PRACTICALS								
8.	DS4111	Statistical Signal Processing Laboratory	PCC	0	0	4	4	2
9.	DS4112	DSP Processor Laboratory - I	PCC	0	0	4	4	2
			TOTAL	**20**	**0**	**10**	**30**	**23**

*Audit course is optional

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK L	T	P	TOTAL CONTACT PERIODS	CREDITS
THEORY								
1.	DS4251	Multimedia Compression Techniques	PCC	3	0	0	3	3
2.	DS4201	Mixed Signal Processing	PCC	3	0	0	3	3
3.	DS4202	Biomedical Image Processing	PCC	3	0	0	3	3
4.	DS4203	Multispectral Signal Analysis	PCC	3	0	0	3	3
5.		Professional Elective I	PEC	3	0	0	3	3
6.		Professional Elective II	PEC	3	0	0	3	3
7.		Audit Course – II*	AC	2	0	0	2	0
PRACTICALS								
8.	DS4211	Term Paper and Seminar	EEC	0	0	2	2	1
9.	DS4212	DSP Processor Laboratory - II	PCC	0	0	4	4	2
			TOTAL	**20**	**0**	**6**	**26**	**21**

*Audit course is optional

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Professional Elective III	PEC	3	0	0	3	3
2.		Professional Elective IV	PEC	3	0	0	3	3
3.		Professional Elective V	PEC	3	0	2	5	4
4.		Open Elective	OEC	3	0	0	3	3
PRACTICALS								
5.	DS4311	Project Work I	EEC	0	0	12	12	6
			TOTAL	**12**	**0**	**14**	**26**	**19**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	DS4411	Project Work II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL NO. OF CREDITS: 75

PROFESSIONAL ELECTIVES
SEMESTER II, ELECTIVE I

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	DS4072	Wavelet Transforms and Its Applications	PEC	3	0	0	3	3
2.	BM4151	Bio Signal Processing	PEC	3	0	0	3	3
3.	DS4001	MIMO and OFDM	PEC	3	0	0	3	3
4.	VE4152	Embedded System Design	PEC	3	0	0	3	3
5.	DS4002	Digital Control Engineering	PEC	3	0	0	3	3

SEMESTER II, ELECTIVE II

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	DS4003	Neural Networks and Applications	PEC	3	0	0	3	3
2.	DS4004	Underwater Acoustics Signal Processing	PEC	3	0	0	3	3
3.	DS4005	Signal Integrity for High Speed IC Design	PEC	3	0	0	3	3
4.	DS4006	DSP Integrated Circuits	PEC	3	0	0	3	3
5.	DS4007	Design and Analysis of Computer Algorithms	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE III

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	DS4008	Cryptographic Techniques	PEC	3	0	0	3	3
2.	DS4009	5G / 6G Wireless Communication	PEC	3	0	0	3	3
3.	DS4010	Model based signal processing	PEC	3	0	0	3	3
4.	DS4011	Remote Sensing	PEC	3	0	0	3	3
5.	DS4012	Soft Computing and Its Applications for Signal Processing	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE IV

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	IF4078	Pattern Recognition	PEC	3	0	0	3	3
2.	DS4013	Multirate Signal Processing	PEC	3	0	0	3	3
3.	VL4351	VLSI Signal Processing	PEC	3	0	0	3	3
4.	DS4014	Array Signal Processing	PEC	3	0	0	3	3
5.	DS4015	Big Data Analytics	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE V

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	DS4016	Internet of Things System Design and Security	PEC	3	0	2	5	4
2.	DS4017	Machine Learning and Deep Learning	PEC	3	0	2	5	4
3.	DS4018	Artificial Intelligence and optimization Techniques	PEC	3	0	2	5	4
4.	DS4019	Signal Detection and Estimation Theory	PEC	3	0	2	5	4
5.	DS4071	Radar Signal Processing	PEC	3	0	2	5	4

