DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

SRI VENKATESWARA UNIVERSITY COLLEGE OF ENGINEERING:

TIRUPATI-517502

R-23- Scheme of Instructions effective from the academic year 2023 - 2024

Programme Scheme

SRI VENKATESWARA UNIVERSITY COLLEGE OF ENGINEERING (AUTONOMOUS)

SRI VENKATESWARA UNIVERSITY

TIRUPATI-517502 (A.P), INDIA.

SRI VENKATESWARA UNIVERSITY COLLEGE OF ENGINEERING: TIRUPATI - 517 502
Department of Electronics and Communication Engineering-Scheme of Instruction- (CBCS) effective from the Academic Year 2023-2024

M.Tech (PG) (Electronics and Communication Engineering)
Specialization: Signal Processing (SP)

I Semester

S.No.	Category	Course Code	Course Title	Scheme of Instruction (Hours/Week)				No. of Credits	Scheme of Evaluation		
				Lecture	Tutorial	Practical	Total		Sessional Marks	Semester End Examination Marks	Total
1	PCC	SP11C	Advanced Digital Signal Processing (Common to Communication systems CM11C)	3	1	0	4	4	40	60	100
2	PCC	SP12C	Digital Image and Video Processing	3	1	0	4	4	40	60	100
3	PCC	SP13C	DSP Architecture (Common to Communication systems CM12C)	3	1	0	4	4	40	60	100
4	PEC	SP14C	Programme Elective- I	3	0	0	3	3	40	60	100
5	PEC	SP15C	Programme Elective- II	3	0	0	3	3	40	60	100
6	PCC	SP16L	Advanced Digital Signal Processing Lab (Common to Communication systems CM16L)	0	0	3	3	1.5	40	60	100
7	PCC	SP17L	Digital image and Video Processing Lab	0	0	3	3	1.5	40	60	100
8	MAC	SP18C	Research Methodology and IPR	3	0	0	3	3	40	60	100
Total				18	3	6	27	24	320	480	800

List of Programme Elective Course I (SP14C)	List of Programme Elective Course II (SP15C)
1. Computer Vision	1. Joint time Frequency Analysis and Multi Resolution Analysis
2. Artificial Intelligence	2. Voice and Data Networks (Common to Communication systems CM15C)
3. Wireless Sensor Networks (Common to Communication systems CM14C)	3. Audio Video Coding and Compression
4. Optimization Techniques.	4. Modeling and simulation techniques

II Semester

Category	Course Code	Course Title	Scheme of Instruction (Hours/Week)				No. of Credits	Scheme of Evaluation		
			Lecture	Tutorial	Practical	Total		Sessional Marks	Semester End Examination Marks	Total
PCC	SP21C	Pattern recognition and Machine Learning (Common to Communication systems CM24C)	3	1	0	4	4	40	60	100
PCC	SP22C	Detection and Estimation Theory	3	1	0	4	4	40	60	100
PEC	SP23C	Programme Elective Course - III	3	0	0	3	3	40	60	100
PEC	SP24C	Programme Elective Course - IV	3	0	0	3	3	40	60	100
PCC	SP25L	Pattern recognition and Machine Learning Lab	0	0	3	3	1.5	40	60	100
PCC	SP26L	Detection and Estimation Theory Lab	0	0	3	3	1.5	40	60	100
VAC	SP27C	Cyber Security	2	0	2	4	3	100	-	100
PCC	SP28M	Mini Project with Seminar	0	0	4	4	2	100	-	100
	Total		**14**	**2**	**12**	**28**	**22**	**440**	**360**	**800**

List of Programme Elective Courses III(SP23C)	List of Programme Elective Courses IV (SP24C)
1. Advanced Computer Architecture	1. Random processes and Queueing models (Common to Communication systems CM24C)
2. IoT and Applications (Common to Communication systems CM23C)	2. Multispectral signal analysis
3. Digital design and verification	3. Biomedical signal Processing
4. Audio Processing	4. Remote Sensing (Common to Communication systems CM24C)

III Semester

Category	Course Code	Course Title	Scheme of Instruction (Hours/Week)				No. of Credits	Scheme of Evaluation		
			Lecture	Tutorial	Practical	Total		Sessional Marks	Semester End Examination Marks	Total
OEC	SP31C	Open Elective Course (Through MOOCS)	0	0	0	0	3	100	-	100
PCC	SP32I	Industrial/ Research Internship (Min of 4 Weeks)	0	0	0	0	3	100	-	100
PCC	SP33D	Dissertation Work Phase-I	0	0	24	24	12	40	60	100
	Total		**0**	**0**	**20**	**20**	**18**	**240**	**60**	**300**

IV Semester

Category	Course Code	Course Title	Scheme of Instruction (Hours/Week)				No. of Credits	Scheme of Evaluation		
			Lecture	Tutorial	Practical	Total		Sessional Marks	Semester End Examination Marks	Total
PCC	SP41D	Dissertation Work Phase-II and Viva-Voce	0	0	20	20	10 + 06 = 16	40	60	100
	Total		**0**	**0**	**20**	**20**	**16**	**40**	**60**	**100**

M. Tech.(Electronics and Communication Engineering) Curriculum Structure Specialization: Signal

processing Vision of The Institute

The Vision of Sri Venkateswara University College of Engineering is to be the leader in the creation and development of globally competitive human capital in Engineering Education for Technological, Economical and Social Enrichment of the Society, through its open and flexible Academic Programs.

Mission of The Institute

1. *To be recognized as a premier institution offering Engineering Education programs, training human resources oriented to problem solving and system development.*
2. *To carry out research in Engineering and Technology relevant to all segments of society.*
3. *To assume leadership in sustainable technological growth of the Indian society.*
4. *To be a natural destination for excellence and diversity in thought and practice.*

Department of Electronics &Communication

Engineering Vision

To be a lead department imparting quality and value embedded higher education and research emphasizing freedom of learning andpractice.

Mission

1. *Transforming students into full-fledged professionals and to become leaders in dynamic global environment.*
2. *Augmenting knowledge and technologies in rapidly advancing fields of Electronics and Communication Engineering.*
3. *Promoting in depth research and create Centre of excellence in thrust areas.*

Program Outcomes (POs) for PG programs

POs are statements that describe what students are expected to know and

be able to do upon graduating from the program. These relate to the skills, knowledge, analytical ability attitude and behaviour that students acquire through the program.
The POs essentially indicate what the students can do from subject-wise knowledge acquired by them during the program. As such, POs define the professional profile of a graduate of PG Engineering Program.

NBA has defined the following three POs for a graduate of PG Engineering Program:

1. **PO1***: An ability to independently carry out research/investigation and development work to solve practical problems.*
2. **PO2***: An ability to write and present a substantial technical report/document.*
3. **PO3***: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.*

Program Specific Outcomes (PSOs):

M. Tech. in Signal Processing graduates will be able to:

1. **PSO 1***. Integrate knowledge to identify, formulate, solve complex problems and apply in Signal Processing, Machine Vision and Communication Networks.*
2. **PSO 2.** *Use the concepts and software tools of signal processing to design the systems to meet the specific needs within economic, social and environmental constraints.*

Program Educational Objectives (PEOs):

M. Tech. in Signal Processing Program, graduates will be able to:

1. **PEO 1.***Providetechnical competency to identify, analyze and solve engineering problems pertaining to design, development, and deployment of signal processing systems.*
2. **PEO 2.***Possess suitable knowledge for analyzing, modelling, and evaluating the research problems in signal processing to pursue research and enhance the employability.*
3. **PEO 3.***Inculcate professionalism, ethical attitude, communication skills, social values and ability to relate engineering solutions to real life and practical applications.*

SP11C Advanced Digital Signal Processing
(Common to Communication Systems)

Instruction Hours/week : (L-T-P-C): 3-1-0-4 **Credits : 4**

Sessional Marks : 40 **Semester-End Examination: 60**

Course Description: *This course will provide rigorous foundations in Digital filter structures, Multirate signal processing, Linear prediction, Adaptive filters and Spectral estimation. This course emphasizes the use of digital signal processing techniques for designing digital systems used in Communications, Control, Media Applications etc.*

Prerequisites: *Signals and Systems, Digital Signal Processing.*

Course Objectives: *To enable the student to*

1. *Understand to develop FIR & IIR filter structures depending upon the given applications.*
2. *Understand theory of Multirate DSP, solve numerical problems and write algorithms.*
3. *Understand theory of prediction and solution of normal equations.*
4. *Understand the different types of adaptive filters used in signal processing applications.*
5. *Discuss different methods of spectrum estimation and analysis.*

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

1. *Learn and implement the digital filters to computational complexity problems.*
2. *Analyze multirate DSP systems and Design a decimator and integrator including multi-stages.*
3. *Apply theory of prediction and find solution of normal equations*
4. *Design different types of filters such as Adaptive filters, poly phase filters, Wiener filters, ARMA lattice-ladder filters, etc.*
5. *Estimate the power spectrum by using different methods.*

Contents:

Unit 1

Digital filter structures: *Basic FIR/IIR filter structures, FIR/IIR Cascaded lattice structures, Parallel structures, all pass realization of IIR transfer functions, Sine- cosine generator, Computational complexity of filter structures.*

Unit 2

Multirate Digital Signal Processing*: Decimators and Interpolators,* *Sampling rate conversion, multistage decimator & interpolator, poly phase* *filters, Quadrature mirror filter (QMF) banks, Conditions for perfect reconstruction, digital filter banks, Applications in sub-band coding.*

Unit 3

Linear Prediction and Optimum Linear Filters*: Innovations Representation of a Stationary Random Process, Forward and Backward linear prediction, Solution of the Normal Equations, Properties of linear prediction-Error Filter, AR Lattice and ARMA Lattice-Ladder Filters, Wiener Filters for Filtering and Prediction.*

Unit 4

Adaptive Filters, Applications, Gradient Adaptive Lattice, Minimum mean square criterion, The Least-Mean-Square (LMS) algorithm, Normalized LMS (NLMS), The Leaky LMS, Recursive Least Square (RLS) algorithm.

