ANNA UNIVERSITY, CHENNAI
AFFILIATED INSTITUTIONS
M.E. DIGITAL SIGNAL PROCESSING
REGULATIONS – 2017
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 biomedical and optical signals along with relevant processor architectures to enable them to take up a career in the core industry
3. To offer topics in the advanced digital signal processing techniques with applications to multi-dimensional data processing and analysis
4. To familiarize different hardware and software designing tools to design DSP systems.

PROGRAMME OUTCOMES (POS):

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OBJECTIVES (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 are expected to have a good understanding of the DSP based real time data processing system for various DSP based high speed applications.

Provide mapping of 1) POs to PEOs and 2) PSOs to PEOs.
Use the following marking:

Contribution 1: Reasonable 2:Significant 3:Strong

MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVES WITH PROGRAMME OUTCOMES

A broad relation between the programme objective and the outcomes is given in the following table

PEO's	Programme Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
1	1	3	1							1		2
2	1		1	2		1		3	2	1	3	
3	3	1	3	3	2	1	2			2	2	2
4	2		3	1	3	3	2	1	2	3	3	

MAPPING OF COURSES WITH PROGRAMME OUTCOMES
SEMESTER - I

COURSES	PROGRAMME OUTCOMES											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO 8**	**PO 9**	**PO 10**	**PSO 11**	**PSO 12**
Applied Mathematics for Signal Processing Engineers	3	2	2	1	1					2	2	3
DSP Processor Architecture and Programming	1	3	3	2	2				2	**1**		**3**
Advanced Digital Signal Processing	2	1	2		1	2		1			**2**	**2**
Video Compression Techniques	1			2			2	2				**2**
Model Based Signal Processing	2	1	2			1					**1**	**1**
Professional Elective I	-	-	-	-	-	-	-	-	-	**-**	**-**	**-**
Digital Signal Processing Laboratory – I	2		3				2	2	2		**1**	**3**

SEMESTER - II

COURSES	PROGRAMME OUTCOMES											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PSO 1**	**PSO 2**
Advanced Digital Image Processing	2	1	2		1	2		1			1	3
Radar Signal Processing	1	2	1	3	2	1	2	2		**2**		**1**
VLSI Signal Processing	1	2	1	1	2	1		1			**1**	**3**
Speech and Audio Signal Processing	1	2	1	1	2	1		1			**1**	**2**
Professional Elective II												
Professional Elective III												
Digital Signal Processing Laboratory - II	2		3				2	2	2	**1**		**3**
Term Paper Writing and Seminar	1		1				1	1	3	**3**		**1**

SEMESTER - III

COURSES	PROGRAMME OUTCOMES											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PSO 1	PSO 2
Optical Signal Processing	2	1	2		1	2		1			1	3
Professional Elective IV												
Professional Elective V												
Project Work Phase I	1	2	3	1	3	1	1	2	3	**3**	**1**	**2**

SEMESTER - IV

COURSES	PROGRAMME OUTCOMES											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PSO 1	PSO 2
Project Work Phase II	1	2	3	1	3	1	1	2	3	**3**	**1**	**2**

PROFESSIONAL ELECTIVES (PE)*
SEMESTER I
ELECTIVE I

COURSES	PROGRAMME OUTCOMES											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PSO 1	PSO 2
Neural Networks and Applications	1		3	2	2	1				2		3
Robotics	1	2	3	1	1			1	1		**1**	**2**
Introduction to Machine Learning	1	2	2	1		1				**1**		**1**

SEMESTER II
ELECTIVE II

COURSES	PROGRAMME OUTCOMES											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PSO 1	PSO 2
Bio Signal Processing	2	1	2		1	2		1		1	1	3
Non – Linear Signal Processing	3	2	1	1	1				1	**1**		**2**
Array Signal Processing	2	2	1		1	2		1			**1**	**3**

SEMESTER II
ELECTIVE III

COURSES	PROGRAMME OUTCOMES											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PSO 1**	**PSO 2**
Wireless Sensor Networks	1	1	2	1		1	1		1	1		
Cryptographic Techniques	2	1	2	1	1	1	1	2				
Underwater Acoustics Signal Processing	1	2	1		1	2	1	1			**1**	**2**

SEMESTER III
ELECTIVE IV

COURSES	PROGRAMME OUTCOMES											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PSO 1**	**PSO 2**
Embedded System Design	2	1	2	1		1			1	1		
Real Time Operating Systems		2		1	2	1	1	1				
DSP Integrated Circuits	2	1	2	1		1			1	**1**	**2**	**2**

SEMESTER III
ELECTIVE V

COURSES	PROGRAMME OUTCOMES											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO1**	**PSO2**
Applied Medical Image Processing	2	1	2		1	2		1			2	1
Mixed Signal Processing	2	1	2		1	2		1			2	1
Digital Modulation and Coding	1		1	1					1	**2**		

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CHOICE BASED CREDIT SYSTEM
CURRICULA AND SYLLABI

SEMESTER - I

SI.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	MA5159	Applied Mathematics for Signal Processing Engineers	FC	4	4	0	0	4
2.	DS5191	DSP Processor Architecture and Programming	PC	3	3	0	0	3
3.	AP5152	Advanced Digital Signal Processing	PC	5	3	2	0	4
4.	DS5101	Video Compression Techniques	PC	3	3	0	0	3
5.	DS5102	Model Based Signal Processing	PC	3	3	0	0	3
6.		Professional Elective I	PE	3	3	0	0	3
PRACTICALS								
7.	DS5111	Digital Signal Processing Laboratory – I	PC	4	0	0	4	2
			TOTAL	**25**	**19**	**2**	**4**	**22**

SEMESTER II

SI.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	DS5291	Advanced Digital Image Processing	PC	5	3	2	0	4
2.	DS5292	Radar Signal Processing	PC	3	3	0	0	3
3.	VL5291	VLSI Signal Processing	PC	3	3	0	0	3
4.	AP5074	Speech and Audio Signal Processing	PC	3	3	0	0	3
5.		Professional Elective II	PE	3	3	0	0	3
6.		Professional Elective III	PE	3	3	0	0	3
PRACTICALS								
7.	DS5211	Digital Signal Processing Laboratory - II	PC	4	0	0	4	2
8.	CP5281	Term Paper Writing and Seminar	EEC	2	0	0	2	1
			TOTAL	**26**	**18**	**2**	**6**	**22**

SEMESTER III

SI.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	DS5301	Optical Signal Processing	PC	3	3	0	0	3
2.		Professional Elective IV	PE	3	3	0	0	3
3.		Professional Elective V	PE	3	3	0	0	3
PRACTICALS								
4.	DS5311	Project Work Phase I	EEC	12	0	0	12	6
			TOTAL	**21**	**9**	**0**	**12**	**15**

SEMESTER IV

SI.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
PRACTICALS								
1.	DS5411	Project Work Phase II	EEC	24	0	0	24	12
				TOTAL	**0**	**0**	**24**	**12**

TOTAL NO. OF CREDITS:71

FOUNDATION COURSES (FC)

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MA5159	Applied Mathematics for Signal Processing Engineers	FC	4	4	0	0	4

PROFESSIONAL CORE (PC)

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	DS5191	DSP Processor Architecture and Programming	PC	3	3	0	0	3
2.	AP5152	Advanced Digital Signal Processing	PC	5	3	2	0	4
3.	DS5101	Video Compression Techniques	PC	3	3	0	0	3
4.	DS5102	Model Based Signal Processing	PC	3	3	0	0	3
5.	DS5111	Digital Signal Processing Laboratory – I	PC	4	0	0	4	2
6.	DS5291	Advanced Digital Image Processing	PC	5	3	2	0	4
7.	DS5292	Radar Signal Processing	PC	3	3	0	0	3
8.	VL5291	VLSI Signal Processing	PC	3	3	0	0	3
9.	AP5074	Speech and Audio Signal Processing	PC	3	3	0	0	3
10.	DS5211	Digital Signal Processing Laboratory - II	PC	4	0	0	4	2
11.	DS5301	Optical Signal Processing	PC	3	3	0	0	3

EMPLOYABILITY ENHANCEMENT COURSE (EEC)

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	CP5281	Term Paper Writing and Seminar	EEC	2	0	0	2	1
2.	DS5311	Project Work Phase – I	EEC	12	0	0	12	6
3.	DS5411	Project Work Phase – II	EEC	24	0	0	24	12

PROFESSIONAL ELECTIVES (PE)*
SEMESTER I
ELECTIVE I

SL. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	DS5001	Neural Networks and Applications	PE	3	3	0	0	3
2.	AP5093	Robotics	PE	3	3	0	0	3
3.	DS5002	Introduction to Machine Learning	PE	3	3	0	0	3

SEMESTER II
ELECTIVE II

SL. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	BM5191	Bio Signal Processing	PE	3	3	0	0	3
2.	DS5003	Non – Linear Signal Processing	PE	3	3	0	0	3
3.	DS5004	Array Signal Processing	PE	3	3	0	0	3

SEMESTER II
ELECTIVE III

SL. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	CU5097	Wireless Adhoc and Sensor Networks	PE	3	3	0	0	3
2.	DS5005	Cryptographic Techniques	PE	3	3	0	0	3
3.	DS5006	Underwater Acoustics Signal Processing	PE	3	3	0	0	3

SEMESTER III
ELECTIVE IV

SL. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	AP5191	Embedded System Design	PE	3	3	0	0	3
2.	DS5007	Real Time Operating Systems	PE	3	3	0	0	3
3.	VL5191	DSP Integrated Circuits	PE	3	3	0	0	3

SEMESTER III
ELECTIVE V

SL.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	BM5291	Applied Medical Image Processing	PE	3	3	0	0	3
2.	DS5008	Mixed Signal Processing	PE	3	3	0	0	3
3.	DS5009	Digital Modulation and Coding	PE	3	3	0	0	3

MA5159 APPLIED MATHEMATICS FOR SIGNAL PROCESSING ENGINEERS

L	T	P	C
4	0	0	4

OBJECTIVES :

The main objective of this course is to provide the student with a repertoire of mathematical methods that are essential to the solution of advanced problems encountered in the field of signal processing. This course covers a broad spectrum of mathematical techniques including linear algebra, Bessel functions, linear programming, numerical solution of algebraic equations and differential equations.