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	AX4091	English for Research Paper Writing	2	0	0	0
2.	AX4092	Disaster Management	2	0	0	0
3.	AX4093	Constitution of India	2	0	0	0
4.	AX4094	நற்றமிழ் இலக்கியம்	2	0	0	0

MA4102   APPLIED MATHEMATICS FOR SIGNAL PROCESSING ENGINEERS   L T P C
                                                                        4 0 0 4

COURSE OBJECTIVES :

This course will help the students to

- study the vector space theory, inner product, eigenvalues, generalized eigenvectors and apply these in linear algebra to solve system of linear equations.
- study the solution of Bessel's equations, Recurrence relations, Bessel's functions and its properties.
- study the linear programming models and transportation models and various techniques to solve them.
- acquire the knowledge of solving an algebraic or transcendental equations and system of liners equations using an appropriate numerical methods.
- study the numerical solution of differential equations by single and multistep methods.

UNIT I   LINEAR ALGEBRA   12

Vector spaces – Norms – Inner products – Eigenvalues using QR transformations – QR factorization - Generalized eigenvectors – Canonical forms – Singular value decomposition and applications - Pseudo inverse – Least square approximations --Toeplitz matrices and some applications.

UNIT II   BESSEL FUNCTIONS   12

Bessel's equation – Bessel function – Recurrence relations - Generating function and orthogonal property for Bessel functions of first kind – Fourier - Bessel expansion.

UNIT III   LINEAR PROGRAMMING   12

Formulation – Graphical solution – Simplex method – Big M method - Two phase method - Transportation problems - Assignment models.

UNIT IV   NUMERICAL SOLUTION OF ALGEBRAIC EQUATIONS   12

Systems of linear equations : Gauss elimination method - Pivoting techniques - Thomas algorithm for tridiagonal system – Gauss - Jacobi, Gauss - Seidel, SOR iteration methods – Conditions for convergence - Systems of nonlinear equations : Fixed point iterations, Newton's method, Eigenvalue problems : Power method and Given's method.

UNIT V   NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS   12

Runge - Kutta method of fourth order for system of IVPs - Numerical stability of Runge - Kutta method - Adams - Bashforth multistep method - Shooting method – BVP : Finite difference method - Collocation method - Orthogonal collocation method.

                                                                        TOTAL: 60 PERIODS

COURSE OUTCOMES :

At the end of the course, students will be able to

- concepts on vector spaces, linear transformation, inner product spaces, eigenvalues and generalized eigenvectors, to solve system of linear equations.
- solution of Bessel's differential equations, Bessel functions and its properties.
- could develop a fundamental understanding of linear programming models, able to develop a linear programming model from problem description, apply the simplex method for solving linear programming problems.
- solve an algebraic or transcendental equation and linear system of equations using an appropriate numerical method.

- numerical solution of differential equations by single and multistep methods.

REFERENCES :

1. Andrews, L.C., "Special Functions of Mathematics for Engineers", 2nd Edition, Oxford University Press, 1998.
2. Bronson, R. and Costa, G. B., "Linear Algebra", 2nd Edition, Academic Press, 2007.
3. Jain, M. K., Iyengar, S.R.K, and Jain, R.K., "Computational Methods for Partial Differential Equations", New Age International, 2007.
4. Jain, M. K., Iyengar, S. R. K and Jain, R. K., "Numerical Methods for Scientific and Engineering Computation", 6th Edition, New Age International, 2014.
5. Sastry, S. S., "Introductory Methods of Numerical Analysis ", 5th Edition, PHI Learning, 2015.
6. Taha, H.A., "Operations Research", 10th Edition, Pearson Education, 2018.

RM4151	RESEARCH METHODOLOGY AND IPR	L T P C
		2 0 0 2

UNIT I   RESEARCH DESIGN   6
Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

UNIT II   DATA COLLECTION AND SOURCES   6
Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.

UNIT III   DATA ANALYSIS AND REPORTING   6
Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.

UNIT IV   INTELLECTUAL PROPERTY RIGHTS   6
Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

UNIT V   PATENTS   6
Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.