Unit 5

Power Spectral Estimation: *Estimation of Spectra from Finite Duration Observations of a Signal, Periodogram, Use DFT in power Spectral Estimation, Bartlett, Welch and Blackman, Tukey methods, Comparison of performance of Non-Parametric Power Spectrum Estimation Methods.*

Parametric Methods of Power Spectrum Estimation: *Relationship between Auto-Correlation and Model Parameters, Yule-Walker, Burg and Unconstructrained Least Squares Methods, Moving Average (MA) and ARMA Models Minimum Variance Method, Eigen analysis Algorithms for Spectrum Estimation.*

Text Books*:*

1. **John G. Proakis** *and***Dimitris G. Manolakis,** *Digital Signal Processing: Principles, Algorithms and Applications, 5th Edition,* **ISBN- 13: 9780137348657,** *Published by Pearson, 2021.*
2. *John G. Proakis, Digital Signal Processing Principles, Algorithms, and Applications, Prentice Hall International Inc, 4th Edition, 2012.*
3. *Sanjit Kumar Mitra, Digital Signal Processing- A Computer Based Approach, 4th edition, McGraw Hill Education, 2011.*
4. *D.G. Manolakis, V.K. Ingle and S.M.Kogon, "Statistical and Adaptive Signal Processing", McGraw Hill, 2000.*

References:

1. *N. J. FliegMultirate Digital Signal Processing: Multirate Systems - Filter Banks – Wavelets,1st Edition, John Wiley and Sons Ltd, 1999.*
2. *Sanjit Kumar Mitra, and Yonghong Kuo. Digital Signal Processing: A Computer-Based Approach, 4 th. Edition McGraw-Hill Higher Education, New York, 2013.*
3. *M. H. Hayes, "Statistical Digital Signal Processing and Modeling", John*

Wiley & Sons Inc., 2002.
4. *Simon Haykin, "Adaptive Filter Theory", 4th Edition, Prentice Hall, 2001.*

SP12C Digital Image and Video Processing

Instruction Hours/week : (L-T-P-C): 3-1-0-4 **Credits : 4**

Sessional Marks : 40 **Semester-End Examination: 60**

Course Description:*n this course you will learn the basic principles and tools used to process images and videos, and how to apply them in solving practical problems. Digital images and videos are everywhere these days – in thousands of scientific, consumer, industrial, and creative applications. Which are obtained from a wide range of the electromagnetic spectrum - from visible light and infrared to gamma rays and beyond. The ability to process image and video signals is therefore an incredibly important skill to master for engineering/science students, software developers, and practicing scientists. Digital image and video processing continues to enable the multimedia technology revolution we are experiencing today. This course will strengthen fundamental knowledge about digital image and video processing techniques along with mathematical framework to describe and analyze images and videos. Digital image and video processing is used in almost all engineering fields and wide range of applications in industrial automation, medical, agriculture, security, entertainment, education and many more.*

Course Objectives:*The student should be made to:*

1. *To know the concept of image fundamentals and mathematical transforms necessary for image Processing*
2. *To study the image enhancement and segmentation techniques*
3. *To learn about different color models and image compression procedures*
4. *To understand fundamentals of Video Coding*

Course Outcomes:

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

1. *Learn different techniques for image enhancement, video and image recovery*
2. *Understand techniques for image and video segmentation*
3. *Study techniques for image and video compression and object recognition*

Syllabus Contents:

Unit 1

Digital Image and Video Fundamentals: *Digital image and video fundamentals and formats, 2-D and 3-D sampling and aliasing, 2-D/3-D filtering, image decimation/interpolation, video sampling and interpolation, Basic image processing operations, Image Transforms,Need for image* *transforms, DFT, DCT, Walsh, Hadamard transform, Haar transform, Wavelet transform*

Unit 2

Image and Video Enhancement and Restoration: *Histogram, Point processing, filtering, image restoration, algorithms for 2-D motion estimation, change detection, motion-compensated filtering, frame rate conversion, deinterlacing, video resolution enhancement, Image and Video restoration (recovery).*

Colour image Processing: *Colour fundamentals, Colour models, Conversion of colour models, Pseudo colour image processing, Full colour processing*

Unit 3

Image and Video Segmentation: *Discontinuity based segmentation- Line detection, edge detection, thresholding, Region based segmentation, Scene Change Detection, Spatiotemporal Change Detection, Motion Segmentation, Simultaneous Motion Estimation and Segmentation Semantic Video Object Segmentation, Morphological image processing.*

Unit 4

Image and Video Compression: *Lossless image compression including entropy coding, lossy image compression, video compression techniques, and international standards for image and video compression (JPEG, JPEG 2000, MPEG-2/4, H.264, SVC), Video Quality Assessment*

Unit 5

Object recognition: *Image Feature representation and description-boundary representation, boundary descriptors, regional descriptors, feature selection techniques, introduction to classification, supervised and unsupervised learning, Template matching, Bayes classifier*

References:

1. *Ed. Al Bovik ,"Handbook of Image and Video Processing", 2nd Edition, Academic Press,2000.*
2. *J. W. Woods, "Multidimensional Signal, Image and Video Processing and Coding", 2nd Edition, Academic Press, 2011.*
3. *Rafael C. Gonzalez and Richard E. Woods," Digital Image Processing", 3rd Edition,Prentice Hall, 2008.*
4. *M. Tekalp, "Digital Video Processing", 2nd Edition, Prentice Hall, 2015.*
5. *S. Shridhar, "Digital Image Processing", 2nd Edition, Oxford University Press, 2016.*

SP13C DSP Architecture (Common to Communication Systems)

Instruction Hours/week :(L-T-P-C): 3-1-0-4 **Credits : 4**

Sessional Marks : 40 **Semester-End Examination: 60**

Course Description: *This course explains fundamental concepts of Digital Signal Processing and implementation of various applications on Advanced Processor. Helps students to understand architecture of advanced Digital Signal Processor and how to program it for signal processing applications.*

Course Objectives:

1. *To describe features and architectural improvements of DSP processors.*
2. *Introduce addressing modes and instruction description of TMS320C6x processors.*
3. *To demonstrate data representation in DSP Processors and FIR filters.*
4. *To demonstrate the usefulness of the adaptive filters and learn techniques of code optimization.*

Course Outcomes:

1. *At the end of this course, students will be able to*
2. *Identify and formalize architectural level characterization of P-DSP hardware*
3. *Ability to design, programming (assembly and C), and testing code using Code Composer Studio environment*
4. *Deployment of DSP hardware for Control, Audio and Video Signal processing applications*
5. *Understanding of major areas and challenges in DSP based embedded systems.*

Syllabus Contents:

Unit 1

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

Unit 2

Structural and Architectural Considerations: Parallelism in DSP processing, Texas Instruments, TMS320 Digital Signal Processor Families, Fixed Point

TI DSP Processors: TMS320C1X and TMS320C2X Family,TMS320C25 – Internal Architecture, Arithmetic and Logic Unit, Auxiliary Registers, *Addressing Modes (Immediate, Direct and Indirect, Bit-reverse Addressing), Basics of TMS320C54x and C55x Families in respect of Architecture improvements and new applications fields, TMS320C5416 DSP Architecture, Memory Map, Interrupt System, Peripheral Devices, Illustrative Examples for assembly coding.*

Unit 3

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

Unit 4

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

Unit 5

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

References:

1. *M. Sasikumar, D. Shikhare, Ravi Prakash, "Introduction to Parallel Processing", 1st Edition, PHI, 2006.*
2. *Fayez Gebali, "Algorithms and Parallel Computing",1st Edition, John Wiley & Sons, 2011*
3. *Rohit Chandra, Ramesh Menon, Leo Dagum, David Kohr, DrorMaydan, JeffMcDonald,"Parallel Programming in OpenMP", 1st Edition, Morgan Kaufman,2000.*
4. *Ann Melnichuk,Long Talk, "Multicore Embedded systems", 1st Edition, CRC Press,2010.*
5. *Wayne Wolf, "High Performance Embedded Computing: Architectures, Applications and Methodologies", 1st Edition, Morgan Kaufman, 2006.*
6. *E.S.Gopi, "Algorithmic Collections for Digital Signal Processing Applications Using MATLAB", 1st Edition, Springer Netherlands,2007.*

SP14C :Program Elective-I

1. Computer Vision

Instruction Hours/week : 3(L) **Credits : 3**
Sessional Marks : 40 **Semester-end Examination : 60**

Course Description:*This course introduces fundamental concepts, theories, and algorithms for pattern recognition and machine learning, which are used in computer vision, speech recognition, data mining, statistics, information retrieval, and bioinformatics. Topics include: Bayesian decision theory, parametric and non-parametric learning, data clustering, component analysis, boosting techniques, support vector machine, and deep learning with neural networks.*

Course Objectives:

1. *To understand, describe and critique pattern recognition, machine learning and deep learning techniques.*
2. *To identify and select suitable modeling, learning and prediction techniques to solve a problem.*
3. *To design and implement a machine learning solution.*
4. *To appraise ethical and privacy issues of artificial intelligence techniques.*

Course Outcomes:

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

1. *Study the image formation models and feature extraction for computer vision*
2. *Identify the segmentation and motion detection and estimation techniques*
3. *Develop small applications and detect the objects in various applications*

Syllabus Contents:

Unit 1

Image Formation Models: *Monocular imaging system • Orthographic & Perspective Projection • Camera model and Camera calibration • Binocular imaging systems, Perspective, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto-calibration. Apparel, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto-calibration. Apparel, Stereo vision*

Unit 2

Feature Extraction

Image representations (continuous and discrete) • Edge detection, Edge *linking, corner detection, texture, binary shape analysis, boundary pattern analysis, circle and ellipse detection, Light at Surfaces; Phong Model; Reflectance Map; Albedo estimation; Photometric Stereo; Use of Surface Smoothness Constraint; Shape from Texture, color, motion and edges.*

Unit 3

Shape Representation and Segmentation • *Deformable curves and surfaces • Snakes and activecontours • Level set representations • Fourier and wavelet descriptors • Medial representations • Multi-resolution analysis, Region Growing, Edge Based approaches to segmentation, Graph- Cut, Mean-Shift, MRFs, Texture Segmentation*

Unit 4

Motion Detection and Estimation • *Regularization theory • Optical computation • Stereo Vision*
Motion estimation, Background Subtraction and Modelling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation • Structure from motion, Motion Tracking in Video

Unit 5

Object recognition • *Hough transforms and other simple object recognition methods, Shapecorrespondence and shape matching, Principal component analysis, Shape priors for recognition.*
Applications of Computer Vision: *Automated Visual Inspection, Inspection of Cereal Grains, Surveillance, In-Vehicle Vision Systems, CBIR, CBVR, Activity Recognition, computational photography, Biometrics, stitching and document processing*

References:

1. *D. Forsyth and J. Ponce,"Computer Vision - A modern approach", 2nd Edition, Pearson Prentice Hall, 2012*
2. *Szeliski, Richard, "Computer Vision: Algorithms and Applications", 1st Edition, Springer-Verlag London Limited, 2011.*
3. *Richard Hartley and Andrew Zisserman, "Multiple View Geometry in Computer Vision", 2nd Edition, Cambridge University Press, 2004.*
4. *K. Fukunaga,"Introduction to Statistical Pattern Recognition",2nd Edition, Morgan Kaufmann, 1990.*
5. *Rafael C. Gonzalez and Richard E. Woods," Digital Image Processing", 3rd Edition, Prentice Hall, 2008.*
6. *B. K. P. Horn, "Robot Vision", 1st Edition, McGraw-Hill, 1986.*
7. *E. R. Davies"Computer and Machine Vision: Theory, Algorithms, Practicalities", 4th Edition, Elsevier Inc,2012.*