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

OUTCOMES :

After completing this course, students should demonstrate competency in the following skills:

- Concepts on vector spaces, linear transformation, inner product spaces, eigenvalues and generalized eigenvectors.
- Apply various methods in linear algebra 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", 2^{nd} Edition, Oxford University Press, 1998.
2. Bronson, R. and Costa, G. B., “Linear Algebra”, 2^{nd} 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, 1993.
4. Jain, M. K., Iyengar, S. R. K and Jain, R. K., "Numerical Methods for Scientific and Engineering Computation", 5^{th} Edition, New Age International, 2010.
5. Sastry, S. S., "Introductory Methods of Numerical Analysis ", 5^{th} Edition, PHI Learning, 2015.
6. Taha, H.A., "Operations Research", 9^{th} Edition, Pearson Education, 2016.

DS5191	DSP PROCESSOR ARCHITECTURE AND PROGRAMMING	L	T	P	C
		3	0	0	3

OBJECTIVES:

The objective of this course is to provide in-depth knowledge on

- Digital Signal Processor basics
- Third generation DSP Architecture and programming skills
- Advanced DSP architectures and some applications.

UNIT I FUNDAMENTALS OF PROGRAMMABLE DSPs 9

Multiplier and Multiplier accumulator – Modified Bus Structures and Memory access in PDSPs – Multiple access memory – Multi-port memory – VLIW architecture- Pipelining – Special Addressing modes in P-DSPs – On chip Peripherals.

UNIT II SPECIAL FUNCTIONS 9

Architecture – Assembly language syntax - Addressing modes – Assembly language Instructions - Pipeline structure, Operation – Block Diagram of DSP starter kit – Application Programs for processing real time signals.

UNIT III LINEAR PROGRAMMING 9

Architecture of the C6x Processor - Instruction Set - DSP Development System: Introduction– DSP Starter Kit Support Tools- Code Composer Studio - Support Files - Programming Examples to Test the DSK Tools – Application Programs for processing real time signals.

UNIT IV ALGEBRAIC EQUATIONS 9

Architecture of ADSP-21XX and ADSP-210XX series of DSP processors- Addressing modes and assembly language instructions – Application programs –Filter design, FFT calculation.

UNIT V ORDINARY DIFFERENTIAL EQUATIONS 9

Architecture of TMS320C54X: Pipe line operation, Code Composer studio – Architecture of TMS320C6X - Architecture of Motorola DSP563XX – Comparison of the features of DSP family processors.

TOTAL :45 PERIODS

OUTCOMES:
Students should be able to:

- Become Digital Signal Processor specialized engineer
- DSP based System Developer

REFERENCES:

1. Avtar Singh and S. Srinivasan, Digital Signal Processing – Implementations using DSPMicroprocessors with Examples from TMS320C54xx, cengage Learning India PrivateLimited, Delhi 2012
2. B.Venkataramani and M.Bhaskar, "Digital Signal Processors – Architecture,
3. Programming and Applications" – Tata McGraw – Hill Publishing Company Limited. NewDelhi, 2003.
4. RulphChassaing, Digital Signal Processing and Applications with the C6713 and C6416DSK, A JOHN WILEY & SONS, INC., PUBLICATION, 2005
5. User guides Texas Instrumentation, Analog Devices, Motorola.

AP5152	**ADVANCED DIGITAL SIGNAL PROCESSING**	**L**	**T**	**P**	**C**
		3	**2**	**0**	**4**

OBJECTIVES:

- The student comprehends mathematical description and modelling of discrete time random signals.
- The student is conversant with important theorems and algorithms.
- The student learns relevant figures of merit such as power, energy, bias and consistency.
- The student is familiar with estimation, prediction and filtering concepts and techniques.

UNIT I DISCRETE RANDOM SIGNAL PROCESSING 9+6

Wide sense stationary process – Ergodic process – Mean – Variance - Auto-correlation and Auto-correlation matrix - Properties - Weiner Khitchine relation - Power spectral density – filtering random process, Spectral Factorization Theorem–Finite Data records,Simulation of uniformly distributed/Gaussian distributed white noise – Simulation of Sine wave mixed with Additive White Gaussian Noise.

UNIT II SPECTRUM ESTIMATION 9+6

Bias and Consistency of estimators - Non-Parametric methods - Correlation method - Co-variance estimator - Performance analysis of estimators – Unbiased consistent estimators - Periodogram estimator - Barlett spectrum estimation - Welch estimation.

UNIT III LINEAR ESTIMATION AND PREDICTION 9+6

Model based approach - AR, MA, ARMA Signal modeling - Parameter estimation using Yule-Walker method - Maximum likelihood criterion - Efficiency of estimator - Least mean squared error criterion – Wiener filter - Discrete Wiener Hoff equations – Mean square error.

UNIT IV ADAPTIVE FILTERS 9+6

Recursive estimators - Kalman filter - Linear prediction – Forward prediction and Backward prediction, Prediction error - Whitening filter, Inverse filter - Levinson recursion, Lattice realization, Levinson recursion algorithm for solving Toeplitz system of equations.

UNIT V MULTIRATE DIGITAL SIGNAL PROCESSING 9+6

FIR Adaptive filters - Newton's steepest descent method - Adaptive filters based on steepest descent method - Widrow Hoff LMS Adaptive algorithm - Adaptive channel equalization - Adaptive echo canceller - Adaptive noise cancellation - RLS Adaptive filters - Exponentially weighted RLS – Sliding window RLS - Simplified IIR LMS Adaptive filter.

TOTAL 45+30 : 75 PERIODS

OUTCOMES:

- Formulate time domain and frequency domain description of Wide Sense Stationary process in terms of matrix algebra and relate to linear algebra concepts.
- State Parseval's theorem, W-K theorem, principle of orthogonality, spectral factorization theorem, Widrow-Hoff LMS algorithm and Shannon's sampling theorem, and define linear prediction, linear estimation, sample auto-correlation, periodogram, bias and consistency.
- Explain various noise types, Yule-Walker algorithm, parametric and non-parametric methods, Wiener and Kalman filtering, LMS and RMS algorithms, Levinson Durbin algorithm, adaptive noise cancellation and adaptive echo cancellation, speed verses convergence issues, channel equalization, sampling rate change, subband coding and wavelet transform.
- Calculate mean, variance, auto-correlation and PSD for WSS stochastic processes, and derive prediction error criterion, Wiener-Hoff equations, Parseval'stheorem,W-K theorem and normal equations.
- Design AR, MA, ARMA models, Weiner filter, anti aliasing and anti imaging filters, and develop FIR adaptive filter and polyphase filter structures.
- Simulate spectral estimation algorithms and basic models on computing platform.

REFERENCES:

1. John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing", Prentice Hall of
1. India, New Delhi, 2005.
2. Monson H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley and
3. Sons Inc., New York, 2006.
4. P. P. Vaidyanathan, "Multirate Systems and Filter Banks", Prentice Hall, 1992.
5. Sophoncles J. Orfanidis, "Optimum Signal Processing ", McGraw-Hill, 2000.
6. Simon Haykin, "Adaptive Filter Theory", Prentice Hall, Englehood Cliffs, NJ1986.
7. S. Kay," Modern spectrum Estimation theory and application", Prentice Hall, Englehood Cliffs, NJ1988.

DS5101	VIDEO COMPRESSION TECHNIQUES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basics of Video representation in space and transform domains.
- To understand intra frame coding Techniques.
- To understand inter frame compression.
- To know the basics of Video Compression standards.
- To understand the basics of JPEG.

UNIT I DIGITAL VIDEO REPRESENTATION 9

Video Frames and Fields- Colour Spaces- Spatial and Temporal sampling-Quantization – MSE-Uniform Scalar Quanitization- Non-Uniform Scalar Quantization- Transform Representation – 2D_DFT- DCT- 2D Wavelet Transform.

UNIT II STILL IMAGE COMPRESSION TECHNIQUES 9

Spatial Redundancy Reduction- Predictive Coding - Transform Coding Techniques-Variable Length Coding_ Huffman Coding – Arithmetic Coding –Run Length Coding -Still Image Compression-JPEG.

UNIT III VIDEO COMPRESSION 9

Inter-frame Coding- I, P,B and D frames-Motion estimation – Motion estimation with Half Pixel Precision-Bidirectional Motion estimation- MPEG2-Scalability.

UNIT IV LOW BIT RATE VIDEO CODING 9

Coding for Video Conferencing – Overview of H.261 – Coding in H.263- Coding of Motion Vectors.

UNIT V CONTENT BASED VIDEO CODING 9

Video Object Plane-encoding of VOPs-Segmenation-shape Coding- Texture Coding-MPEG-4 – Basics of content description, search and delivery in MPEG7.

TOTAL 45 PERIODS

OUTCOMES:

- To be able to design Video Compression schemes
- To be able to implement the state-of the art Video Standards
- To be able to design Motion pixel
- To be able to implementVideo Conferencing
- To be able to design VOPs and MPEG7

REFERENCES:

1. Iain E.G. Richardson, H.264 and MPEG-4, Video Compression: Video Coding for Next Generation Multimedia, John Wiley, 2003.
2. Mohammed Ghanbari, Standard Codecs: Image compression to Advanced Video Coding, Telecommunication Series, IET, 2008
3. Peter Symes, Digital Video Compression, McGraw Hill, 2004

DS5102	MODEL BASED SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Fundamentals of model based Processing
- Discrete Random Signals and systems
- State-Space Adaption Algorithms
- Applied Physics-Based Processors

UNIT I DISCRETE RANDOM SIGNALS AND SYSTEMS 9

Deterministic Signals and Systems, Spectral Representation of Discrete Signals, Discrete Random Signals, Spectral Representation of Random Signals, Discrete Systems with Random Inputs, ARMAX Models, Lattice Models, Exponential Models, Spatiotemporal Wave Models, State-Space Models, State-Space, ARMAX Equivalence Models, State-Space and Wave Model Equivalence.

UNIT II ESTIMATION THEORY AND MODEL-BASED PROCESSORS 9

Estimation Theory: Introduction, Minimum Variance Estimation, Least-Squares Estimation, Optimal Signal Estimation, Model-Based Processors: AR MBP, MA MBP, Lattice MBP, ARMAX MBP, Order Estimation for MBP, Case Study: Electromagnetic Signal Processing, Exponential MBP, Wave MBP.

UNIT III LINEAR AND NON-LINEAR STATE-SPACE MODEL-BASED PROCESSORS 9

Nonlinear State-Space Model-Based Processors: State-Space MBP, Innovations Approach to the MBP, Innovations Sequence of the MBP, Bayesian Approach to the MBP, Tuned MBP, Tuning and Model Mismatch in the MBP, MBP Design Methodology, MBP Extensions, MBP Identifier, MBP Deconvolver, Steady-State MBP Design, Case Study: MBP Design for a Storage Tank. Nonlinear State-Space Model-Based Processors: Linearized MBP, Extended MBP, Iterated-Extended MBP, Unscented MBP, Case Study: 2D-Tracking Problem.