TOTAL:30 PERIODS

REFERENCES:

1. Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education, 11e (2012).
2. Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
3. David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2007.

4. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013.

DS4151	DIGITAL IMAGE AND VIDEO PROCESSING	L T P C
		3 0 2 4

COURSE OBJECTIVES:

- To provide the student with basic understanding of image fundamentals and transforms
- To provide exposure to the students about image enhancement and restoration
- To impart a thorough understanding about segmentation and Recognition.
- To know the Video Processing and motion estimation
- Learning the concepts will enable students to design and develop an image processing application .

UNIT I FUNDAMENTALS OF IMAGE PROCESSING AND TRANSFORMS 9

Introduction, Image sampling, Quantization, Resolution, Image file formats, Elements of image processing system, Need for transform, image transforms, Fourier transform, 2 D Discrete Fourier transform ,Walsh transform, Hadamard transform, Haar transform, KL transform, singular value decomposition, Radon transform, comparison of different image transforms. Digital Camera working principle.

UNIT II ENHANCEMENT AND RESTORATION 9

Spatial domain methods: Histogram processing, Fundamentals of Spatial filtering, Smoothing spatial filters, Sharpening spatial filters. Frequency domain methods: Basics of filtering in frequency domain, image smoothing, image sharpening, Introduction to Image restoration, Image degradation, Image restoration model, Linear and Nonlinear image restoration techniques, Blind deconvolution. Color image enhancement.

UNIT III SEGMENTATION AND RECOGNITION 9

Edge detection, Edge linking via Hough transform – Thresholding – Region based segmentation – Region growing – Region splitting and merging – Morphological processing- erosion and dilation, Boundary representation, Boundary description, Fourier Descriptor, Regional Descriptors – Topological feature, Texture – Patterns and Pattern classes – Recognition based on matching.

UNIT IV BASIC STEPS OF VIDEO PROCESSING 9

Analog Video, Digital Video. Time-Varying Image Formation models:Three-Dimensional Motion Models, Geometric Image Formation, Photometric Image Formation,Sampling of Videosignals, Filtering operations

UNIT V 2-D MOTION ESTIMATION 9

Optical flow, optical flow constraints, General Methodologies, Pixel Based Motion Estimation, Block-Matching Algorithm, Mesh based Motion Estimation, Global Motion Estimation, Region based MotionEstimation, Multi resolution motion estimation, Waveform based coding, Block based transform coding,Predictive coding, Application of motion estimation in Video coding.

45 PERIODS

- Histogram Equalization
- Image Filtering (spatial-domain)
- Image Filtering (frequency-domain)
- Image Segmentation
- Familiarization with Video Processing tools
- Denoising video
- Video resizing
- Background subtraction
- Interpolation methods for re-sampling
- Adaptive unsharp masking based interpolation for video up-sampling
- Gaussian mixture model (GMM) based background subtraction
- Video encoding

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO1: Analyze the digital image, representation of digital image and digital images in transform Domain.
CO2: Analyze the detection of point, line and edges in images and understand the redundancy in images, various image compression techniques.
CO3: Analyze the video technology from analog color TV systems to digital video systems, how video signal is sampled and filtering operations in video processing.
CO4: Obtain knowledge in general methodologies for 2D motion estimation, various coding used in video processing.
CO5: Design image and video processing systems.

TOTAL:75 PERIODS

REFERENCES:
1. Digital Image Processing – Gonzalez and Woods, 3rd Ed., Pearson, 2016
2. Handbook of Image and Video processing, Academic press, 2010
3. K.R.Castelman, Digital Image processing, Prentice Hall, 1996
4. Anil Kumar Jain, Fundamentals of Digital Image Processing, Prentice Hall of India.2nd edition, 2002
5. R C Gonzalez, R E Woods and S L Eddins, Digital Image Processing Using Matlab, Pearson Education , 2006

DS4152	STATISTICAL SIGNAL PROCESSING	L T P C
		3 0 0 3

COURSE OBJECTIVES:
- To introduce the basics of random signal processing
- To learn the concept of estimation and signal modeling
- To know about optimum filters and adaptive filtering and its applications

UNIT I **DISCRETE RANDOM SIGNAL PROCESSING** **9**

Discrete random processes – Ensemble averages – Wide sense stationary process – Properties - Ergodic process – Sample mean & variance - Auto-correlation and Auto-correlation matrices- Auto

covariance and Cross covariance- Properties – White noise process – Wiener Khintchine relation - Power spectral density – Filtering random process – Spectral Factorization Theorem – Special types of Random Processes – AR,MA, ARMA Processes – Yule-Walker equations.