SP14C : Program Elective-I

2. Artificial Intelligence

Instruction Hours/week : 3(L) **Credits : 3**
Sessional Marks : 40 **Semester-end Examination : 60**

Course Description:*This course introduces fundamental concepts, theories, and algorithms for pattern recognition and machine learning, which are used in computer vision, speech recognition, data mining, statistics, information retrieval, and bioinformatics. Topics include: Bayesian decision theory, parametric and non-parametric learning, data clustering, component analysis, boosting techniques, support vector machine, and deep learning with neural networks.*

Course Objectives:

1. *To understand, describe and critique pattern recognition, machine learning and deep learning techniques.*
2. *To identify and select suitable modeling, learning and prediction techniques to solve a problem.*
3. *To design and implement a machine learning solution.*
4. *To appraise ethical and privacy issues of artificial intelligence techniques.*

Syllabus Contents:

Unit 1

What is AI (Artificial Intelligence)? : The AI Problems, The Underlying Assumption, What are AI Techniques, The Level Of The Model, Criteria For Success, Some General References, One Final WordProblems, State Space Search & Heuristic Search Techniques: Defining The Problems As A State Space Search, Production Systems, Production Characteristics, Production System Characteristics, And Issues In The Design Of Search Programs, Additional Problems. Generate-And-Test, Hill Climbing, Best-First Search, Problem Reduction, Constraint Satisfaction, Means-Ends Analysis.

Unit 2

Knowledge Representation Issues: Representations And Mappings, Approaches To Knowledge

Representation. Using Predicate Logic: Representation Simple Facts In Logic, Representing Instance And Isa Relationships, Computable Functions And Predicates, Resolution. Representing Knowledge Using Rules: Procedural Versus Declarative Knowledge, Logic Programming, Forward Versus Backward Reasoning.

Unit 3

Symbolic Reasoning Under Uncertainty: Introduction To No monotonic Reasoning, Logics For Non-monotonic Reasoning. Statistical Reasoning: Probability And Bays" Theorem, Certainty.Factors And Rule-Base Systems, Bayesian Networks, Dempster Shafer Theory.

Fuzzy Logic. Weak Slot-and-Filler Structures: Semantic Nets, Frames. Strong Slot-and-Filler

Structures: Conceptual Dependency, Scripts, CYC

Unit 4`

Game Playing: Overview, And Example Domain: Overview, MiniMax, Alpha-Beta Cut-off, Refinements, Iterative deepening, The Blocks World, Components Of A Planning System, Goal Stack Planning, Nonlinear Planning Using Constraint Posting, Hierarchical Planning, Reactive Systems, Other Planning Techniques. Understanding: What is understanding? What makes it hard? As constraint satisfaction

Unit 5

Natural Language Processing: Introduction, Syntactic Processing, Semantic Analysis, Semantic Analysis, Discourse And Pragmatic Processing, Spell Checking Connectionist Models: Introduction: Hopfield Network, Learning In Neural Network, Application of Neural Networks, Recurrent Networks, Distributed Representations, Connectionist AI And Symbolic AI.

References:

1. *Elaine Rich and Kevin Knight "Artificial Intelligence", 2nd Edition, Tata Mcgraw-Hill, 2005.*
2. *Stuart Russel and Peter Norvig, "Artificial Intelligence: A Modern Approach", 3rdEdition, Prentice Hall, 2009.*

SP14C : Program Elective-I
3. Wireless Sensor Networks
(Common to Communication Systems)

Instruction Hours/week : 3(L) **Credits : 3**

Sessional Marks : 40 **Semester-end Examination : 60**

Course Description:*This course offers an insight into the concepts of mobile and wireless data communication technologies. The objective of this course is to enable the student to understand the emerging technologies of wireless and mobile communications and simulate them.*

Course Objectives:

1. *To understand the new trends in mobile/wireless communications networks.*

2. *To understand multiple radio access techniques.*
3. *To analyze various routing algorithms used in mobile/wireless networks.*
4. *To identify the issues in transport and application layers.*

Course Outcomes:

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

1. *Design wireless sensor network system for different applications under consideration.*
2. *Understand the hardware details of different types of sensors and select right type of sensor for various applications.*
3. *Understand radio standards and communication protocols to be used for wireless sensor network based systems and application.*
4. *Use operating systems and programming languages for wireless sensor nodes, performance of wireless sensor networks systems and platforms.*
5. *Handle special issues related to sensors like energy conservation and security challenges.*

Syllabus Contents:

Unit 1

Introduction and overview of sensor network architecture and its applications, sensornetwork comparison with Ad Hoc Networks, Sensor node architecture with hardware and software details.
Hardware: Examples like mica2, micaZ, telosB, cricket, Imote2, tmote, btnode, and Sun
SPOT, Software (Operating Systems): tinyOS, MANTIS, Contiki, and RetOS.

Unit 2

Programming tools: C, nesC. Performance comparison of wireless sensor networkssimulation and experimental platforms like open source (ns-2) and commercial (QualNet, Opnet)

Unit 3

Overview of sensor network protocols (details of atleast 2 important protocol per layer):Physical, MAC and routing/ Network layer protocols, node discovery protocols, multi-hop and cluster based protocols, Fundamentals of 802.15.4, Bluetooth, BLE (Bluetooth low energy), UWB.

Unit 4

Data dissemination and processing; differences compared with other database managementsystems, data storage; query processing.

Unit 5

Specialized features: Energy preservation and efficiency; security challenges; fault-tolerance, Issues related to Localization, connectivity and *topology, Sensor deployment mechanisms; coverage issues; sensor Web; sensor Grid, Open issues for future research, and Enabling technologies in wireless sensor network.*

References:

1. *H. Karl and A. Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley & Sons, India, 2012.*
2. *C. S. Raghavendra, K. M. Sivalingam, and T. Znati, Editors, "Wireless Sensor Networks", Springer Verlag, 1st Indian reprint, 2010.*
3. *F. Zhao and L. Guibas, "Wireless Sensor Networks: An Information Processing Approach", Morgan Kaufmann, 1st Indian reprint, 2013.*
4. *YingshuLi, MyT. Thai, Weili Wu, "Wireless sensor Network and Applications", Springer series on signals and communication technology, 2008.*

SP14C : Program Elective-I

4. Optimization Techniques

Instruction Hours/week : 3(L) **Credits : 3**
Sessional Marks : 40 **Semester-end Examination :60**

Course Description:*The students will try to learn the operation research models using optimization techniques based upon the fundamentals of engineering mathematics (minimization and Maximization of objective function). The problem formulation by using linear, dynamic programming, game theory and queuing models.*

Course Objectives:

1. *Operation research models using optimization techniques based upon the fundamentals of engineering mathematics (minimization and Maximization of objective function).*
2. *The problem formulation by using linear, dynamic programming, game theory and queuing models.*
3. *The stochastic models for discrete and continuous variables to control inventory and simulation of manufacturing models for the production decision making.*
4. *Formulation of mathematical models for quantitative analysis of managerial problems in industry.*

Course Outcomes:

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

1. *Understand importance of optimization*
2. *Apply basic concepts of mathematics to formulate an optimization problem*
3. *Analyze and appreciate variety of performance measures for various optimization problems*

Syllabus Contents:

Unit 1

Introduction to ClassicalMethods & Linear Programming ProblemsTerminology, Design Variables, Constraints, Objective Function, Problem Formulation. Calculus method, Kuhn Tucker conditions, Method of Multipliers.

Unit 2

Linear Programming Problem,Simplex method, Two-phase method, Big-M method, duality, Integer linear Programming, Dynamic Programming, Sensitivity analysis.

Unit 3

Single Variable Optimization Problems: Optimality Criterion, Bracketing Methods, Region Elimination Methods, Interval Halving Method, Fibonacci Search Method, Golden Section Method. Gradient Based Methods: Newton-Raphson Method, Bisection Method, Secant Method, Cubic search method.

Unit 4

Multi Variable and Constrained Optimization Technique, Optimality criteria, Direct search Method, Simplex search methods, Hooke-Jeeve„s pattern search method, Powell„s conjugate direction method,Gradient based method, Cauchy„s Steepest descent method, Newton„s method , Conjugate gradient method. Kuhn - Tucker conditions, Penalty Function, Concept of Lagrangian multiplier, Complex search method, Random search method.

Unit 5

Intelligent Optimization Techniques:Introduction to Intelligent Optimization, Soft Computing, Genetic Algorithm: Types of reproduction operators, crossover & mutation, Simulated Annealing Algorithm, Particle Swarm Optimization (PSO) - Graph Grammer Approach - Example Problems Genetic Programming (GP): Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, random population generation, solving differential equations using GP.

References:

1. *S. S. Rao, "Engineering Optimisation: Theory and Practice", Wiley, 2008.*
2. *K. Deb, "Optimization for Engineering design algorithms and Examples", Prentice Hall, 2005.*
3. *C.J. Ray, "Optimum Design of Mechanical Elements", Wiley, 2007.*
4. *R. Saravanan, "Manufacturing Optimization through Intelligent Techniques, Taylor & Francis Publications, 2006.*

5. *D. E. Goldberg, "Genetic algorithms in Search, Optimization, and Machine learning",*
6. *Addison-Wesley Longman Publishing, 1989.*

SP15C : Program Elective-II

1. Joint Time Frequency Analysis & Multi Resolution Analysis

Instruction Hours/week : 3(L) **Credits : 3**
Sessional Marks : 40 **Semester-end Examination : 60**

Course Outcomes:

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

1. *Introduction to Transforms in signal processing*
2. *To understand Time -Frequency Analysis & Multiresolution*
3. *Analysis Study of Wavelets and its Applications*

Syllabus Contents:

Unit 1

Introduction Review of Fourier Transform, Parseval Theorem and need for joint time-frequency Analysis. Concept of non-stationary signals, Short-time Fourier transforms (STFT), Uncertainty Principle, and Localization/Isolation in time and frequency, Hilbert Spaces, Banach Spaces, and Fundamentals of Hilbert Transform.

Unit 2

Bases for Time-Frequency Analysis: Wavelet Bases and filter Banks, Tilings of Wavelet Packet and Local Cosine Bases, Wavelet Transform, Real Wavelets, Analytic Wavelets, Discrete Wavelets, Instantaneous Frequency, Quadratic time-frequency energy, Wavelet Frames, Dyadic wavelet Transform, Construction of Haar and Roof scaling function using dilation equation and graphical method.