UNIT IV ADAPTIVE STATE-SPACE MODEL-BASED PROCESSORS 9

State-Space Adaption Algorithms, Adaptive Linear State-Space MBP, Adaptive Innovations State-Space MBP: Innovations Model, RPE Approach Using the Innovations Model, Adaptive Covariance State-Space MBP, Adaptive Nonlinear State-Space MBP, Case Study: AMBP for Ocean Acoustic Sound Speed Inversion: State-Space Forward Propagator, Sound-Speed Estimation: AMBP Development

UNIT V APPLIED PHYSICS-BASED PROCESSORS 9

MBP for Reentry Vehicle Tracking, MBP for Laser Ultrasonic Inspections, MBP for Structural Failure Detection, MBP for Passive Sonar Direction-of-Arrival and Range Estimation, MBP for Passive Localization in a Shallow Ocean, MBP for Dispersive Waves, MBP for Groundwater Flow.

TOTAL 45 PERIODS

OUTCOMES:

- Become a Signal Processor engineer
- Model Based Signal Developer

REFERENCES:

1 James V. Candy “Model-based signal processing”, IEEE Press: Wiley-Interscience, 2006.
2 J. Candy, Signal Processing: The Modern Approach, New York: McGraw-Hill, 1988.
3 S. Kay, Modern Spectral Estimation: Theory and Applications, Englewood Cliffs, NJ: Prentice-Hall, 1988.
4 S. Kay, Fundamentals of Statistical Signal Processing: Estimation Theory, Englewood Cliffs, NJ: Prentice-Hall, 1993.

DS5111	DIGITAL SIGNAL PROCESSING LABORATORY I	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To understand the Digital Signal Processor Starter Kit.
- To learn the basic experiments in the DSP Starter Kit.
- To known DSP Embedded System based Assembly and C Language.

LIST OF EXPERIMENTS:

1. Sine wave Generation Using Eight Points with DIP Switch Control
2. Sine wave Generation with Two Sliders for Amplitude and Frequency Control
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 Band Stop
8. FIR Implementation Using C Calling an ASM Function with a Circular Buffer
9. IR Filter Implementation Using Second-Order Stages in Cascade

TOTAL: 60 PERIODS

OUTCOMES:

Upon Completion of the course, the students will be able to:

- Install the DSP Starter Kit
- Write C & Assembly based Algorithms
- Write Basic and Advanced Digital filter based programmes

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

SL. NO	DESCRIPTION OF EQUIPMENT	QUANTITY REQUIRED
1	TMS 320 C67X Kits	10
2	MATLAB or Equivalent Licensed or Open Source S/W with Signal Processing Tool box	15
3	CRO 50 MHz	10
4	function Generator 1 MHz	10
5	Speakers	10

DS5291	ADVANCED DIGITAL IMAGE PROCESSING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the image fundamentals.
- To understand the various image segmentation techniques.
- To extract features for image analysis.
- To introduce the concepts of image registration and image fusion.
- To illustrate 3D image visualization.

UNIT I FUNDAMENTALS OF DIGITAL IMAGE PROCESSING 9

Elements of visual perception, brightness, contrast, hue, saturation, mach band effect, 2D image transforms-DFT, DCT, KLT, and SVD. Image enhancement in spatial and frequency domain, Review of morphological image processing

9

UNIT II SEGMENTATION

Edge detection, Thresholding, Region growing, Fuzzy clustering, Watershed algorithm, Active contour methods, Texture feature based segmentation, Model based segmentation, Atlas based segmentation, Wavelet based Segmentation methods

UNIT III FEATURE EXTRACTION 9

First and second order edge detection operators, Phase congruency, Localized feature extraction-detecting image curvature, shape features Hough transform, shape skeletonization, Boundary descriptors, Moments, Texture descriptors- Autocorrelation, Cooccurrence features, Runlength features, Fractal model based features, Gabor filter, wavelet
features.

UNIT IV REGISTRATION AND IMAGE FUSION 9

Registration- Preprocessing, Feature selection-points, lines, regions and templates Feature correspondence-Point pattern matching, Line matching, region matching Template matching .Transformation functions-Similarity transformationand Affine Transformation. Resampling-Nearest Neighbour and Cubic Splines Image Fusion-Overview of image fusion, pixel fusion, Multiresolution based fusiondiscrete wavelet transform, Curvelet transform. Region based fusion.

UNIT V 3D IMAGE VISUALIZATION 9

Sources of 3D Data sets, Slicing the Data set, Arbitrary section planes, The use of color, Volumetric display, Stereo Viewing, Ray tracing, Reflection, Surfaces, Multiply connected surfaces, Image processing in 3D, Measurements on 3D images.

TOTAL:45PERIODS

OUTCOMES:

Upon Completion of the course, the students will be able to

- Explain the fundamentals digital image processing.
- Describe image various segmentation and feature extraction techniques for image analysis.
- Discuss the concepts of image registration and fusion.
- Explain 3D image visualization.

REFERENCES:

1. Anil K. Jain,Fundamentals of Digital Image Processing', Pearson Education,Inc., 2002.
2. ArdeshirGoshtasby, “ 2D and 3D Image registration for Medical, Remote Sensing and Industrial Applications”,John Wiley and Sons,2005.
3. John C.Russ, “The Image Processing Handbook”, CRC Press,2007
4. Mark Nixon, Alberto Aguado, “Feature Extraction and Image Processing”, Academic Press, 2008.
5. Rafael C. Gonzalez, Richard E. Woods, , Digital Image Processing', Pearson,Education, Inc., Second Edition, 2004.
6. Rick S.Blum, Zheng Liu,“ Multisensor image fusion and its Applications“,Taylor& Francis,2006.

DS5292 RADAR SIGNAL PROCESSING

	L	T	P	C
	3	0	0	3

OBJECTIVES:

- To understand the Radar Signal acquisition and sampling in multiple domains
- To provide clear instruction in radar DSP basics
- To equip the skills needed in both design and analysis of common radar algorithms
- To understand the basics of synthetic aperture imaging and adaptive array processing
- To illustrate how theoretical results are derived and applied in practice

UNIT I INTRODUCTION TO RADAR SYSTEMS 9

History and application of radar, basic radar function, elements of pulsed radar,review of signal processing concepts and operations, A preview of basic radar signal processing, radar system components, advanced radar signal processing

UNIT II SIGNAL MODELS 9

Components of a radar signal, amplitude models, types of clutters, noise model and signal-to noise ratio, jamming, frequency models: the doppler shift, spatial models, spectral model

UNIT III SAMPLING AND QUANTIZATION OF PULSED RADAR SIGNALS 9

Domains and criteria for sampling radar signals, Sampling in the fast time dimension,Sampling in slow time: selecting the pulse repetition interval,sampling the doppler spectrum,Sampling in the spatial and angle dimension, Quantization, I/Q Imbalance and Digital I/Q.

UNIT IV RADAR WAVEFORMS 9

Introduction, The waveform matched filter, Matched filtering of moving targets, The ambiguity function, The pulse burst waveform, frequency-modulated pulse compression waveforms, Range sidelobe control for FM waveforms, the stepped frequency waveform, Phase-modulated pulse compression waveforms, COSTAS Frequency Codes.

UNIT V DOPPLER PROCESSING 9

Alternate forms of the Doppler spectrum, Moving target indication (MTI), Pulse Doppler processing, dwell-to-dwell stagger, Pulse pair processing, additional Doppler processing issues, clutter mapping and the moving target detector, MTI for moving platforms: adaptive displaced phase center antenna processing

TOTAL 45PERIODS

OUTCOMES:

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

- To be able to perform radar signal acquisition and sampling
- To be able to perform algorithm on radar processing
- To be able to design basic radar algorithm
- To be able to design on aperture imaging and array processing

REFERENCES:

1. Francois Le Chevalier, "Principles of Radar and Sonar Signal Processing", Artech House , 2002
2. Mark A. Richards, "Fundamentals of Radar Signal Processing", McGraw-Hill, New York, 2005
3. Michael O Kolawole, "Radar systems, Peak Detection and Tracking", Elseveir Introduction To Radar Systems 3/E, Skolnik, McGraw Hill. 2010
4. Radar Principles, Peyton Z. Peebles, Wiley India 2009.
5. Fred E. Nathanson, Radar Design Principles-Signal Processing and the environment PHI

VL5291 **VLSI SIGNAL PROCESSING** **L T P C**
3 0 0 3

OBJECTIVES:

- To introduce techniques for altering the existing DSP structures to suit VLSI implementations
- To introduce efficient design of DSP architectures suitable for VLSI

UNIT I PIPELINING AND PARALLEL PROCESSING OF DIGITAL FILTERS 9

Introduction to DSP systems – Typical DSP algorithms, Data flow and Dependence graphs – critical path, Loop bound, iteration bound, Longest path matrix algorithm, Pipelining and Parallel processing of FIR filters, Pipelining and Parallel processing for low power.

UNIT II ALGORITHMIC STRENGTH REDUCTION TECHNIQUE I 9

Retiming – definitions and properties, Unfolding – an algorithm for unfolding, properties of unfolding, sample period reduction and parallel processing application, Algorithmic strength reduction in filters and transforms – 2-parallel FIR filter, 2-parallel fast FIR filter, DCT architecture, rank-order filters, Odd-Even merge-sort architecture, parallel rank-order filters.

UNIT III ALGORITHIMIC STRENGTH REDUCTION -II 9

Fast convolution – Cook-Toom algorithm, modified Cook-Toom algorithm, Pipelined and parallel recursive filters – Look-Ahead pipelining in first-order IIR filters, Look-Ahead pipelining with powerof-2 decomposition, Clustered look-ahead pipelining, Parallel processing of IIR filters, combined pipelining and parallel processing of IIR filters.

UNIT IV BIT-LEVEL ARITHMETIC ARCHITECTURES 9

Bit-level arithmetic architectures – parallel multipliers with sign extension, parallel carry-ripple and carry-save multipliers, Design of Lyon"s bit-serial multipliers using Horner"s rule, bit-serial FIR filter, CSD representation, CSD multiplication using Horner"s rule for precision improvement, Distributed Arithmetic fundamentals and FIR filters

UNIT V NUMERICAL STRENGTH REDUCTION, WAVE AND ASYNCHRONOUS PIPELINING 9

Numerical strength reduction – subexpression elimination, multiple constant multiplication, iterative matching, synchronous pipelining and clocking styles, clock skew in edge-triggered single phase clocking, two-phase clocking, wave pipelining. Asynchronous pipelining bundled data versus dual rail protocol.