UNIT II   PARAMETER ESTIMATION THEORY   9
Principle of estimation and applications-Properties of estimates-unbiased and consistent estimators, Minimum Variance Unbiased Estimates (MVUE)-Cramer Rao bound- Efficient estimators; Criteria of estimation: Methods of maximum likelihood and its properties ; Bayesian estimation : Mean square error and MMSE, Mean Absolute error, Hit and Miss cost function and MAP estimation

UNIT III   SPECTRUM ESTIMATION   9
Estimation of spectra from finite duration signals, Bias and Consistency of estimators - Non-Parametric methods: Periodogram, Modified Periodogram, Bartlett, Welch and Blackman-Tukey methods, Parametric Methods: AR, MA and ARMA spectrum estimation - Detection of Harmonic signals - Performance analysis of estimators. MUSIC and ESPRIT algorithms

UNIT IV   SIGNAL MODELING AND OPTIMUM FILTERS   9
Introduction- Least square method – Pade approximation – Prony's method – Levinson Recursion – Lattice filter - FIR Wiener filter – Filtering – Linear Prediction – Non Causal and Causal IIR Wiener Filter -– MSE – State-space model and the optimal state estimation problem, discrete Kalman filter, continuous-time Kalman filter, extended Kalman filter.

UNIT V   ADAPTIVE FILTERS   9
FIR Adaptive filters - Newton's steepest descent method – Widrow Hoff LMS Adaptive algorithm – Convergence – Normalized LMS – Applications: Noise cancellation, channel equalization, echo canceller, Adaptive Recursive Filters: RLS adaptive algorithm, Exponentially weighted RLS-sliding window RLS. Matrix inversion Lemma, Initialization, tracking of nonstationarity.

COURSE OUTCOMES:
On the successful completion of the course, students will be able to
CO1: Analyze discrete time random processes
CO2: Apply appropriate model for estimation and signal modeling for the given problem
CO3: Analyze non-parametric and parametric methods for spectral estimation
CO4: Design optimum filter for the given problem
CO5: Design adaptive filters for different applications

TOTAL PERIODS:45

REFERENCES:
1. Monson. H. Hayes, Statistical Digital Signal Processing and Modelling, John Willey and Sons, 1996 (Reprint 2008)
2. Simon Haykin, Adaptive Filter Theory, Pearson Prentice Hall, 5th edition, 2014
3. D.G. Manolakis, V.K. Ingle and S.M. Kogon, Statistical and Adaptive SignalProcessing, Artech House Publishers, 2005.
4. Steven. M. Kay, Modern Spectral Estimation, Theory and Application, Pearson India, 2009
5. A.Veloni, N I. Miridakis, E Boukouvala, Digital and Statistical SignalProcessing, CRC Press, 2019
6. S Nandi, D Kundu, Statistical Signal Processing- Frequency Estimation, Springer Nature Singapore, 2nd edition , 2020
7. M.D. Srinath, P.K. Rajasekaran and R. Viswanathan, Statistical Signal Processing with Applications, PHI, 1996.