Unit 3

Multiresolution Analysis: Haar Multiresolution Analysis, MRA Axioms, Spanning Linear Subspaces, nested subspaces, Orthogonal Wavelets Bases, Scaling Functions, Conjugate Mirror Filters, Haar 2-band filter Banks, Study of up samplers and down samplers, Conditions for alias cancellation and perfect reconstruction, Discrete wavelet transform and relationship with filter Banks, Frequency analysis of Haar 2-band filter banks, scaling and wavelet dilation equations in time and frequency domains, case study of decomposition and reconstruction of given signal using orthogonal framework of Haar 2band filter bank.

Unit 4

Wavelets: Daubechies Wavelet Bases, Daubechies compactly supported family of wavelets; Daubechies filter coefficient calculations, Case study of Daub-4 filter design, Connection between Haar and Daub-4, Concept of Regularity, Vanishing moments. Other classes of wavelets like Shannon, Meyer, and Battle-Lamarie.

Unit 5

Bi-orthogonal wavelets and Applications: Construction and design. Case studies of biorthogonal 5/3 tap design and its use in JPEG 2000. Wavelet Packet Trees, Time-frequency localization, compactly supported wavelet packets, case study of Walsh wavelet packet bases generated using Haar conjugate mirror filters till depth level 3. Lifting schemes for generating orthogonal bases of second generation wavelets.

JTFA Applications: Riesz Bases, Scalograms, Time-Frequency distributions: fundamental ideas, Applications: Speech,audio, image and video compression; signal denoising, feature extraction, inverse problem.

References:

1. *S. Mallat, "A Wavelet Tour of Signal Processing," 2nd Edition, Academic Press, 1999.*
2. *L. Cohen, "Time-frequency analysis", 1st Edition, Prentice Hall, 1995.*
3. *G.Strang and T. Q. Nguyen, "Wavelets and Filter Banks",2nd Edition, Wellesley Cambridge Press, 1998.*
4. *Daubechies, "Ten Lectures on Wavelets", SIAM, 1992.*
5. *P. P. Vaidyanathan, "Multirate Systems and Filter Banks", Prentice Hall, 1993.*
6. *M. Vetterli and J. Kovacevic, "Wavelets and Subband Coding", Prentice Hall, 1995*

SP15C : Program Elective-II
2. Voice and Data Networks
(Common to Communication Systems)

Teaching Scheme

Instruction Hours/week : 3(L) **Credits : 3**

Sessional Marks : 40 **Semester-end Examination : 60**

Course Description: *This course provides an introduction to voice and data networking technologies, including design and performance issues. And also focus is on layered & cross layer communication along with*

Packet and circuit switching communication. Provides Link layer error and flow control mechanisms, also know about queuing models of networks and its applications. Finally have idea about different internet protocols and packet scheduling algorithm.

Course Objectives:

1. *Know different design and performance issues of communications networks.*
2. *Understand the concepts of layered & cross layer communication, along with circuit & packet switching technologies and their deployments in public networks*
3. *Understand the role of data link layer and various queuing models for communication.*
4. *Understand the functions of internetworking devices and importance of different internet protocols.*

Outcomes:

1. *An ability to apply knowledge of networking. network topologies in designing of a network.*
2. *An ability to model systems using concept of layered/cross layered and TCP/IP architecture.*
3. *An ability apply the link layer functionalities and queuing models during communication.*
4. *An ability to use modern engineering techniques for analysis and design of a network with the knowledge of internet concepts and protocols.*

Syllabus Contents:

Unit 1

Network Design Issues, Network Performance Issues, Network Terminology, centralized and distributed approaches for networks design, Issues in design of voice and data networks.

Unit 2

Layered and Layer less Communication, Cross layer design of Networks, Voice Networks (wired and wireless) and Switching, Circuit Switching and Packet Switching, Statistical Multiplexing.

Unit 3

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

Unit 4

Queuing Models of Networks , Traffic Models , Little's Theorem, Markov chains, M/M/1 and other Markov systems, Multiple Access Protocols , Aloha System , Carrier Sensing , Examples of Local area networks,

Unit 5

Inter-networking, Bridging, Global Internet, IP protocol and addressing , Sub netting , Classless Inter domain Routing (CIDR) , IP address lookup , Routing in Internet. End to End Protocols, TCP and UDP. Congestion Control, Additive Increase/Multiplicative Decrease, Slow Start, Fast Retransmit/ Fast Recovery,

Congestion avoidance, RED TCP Throughput Analysis, Quality of Service in Packet Networks,Network Calculus, Packet Scheduling Algorithms.

References:

1. *D. Bertsekas and R. Gallager, "Data Networks", 2nd Edition, Prentice Hall, 1992.*
2. *L. Peterson and B. S. Davie, "Computer Networks: A Systems Approach",5th Edition, Morgan Kaufman, 2011.*
3. *Kumar, D. Manjunath and J. Kuri, "Communication Networking: An analytical approach", 1st Edition, Morgan Kaufman, 2004.*
4. *Walrand,"Communications Network: A First Course", 2nd Edition, McGraw Hill, 2002.*
5. *Leonard Kleinrock, "Queueing Systems,Volume I: Theory", 1st Edition, John Wiley and Sons, 1975.*
6. *Aaron Kershenbaum, "Telecommunication Network Design Algorithms", McGraw Hill, 1993.*
7. *Vijay Ahuja, "Design and Analysis of Computer Communication Networks", McGrawHill, 1987*

SP15C : Program Elective-II

3. Audio Video Coding &

Compression Teaching Scheme

Instruction Hours/week : 3(L) **Credits : 3**
Sessional Marks : 40 **Semester-end Examination : 60**

Course Outcomes:

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

1. *Familiarity to lossy and lossless compression systems.*
2. *Study of Video coding techniques and standards.*
3. *Understand audio coding and multimedia synchronization techniques.*

Syllabus Contents:

Unit 1
Introduction to Multimedia Systems and Processing, Lossless Image Compression Systems Image Compression Systems, Huffman Coding, Arithmetic and Lempel-Ziv Coding, Other Coding Techniques

Unit 2
Lossy Image Compression Systems, Theory of Quantization, Delta Modulation and DPCM, Transform Coding & K-L Transforms, Discrete Cosine Transforms, Multi-Resolution Analysis, Theory of Wavelets, Discrete Wavelet Transforms, Still Image Compression Standards: JBIG and JPEG

Unit 3
Video Coding and Motion Estimation: Basic Building Blocks & Temporal Redundancy, Block based motion estimation algorithms, Other fast search motion estimation algorithms
Video Coding Standards MPEG-1 standards, MPEG-2 Standard, MPEG-4 Standard, H.261, H.263 Standards, H.264 standard

Unit 4
Audio Coding, Basic of Audio Coding, Audio Coding, Transform and Filter banks, Polyphase filter implementation, Audio Coding, Format and encoding, Psychoacoustic Models

Unit 5
Multimedia Synchronization, Basic definitions and requirements, References Model and Specification, Time stamping and pack architecture, Packet architectures and audio-video interleaving, Multimedia Synchronization, Playback continuity, Video Indexing And Retrieval: Basics of content based image retrieval, Video Content Representation, Video Sequence Query Processing

References:

1. *Iain E.G. Richardson, "H.264 and MPEG-4 Video Compression", Wiley, 2003.*
2. *Khalid Sayood, "Introduction to Data Compression", 4th Edition, Morgan Kaufmann, 2012*
3. *Mohammed Ghanbari, "Standard Codecs: Image Compression to Advanced Video Coding", 3rd Edition, The Institution of Engineering and Technology, 2011.*
4. *Julius O. Smith III, "Spectral Audio Signal Processing", W3K Publishing, 2011.*
5. *Nicolas Moreau, "Tools for Signal Compression: Applications to Speech and Audio Coding", Wiley, 2011.*

SP15C : Program Elective-II

4. Modelling and Simulation

Techniques Teaching Scheme

Instruction Hours/week : 3(L) **Credits : 3**
Sessional Marks : 40 **Semester-end Examination :60**

Course Outcomes:
At the end of this course, students will be able to

1. *Identify and model discrete systems (deterministic and random)*
2. *Identify and model discrete signals (deterministic and random)*
3. *Understand modelling and simulation techniques to characterize systems/processes.*

Syllabus Contents:

Unit 1
Introduction Circuitsas dynamicsystems, Transfer functions, poles and zeroes, State space, Deterministic Systems, Difference and Differential Equations, Solution of Linear Difference and Differential Equations, Numerical Simulation Methods for ODEs, System Identification, Stability and Sensitivity Analysis.

Unit 2
Statistical methods, Description of data, Data-fitting methods, Regression analysis, Least Squares Method, Analysis of Variance, Goodness of fit.

Unit 3
Probability and Random Processes, Discrete and Continuous Distribution, Central Limit theorem, Measure of Randomness, MonteCarlo Methods. Stochastic Processes and Markov Chains, Time Series Models.

Unit 4
Modeling and simulation concepts, Discrete-event simulation, Event scheduling/Time advance algorithms, Verification and validation of simulation models.

Unit 5
Continuous simulation: Modeling with differential equations, Example models, Bond Graph Modeling, Population Dynamics Modeling, System dynamics.

References:

1. *1.R. L. Woods and K. L. Lawrence, "Modeling and Simulation of Dynamic Systems", Prentice-Hall, 1997.*
2. *2.Z. Navalih, "VHDL Analysis and Modelling of Digital Systems", McGraw-Hill, 1993.*
3. *3.J. Banks, JS. Carson and B. Nelson, "Discrete-Event System Simulation", 2nd Edition, Prentice-Hall of India, 1996.*

SP16L: Advanced Digital Signal Processing Lab (Common to Communication Systems)

Instruction Hours/week :3(P) **Credits : 1.5**
Sessional Marks : 40 **Semester-end Examination : 60**

Course Overview: *This practical course enables students to apply skills learned in Advanced Digital Signal Processing algorithms and will help to teach implementation of them. MATLAB is used to apply theoretical concepts and to demonstrate signal processing techniques by means of hands-on application examples. Recognize estimation problems and design, implement and analyze algorithms for solving them. Implement signal processing systems with DSP based development platforms.*

Pre-requisites: *Signals & Systems, Digital Signal Processing, Digital Signal Processing Lab, MATLAB, and Code Composer Studio.*

Course Learning Objectives: *The student after studying this courseis able to:*

1. *Understand how to analyze and manipulate digital signals and have the programming knowledge to do so.*
2. *Understand the trade-offs in the practical design and implement of various structures of FIR and IIR digital filters, for example which can be reduces noise or realizes various applications.*
3. *Understand theory of prediction and solution of normal equations.*
4. *Acquaint knowledge of the concepts, algorithms and applications of adaptive signal processing in digital communication systems.*
5. *Understand the implementation of adaptive filters used in signal processing applications.*
6. *Understand different methods for estimation of power spectra and its analysis.*

Course Outcomes: *After completion of this coursethe student is:*

1. *Able to design, analyze, and implement digital filters using MATLAB.*
2. *Able to implement various structures of digital filters.*

3. *Able to implement up-sampling and down-sampling of a given Sequences.*
4. *Apply the Lattice filter architecture and implement the Wiener filter, Least Squares, LMS and RLS algorithms, and apply to selected applications.*
5. *Deduce and apply correlation functions and power spectra for various signal classes, in particular for stochastic signals.*

Course Contents:

Note: (i) Minimum of 10 Experiments have to be done invariably.
(ii) All Experiments may be Simulated using MATLAB and to be verified theoretically.