TOTAL: 45 PERIODS

OUTCOME:

- Ability to modify the existing or new DSP architectures suitable for VLSI.

REFERENCES:

1. Keshab K. Parhi, “VLSI Digital Signal Processing Systems, Design and implementation “, Wiley, Interscience, 2007.
2. U. Meyer – Baese, “Digital Signal Processing with Field Programmable Gate Arrays”, Springer, Second Edition, 2004

AP5074 SPEECH AND AUDIO SIGNAL PROCESSING

		L T P C
		3 0 0 3

OBJECTIVES:

- To study basic concepts of processing speech and audio signals
- To study and analyse various M-band filter-banks for audio coding
- To understand audio coding based on transform coders.
- To study time and frequency domain speech processing methods

UNIT I MECHANICS OF SPEECH AND AUDIO 9

Introduction - Review of Signal Processing Theory-Speech production mechanism – Nature of Speech signal – Discrete time modelling of Speech production – Classification of Speech sounds – Phones – Phonemes – Phonetic and Phonemic alphabets – Articulatory features. Absolute Threshold of Hearing - Critical Bands- Simultaneous Masking, Masking-Asymmetry, and the Spread of Masking- Non-simultaneous Masking - Perceptual Entropy - Basic measuring philosophy -Subjective versus objective perceptual testing - The perceptual audio quality measure (PAQM) - Cognitive effects in judging audio quality.

UNIT II TIME-FREQUENCY ANALYSIS: FILTER BANKS AND TRANSFORMS 9

Introduction - Analysis-Synthesis Framework for M-band Filter Banks- Filter Banks for Audio Coding: Design Considerations - Quadrature Mirror and Conjugate Quadrature Filters - Tree-Structured QMF and CQF M-band Banks - Cosine Modulated “Pseudo QMF” M-band Banks -Cosine Modulated Perfect Reconstruction (PR) M-band Banks and the Modified Discrete Cosine
Transform (MDCT) - Discrete Fourier and Discrete Cosine Transform - Pre-echo Distortion- Pre-echo Control Strategies

UNIT III AUDIO CODING AND TRANSFORM CODERS 9

Lossless Audio Coding – Lossy Audio Coding - ISO-MPEG-1A, 2A, 2A-Advaned, 4A Audio Coding - Optimum Coding in the Frequency Domain - Perceptual Transform Coder –Brandenburg - Johnston Hybrid Coder - CNET Coders - Adaptive Spectral Entropy Coding –Differential Perceptual Audio Coder - DFT Noise Substitution -DCT with Vector Quantization -MDCT with Vector Quantization

UNIT IV TIME AND FREQUENCY DOMAIN METHODS FOR SPEECH PROCESSING 9

Time domain parameters of Speech signal – Methods for extracting the parameters :Energy, Average Magnitude – Zero crossing Rate – Silence Discrimination using ZCR and energy Short Time Fourier analysis – Formant extraction – Pitch Extraction using time and frequency domain methods Homomorphic Speech Analysis: Cepstral analysis of Speech – Formant and Pitch Estimation – Homomorphic Vocoders

UNIT V 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

TOTAL : 45 PERIODS

OUTCOMES:

Upon completion of this course, the students should be able to:

- Evaluate audio coding and transform coders
- Discuss time and frequency domain methods for speech processing
- Explain predictive analysis of speech

REFERENCES:

1. B.Gold and N.Morgan, “Speech and Audio Signal Processing”, Wiley and Sons, 2000
2. L.R.Rabiner and R.W.Schaffer, "Digital Processing of Speech Signals", Prentice Hall, 1978.
3. Mark Kahrs, Karlheinz Brandenburg, "Applications of Digital Signal Processing to Audio And Acoustic", Kluwer Academic Publishers
4. UdoZölzer, "Digital Audio Signal Processing", Second Edition, A John Wiley& sons Ltd

DS5211	DIGITAL SIGNAL PROCESSING LABORATORY II	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To be able to learn Matlab/Simulink software interface
- To be able to Digital Signal Processor Kit & Matlab/Simulink hardware interface
- Able to develop offline and Real Time Applications in Filters etc.

LIST OF EXPERIMENTS

1. MATLAB–DSK Interface Using RTDX
2. MATLAB–DSK Interface Using RTDX for FIR Filter Implementation
3. Adaptive Filter for Sinusoidal Noise Cancellation
4. Adaptive Predictor for Cancellation of Narrowband Interference Added to a Desired Wideband Signal
5. DSK Interface Using RTDX with MATLAB Functions for FFT and Plotting
6. mini-project based on the Matlab/Simulink-DSK

TOTAL: 45 PERIODS

OUTCOMES:

Upon Completion of the course, the students will be able to:

- Design & Develop a Digital Signal Processor based applications
- Design & Develop a Digital Signal Processor & Matlab/Simulink based various applications

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

SL. NO.	DESCRIPTION OF EQUIPMENT	QUANTITY REQUIRED
1	TMS 320 C67X Kits	10
2	MATLAB or Equivalent Licensed or Open Source S/W with Signal Processing Tool box	15
3	CRO 50 MHz	10
4	function Generator 1 MHz	10
5	Speakers	10

CP5281 **TERM PAPER WRITING AND SEMINAR** **L T P C**
0 0 2 1

In this course, students will develop their scientific and technical reading and writing skills that they need to understand and construct research articles. A term paper requires a student to obtain information from a variety of sources (i.e., Journals, dictionaries, reference books) and then place it in logically developed ideas. The work involves the following steps:

1. Selecting a subject, narrowing the subject into a topic
2. Stating an objective.
3. Collecting the relevant bibliography (atleast 15 journal papers)
4. Preparing a working outline.
5. Studying the papers and understanding the authors contributions and critically analysing each paper.
6. Preparing a working outline
7. Linking the papers and preparing a draft of the paper.
8. Preparing conclusions based on the reading of all the papers.
9. Writing the Final Paper and giving final Presentation

Please keep a file where the work carried out by you is maintained.
Activities to be carried Out

ACTIVITY	INSTRUCTIONS	SUBMISSION WEEK	EVALUATION
Selection of area of interest and Topic	You are requested to select an area of interest, topic and state an objective	2nd week	**3 %** Based on clarity of thought, current relevance and clarity in writing
Stating an Objective			
Collecting Information about your area & topic	1. List 1 Special Interest Groups or professional society 2. List 2 journals 3. List 2 conferences, symposia or workshops 4. List 1 thesis title 5. List 3 web presences (mailing lists, forums, news sites) 6. List 3 authors who publish regularly in your area 7. Attach a call for papers (CFP) from your area.	3rd week	**3%** (the selected information must be area specific and of international and national standard)

Collection of Journal papers in the topic in the context of the objective – collect 20 & then filter	• You have to provide a complete list of references you will be using- Based on your objective -Search various digital libraries and Google Scholar • When picking papers to read - try to: • Pick papers that are related to each other in some ways and/or that are in the same field so that you can write a meaningful survey out of them, • Favour papers from well-known journals and conferences, • Favour "first" or "foundational" papers in the field (as indicated in other people's survey paper), • Favour more recent papers, • Pick a recent survey of the field so you can quickly gain an overview, • Find relationships with respect to each other and to your topic area (classification scheme/categorization) • Mark in the hard copy of papers whether complete work or section/sections of the paper are being considered	4th week	**6%** (the list of standard papers and reason for selection)
Reading and notes for first 5 papers	Reading Paper Process • For each paper form a Table answering the following questions: • What is the main topic of the article? • What was/were the main issue(s) the author said they want to discuss? • Why did the author claim it was important? • How does the work build on other's work, in the author's opinion? • What simplifying assumptions does the author claim to be making? • What did the author do? • How did the author claim they were going to evaluate their work and compare it to others? • What did the author say were the limitations of their research? • What did the author say were the important directions for future research? Conclude with limitations/issues not addressed by the paper (from the perspective of your survey)	5th week	**8%** (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Reading and notes for next5 papers	Repeat Reading Paper Process	6th week	**8%** (the table given should indicate your

			understanding of the paper and the evaluation is based on your conclusions about each paper)
Reading and notes for final 5 papers	Repeat Reading Paper Process	7^{th} week	**8%** (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Draft outline 1 and Linking papers	Prepare a draft Outline, your survey goals, along with a classification / categorization diagram	8^{th} week	**8%** (this component will be evaluated based on the linking and classification among the papers)
Abstract	Prepare a draft abstract and give a presentation	9^{th} week	**6%** (Clarity, purpose and conclusion) **6%** Presentation & Viva Voce
Introduction Background	Write an introduction and background sections	10^{th} week	**5%** (clarity)
Sections of the paper	Write the sections of your paper based on the classification / categorization diagram in keeping with the goals of your survey	11^{th}week	**10%** (this component will be evaluated based on the linking and classification among the papers)
Your conclusions	Write your conclusions and future work	12^{th} week	**5%** (conclusions – clarity and your ideas)
Final Draft	Complete the final draft of your paper	13^{th} week	**10%** (formatting, English, Clarity and linking) **4%** Plagiarism Check Report
Seminar	A brief 15 slides on your paper	14^{th} & 15^{th} week	**10%** (based on presentation and Viva-voce)

TOTAL : 30 PERIODS

DS5301	OPTICAL SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- The students will be able to understand frequency domain signals
- The students will be able to know about the optical properties of the signals
- Can aware of the Optical signal Imaging techniques
- Understand Laser optical signal Applications

UNIT I ANALYSIS OF TWO DIMENSIONAL SIGNALS AND SYSTEMS 9

Review of one-dimensional Fourier analysis, analysis of two-dimensional signals and systems, Fourier analysis in two dimensions, localization, linear systems and Fourier analysis, two dimensional sampling theory.

UNIT II FOUNDATIONS OF SCALAR DIFFRACTION THEORY 9

Kirchoff and Rayleigh-Sommerfield formulations, comparison of kirchoff and Rayleigh Sommerfield theories, huygens-fresnel principle, non-monochromatic waves, diffraction at boundaries, angular spectrum of plane waves fresnel and fraunhofer diffraction Fresnel approximation, fraunhofer approximation, examples of fraunhofer diffraction patterns, examples of fresnel diffraction calculations.

UNIT III WAVE OPTICS ANALYSIS OF COHERENT OPTICAL SYSTEMS 9

Thin lens as phase transformation, Fourier transforming properties of lenses, image formation monochromatic illumination, analysis of complex coherent optical systems.