DS4101   **MODERN COMMUNICATION SYSTEMS**   **L T P C**
                                                                          3 0 0 3

COURSE OBJECTIVES:
- To describe the basics of spread spectrum communications.
- To compare different Equalizers
- To describe different block coded and convolutional coded Communication systems.
- To perceive the basics of OFDM and MIMO systems

UNIT I   SPREAD SPECTRUM COMMUNICATIONS   9
Spreading sequences- Properties of Spreading Sequences, Pseudo- noise sequence, Gold sequences, Kasami sequences, Walsh Sequences, Orthogonal Variable Spreading Factor Sequences, Barker Sequence, Complementary Codes Direct sequence spread spectrum: DS-CDMA Model, Conventional receiver, Rake Receiver, Synchronization in CDMA, Power Control, Soft handoff, Multiuser detection – Optimum multiuser detector, Linear multiuser detection.

UNIT II   EQUALIZATION TECHNIQUES   9
Band Limited Channels- ISI – Nyquist Criterion- Controlled ISI-Partial Response signals- Equalization algorithms – Viterbi Algorithm – Linear equalizer – Decision feedback equalization – Adaptive Equalization algorithms.

UNIT III   BLOCK AND CONVOLUTIONAL CODED COMMUNICATION   9
Linear block codes; Hamming; Golay; Cyclic; BCH ; Reed – Solomon codes. Space time block codes. Representation of codes using Polynomial, State diagram, Tree diagram, and Trellis diagram –Decoding techniques using Maximum likelihood, Viterbi algorithm, Sequential and Threshold methods – Error probability performance for BPSK and Viterbi algorithm, Turbo Coding.

UNIT IV   ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING   9
Basic Principles of Orthogonality, Single vs Multicarrier Systems, OFDM Block Diagram and Its Explanation, Mathematical Representation of OFDM Signal, Modulation parameters , Pulse shaping in OFDM Signal and Spectral Efficiency, Window in OFDM Signal and Spectrum, Synchronization in OFDM, Pilot Insertion in OFDM, Transmission and Channel Estimation, Amplitude Limitations in OFDM, FFT Point Selection, Constraints in OFDM, CDMA vs OFDM, Hybrid OFDM.

UNIT V   MIMO SYSTEMS   9
Space Diversity and System Based on Space Diversity, Smart Antenna system and MIMO, MIMO Based System Architecture, MIMO Exploits Multipath, Space – Time Processing, Antenna Consideration for MIMO, MIMO Channel Modeling and Measurement, MIMO Channel Capacity, Cyclic Delay Diversity (CDD), Space Time Coding, MIMO Applications in 3G Wireless System and Beyond, MIMO-OFDM

COURSE OUTCOMES:
On Successful completion, students will be able to
CO1: Describe the concepts of spread spectrum communications
CO2: Apply appropriate equalization technique for the given problem
CO3: Analyze the performance of different block codes and convolutional codes.
CO4: Generate OFDM signals and analyze its performance
CO5: Describe MIMO systems

                                                        TOTAL:45 PERIODS

REFERENCES:

1. Ke-Lin Du & M N S Swamy, "Wireless Communication System: From RF Subsystems to 4G Enabling Technologies", Cambridge University, Press, 2010.
2. John G. Proakis, "Digital Communication", Fifth Edition, McGraw Hill Publication, 2008
3. M.K.Simon, S.M.Hinedi and W.C.Lindsey, "Digital communication techniques; Signal Design and Detection", Prentice Hall of India, New Delhi, 1995.
4. Hermann Rohling, "OFDM: Concepts for Future Communication Systems", Springer 2011.
5. Ezio Biglieri , Robert Calderbank , Anthony Constantinides , Andrea Goldsmith Arogyaswami Paulraj , H. Vincent Poor, " MIMO Wireless Communications" Cambridge University Press, April 2010.
6. Robert W. Heath Jr.; A. Lozano, Foundations of MIMO Communication, Cambridge University Press, 2019.

| DS4102 | SPEECH AND AUDIO SIGNAL PROCESSING | L T P C |
| | | 3 0 0 3 |

COURSE OBJECTIVES:

- To analyze the speech signal in the time and frequency domain
- To understand the characteristics of Speech and Audio
- To carry out LPC based characterization
- To understand the applications of Filter banks in speech analysis
- To understand different applications of speech and audio signals

UNIT I   MECHANICS OF SPEECH AND AUDIO   9

Speech production mechanism – Nature of Speech signal – Digital Model of speech signals - Classification of Speech sounds – Phones – Phonemes – Phonetic and Phonemic alphabets – Articulatory features-Anatomical pathways from the ear to perception of sound - The peripheral auditory system. Absolute Threshold of Hearing - Critical Bands- Simultaneous Masking, Masking-Asymmetry, Perceptual Entropy -Basic measuring philosophy - Subjective versus objective perceptual testing - The perceptual audio quality measure(PAQM).