List of Experiments:

1. *Introduction to DSP with MATLAB Programming Environment and Familiarization to Code Composer Studio.*
2. *Basic Operations on Signals, Generation of Various Signals and finding its FFT.*
3. *Simple Digital Filters (LPF, HPF, BPF, BSF and Comb Filters).*
4. *Realization of Structures (Cascade / Parallel/ Lattice Structure"s) of a system transfer function.*
5. *Implement Program to verify Decimation and Interpolation of a given Sequences.*
6. *Implement Program to Convert CD data into DVD data (sampling rate converters).*
7. *Estimation of data series using Nth order Forward Predictor and comparing to the Original Signal.*
8. *Design of linear prediction coding (LPC) filter using Levinson-Durbin Algorithm.*
9. *Apply the Lattice filter architecture from the Levinson-Durbin algorithm.*
10. *Computation of Reflection Coefficients using Schur Algorithm.*
11. *To implement the Wiener filter, and Least Squares algorithms, and apply to selected applications.*
12. *To implement the LMS and RLS algorithms, and apply to selected applications.*
13. *Design and verification of a Matched filter.*
14. *Adaptive Noise Cancellation / Linear Equalizer.*
15. *Computing Power Spectrum of a Square Signal and chirp signal.*
16. *Design and Simulation of Notch Filter to remove 50Hz Hum / any unwanted frequency component of given Signal (Speech / ECG).*
17. *Plot the Periodogram of a Noisy Signal and estimate PSD using*

Periodogram and Modified Periodogram methods.

18. *Estimation of Power Spectrum using Bartlett and Welch methods.*
19. *Parametric methods (Yule-Walker and Burg) of Power Spectrum Estimation.*

For Motivated Learners Extra experiments can be done:

Applications: Adaptive filter and experiments on communication such as generation of a N-tuple PN sequence, generation of a white noise sequence using the PN sequence, restoration of a sinusoidal signal embedded in white noise by Wiener Filtering; speech and multi-media applications.

Texts / References:

1. **John G. Proakis** *and* **Dimitris G. Manolakis,** *Digital Signal Processing: Principles, Algorithms and Applications, 5th Edition,* **ISBN-13: 9780137348657, Published** *by Pearson, 2021.*

2. *Sanjit Kumar Mitra, Digital Signal Processing: A Computer Based Approach, 4th edition, McGraw Hill Education, 2011.*
3. *LjiljanaMilić, Multirate Filtering for Digital Signal Processing: MATLAB Applications, Published by Information Science Reference, Hershey PA 17033, New York, ISBN 978-1-60566-178-0 (Hardcover) - ISBN 978- 1-60566-179-7 (eBook), 2009.*

4. *R. Chassaing and D. Reay, Digital Signal Processing and Applications withTMS320C6713 and TMS320C6416, Wiley, 2008.*

SP17L: Digital Image and Video Processing Lab
Teaching Scheme

Instruction Hours/week :3(P) **Credits : 1.5**
Sessional Marks : 40 **Semester-end Examination : 60**

Course Outcomes:

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

1. *Perform image and video enhancement.*
2. *Perform image and video segmentation*
3. *Detect an object in an image/video*

List of Assignments:

1. *Perform basic operations on images like addition, subtraction etc.*
2. *Plot the histogram of an image and perform histogram equalization*
3. *Implement segmentation algorithms*

4. *Perform video enhancement*
5. *Perform video segmentation*
6. *Perform image compression using lossy technique*
7. *Perform image compression using lossless technique*
8. *Perform image restoration*
9. *Convert a colour model into another*
10. *Calculate boundary features of an image*
11. *Calculate regional features of an image*
12. *Detect an object in an image/video using template matching/Bayes classifier*

SP18C: Research Methodology and IPR

Instruction Hours/week : 3L) **Credits : 3**
Sessional Marks : 40 **Semester-end Examination : 60**

Description of the Course:

This subjects gives how to proceed systematically for research, present research findings. This course consists of basics of research methods, paper writing , patenting methods and requirements..

Course Educational Objectives (Ceos):

1. *To understand the importance of research objectives and procedures.*
2. *To know the procedures of data collection and report writing of research.*
3. *To have the knowledge of filing and obtaining a patent on research findings.*

UNIT I

Meaning, Objective and Motivation in Research: Types of Research, Research Approaches, Research Process, Validity and Reliability in Research, Research Design: Features of Good Design, Types of Research Design, Basic Principles of Experimental Design

UNIT II

Sampling Design: Steps in Sampling Design, Characteristics of a Good Sample Design, Random Samples and Random Sampling Design Measurement and Scaling Techniques: Errors in Measurement, , Scaling and Scale Construction techniques, Forecasting Techniques, Time Series Analysis, Interpolation and Extrapolation

UNIT III

Methods of Data Collection: Primary Data, Questionnaire and Interviews, Collection of Secondary Data, Cases and Schedules. Professional

Attitude and Goals, Concept of Excellence, Ethics in Science and Engineering, Correlation and Regression Analysis, Method of Least Squares, Regression Vs. Correlation, Correlation Vs. Determination.

UNIT IV

Interpretation of Data and Report Writing, Layout of a Research Paper, Techniques o f Interpretation. Making Scientific Presentation at Conferences and Popular Lectures to Semi Technical Audience, Participating in Pubic Debates on Scientific Issues

UNIT V

Nature of Intellectual property rights, Patents, designs, trademarks and copyrights, History of patenting, process of patenting, patent development, international cooperation on IPR, procedure of granting patent, patent rights, licensing and transferring technology, Geographical Indications ,IPR in biological and systems and software.

Text/Reference Books:

1. *Research Methodology: Methods And Techniques - C. R. Kothari,2nd Edition, New Age Intemational Publishers.*
2. *Statistical Methods - S P. Gupta. S. chand& Sons, New Derhi.*
3. *Intellectual ProPerty-the law of trademarks, copyrights, Patents, and trade Secrets- Deborah E. Bouchoux, Esq.Georgetown University, Fourth edition*

Course Outcomes (COs):

1. *Able to know research importance and requirements and procedure*
2. *Able to apply sampling techniques for analysis and forecasting.*
3. *Able to use methods for data collection and analyze the data using different mathematical techniques.*
4. *Able to write report on research done and present the research findings in systematic manner.*
5. *Able to have the knowledge to file and obtain patent on research finding*

Semester - II

SP21C: Pattern Recognition and Machine Learning (Common to Communication Systems)

Instruction Hours/week : (L-T-P-C): 3-1-0-4 Credits : 4
Sessional Marks: 40 Semester-End Examination: 60

Course Outcomes:

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

1. *Study the parametric and linear models for classification*
2. *Design neural network and SVM for classification*
3. *Develop machine independent and unsupervised learning techniques.*

Syllabus Contents:

Unit 1

Introduction to Pattern Recognition*: Problems, applications, design cycle, learning andadaptation, examples, Probability Distributions, Parametric Learning - Maximum likelihood and Bayesian Decision Theory- Bayes rule, discriminant functions, loss functions and Bayesian error analysis*

Unit 2

Linear models: *Linear Models for Regression, linear regression, logistic regression LinearModels for Classification*

Unit 3

Neural Network*: perceptron, multi-layer perceptron, back propagation algorithm, error surfaces,practical techniques for improving back propagation, additional networks and training methods, Adaboost, Deep Learning*

Unit 4

Linear discriminant functions - *decision surfaces, two-category, multi-category, minimum-squared error procedures, the Ho-Kashyap procedures, linear programming algorithms, Support vector machine*

Unit 5

Algorithm independent machine learning *– lack of inherent superiority of any classifier, biasand variance, re-sampling for classifier design, combining classifiers*

Unsupervised learning and clustering - *k-means clustering, fuzzy k-means clustering,hierarchical clustering*

References:

1. *1.Richard O. Duda, Peter E. Hart, David G. Stork, "Pattern Classification", 2nd Edition John Wiley & Sons, 2001.*
2. *Trevor Hastie, Robert Tibshirani, Jerome H. Friedman, "The Elements of Statistical Learning", 2nd Edition, Springer, 2009.*
3. *C. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.*

SP22C: Detection and Estimation Theory

Instruction Hours/week : (L-T-P-C): 3-1-0-4 **Credits : 4**

Sessional Marks : 40 **Semester-End Examination: 60**

Course Outcomes:

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

1. *Understand the mathematical background of signal detection and estimation*
2. *Use classical and Bayesian approaches to formulate and solve problems for signal detection and parameter estimation from noisy signals.*
3. *Derive and apply filtering methods for parameter estimation.*

Syllabus Contents:

Unit I

Review of Vector Spaces: *Vectors and matrices: notation andproperties, orthogonality and linear independence, bases, distance properties, matrix operations, Eigen values and eigenvectors.*

Properties of Symmetric Matrices: *Diagonalization of symmetric matrices, symmetric positive, definite and semi definite matrices, principal component analysis (PCA), singular value decomposition.*

Unit II

Review of Gaussian variables and processes; problem formulation and objective of signal detection and signal parameter estimation in discrete- time domain.

Unit III

Statistical Decision Theory:

Bayesian, minimax, and Neyman-Pearson decision rules, likelihood ratio, receiver operating characteristics, composite hypothesis testing, locally optimum tests, detector comparison techniques, asymptotic relative efficiency.

Unit IV

Detection of Random Signals:

Estimator-correlator, linear model, general Gaussian detection, detection of Gaussian random signal with unknown parameters, weak signal detection.