UNIT IV TRANSFER FUNCTIONS AND FREQUENCY ANALYSIS OF OPTICAL IMAGING SYSTEMS 9

Generalized treatment of imaging systems, amplitude transfer function, frequency response for coherent and incoherent imaging, aberrations and their effect on frequency response,Comparison of coherent and incoherent imaging, resolution beyond classical diffraction limit.

UNIT V WAVEFRONT MODULATION 9

Photographic film, liquid crystals and other modulators, diffractive optical elements, analog optical information processing, incoherent image processing systems, coherent optical image processing systems. Holography- wavefront reconstruction problem, gabor and leith, upatnieks holograms, image locations and magnification, different types of holograms- thick holograms, recording materials, computer-generated holograms, degradation of holographic images, holography with spatially incoherent light, applications.

TOTAL 45 PERIODS

OUTCOMES:

- Expertise frequency domain optical signals
- Deduce Optical signal Imaging techniques
- Development of Laser optical signal Applications

REFERENCES:

1. D. Casasent, “Optical Data Processing, Applications”, Springer, Verlag, Berlin, 1978
2. H.J. Caulfield ,“Handbook of holography”, Academic Press New York 1979 1978
3. Joseph W. Goodman, “Introduction to Fourier Optics”, 3rd edition, Mc Graw Hill
4. P.M. Dufffieux, “The Fourier Transform and its applications to Optics”, John Wiley and sons 1988

DS5001	NEURAL NETWORKS AND APPLICATIONS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the neural networks as means for computational learning.
- To present the basic network architectures for classification and regression
- To provide knowledge of computational and dynamical systems using neural networks,
- To perform algorithmic training of various neural networks.
- To understand training and limitations of learning self organizing systems

UNIT I UNIT I BASIC LEARNING ALGORITHMS 9

Biological Neuron – Artificial Neural Model - Types of activation functions – Architecture:Feedforward and Feedback – Learning Process: Error Correction Learning – Memory Based Learning – Hebbian Learning – Competitive Learning - Boltzmann Learning – Supervised and Unsupervised Learning – Learning Tasks: Pattern Space – Weight Space – Pattern Association – Pattern Recognition – Function Approximation – Control – Filtering - Beamforming – Memory – Adaptation - Statistical Learning Theory – Single Layer Perceptron – Perceptron Learning Algorithm – Perceptron Convergence Theorem – Least Mean Square Learning Algorithm – Multilayer Perceptron – Back Propagation Algorithm – XOR problem – Limitations of Back Propagation Algorithm.

UNIT II RADIAL-BASIS FUNCTION NETWORKS AND SUPPORT VECTOR MACHINES RADIAL BASIS FUNCTION NETWORKS 9

Cover's Theorem on the Separability of Patterns - Exact Interpolator – Regularization Theory – Generalized Radial Basis Function Networks - Learning in Radial Basis Function Networks Applications: XOR Problem – Image Classification.

SUPPORT VECTOR MACHINES

Optimal Hyperplane for Linearly Separable Patterns and Nonseparable Patterns – Support Vector Machine for Pattern Recognition – XOR Problem - □-insensitive Loss Function – Support Vector Machines for Nonlinear Regression

UNIT III COMMITTEE MACHINES 9

Ensemble Averaging - Boosting – Associative Gaussian Mixture Model – Hierarchical Mixture of Experts Model(HME) – Model Selection using a Standard Decision Tree – A Priori and PostprioriProbabilities – Maximum Likelihood Estimation – Learning Strategies for the HME Model - EMAlgorithm – Applications of EM Algorithm to HME Model

NEURODYNAMICS SYSTEMS

Dynamical Systems – Attractors and Stability – Non-linear Dynamical Systems- Lyapunov Stability – Neurodynamical Systems – The Cohen-GrossbergTtheorem.

UNIT IV ATTRACTOR NEURAL NETWORKS: 9

Associative Learning – Attractor Neural Network Associative Memory – Linear Associative Memory – Hopfield Network – Content Addressable Memory – Strange Attractors and Chaos- Error Performance of Hopfield Networks - Applications of Hopfield Networks – Simulated Annealing – Boltzmann Machine – Bidirectional Associative Memory – BAM Stability Analysis – Error Correction in BAMs - Memory Annihilation of Structured Maps in
BAMS – Continuous BAMs – Adaptive BAMs – Applications

ADAPTIVE RESONANCE THEORY:
Noise-Saturation Dilemma - Solving Noise-Saturation Dilemma – Recurrent On-center – Off surround Networks – Building Blocks of Adaptive Resonance – Substrate of Resonance Structural Details of Resonance Model – Adaptive Resonance Theory – Applications

UNIT V SELF ORGANISING MAPS 9
Self-organizing Map – Maximal Eigenvector Filtering – Sanger's Rule – Generalized Learning Law – Competitive Learning - Vector Quantization – Mexican Hat Networks – Self - organizing Feature Maps – Applications

PULSED NEURON MODELS:
Spiking Neuron Model – Integrate-and-Fire Neurons – Conductance Based Models – Computing with Spiking Neurons.

TOTAL :45 PERIODS

OUTCOMES:
- The Students can deduce the basic Computational Algorithms
- Can explore mathematical based computational Algorithms
- Use different methods for the various applications

REFERENCES:

1. James A. Freeman and David M. Skapura, "Neural Networks Algorithms, Applications, and Programming Techniques, Pearson Education (Singapore) Private Limited, Delhi, 2003.
2. Martin T.Hagan, Howard B. Demuth, and Mark Beale, "Neural Network Design", Thomson Learning, New Delhi, 2003.
3. Satish Kumar, "Neural Networks: A Classroom Approach", Tata McGraw-Hill Publishing Company Limited, New Delhi, 2004.
4. Simon Haykin, "Neural Networks: A Comprehensive Foundation", 2ed., Addison Wesley Longman (Singapore) Private Limited, Delhi, 2001.

AP5093	ROBOTICS	L	T	P	C
		3	0	0	3

OBJECTIVES:
- To understand robot locomotion and mobile robot kinematics
- To understand perception in robotics
- To understand mobile robot localization
- To understand mobile robot mapping
- To understand simultaneous localization and mapping (SLAM)
- To understand robot planning and navigation

UNIT I LOCOMOTION AND KINEMATICS 9
Introduction to Robotics – key issues in robot locomotion – legged robots – wheeled mobile robots – aerial mobile robots – introduction to kinematics – kinematics models and constraints – robot maneuverability

UNIT II ROBOT PERCEPTION 9
Sensors for mobile robots – vision for robotics – cameras – image formation – structure from stereo – structure from motion – optical flow – color tracking – place recognition – range data

UNIT III MOBILE ROBOT LOCALIZATION 9

Introduction to localization – challenges in localization – localization and navigation – belief representation – map representation – probabilistic map-based localization – Markov localization – EKF localization – UKF localization – Grid localization – Monte Carlo localization – localization in dynamic environments

UNIT IV MOBILE ROBOT MAPPING 9

Autonomous map building – occupancy grip mapping – MAP occupancy mapping – SLAM – extended Kalman Filter SLAM – graph-based SLAM – particle filter SLAM – sparse extended information filter – fastSLAM algorithm

UNIT V PLANNING AND NAVIGATION 9

Introduction to planning and navigation – planning and reacting – path planning – obstacle avoidance techniques – navigation architectures – basic exploration algorithms

TOTAL :45 PERIODS

OUTCOMES:

Upon Completion of the course, the students will be able to

- Explain robot locomotion
- Apply kinematics models and constraints
- Implement vision algorithms for robotics
- Implement robot localization techniques
- Implement robot mapping techniques
- Implement SLAM algorithms
- Explain planning and navigation in robotics

REFERENCES:

1. Gregory DudekandMichael Jenkin, “Computational Principles of Mobile Robotics”, Second Edition, Cambridge University Press, 2010.
2. Howie Choset et al., “Principles of Robot Motion: Theory, Algorithms, and Implementations”, A Bradford Book, 2005.
3. Maja J. Mataric, “The Robotics Primer”, MIT Press, 2007.
4. Roland Seigwart, Illah Reza Nourbakhsh, and Davide Scaramuzza, “Introduction to autonomous mobile robots”, Second Edition, MIT Press, 2011.
5. Sebastian Thrun, Wolfram Burgard, and Dieter Fox, “Probabilistic Robotics”, MIT Press, 2005.

DS5002	INTRODUCTION TO MACHINE LEARNING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the machine learning theory
- To implement linear and non-linear learning models
- To implement distance-based clustering techniques
- To build tree and rule based models
- To apply reinforcement learning techniques

UNIT I FOUNDATIONS OF LEARNING 9

Components of learning – learning models – geometric models – probabilistic models – logic models – grouping and grading – learning versus design – types of learning – supervised – unsupervised – reinforcement – theory of learning – feasibility of learning – error and noise – training versus testing – theory of generalization – generalization bound – approximation-generalization tradeoff – bias and variance – learning curve

UNIT II LINEAR MODELS 9

Linear classification – univariate linear regression – multivariate linear regression – regularized regression – Logistic regression – perceptrons – multilayer neural networks – learning neural networks structures – support vector machines – soft margin SVM – going beyond linearity – generalization and overfitting – regularization – validation

UNIT III DISTANCE-BASED MODELS 9

Nearest neighbor models – K-means – clustering around medoids – silhouttes – hierarchical clustering – k-d trees – locality sensitive hashing – non-parametric regression – ensemble learning – bagging and random forests – boosting – meta learning

UNIT IV TREE AND RULE MODELS 9

Decision trees – learning decision trees – ranking and probability estimation trees – regression trees – clustering trees – learning ordered rule lists – learning unordered rule lists – descriptive rule learning – association rule mining – first-order rule learning

UNIT V REINFORCEMENT LEARNING 9

Passive reinforcement learning – direct utility estimation – adaptive dynamic programming – temporal-difference learning – active reinforcement learning – exploration – learning an actionutility function – Generalization in reinforcement learning – policy search – applications in game playing – applications in robot control

TOTAL : 45 PERIODS

OUTCOMES:

- Upon Completion of the course, the students will be able to
- To explain theory underlying machine learning
- To construct algorithms to learn linear and non-linear models
- To implement data clustering algorithms
- To construct algorithms to learn tree and rule-based models
- To apply reinforcement learning techniques

REFERENCES

1. C. M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2007.
2. D. Barber, “Bayesian Reasoning and Machine Learning”, Cambridge University Press, 2012.
3. K. P. Murphy, “Machine Learning: A probabilistic perspective”, MIT Press, 2012
4. M. Mohri, A. Rostamizadeh, and A. Talwalkar, “Foundations of Machine Learning”, MIT Press, 2012
5. P. Flach, “Machine Learning: The art and science of algorithms that make sense of data”, Cambridge University Press, 2012.
6. S. Russel and P. Norvig, “Artificial Intelligence: A Modern Approach”, Third Edition, Prentice Hall, 2009.
7. Y. S. Abu-Mostafa, M. Magdon-Ismail, and H.-T. Lin, “Learning from Data”, AMLBook Publishers, 2012.