UNIT II   TIME AND FREQUENCY DOMAIN METHODS FOR SPEECH   9
**   PROCESSING**

Time domain parameters of Speech signal – Methods for extracting the parameters: Energy, Average Magnitude –Zero Crossing Rate (ZCR)– Silence Discrimination using ZCR and energy - Short Time Fourier analysis – Formant extraction and Pitch Extraction.

UNIT III   LINEAR PREDICTIVE ANALYSIS OF SPEECH   9

Formulation of Linear Prediction problem in Time Domain – Basic Principle – Auto correlation method – Covariance method – Solution of LPC equations – Cholesky method – Durbin's Recursive algorithm – lattice formation and solutions – Comparison of different methods – Application of LPC parameters – Pitch detection using LPC parameters – Formant analysis – VELP – CELP.

UNIT IV   TIME-FREQUENCY ANALYSIS FOR AUDIO: FILTER BANKS AND   9
**   TRANSFORMS**

Analysis- Synthesis Framework for M-band Filter Banks- Filter Banks for Audio Coding: Design Considerations- Quadrature Mirror and Conjugate Quadrature Filters- Tree-Structured QMF- Cosine

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Modulated "Pseudo QMF" M-band Banks - Cosine Modulated Perfect Reconstruction (PR) M-band Banks and Modified Discrete Cosine Transform (MDCT).

UNIT V   SPEECH AND AUDIO SIGNAL PROCESSING ALGORITHMS   9

Algorithms: Dynamic Time Warping, Hidden Markov Model– Gaussian Mixture Model - Automatic Speech Recognition – Feature Extraction for ASR - Speaker identification and verification – Voice response system – Speech Synthesis -Digital Audio Watermarking - Audio MPEG 4.

SUGGESTED ACTIVITIES:

1. Design digital model for speech signals
2. Perform time-frequency analysis of speech signals
3. Simulation of LPC Algorithms
4. Design and Develop filter banks for audio signals
5. Create program for speech recognition that suits real- world applications

COURSE OUTCOMES:

On Successful completion, students will be able to

CO1: Characterize Speech and audio signal production and perception mechanisms.
CO2: Analyze speech and audio signals in the time and frequency domains.
CO3: Design a LPC coder
CO4: Develop speech processing solutions based on filter banks
CO5: Design speech recognition, speaker identification and speech synthesis schemes.

TOTAL:45 PERIODS

REFERENCES:

1. L.R.Rabiner and R.W.Schaffer, "Digital Processing of Speech signals", Pearson   Education Singapore Pvt. Ltd, First Edition,2008.
2. Ben Gold and Nelson Morgan, "Speech and Audio Signal Processing", John Wiley and Sons Inc., Singapore,Second Edition, 2011.
3. Quatieri, "Discrete-time Speech Signal Processing", Pearsm Education, First Edition, 2002.
4. UdoZölzer "A John, "Digital Audio Signal Processing", Wiley & sons Ltd Publications, Second Edition, 2008.
5. Mark Kahrs and Karlheinz Brandenburg, "Applications of Digital Signal Processing to Audio And Acoustics",Springer Publishing Company, Incorporated, 2013.
6. Ken C. Pohlmann, "Principles of Digital Audio", McGraw Hill, New Delhi, Sixth Edition, 2010.
7. John Watkinson, "An Introduction to Digital Audio", Focal Press, Second Edition, 2002.
8. SpaniasAndress, Painter Ted @ AttiVentataraman, "Audio Signal Processing and Coding", John Wiley &Sons, New Delhi, 2013.