Unit V

Estimation of Signal Parameters:

Minimum variance unbiased estimation, Fisher information matrix, *Cramer-Rao bound, sufficient statistics, minimum statistics, complete statistics; linear models; best linear unbiased estimation; maximum likelihood estimation, invariance principle; estimation efficiency; Bayesian estimation: philosophy, nuisance parameters, risk functions, minimum mean square error estimation, maximum a posteriori estimation.*

References:

1. *H. L. Van Trees, "Detection, Estimation and Modulation Theory: Part I, II, and III", John Wiley, NY, 1968.*
2. *H. V. Poor, "An Introduction to Signal Detection and Estimation", Springer, 2/e,1998.*
3. *Steven M. Kay, "Fundamentals of Statistical Signal Processing, Volume I: Estimation Theory", Prentice Hall, 1993*
4. *Steven M. Kay, "Fundamentals of Statistical Signal Processing, Volume II: Detection Theory", 1st Edition, Prentice Hall, 1998*
5. *Thomas Kailath, BabakHassibi, Ali H. Sayed, "Linear Estimation", Prentice Hall, 2000.*
6. *H. Vincent Poor, "An Introduction to Signal Detection and Estimation",2nd Edition, Springer, 1998.*

SP23C:Program Elective-III

1. Advanced Computer Architecture

Instruction Hours/week : 3(L) **Credits : 3**
Sessional Marks : 40 **Semester-end Examination : 60**

Course Outcomes:

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

1. *Understand parallelism and pipelining concepts, the design aspects and challenges.*
2. *Evaluate the issues in vector and array processors.*
3. *Study and analyze the high performance scalable multithreaded and multiprocessor systems.*

Syllabus Contents:

Unit 1

Parallel Processing and Pipelining Processing- *Architectural Classification, Applications ofparallel processing, Instruction level Parallelism and Thread Level Parallelism, Explicitly Parallel Instruction Computing (EPIC) Architecture*

Unit 2

Pipeline Architecture-*Principles and implementation of Pipelining, Classification of pipeliningprocessors, Design aspect of Arithmetic and*

Instruction pipelining, Pipelining hazards and resolving techniques, Data buffering techniques, Advanced pipelining techniques, Software pipelining, VLIW (Very Long Instruction Word) processor.

Unit 3

Vector and Array Processor- *Issues in Vector Processing, Vector performance modeling, SIMD Computer Organization, Static Vs Dynamic network, Parallel Algorithms for Array Processors: Matrix Multiplication.*

Unit 4

Multiprocessor Architecture - *Loosely and Tightly coupled multiprocessors, Inter Processorcommunication network, Time shared bus, Multiport Memory Model, Memory contention and arbitration techniques, Cache coherency and bus snooping, Massively Parallel Processors (MPP).*

Unit 5

Multithreaded Architecture- *Multithreaded processors, Latency hiding techniques, Principles ofmultithreading, Issues and solutions, Parallel Programming Techniques: Message passing program development.*

Parallel algorithms for multiprocessors- *Classification and performance of parallel algorithms,operating systems for multiprocessors systems, Message passing libraries for parallel programming interface, PVM (in distributed memory system), Message Passing Interfaces (MPI).*

References:

1. *Kai Hwang, Faye A. Briggs, "Computer Architecture and Parallel Processing" McGraw Hill Education, 2012.*
2. *Kai Hwang, "Advanced Computer Architecture", McGraw Hill Education, 1993.*
3. *William Stallings, "Computer Organization and Architecture, Designing for Performance" Prentice Hall, 6th edition, 2006.*
4. *Kai Hwang, "ScalableParallelComputing", McGraw Hill Education, 1998.*
5. *Harold S. Stone "High-Performance Computer Architecture", Addison-Wesley, 1993.*

SP23C:Program Elective-III

2. IOT and Applications

(Common to Communication Systems)

Instruction Hours/week : 3(L) **Credits : 3**

Sessional Marks : 40 **Semester-end Examination : 60**

Course Objectives:

1. *To apprise students with basic knowledge of IoT that paves a platform to understand physical and logical design of IOT*
2. *To teach a student how to analyse requirements of various communication models and protocols for cost-effective design of IoT*

applications on different IoT platforms.

3. *To introduce the technologies behind Internet of Things (IoT).*
4. *To explain the students how to code for an IoT application using Arduino/Raspberry Pi open platform.*

Syllabus Contents:

UNIT I

THE INTERNET OF THINGS TODAY, TIME FOR CONVERGENCE

M2M to IoT – A Basic Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structurefor IoT, The international driven global valuechain and global information monopolies. M2M to IoT-An Architectural Overview– Building anarchitecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.

UNIT II

COMPONENTS IN INTERNET OF THINGS

Functional Blocks of an IoT Ecosystem – Sensors, Actuators, and Smart Objects – Control Units - Communication modules (Bluetooth, Zigbee,Wi-Fi, GPS, GSM Modules)

UNIT III

PROTOCOLS AND TECHNOLOGIES BEHIND IOT

IOT Protocols - IPv6, 6LoWPAN, MQTT, CoAP - RFID, Wireless Sensor Networks, BigData Analytics, Cloud Computing, Embedded Systems.

UNIT IV

OPEN PLATFORMS AND PROGRAMMING

IOT deployment for Raspberry Pi /Arduino platform-Architecture – Programming – Interfacing – Accessing GPIO Pins – Sending and Receiving Signals Using GPIO Pins – Connecting to the Cloud.

UNIT V

IOT APPLICATIONS

Business models for the internet of things, Smart city, Smart mobility and transport, Industrial IoT, Smart health, Environment monitoring and surveillance – Home Automation – Smart Agriculture

COURSE OUTCOMES:

Upon completion of the course, students will be able to

1. *Explain the concept of IoT.*
2. *Understand the communication models and various protocols for IoT.*
3. *Design portable IoT using Arduino/Raspberry Pi/open platform.*

4. *Apply data analytics and use cloud offerings related to IoT.*
5. *Analyze applications of IoT in real time scenario.*

TEXT BOOKS:

1. *Dr. Ovidiu Vermesan, Dr. Peter Friess, "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publishers, Aalborg, 2013*
2. *Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", CISCO Press, 2017*
3. *Samuel Greengard, The Internet of Things, The MIT Press, 2015*

REFERENCES:

1. *Perry Lea, "Internet of things for architects", Packt, 2018*
2. *Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things – Key applications and Protocols", Wiley, 2012*
3. *IOT (Internet of Things) Programming: A Simple and Fast Way of Learning, IOT Kindle Edition.*
4. *Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet of Things", Springer, 2011.*
5. *ArshdeepBahga, Vijay Madisetti, "Internet of Things – A hands-on approach", Universities Press, 2015.*
6. *https://www.arduino.cc/https://www.ibm.com/smarterplanet/us/e n/?ca=v_smarterplanet.*

SP23C:Program Elective-III
3. Digital Design and Verification

Instruction Hours/week : 3(L) **Credits : 3**
Sessional Marks : 40 **Semester-end Examination : 60**

Course Outcomes:

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

1. *Familiarity of Front end design and verification techniques and create reusable test environments.*
2. *Verify increasingly complex designs more efficiently and effectively.*
3. *Use EDA tools like Cadence, Mentor Graphics.*

Syllabus Contents:

Unit 1

Revision of basic Digital systems: Combinational Circuits, Sequential Circuits, Logic families, Synchronous FSM and asynchronous design, *Metastability, Clock distribution and issues, basic building blocks like PWM module, pre-fetch unit, programmable counter, FIFO, Booth's multiplier, ALU, Barrel shifter etc.*

Unit 2

Verilog/VHDL Comparisons and Guidelines, Verilog: HDL fundamentals, simulation, and test-bench design, Examples of Verilog codes for combinational and sequential logic, Verilog AMS

Unit 3

System Verilog and Verification: Verification guidelines, Data types, procedural statements and routines, connecting the test bench and design, Assertions, Basic OOP concepts, Randomization, Introduction to basic scripting language: Perl, Tcl/Tk

Unit 4

Current challenges in physical design: Roots of challenges, Delays: Wire load models Generic PD flow, Challenges in PD flow at different steps, SI Challenge - Noise & Crosstalk, IR Drop, Process effects: Process Antenna Effect &Electromigration

Unit 5

Programmable Logic Devices: Introduction, Evolution: PROM, PLA, PAL, Architecture of PAL's,

Applications, Programming PLD's, FPGA with technology: Antifuse, SRAM, EPROM, MUX, FPGA structures, and ASIC Design Flows, Programmable Interconnections, Coarse grained reconfigurable devices

IP and Prototyping: IP in various forms: RTL Source code, Encrypted Source code, Soft IP, Netlist, Physical IP, and Use of external hard IP during prototyping, Case studies, and Speed issues. Testing of logic circuits: Fault models, BIST, JTAG interface

References:

1. *Douglas Smith, "HDL Chip Design: A Practical Guide for Designing, Synthesizing & Simulating ASICs & FPGAs Using VHDL or Verilog", Doone publications, 1998.*
2. *Samir Palnitkar, "Verilog HDL: A guide to Digital Design and Synthesis", Prentice Hall, 2nd Edition, 2003.*
3. *Doug Amos, Austin Lesea, Rene Richter, "FPGA based Prototyping Methodology Manual", Synopsys Press, 2011.*
4. *Christophe Bobda, "Introduction to Reconfigurable Computing, Architectures, Algorithms and Applications", Springer, 2007.*
5. *Janick Bergeron, "Writing Testbenches: Functional Verification of HDL Models", Second Edition, Springer, 2003.*

SP23C:Program Elective-III
4. Audio Processing

Instruction Hours/week : 3(L) **Credits : 3**
Sessional Marks : 40 **Semester-end Examination : 60**

Course Outcomes:

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

1. *Understand different characteristics of Speech.*
2. *Identify and analyze different speech analysis system.*
3. *Write algorithms for Recognition of speech.*

Syllabus Contents:

Unit 1

Principle Characteristics of Speech: Linguistic information, Speech and Hearing, Speech production mechanism, Acoustic characteristic of speech Statistical Characteristics of speech. Speech production models, Linear Separable equivalent circuit model, Vocal Tract and Vocal Cord Model.

Unit 2

Speech Analysis and Synthesis Systems: Digitization, Sampling, Quantization and coding, Spectral Analysis, Spectral structure of speech, Autocorrelation and Short Time Fourier transform, Window function, Sound Spectrogram, Mel frequency Cepstral Coefficients, Filter bank and Zero Crossing Analysis, Analysis –by-Synthesis, Pitch Extraction.

Unit 3

Linear Predictive Coding Analysis: Principle of LPC analysis, Maximum likelihood spectral estimation, Source parameter estimation from residual signals, LPC Encoder and Decoder, PARCOR analysis and Synthesis, Line Spectral Pairs, LSP analysis and Synthesis.

Unit 4

Speech Coding: Reversible coding, Irreversible coding and Information rate distortion theory,

coding in time domain: PCM, ADPCM, Adaptive Predictive coding, coding in Frequency domain: Sub band coding, Adaptive transform coding, Vector Quantization, Code Excited Linear Predictive Coding (CELP).

Unit 5

Speech Recognition: Principles of speech recognition, Speech period detection, Spectral distance measure, Structure of word recognition system, Dynamic Time Warping (DTW), Theory and implementation of Hidden

Markov Model (HMM).