BM5191 **BIO SIGNAL PROCESSING** **L T P C**
3 0 0 3

OBJECTIVES

- It provides a solid foundation in advanced biomedical signaling and imaging systems including up-to-date coverage of commercially relevant topics.
- It focuses on biomedical signals, processing the signals, and validate the methods and results for optimization of clinical applications
- To introduce techniques for automated classification and decision making to aid diagnosis

UNIT I SIGNAL, SYSTEM AND SPECTRUM 9

Characteristics of some dynamic biomedical signals, Noises- random, structured and physiological noises. Filters- IIR and FIR filters. Spectrum – power spectral density function, cross-spectral density and coherence function, cepstrum and homomorphic filtering. Estimation of mean of finite time signals.

UNIT II TIME SERIES ANALYSIS AND SPECTRAL ESTIMATION 9

Time series analysis – linear prediction models, process order estimation, non stationary process, fixed segmentation, adaptive segmentation, application in EEG, PCG and HRV signals, model based ECG simulator. Spectral estimation – Blackman Tukey method, periodogram, and model based estimation. Application in Heart rate variability, PCG signals.

UNIT III ADAPTIVE FILTERING AND WAVELET DETECTION 9

Filtering – LMS adaptive filter, adaptive noise cancelling in ECG, improved adaptive filtering in FECG, EEG and other applications in Bio signals, Wavelet detection in ECG – structural features, matched filtering, adaptive wavelet detection, detection of overlapping wavelets.

UNIT IV BIOSIGNAL CLASSIFICATION AND RECOGNITION 9

Signal classification and recognition – Statistical signal classification, linear discriminant function, direct feature selection and ordering, Back propagation neural network based classification. Application in Normal versus Ectopic ECG beats and other biomedical applications

UNIT V TIME FREQUENCY AND MULTIVARIATE ANALYSIS 9

Time frequency representation, spectrogram, Time-scale representation, scalogram, wavelet analysis – Data reduction techniques, ECG data compression, ECG characterization, Feature extraction-Wavelet packets, Multivariate component analysis-PCA, ICA

TOTAL: 45 PERIODS

REFERENCES:

1. Arnon Cohen, Bio-Medical Signal Processing Vol I and Vol II, CRC Press Inc., Boca Rato, Florida 1999.
2. Emmanuel C. Ifeachor, Barrie W.Jervis, second edition „Digital Signal processing- A Practical Approach‟ Pearson education Ltd., 2002
3. P.Ramesh Babu, “Digital Signal Processing”, Sixth Edition, Scitech publications, Chennai, 2014.
4. Rangaraj M. Rangayyan, 2nd edition „Biomedical Signal Analysis-A case study approach‟, Wiley- Interscience/IEEE Press, 2015.
5. Raghuveer M. Rao and AjithS.Bopardikar, Wavelets transform – Introduction to theory and its applications, Pearson Education, India 2000
6. Willis J. Tompkins, Biomedical Digital Signal Processing, Prentice Hall of India, New Delhi, 2003.

DS5003 NON – LINEAR SIGNAL PROCESSING

	L	T	P	C
	3	**0**	**0**	**3**

OBJECTIVES:

- The student understands Maximum Likelihood estimation, point and scale estimation.
- The student is familiar with binary and colour image processing basics.
- The student can handle median based operations.
- The student has knowledge about sorting operations.
- The student can explain various implementation technologies.

UNIT I LINEAR SIGNAL PROCESSING AND STATISTICAL PRELIMINARIES 9

Random Variables and Distributions – Estimation – Point Estimation – Maximum likelihood Estimators – M-Estimators – L-Estimators – R-Estimators – Scale Estimation - Noise Models.

UNIT II BINARY IMAGE AND COLOUR IMAGE PROCESSING 9

Introduction – Morphological Image Processing –Standard Binary morphological operations – Dilation and Erosion based operations. Introduction to colour image processing – Light and colour – Colour formation – Human perception of colour – Colour Model – the Chromaticity Diagram – Colour image Quantization – Histogram of a Colour image – Colour image Filtering – Pseudo-Colouring – colour image segmentation.

UNIT III INTRODUCTION TO NON LINEAR FILTERS 9

Nonlinear filters – Measures of robustness – Order Statistics Filters – Median filters and their characteristics – Impulse noise filtering by median filters – Recursive and weighted median filters –Decision based filters – Switched Median filters.

UNIT IV ALGORITHMS 9

Sorting and Selection Algorithm – Running Median Algorithm – Bitonic sort – Bubble sort and its variant – Shellsort – Quick sort – Bucket and Sample sort – Enumeration sort and Radix sort.

UNIT V ARCHITECTURE AND APPLICATIONS OF NONLINEAR FILTERS 9

Basic structure for order statistics filtering – Systolic array implementation – Wavefront array implementation – General nonlinear filter structure – Signal dependent noise filtering – Computational complexity of general nonlinear filter model – Nonlinear Edge Detection – Implementation of decision logics.

TOTAL :45 PERIODS

OUTCOMES:

- Derive Maximum Likelihood criterion in the least square sense.
- Define the rules and standards for binary and colour image processing.
- Describe different sorting algorithms.
- Design simple median based filters.
- Develop different architecture schemes for nonlinear filters.

REFERENCES

1. Gonzalo R. Arce,"Nonlinear Signal Processing: A Statistical Approach", Wiley-Interscience, 2004.
2. Loannis Pitas, Anastasios N. Venetsanopoulos,"Nonlinear digital filters: principles and applications", Springer, 1990 – Technology & Engineering.
3. S. K Mitra, "Nonlinear Image Processing ", Academic Press, 2000.

DS5004	ARRAY SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

OBJECTIVES

- To know basis of the Antenna Signals and its types
- To know about the representation of the Antenna acquisition signals in different domains
- To understand statistical techniques of the signal representation
- To be able to study different applications of the Antenna Systems

UNIT I INTRODUCTION 9

Antenna parameters, Basic Antenna elements, Array Fundamentals- Element pattern, directive gain, Directivity, Power Gain, Polarization, array pattern, array gain, array taper efficiency, Pencil beam array, linear array synthesis-schelknoff 's polynomial array, binomial array, Chebyshev array, Microstrip patch array, Noise in communication.

UNIT II SPATIAL SIGNALS AND SENSOR ARRAYS 9

Signals in space and time. Spatial frequency, Direction vs. frequency. Wave fields. Far field and Near field signals. Spatial sampling, Nyquist criterion. Sensor arrays. Uniform linear arrays, planar and random arrays. Array transfer (steering) vector. Array steering vector for ULA. Broadband arrays.

UNIT III SPATIAL FREQUENCY 9

Aliasing in spatial frequency domain. Spatial Frequency Transform, Spatial spectrum. Spatial Domain Filtering, sectorization, switched beam, phased antenna array, adaptive antenna array and adaptive signal processing application, Beam Forming. Spatially white signal. Introduction to microphone array signal processing

UNIT IV DIRECTION OF ARRIVAL ESTIMATION 9

Non parametric methods - Beam forming and Capon methods. Resolution of Beam forming method. Subspace methods - MUSIC, Minimum Norm and ESPRIT techniques. Spatial Smoothing.

UNIT V APPLICATIONS OF ARRAY SIGNAL PROCESSING 9

RADAR, Sonar, Seismic, Acoustics, Wireless Communications and networks and Radio Astronomy signal processing applications

TOTAL : 45 PERIODS

OUTCOMES:

- To be able to design Antenna based signal Acquisition System
- To be able to develop different mathematical techniques for signal acquired from the Antenna Receiver system
- To be able to understand different Antenna Acquisition Applications

REFERENCES:

1. Bass J, McPheeters C, Finnigan J, Rodriguez E. Array Signal Processing, February 2005.
2. Dan E. Dugeon and Don H. Johnson. Array Signal Processing: Concepts and Techniques. Prentice Hall. 1993.
3. PetreStoica and Randolph L. Moses, Spectral Analysis of Signals. Prentice Hall. 2005
4. Simon Haykins and K. J. Ray Liu, Handbook of Array Signal Processing and Sensor Networks, Wiley

CU5097	WIRELESS ADHOC AND SENSOR NETWORKS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basics of Ad-hoc & Sensor Networks.
- To learn various fundamental and emerging protocols of all layers.
- To study about the issues pertaining to major obstacles in establishment and efficient management of Ad-hoc and sensor networks.
- To understand the nature and applications of Ad-hoc and sensor networks.
- To understand various security practices and protocols of Ad-hoc and Sensor Networks.

UNIT I MAC & TCP IN AD HOC NETWORKS 9

Fundamentals of WLANs – IEEE 802.11 Architecture - Self configuration and Auto configuration-Issues in Ad-Hoc Wireless Networks – MAC Protocols for Ad-Hoc Wireless Networks – Contention Based Protocols - TCP over Ad-Hoc networks-TCP protocol overview - TCP and MANETs – Solutions for TCP over Ad-Hoc Networks.

UNIT II ROUTING IN AD HOC NETWORKS 9

Routing in Ad-Hoc Networks- Introduction-Topology based versus Position based Approaches-Proactive, Reactive, Hybrid Routing Approach-Principles and issues – Location services - DREAM – Quorums based location service – Grid – Forwarding strategies – Greedy packet forwarding – Restricted directional flooding- Hierarchical Routing- **Issues and Challenges in providing QoS.**

UNIT III MAC, ROUTING & QOS IN WIRELESS SENSOR NETWORKS 9

Introduction – Architecture - Single node architecture – Sensor network design considerations – Energy Efficient Design principles for WSNs – Protocols for WSN – Physical Layer : Transceiver Design considerations – MAC Layer Protocols – IEEE 802.15.4 Zigbee – Link Layer and Error Control issues - Routing Protocols – Mobile Nodes and Mobile Robots - Data Centric & Contention Based Networking – Transport Protocols & QOS – Congestion Control issues – Application Layer support.

UNIT IV SENSOR MANAGEMENT 9

Sensor Management - Topology Control Protocols and Sensing Mode Selection Protocols - Time synchronization - Localization and positioning – Operating systems and Sensor Network programming – Sensor Network Simulators.

UNIT V SECURITY IN AD HOC AND SENSOR NETWORKS 9

Security in Ad-Hoc and Sensor networks – Key Distribution and Management – Software based Anti-tamper techniques – water marking techniques – Defense against routing attacks - Secure Adhoc routing protocols – Broadcast authentication WSN protocols – TESLA – Biba – Sensor Network Security Protocols – SPINS.