DS4111   **STATISTICAL SIGNAL PROCESSING LABORATORY**   **L T P C**
                                                                                0 0 4 2

PRACTICAL EXERCISES:

Using Simulation Software Tools

1. Simulation of standard discrete time deterministic and random signals
2. Simulation of spatially separated target signal
    a. In the presence of Additive Correlated White Noise
    b. In the presence of Additive Uncorrelated White Noise
3. Detection of Constant Amplitude Signal, Time varying Known Signals, Unknown Signals.
4. Estimation of PSD of a noisy signal using Periodogram and Modified Periodogram.
5. Estimation of PSD using different methods (Bartlett, Welch, Blackman-Tukey).
6. Estimation of power spectrum using parametric methods (Yule Walker& Burg).
7. State Space Matrix evolution from Differential Equation
8. Normal Equation evolution Using Levinson-Durbin
9. Cascade and Parallel Realization of IIR filter
10. Implementation of Normal Density Estimation
11. Implementation of Wiener Filter for 1-D Signals
12. Implementation of LMS and RLS algorithm for the given problem
13. Estimation techniques - MLE, MMSE, Bayes Estimator, MAP Estimator
14. Implementation of Expectation Maximization (EM) algorithm
15. Performance comparison of the Estimation techniques

TOTAL:60 PERIODS

COURSE OUTCOMES:
On the successful completion of the course, students will be able to
- Simulate standard discrete time signals and random signals
- Detect signals in the presence of noise using appropriate method
- Estimate signals and parameters using appropriate estimation techniques
- Implement adaptive filtering concept for the given problem
- Analyze the performance of detection and estimation techniques.

DS4112   **DSP PROCESSOR LABORATORY – I**   **L T P C**
                                                                    0 0 4 2

PRACTICAL EXERCISES:

1. Sine wave generation with DIP switch control and slide control for amplitude and frequency
2. Digital communication using Binary Phase Shift Keying
3. Square, Ramp Generation Using a Lookup Table
4. Loop Program with Stereo Input and Stereo Output
5. Program to generate Echo with controls for different effects
6. Pseudorandom noise sequence generation program
7. Implementation of Four Different Filters: Low pass, High pass, Band pass, and BandStop
8. Implement the system identification task.
9. FIR Implementation Using C Calling an ASM Function with a Circular Buffer

10. IIR Filter Implementation Using Second-Order Stages in Cascade
11. Design and analysis at fixed point digital filtering system

<div align="right">TOAL:60 PERIODS</div>

COURSE OUTCOMES:
1. Write C & Assembly based Algorithms
2. Ability to implement and simulate signal processing algorithms
3. Ability to demonstrate the frequency domain analysis
4. Ability to demonstrate system realization using digital signal processor

AUDIT COURSES

AX4091   **ENGLISH FOR RESEARCH PAPER WRITING**   **L T P C**
                                                                              2 0 0 0

COURSE OBJECTIVES:
- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I   INTRODUCTION TO RESEARCH PAPER WRITING   6
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II   PRESENTATION SKILLS   6
Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III   TITLE WRITING SKILLS   6
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV   RESULT WRITING SKILLS   6
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V   VERIFICATION SKILLS   6
Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission

<div align="right">TOTAL: 30 PERIODS</div>

COURSE OUTCOMES:
CO1 –Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title

CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

REFERENCES:
1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

AX4092   **DISASTER MANAGEMENT**   **L T P C**
                                                                                       2 0 0 0

COURSE OBJECTIVES:
- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I   **INTRODUCTION**   **6**
Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II   **REPERCUSSIONS OF DISASTERS AND HAZARDS**   **6**
Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III   **DISASTER PRONE AREAS IN INDIA**   **6**
Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV   **DISASTER PREPAREDNESS AND MANAGEMENT**   **6**
Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V   **RISK ASSESSMENT**   **6**
Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

                                                     TOTAL : 30 PERIODS

COURSE OUTCOMES:
CO1: Ability to summarize basics of disaster
CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5: Ability to develop the strengths and weaknesses of disaster management approaches

REFERENCES:
1. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'NewRoyal book Company,2007.
3. Sahni, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi,2001.