Speaker recognition: Human and Computer speaker recognition Principles Text dependent and Text Independent speaker recognition systems. Applications of speech Processing.

References:

1. *SadaokiFurui, "Digital Speech Processing, Synthesis and Recognition" 2nd Edition, Taylor & Francis, 2000.*
2. *Rabiner and Schafer, "Digital Processing of Speech Signals", Pearson Education, 1979.*

SP24C:Program Elective-IV

1. Random Processes and Queuing Models

(Common to Communication Systems)

Instruction Hours/week : 3(L) **Credits : 3**

Sessional Marks : 40 **Semester-end Examination : 60**

Prerequisites: *Probability Theory and Stochastic Processes*

Preamble: *This course is designed to provide necessary basic concepts in random processes which are widely applied in random signals, linear systems in communication engineering and IT fields. The objective of this course is to familiarize the understanding of stochastic processes and queuing models. The syllabus also covers the concepts of Markovian and advanced queueing models which are essential to design and analyze communication networks.*

Course Learning Objectives: *The objectives of this course is to enable the student to*

1. *Characterize stochastic processes with an emphasis on stationary random processes.*
2. *Use the properties of random processes with LTI systems in real world situations.*
3. *Understand Markov chains and their transient behavior.*
4. *Differentiate between different models of queuing theory and their performance measures.*
5. *Understand network of queues with Poisson external arrivals, exponential service requirements and independent routing.*

Course Outcomes: *At the end of the course, the students will be able to*

1. *Analyze the various classifications of Random Processes and characterize. phenomena which evolve with respect to time in a probabilistic manner.*
2. *Apply the ideas of Random Processes to the LTI Systems for Spectral analysis.*
3. *Understand Markov Chains and regenerative processes used in modeling a*

wide variety of systems.

4. *Understand the basic characteristic features of a queuing system and acquire skills in analyzing queuing models.*
5. *Analyze the performance of the queuing networks.*

UNIT I

REVIEW OF RANDOM PROCESSES: *Classification of General Random Processes, Binomial Processes, Poisson Processes, Ergodic Process, Gaussian Random Processes, Stationary and Wide Sense Stationary Random Processes, Random walks and gambler‟s ruin, Processes with independent increments and martingales, Brownian motion, Counting processes and the Poisson process, Stationarity, Joint properties of random processes.*

UNIT II

RANDOM PROCESSES IN LINEAR SYSTEMS AND SPECTRAL ANALYSIS*: Basic definitions, Spectral Density Function, transfer functions and power spectral densities, Discrete-time processes in linear systems, Low Pass and Band Pass Processes, Baseband random processes, Narrowband random processes.*

UNIT III

MARKOV PROCESSES: *Markov Chains, Probability Distribution of a Markov Chain, Transition Probability Matrices of a Markov Chain, Classification of States and Chains, Chapman-Kolmogorov Theorem, Stationary Distribution for a Markov Chains, Classification of States of a Markov Chain, Birth and Death Processes, Renewal Process, The Transition Probability Function, Limiting Probabilities, Exponential Distribution & Poison Process.*

UNIT IV

QUEUING THEORY: *Basic Characteristics of Queueing Models, Introduction to Markovian queueing models, Steady state distribution, Little‟s Theorem, Cost equations, steady state probabilities, Queuing Models:* **(M/M/1) : (∞/FIFO)** *Single server with infinite system capacity,* **(M/M/1) : (k/FIFO)** *Single Server with Finite Capacity,* **(M/M/s) : (∞/FIFO)** *Multiple Server with Infinite Capacity,* **(M/M/s) : (k/FIFO)** *Multiple Server with Finite Capacity, models balance equations, Erlang‟s B and C formulae, M/G/1 Queuing system characteristics, Queues with finite waiting rooms – Queues with impatient customers: Balking and reneging.*

Unit V

QUEUEING NETWORKS: *Network of queues basic concepts, Tandem Queues, Channels in Series or Jackson Networks, Queues in series with multiple channels at each phase, Closed Jackson Networks, Approximating*

Closed Networks, Open Networks with General Customer Routes, Symmetric Queues.

Text Books:

1. *Sheldon M. Ross, Introduction to Probability Models, 10th Edition, Elsevier, 2010.*
2. *T Veera Rajan , Probability, Statistics and Random Process, 3rd Edition, Tata Mc Graw Hill, 2008.*
3. *R. D. Yates and D. J. Goodman, "Probability and Stochastic Processes: A Friendly Introduction for Electrical and Computer Engineers", 3rd Edition International Student Version, Wiley, 2014.*

Reference Books:

1. *J.F. Shortle, J.M. Thompson, D. Gross and C.M. Harris, Fundamentals of Queueing Theory, 5th Edition, Wiley, 2018.*
2. *J. Medhi, Stochastic Models in Queueing Theory, 2nd Edition, Academic Press, 2003.*
3. *U.N. Bhat, An Introduction to Queueing Theory, Springer, 2015.*

SP24C:Program Elective-IV
2. Multispectral Signal Analysis

Instruction Hours/week : 3(L) **Credits : 3**
Sessional Marks : 40 **Semester-end Examination : 60**

Course Outcomes:

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

1. *Select appropriate hyperspectral data for a particular application.*
2. *Understand basic concepts of data acquisition and image processing tasks required for multi and hyperspectral data analysis*
3. *Learn techniques for classification and analysis of multi and hyperspectral data.*

Syllabus Contents:

Unit 1

Hyperspectral Sensors and Applications: Introduction, Multi-spectral Scanning Systems (MSS), Hyperspectral Systems, Airborne sensors, Spaceborne sensors, Ground Spectroscopy, Software for Hyperspectral Processing, Applications, Atmosphere and Hydrosphere, Vegetation, Soils and Geology, Environmental Hazards and Anthropogenic Activity

Unit 2

Overview of Image Processing: Introduction, Image File Formats, Image Distortion and Rectification, Radiometric Distortion, Geometric Distortion *and Rectification, Image Registration, Image Enhancement, Point Operations, Geometric Operation, Image Classification, Supervised Classification, Unsupervised Classification, Crisp Classification Algorithms, Fuzzy Classification Algorithms, Classification Accuracy Assessment, Image Change Detection, Image Fusion, Automatic Target Recognition*

Unit 3

Mutual Information: A Similarity Measure for Intensity Based Image Registration: Introduction, Mutual Information Similarity Measure, Joint Histogram Estimation Methods, Two-Step Joint Histogram Estimation, One-Step Joint Histogram Estimation, Interpolation Induced Artifacts, Generalized Partial Volume Estimation of Joint Histograms, Optimization Issues in the Maximization of MI

Unit 4

Independent Component Analysis: Introduction, Concept of ICA, ICA Algorithms, Preprocessing using PCA, Information Minimization Solution for ICA, ICA Solution through Non-Gaussianity Maximization, Application of ICA to Hyperspectral Imagery, Feature Extraction Based Model, Linear Mixture Model Based Model, An ICA algorithm for Hyperspectral Image Processing, Applications using ICA.

Unit 5

Support Vector Machines : Introduction, Statistical Learning Theory, Empirical Risk Minimization, Structural Risk Minimization, Design of Support Vector Machines, Linearly Separable Case, Linearly Non-Separable Case, Non-Linear Support Vector Machines, SVMs for Multiclass Classification, One Against the Rest Classification, Pair wise Classification, Classification based on Decision Directed Acyclic Graph and Decision Tree Structure, Multiclass Objective Function, optimization Methods , Applications using SVM. Markov Random Field Models: Introduction, MRF and Gibbs Distribution, Random Field and Neighborhood ,Cliques, Potential and Gibbs Distributions, MRF Modeling in Remote Sensing Applications, Optimization Algorithms, Simulated Annealing, Metropolis Algorithm, Iterated Conditional Modes Algorithm

References:

1. *1.Pramod K. Varshney, Manoj K. Arora, "Advanced Image Processing Techniques for Remotely Sensed Hyperspectral Data", Springer, 2013.*
2. *2.S. Svanberg, "Multi-spectral Imaging– from Astronomy to Microscopy– from Radio waves to Gamma rays", Springer Verlag, 2009*

SP24C:Program Elective-IV
3. Biomedical Signal Processing

Teaching Scheme
Instruction Hours/week : 3(L) **Credits : 3**
Sessional Marks : 40 **Semester-end Examination : 60**

Course Outcomes:

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

1. *Understand different types of biomedical signal.*
2. *Identify and analyze different biomedical signals*
3. *Find applications related to biomedical signal processing*

Syllabus Contents:

Unit 1
Acquisition, Generation of Bio-signals,Origin of bio-signals, Types of bio-signals,Study of diagnostically significant bio-signal parameters

Unit 2
Electrodes for bio-physiological sensing and conditioning, Electrode- electrolyte interface, polarization, electrode skin interface and motion artefact, biomaterial used for electrode, Types of electrodes (body surface, internal, array of electrodes,microelectrodes), Practical aspects of using electrodes, Acquisition of bio-signals (signal conditioning) and Signal conversion (ADC"s DAC"s) Processing, Digital filtering

Unit 3
Biomedical signal processing by Fourier analysis, Biomedical signal processing by wavelet (time-frequency) analysis, Analysis (Computation of signal parameters that are diagnostically significant),Classification of signals and noise, Spectral analysis of deterministic, stationary random signals and non-stationary signals.

Unit 4
Coherent treatment of various biomedical signal processing methods and applications.
Principal component analysis, Correlation and regression, Analysis of chaotic signals Application areas of Bio–Signals analysis Multiresolution analysis(MRA) and wavelets, Principal component analysis(PCA), Independent component analysis(ICA)

Unit 5
Pattern classification–supervised and unsupervised classification, Neural networks, Support vector Machines, Hidden Markov models. Examples of

biomedical signal classification examples.

References:

1. *W. J. Tompkins, "Biomedical Digital Signal Processing", Prentice Hall, 1993.*
2. *Eugene N Bruce, "Biomedical Signal Processing and Signal Modeling", John Wiley & Son"s publication, 2001.*
3. *Myer Kutz, "Biomedical Engineering and Design Handbook, Volume I", McGraw Hill, 2009.*
4. *D C Reddy, "Biomedical Signal Processing", McGraw Hill, 2005.*
5. *Katarzyn J. Blinowska, JaroslawZygierewicz, "Practical Biomedical Signal Analysis Using MATLAB", 1st Edition, CRC Press, 2011.*

SP24C:Program Elective-IV

4. Remote Sensing

(Common to Communication Systems)

Instruction Hours/week : 3(L) **Credits : 3**

Sessional Marks : 40 **Semester-end Examination :60**

Course Outcomes:

At the end of this course, students shall be able to

1. *Understand basic concepts, principles and applications of remote sensing, particularly the geometric and radiometric principles*
2. *Provide examples of applications of principles to a variety of topics in remote sensing, particularly related to data collection, radiation, resolution, and sampling.*

Syllabus Contents:

Unit 1

Physics Of Remote Sensing: Electro Magnetic Spectrum, Physics of Remote Sensing-Effects of Atmosphere-Scattering–Different types–Absorption-Atmospheric window-Energy interaction with surface features –Spectral reflectance of vegetation, soil and water atmospheric influence on spectral response patterns-multi concept in Remote sensing.