TOTAL : 45 PERIODS

OUTCOMES:

Upon Completion of the course, the students should be able to

- Identify different issues in wireless ad hoc and sensor networks.
- To analyze protocols developed for ad hoc and sensor networks.
- To identify and address the security threats in ad hoc and sensor networks.
- Establish a Sensor network environment for different type of applications.

REFERENCES:

1. Adrian Perrig, J. D. Tygar, "Secure Broadcast Communication: In Wired and Wireless Networks", Springer, 2006.
2. Carlos De Morais Cordeiro, Dharma Prakash Agrawal “Ad Hoc and Sensor Networks: Theory and Applications (2nd Edition), World Scientific Publishing, 2011.
3. C.Siva Ram Murthy and B.S.Manoj, “Ad Hoc Wireless Networks – Architectures and Protocols”, Pearson Education, 2004.
4. C.K.Toh, “Ad Hoc Mobile Wireless Networks”, Pearson Education, 2002.
5. Erdal Çayırcı , Chunming Rong, “Security in Wireless Ad Hoc and Sensor Networks”, John Wiley and Sons, 2009.
6. Holger Karl, Andreas willig, Protocols and Architectures for Wireless Sensor Networks, John Wiley & Sons, Inc .2005.
7. Subir Kumar Sarkar, T G Basavaraju, C Puttamadappa, “Ad Hoc Mobile Wireless Networks”, Auerbach Publications, 2008.
8. Waltenegus Dargie, Christian Poellabauer, “Fundamentals of Wireless Sensor Networks Theory and Practice”, John Wiley and Sons, 2010.

DS5005	CRYPTOGRAPHIC TECHNIQUES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Encryption techniques and key generation techniques
- To learn about Authentication and security measures
- To study security system and wireless security analysis

UNIT I SYMMETRIC CIPHERS 9

Overview – classical Encryption Techniques – Block Ciphers and the Data Encryption standard – Introduction to Finite Fields – Advanced Encryption standard – Contemporary Symmetric Ciphers – Confidentiality using Symmetric Encryption.

UNIT II PUBLIC-KEY ENCRYPTION AND HASH FUNCTIONS 9

Introduction to Number Theory – Public-Key Cryptography and RSA – Key Management – Diffie-Hellman Key Exchange – Elliptic Curve Cryptography – Message Authentication and Hash Functions – Hash Algorithms – Digital Signatures and Authentication Protocols.

UNIT III NETWORK SECURITY PRACTICE 9

Authentication Applications – Kerberos – X.509 Authentication Service – Electronic mail Security – Pretty Good Privacy – S/MIME – IP Security architecture – Authentication Header – Encapsulating Security Payload – Key Management.

UNIT IV SYSTEM SECURITY 9

Intruders – Intrusion Detection – Password Management – Malicious Software – Firewalls – Firewall Design Principles – Trusted Systems.

UNIT V WIRELESS SECURITY 9

Introduction to Wireless LAN Security Standards – Wireless LAN Security Factors and Issues.

TOTAL : 45 PERIODS

OUTCOMES:
To be able to present Encryption techniques and key generation techniques
Has practice in Authentication and security measures
Having exposure of security system and wireless security issues

REFERENCES:

1. Atul Kahate, “Cryptography and Network Security”, Tata McGraw Hill, 2003
2. Bruce Schneier, “Applied Cryptography”, John Wiley and Sons Inc, 2001.
3. Charles B. Pfleeger, Shari Lawrence Pfleeger, “Security In Computing”, 3rd Edition,PearsonEducation, 2003
4. Mao, “Modern Cryptography: Theory and Practice” , First Edition, Pearson Education, 2003.
5. Stewart S. Miller, “Wi-Fi Security”, McGraw Hill , 2003.
6. William Stallings, “Cryptography And Network Security – Principles And Practices”, Pearson Education, 3rd Edition, 2003.

DS5006	UNDERWATER ACOUSTICS SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

OBJECTIVES:
- To understand the characteristics of Underwater Channel
- To understand the principles of SONAR
- To understand the challenges in underwater signal processing

UNIT I UNDERWATER ACOUSTIC CHANNEL 9
Underwater Channel Characterization – Sound Transmission Losses-Acoustic Characteristics of surface layer-Ambient Noise in the ocean- Correlation properties of Ambient Noise

UNIT II SONAR 9
Basics of SONAR- correlation and ambiguities-Wideband Synthetic Aperture SONAR processing-Discrete Spatial arrays-Beam stearing- Target Angle Estimation –Array Shading:

UNIT III TARGET DETECTION 9
Passive Acoustic signatures of Ships and Submarines-Target strength for Active Systems-Hypothesis testing- receiver operating Characteristics-estimation of signal Parameters

UNIT IV STATISTICAL PROCESSING & ADAPTIVE SPATIAL FILTERING 9
Monostatic Sounding of Single point Targets-Target strength estimation from Echo ensemble-Optimum Filter for Maximum SNR-High Resolution Beam Forming

UNIT V UNDERWATER ACOUSTIC COMMUNICATION 9
Underwater Bio Telemetry System -system Design principle-Speech Coding and Decoding-Transmission and Detection of speech

TOTAL :45 PERIODS

OUTCOMES:

- To be able to design underwater signal processing systems
- To be able to analyze the performance of underwater signal processing systems

REFERENCES

1. Robert S.H. Istepanian and MilicaStojanovic, Underwater Acoustic Digital signal processing & communication system, Kluwer academic Publisher, 2002
2. William S. Burdic, Underwater Acoustic Systems, Prentice Hall Inc., 2002

AP5191	EMBEDDED SYSTEM DESIGN	L T P C
		3 0 0 3

OBJECTIVES :

The students should be made to:

- Learn design challenges and design methodologies
- Study general and single purpose processor
- Understand bus structures

UNIT I EMBEDDED SYSTEM OVERVIEW 9

Embedded System Overview, Design Challenges – Optimizing Design Metrics, Design Methodology, RT-Level Combinational and Sequential Components, Optimizing Custom Single-Purpose Processors.

UNIT II GENERAL AND SINGLE PURPOSE PROCESSOR 9

Basic Architecture, Pipelining, Superscalar and VLIW architectures, Programmer's view, Development Environment, Application-Specific Instruction-Set Processors (ASIPs) Microcontrollers, Timers, Counters and watchdog Timer, UART, LCD Controllers and Analog-to-Digital Converters, Memory Concepts.

UNIT III BUS STRUCTURES 9

Basic Protocol Concepts, Microprocessor Interfacing – I/O Addressing, Port and Bus-Based I/O, Arbitration, Serial Protocols, I^2C, CAN and USB, Parallel Protocols – PCI and ARM Bus, Wireless Protocols – IrDA, Bluetooth, IEEE 802.11**.**

UNIT IV STATE MACHINE AND CONCURRENT PROCESS MODELS 9

Basic State Machine Model, Finite-State Machine with Datapath Model, Capturing State Machine in Sequential Programming Language, Program-State Machine Model, Concurrent Process Model, Communication among Processes, Synchronization among processes, Dataflow Model, Real-time Systems, Automation: Synthesis, Verification : Hardware/Software Co-Simulation, Reuse: Intellectual Property Cores, Design Process Models.

UNIT V EMBEDDED SOFTWARE DEVELOPMENT TOOLS AND RTOS 9

Compilation Process – Libraries – Porting kernels – C extensions for embedded systems – emulation and debugging techniques – RTOS – System design using RTOS.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students should be able to:

- Explain different protocols
- Discuss state machine and design process models
- Outline embedded software development tools and RTOS

REFERENCES:

1. Bruce Powel Douglas, "Real time UML, second edition: Developing efficient objects for embedded systems", 3rd Edition 1999, Pearson Education.
2. Daniel W. Lewis, "Fundamentals of embedded software where C and assembly meet", Pearson Education, 2002.
3. Frank Vahid and Tony Gwargie, "Embedded System Design", John Wiley & sons, 2002.
4. Steve Heath, "Embedded System Design", Elsevier, Second Edition, 2004.

DS5007	REAL TIME OPERATING SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To expose the students to the fundamentals of interaction of OS with a compu ter and User computation
- To teach the fundamental concepts of how process are created and controlled with OS
- To study on programming logic of modeling Process based on range of OS features
- To compare types and Functionalities in commercial OS, application development using RTOS
- To involve Discussions/ Practice/Exercise onto revising & familiarizing the concepts acquired over the 5 Units of the subject for improved employability skills

UNIT I REVIEW OF OPERATING SYSTEMS 9

Basic Principles - Operating System structures –System Calls –Files –Processes –Design and Implementation of processes –Communication between processes –Introduction to Distributed operating system –issues in distributed system: states, events, clocks -Distributed scheduling-Fault & recovery.

UNIT II OVERVIEW OF RTOS 9

RTOS Task and Task state – Multithreaded Preemptive scheduler - Process Synchronization - Message queues – Mail boxes - pipes – Critical section – Semaphores – Classical synchronization problem – Deadlocks

UNIT III REAL TIME MODELS AND LANGUAGES 9

Event Based –Process Based and Graph based Models –Real Time Languages –RTOS Tasks –RT scheduling -Interrupt processing –Synchronization –Control Blocks –Memory Requirements.

UNIT IV REAL TIME KERNEL 9

Principles –Design issues –Polled Loop Systems –RTOS Porting to a Target –Comparison and Basic study of various RTOS like –VX works –Linux supportive RTOS –C Executive.

UNIT V APPLICATION DEVELOPMENT USING OS 9

Discussions on Basics of Linux supportive RTOS–uCOS-C Executive for development of RTOS Application–introduction to Android Environment-The Stack–Android User Interface–Preferences, the File System, the Options Menu and Intents, with one Case study

TOTAL :45 PERIODS

OUTCOMES:

- The learning process delivers insight into scheduling, disciplining various embedded & Computational processes with improved design strategies.
- Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design.