AX4093	CONSTITUTION OF INDIA	L T P C
		2 0 0 0

COURSE OBJECTIVES:
Students will be able to:
- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

UNIT I   HISTORY OF MAKING OF THE INDIAN CONSTITUTION
History, Drafting Committee, (Composition & Working)

UNIT II   PHILOSOPHY OF THE INDIAN CONSTITUTION
Preamble, Salient Features

UNIT III   CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES
Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV   ORGANS OF GOVERNANCE
Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V   LOCAL ADMINISTRATION
District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role

of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI   ELECTION COMMISSION

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization
- of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING

1. The Constitution of India,1950(Bare Act),Government Publication.
2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
3. M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

AX4094	நற்றமிழ் இலக்கியம்	L T P C
		2 0 0 0

UNIT I   சங்க இலக்கியம்   **6**

1. தமிழின் துவக்க நூல் தொல்காப்பியம்
   – எழுத்து, சொல், பொருள்
2. அகநானூறு (82)
   - இயற்கை இன்னிசை அரங்கம்
3. குறிஞ்சிப் பாட்டின் மலர்க்காட்சி
4. புறநானூறு (95,195)
   - போரை நிறுத்திய ஒளவையார்

UNIT II   அறநெறித் தமிழ்   **6**

1. அறநெறி வகுத்த திருவள்ளுவர்
   - அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புறவு அறிதல், ஈகை, புகழ்
2. பிற அறநூல்கள் - இலக்கிய மருந்து
   – ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை (தூய்மையை

வலியுறுத்தும் நூல்)

| UNIT III | **இரட்டைக் காப்பியங்கள்** | **6** |

1. கண்ணகியின் புரட்சி
   - சிலப்பதிகார வழக்குரை காதை
2. சமூகசேவை இலக்கியம் மணிமேகலை
   - சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை

| UNIT IV | **அருள்நெறித் தமிழ்** | **6** |

1. சிறுபாணாற்றுப்படை
   - பாரி முல்லைக்குத் தேர் கொடுத்தது, பேகன் மயிலுக்குப் போர்வை கொடுத்தது, அதியமான் ஒளவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள்
2. நற்றிணை
   - அன்னைக்குரிய புன்னை சிறப்பு
3. திருமந்திரம் (617, 618)
   - இயமம் நியமம் விதிகள்
4. தர்மச்சாலையை நிறுவிய வள்ளலார்
5. புறநானூறு
   - சிறுவனே வள்ளலானான்
6. அகநானூறு (4) - வண்டு
   நற்றிணை (11) - நண்டு
   கலித்தொகை (11) - யானை, புறா
   ஐந்திணை 50 (27) - மான்
   ஆகியவை பற்றிய செய்திகள்

| UNIT V | **நவீன தமிழ் இலக்கியம்** | **6** |

1. உரைநடைத் தமிழ்,
   - தமிழின் முதல் புதினம்,
   - தமிழின் முதல் சிறுகதை,
   - கட்டுரை இலக்கியம்,
   - பயண இலக்கியம்,
   - நாடகம்,
2. நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும்,
3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும்,
4. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும்,
5. அறிவியல் தமிழ்,
6. இணையத்தில் தமிழ்,
7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.

TOTAL: 30 PERIODS

தமிழ் இலக்கிய வெளியீடுகள் / புத்தகங்கள்

1. தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University)
   - www.tamilvu.org
2. தமிழ் விக்கிப்பீடியா (Tamil Wikipedia)
   - https://ta.wikipedia.org
3. தர்மபுர ஆதின வெளியீடு
4. வாழ்வியல் களஞ்சியம்
   - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்
5. தமிழ்கலைக் களஞ்சியம்
   - தமிழ் வளர்ச்சித் துறை (thamilvalarchithurai.com)
6. அறிவியல் களஞ்சியம்
   - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்