REFERENCES:

1. Charles Crowley, "Operating Systems-A Design Oriented approach" McGraw Hill,1997
2. Herma K., "Real Time Systems –Design for distributed Embedded Applications", Kluwer Academic, 1997
3. Karim Yaghmour,Building Embedded Linux System",O'reilly Pub,2003
4. Raj Kamal, "Embedded Systems -Architecture, Programming and Design" Tata McGraw Hill,2006.
5. Silberschatz,Galvin,Gagne" Operating System Concepts,6th Ed, John Wiley,2003

VL5191	**DSP INTEGRATED CIRCUITS**	**L T P C**
		3 0 0 3

OBJECTIVES:

- To familiarize the concept of DSP and DSP algorithms.
- Introduction to Multirate systems and finite wordlength effects
- To know about the basic DSP processor architectures and the synthesis of the processing elements

UNIT I INTRODUCTION TO DSP INTEGRATED CIRCUITS 9

Introduction to Digital signal processing, Sampling of analog signals, Selection of sample frequency, Signal- processing systems, Frequency response, Transfer functions, Signal flow graphs, Filter structures, Adaptive DSP algorithms, DFT-The Discrete Fourier Transform, FFT Algorithm, Image coding, Discrete cosine transforms, Standard digital signal processors, Application specific ICs for DSP, DSP systems, DSP system design, Integrated circuit design.

UNIT II DIGITAL FILTERS AND FINITE WORD LENGTH EFFECTS 9

FIR filters, FIR filter structures, FIR chips, IIR filters, Specifications of IIR filters, Mapping of analog transfer functions, Mapping of analog filter structures, Multi rate systems, Interpolation with an integer factor L, Sampling rate change with a ratio L/M, Multi rate filters. Finite word length effects - Parasitic oscillations, Scaling of signal levels, Round-off noise, Measuring round-off noise, Coefficient sensitivity, Sensitivity and noise.

UNIT III DSP ARCHITECTURES 9

DSP system architectures, Standard DSP architecture-Harvard and Modified Harvard architecture. Ideal DSP architectures, Multiprocessors and multi computers, Systolic and Wave front arrays, Shared memory architectures.

UNIT IV SYNTHESIS OF DSP ARCHITECTURES 9

Synthesis: Mapping of DSP algorithms onto hardware, Implementation based on complex PEs, Shared memory architecture with Bit – serial PEs. Combinational & sequential networks- Storage elements – clocking of synchronous systems, Asynchronous systems -FSM

UNIT V ARITHMETIC UNIT AND PROCESSING ELEMENTS 9

Conventional number system, Redundant Number system, Residue Number System, Bit-parallel and Bit-Serial arithmetic, Digit Serial arithmetic, CORDIC Algorithm, Basic shift accumulator, Reducing the memory size, Complex multipliers, Improved shift-accumulator. Case Study : DCT and FFT processor

TOTAL: 45 PERIODS

OUTCOMES:

- Get to know about the Digital Signal Processing concepts and its algorithms
- Get an idea about finite word length effects in digital filters
- Concept behind multi rate systems is understood.
- Get familiar with the DSP processor architectures and how to perform synthesis of processing elements

REFERENCES:

1. B.Venkatramani, M.Bhaskar, "Digital Signal Processors", Tata McGraw-Hill, 2002.
2. John J. Proakis, Dimitris G. Manolakis, "Digital Signal Processing", Pearson Education, 2002.
3. Keshab Parhi, "VLSI Digital Signal Processing Systems design & Implementation", John Wiley & Sons, 1999.
4. Lars Wanhammer, "DSP Integrated Circuits", Academic press, New York, 1999.

BM5291 APPLIED MEDICAL IMAGE PROCESSING L T P C
3 0 0 3

OBJECTIVES:

- To develop computational methods and algorithms to analyze and quantify biomedical data
- To understand the fundamentals of medical image processing techniques.

UNIT I IMAGE FUNDAMENTALS 9

Image perception, MTF of the visual system, Image fidelity criteria, Image model, Image sampling and quantization – two dimensional sampling theory, Image quantization, Optimum mean square quantizer, Image transforms – DFT, DCT, KLT, SVD.

UNIT II IMAGE ENHANCEMENT AND RESTORATION 9

Histogram equalization and specification techniques, Noise distributions, Spatial averaging, Directional Smoothing, Median, Geometric mean, Harmonic mean, Contra harmonic mean filters, Homomorphic filtering, Color image enhancement. Image Restoration - degradation model, Unconstrained and constrained restoration, Inverse filtering- Wiener filtering

UNIT III MEDICAL IMAGE REPRESENTATION 9

Pixels and voxels – algebraic image operations - gray scale and color representation- depth-color and look up tables - image file formats- DICOM- other formats- Analyze 7.5, NifTI and Interfile, Image quality and the signal to noise ratio

UNIT IV MEDICAL IMAGE ANALYSIS AND CLASSIFICATION 9

Image segmentation- pixel based, edge based, region based segmentation. Image representation and analysis, Feature extraction and representation, Statistical, Shape, Texture, feature and image classification – Statistical, Rule based, Neural Network approaches

UNIT V IMAGE REGISTRATIONS AND VISUALIZATION 9

Rigid body visualization, Principal axis registration, Interactive principal axis registration, Feature based registration, Elastic deformation based registration, Image visualization – 2D display methods, 3D display methods, virtual reality based interactive visualization.

TOTAL: 45 PERIODS

OUTCOMES:

- Students will be able to apply image processing concepts for medical images.
- Will be able to analyze Morphology, Segmentation techniques and implement these in images.
- Enables quantitative analysis and visualization of medical images of numerous modalities such as PET, MRI, CT, or microscopy

REFERENCES:

1. Atam P.Dhawan, "Medical Image Analysis", Wiley Interscience Publication, NJ, USA 2003.
2. Anil. K. Jain, "Fundamentals of Digital Image Processing", Pearson education, Indian Reprint 2003.
3. John L.Semmlow, "Biosignal and Biomedical Image Processing Matlab Based applications" Marcel Dekker Inc.,New York,2004
4. Kavyan Najarian and Robert Splerstor, "Biomedical signals and Image processing",CRC – Taylor and Francis,New York,2006
5. Milan Sonka et al, "IMAGE PROCESSING, ANALYSIS AND MACHINE VISION", Brookes/Cole, Vikas Publishing House, 2nd edition, 1999.
6. R.C.Gonzalez and R.E.Woods, "Digital Image Processing", Second Edition, Pearson Education, 2002.
7. Wolfgang Birkfellner, "Applied Medical Image Processing – A Basic course", CRC Press, 2011.

DS5008	**MIXED SIGNAL PROCESSING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To know the fundamentals of Signals, Filters and Sampling process
- To understand the design techniques of analog and digital filters Structures
- To know the fundamentals of analog and digital conversion techniques in logical design
- To understand the various conversion architectures for analog and digital signal processing

UNIT I SIGNALS, FILTERS AND SAMPLING 9

Sinusoidal Signals, Comb Filters, Representing Signals, Impulse Sampling, Decimation, The Sample-and-Hold, Interpolation, K-Path Sampling, The Track-and-Hold Implementing the S/H, The S/H with Gain, The Discrete Analog Integrator.

UNIT II ANALOG FILTERS 9

Integrator Building Blocks- Lowpass Filters, Active-RC Integrators, MOSFET-C Integrators, gm-C (Transconductor-C) Integrators, Discrete-Time Integrators, Filtering Topologies- The Bilinear Transfer Function, The Biquadratic Transfer Function

UNIT III DIGITAL FILTERS 9

SPICE Models for DACs and ADCs- The Ideal DAC, The Ideal ADC, Number Representation, Sinc-Shaped Digital Filters- The Counter, Lowpass Sinc Filters, Bandpass and Highpass Sinc Filters, Interpolation using Sinc Filters, Decimation using Sinc Filters, Filtering Topologies- FIR Filters, Stability and Overflow, The Bilinear Transfer Function, The Biquadratic Transfer Function

UNIT IV DATA CONVERTER FUNDAMENTALS 9

Analog Versus Discrete Time Signals, Converting Analog Signals to Digital Signals, Sample-and-Hold (S/H) Characteristics, Digital-to-Analog Converter (DAC) Specifications, Analog-to-Digital Converter (ADC) Specifications, Mixed-Signal Layout Issues.

UNIT V DATA CONVERTER ARCHITECTURES 9

DAC Architectures- Digital Input Code, Resistor String, R-2R Ladder Networks, Current Steering, Charge-Scaling DACs, ADC Architectures- Flash, The Two-Step Flash ADC, The Pipeline ADC, Integrating ADCs, The Successive Approximation ADC, The Oversampling ADC

TOTAL : 45 PERIODS

OUTCOMES:

- To be able to design analog and digital filters Structures
- To be able to carry out the filters design in data conversions
- To be able to design conversion architectures for DSP algorithms.

REFERENCES:

1. R. Jacob Baker, CMOS Mixed-Signal Circuit Design, A JOHN WILEY & SONS, Second Edition, 2008.
2. R. Jacob Baker, CMOS Circuit Design, Layout, and Simulation, A JOHN WILEY & SONS, Third Edition, 2010.
3. S.Y.Kuang, H.J. White house, T. Kailath, “VLSI and Modern Signal Processing”, Prentice Hall, 1995.

DS5009	DIGITAL MODULATION AND CODING	L	T	P	C
		3	0	0	3

OBJECTIVES:

To learn about representation of signals in information coding aspect
To learn various modulation techniques
To learn error detection and correction information coding
To learn various method of coding

UNIT I BAND PASS DATA TRANSMISSION 9

Geometric representation of signals; Coherent detection of signals in noise. Correlation receiver and matched filter receiver.

UNIT II DIGITAL MODULATION 9

Probability of error and receiver implementation of BPSK, BFSK, QPSK, MSK, Mary PSK and Mary FSK.

UNIT III DEMODULATION OF SIGNALS 9

Union bound approximation for the probability of error. Detection of signals with unknown phase Spectra of digitally modulated signals. Carrier and clock recovery methods.

UNIT IV ERROR CONTROL CODES 9

Error control coding: Linear block codes: Generator and parity check matrices. Syndrome calculation. Error detection and error correction using block codes. Conventional codes: Generator and transfer function matrices.

UNIT V CONVENTIONAL CODES 9

State and trellis diagrams. Maximum likelihood decoding of conventional codes: The Viterbi algorithm. Trellis coded modulation.

TOTAL :45 PERIODS

OUTCOMES:

- Fundamental signal representation in information coding
- various modulation techniques in order to develop the similar techniques
- has knowledge in error detection and correction methods information coding and various method of coding

REFERENCES

1. John G. Prakis "Digital Communication 4th Edition McGRAW HILL Publication 2012.
2. M. K. Simon S. M. Winedi and N. C. Lindsey " DIGITAL COMMUNICATION TECHNIQUES'' Signalling and detection preatice wall India, New Delhi 195
3. Simon Waykin Digital Communication Johnwiley and sons 1998
4. Stephen G. Wilson, Digital Modulation and Coding, Prentice Hall, 1996
5. Theodooc S. Rappaport " Wireless Communication 2nd Edition "Pearson Education 2002.