Data Acquisition: Types of Platforms–different types of aircrafts-Manned and Unmanned space crafts–sun synchronous and geo synchronous satellites – Types and characteristics of different platforms –LANDSAT, SPOT, IRS, INSAT, IKONOS, QUICKBIRDetc.

Unit 2

Photographic products, B/W,color, color IR film and their characteristics – resolving power of lens and film - Optomechanical electro optical sensors – across track and along track scanners-multispectral scanners and thermal scanners–geometric characteristics of scanner imagery - calibration of *thermal scanners.*

Unit 3

Scattering System: Microwave scatterometry, types of RADAR –SLAR – resolution –range and azimuth –real aperture and synthetic aperture RADAR. Characteristics of Microwave images topographic effect-different types of Remote Sensing platforms –airborne and space borne sensors - ERS, JERS, RADARSAT, RISAT -Scatterometer, Altimeter-LiDAR remote sensing, principles, applications.

Unit 4

Thermal And Hyper Spectral Remote Sensing: Sensors characteristics- principle of spectroscopy-imaging spectroscopy–field conditions, compound spectral curve, Spectral library, radiative models, processing procedures, derivative spectrometry, thermal remote sensing –thermal sensors, principles, thermal data processing, applications.

Unit 5

Data Analysis: Resolution–Spatial, Spectral, Radiometric and temporal resolution-signal to noise ratio-data products and their characteristics- visual and digital interpretation–Basic principles of data processing – Radiometric correction–Image enhancement–Image classification–Principles of LiDAR, Aerial Laser Terrain Mapping.

References:

1. *Lillesand.T.M. and Kiefer.R.W,"Remote Sensing and Image interpretation", 6thEdition, John Wiley & Sons, 2000.*
2. *John R. Jensen, "Introductory Digital Image Processing: A Remote Sensing Perspective", 2nd Edition, Prentice Hall,1995.*
3. *Richards, John A., Jia, Xiuping, "Remote Sensing Digital Image Analysis", 5th Edition, Springer-Verlag Berlin Heidelberg, 2013.*
4. *Paul Curran P.J. Principles of Remote Sensing, 1st Edition, Longman Publishing Group, 1984.*
5. *Charles Elachi, Jakob J. van Zyl, "Introduction to The Physicsand Techniques of Remote Sensing", 2nd Edition, Wiley Serie, 2006.*
6. *Sabins, F.F.Jr, "Remote Sensing Principles and Image Interpretation", 3rd Edition,W.H.Freeman& Co, 1978*

SP25L: Pattern Recognition & Machine Learning Lab

Teaching Scheme

Instruction Hours/week :3(P) **Credits : 1.5**

Sessional Marks : 40 **Semester-end Examination : 60**

Course Outcomes:

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

1. *Perform image and video enhancement*
2. *Perform image and video segmentation*
3. *Detect an object in an image/video*

List of Assignments:

1. *Implement maximum likelihood algorithm*
2. *Implement Bayes classifier*
3. *Implement linear regression*
4. *Design a classifier using perceptron rule*
5. *Design a classifier using feedforward back-propagation and delta rule algorithms*
6. *Implement deep learning algorithm*
7. *Implement linear discriminant algorithm*
8. *Design a two class classifier using SVM*
9. *Design a multiclass classifier using SVM*
10. *Perform unsupervised learning*

SP26L: Detection and Estimation Theory
Lab Teaching Scheme

Instruction Hours/week :3(L) **Credits : 1.5**

Sessional Marks : 40 **Semester-end Examination : 60**

Course Outcomes:

Syllabus Contents:

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

1. *Simulate signals and noise*
2. *Detect signals in the presence of noise*
3. *Compare various estimation techniques*

List of Assignments:

1. *Simulate signal and noise models models.*
2. *Simulate spatially separated target Signal in the presence of Additive Correlated White Noise*
3. *Simulate spatially separated target Signal in the presence of Additive Uncorrelated White Noise*
4. *Simulate spatially separated target Signal in the presence of Additive Correlated Colored Noise*
5. *Detect Constant amplitude Signal in AWGN*

6. *Detect Time varying Known Signals in AWGN*
7. *Detect Unknown Signals in AWGN*
8. *Compare performance comparison of the Estimation techniques - MLE, MMSE, Bayes Estimator, MAP Estimator, Expectation Maximization (EM) algorithm*
9. *Performance comparison of conventional Energy Detectors and Coherent Matched Filter Techniques*

CM27C:Cyber Security

Course Type:	**Value Added**	**Semester:**	**II Sem**	**Credits :**	**3**
Course Code:	**CM27C**	**Theory :**	**2 Hrs/Week**	**Practical :**	**2Hrs/ Week**
		Assessment:	**Lab reports and written exams**	**Internal Continuous Assessment:**	**100 M**

Course Overview / Description: Cyber security is perhaps the most important topic in today environment. Demand for cyber security professionals has exploded, in the private and public sectors alike. Student can learn how to defend information systems from cyber attacks, how to recover compromised systems, how to architect secure systems and so much more. This course is focuses on the models, tools, and techniques for enforcement of security with some emphasis on the use of cryptography. Students will learn security from multiple perspectives.

Course Learning Objectives:

1. To prepare students with the technical knowledge and skills needed to protect and defend computer systems and networks from cyber security attacks.
2. To develop graduates that can plan, implement, and monitor cyber security mechanisms to help ensure the protection of information technology assets.
3. To develop graduates that can identify, analyze, and remediate computer security breaches.

Course Outcomes: After completing this course student will be:

1. Be able to understand the basic terminologies related to cyber security and current cyber security threat landscape. They will also develop understanding about the Cyber warfare and necessity to strengthen the cyber security of end user machine, critical IT and national critical infrastructure.
2. Have complete understanding of the cyber attacks that target computers, mobiles and persons. They will also develop understanding about the type and nature of cyber crimes and as to how report these crimes through the prescribed legal and Government channels.

3. Be able to understand the legal framework that exist in India for cyber crimes and penalties and punishments for such crimes, It will also expose students to limitations of existing IT Act, 2000 legal framework that is followed in other countries and legal and ethical aspects related to new technologies.
4. Understand the aspects related to personal data privacy and security. They will also get insight into the Data Protection Bill, 2019 and data privacy and security issues related to Social media platforms.
5. Understand the main components of cyber security plan. They will also get insights into risk-based assessment, requirement of security controls and need for cyber security audit and compliance.

Unit- I Overview of Cyber security

Cyber security increasing threat landscape, Cyber security terminologies- Cyberspace, attack, attack vector, attack surface, threat, risk, vulnerability, exploit, exploitation, hacker., Non-state actors, Cyber terrorism, Protection of end user machine, Critical IT and National Critical Infrastructure, Cyber warfare, Case Studies.

Unit-II Cyber Crimes

Cyber crimes targeting Computer systems and Mobiles- data diddling attacks, spyware, logic bombs, DoS, DDoS, APTs, virus, Trojans, ransomware, data breach., Online scams and frauds- email scams, Phishing, Vishing, Smishing, Online job fraud, Online sextortion, Debit/ credit card fraud, Online payment fraud, Cyber bullying, website defacement, Cyber squatting, Pharming, Cyber espionage, Cryptojacking, Darknet- illegal trades, drug trafficking, human trafficking., Social Media Scams & Frauds- impersonation, identity theft, job scams, misinformation, fake news cyber crime against persons - cyber grooming, child pornography, cyber stalking., Social Engineering attacks, Cyber Police stations, Crime reporting procedure, Case studies.

Unit-III Cyber Law

Cyber crime and legal landscape around the world, IT Act, 2000 and its amendments, Limitations of IT Act, 2000,Cyber crime and punishments, Cyber Laws and Legal and ethical aspects related to new technologies- AI/ML, IoT, Blockchain, Darknet and Social media, Cyber Laws of other countries, Case Studies.

Unit-IV Data Privacy and Data Security

Defining data, meta-data, big data, non-personal data. Data protection, Data privacy and data security, Personal Data Protection Bill and its compliance, Data protection principles, Big data security issues and challenges, Data protection regulations of other countries- General Data Protection Regulations(GDPR), 2016 Personal Information Protection and Electronic Documents Act (PIPEDA), Social media- data privacy and security issues.

Unit-V Cyber security Management, Compliance and Governance:

Cyber security Plan- cyber security policy, cyber crises management plan, Business continuity, Risk assessment, Types of security controls and their goals, Cyber security audit and compliance, National cyber security policy and strategy.

Practical Work

The practical list has been suggested for the applicable modules; however, the faculty may expand the list as per the syllabus content duly taking into consideration the emerging nature of cyber threats and incumbent protective measures to guard against such threats.

Practical list of Experiments:

1. Platforms for reporting cyber crimes.
2. Checklist for reporting cyber crimes online.
3. Setting privacy settings on social media platforms.
4. Do's and Don'ts for posting content on Social media platforms.
5. Registering complaints on a Social media platform.
6. Prepare password policy for computer and mobile device.
7. List out security controls for computer and implement technical security controls in the personal computer.
8. List out security controls for mobile phone and implement technical security controls in the personal mobile phone.
9. Log into computer system as an administrator and check the security policies in the system.

Text Books/ References:

1. Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Sumit Belapure and Nina Godbole, Wiley India Pvt. Ltd.
2. Information Warfare and Security by Dorothy F. Denning, Addison Wesley.
3. Security in the Digital Age: Social Media Security Threats and Vulnerabilities by Henry A. Oliver, Create Space Independent Publishing Platform.
4. Data Privacy Principles and Practice by Natraj Venkataramanan and Ashwin Shriram, CRC Press.
5. Information Security Governance, Guidance for Information Security Managers by W. KragBrothy, 1st Edition, Wiley Publication.
6. Auditing IT Infrastructures for Compliance By Martin Weiss, Michael G. Solomon, 2nd Edition, Jones Bartlett Learning.

SP28M: Mini Project with Seminar

Instruction Hours/week : 4(P) **Credits : 2**
Sessional Marks :100 **Semester-end Examination :-**

Course Outcomes:

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

1. *Understand of contemporary / emerging technology for various processes and systems.*
2. *Share knowledge effectively in oral and written form and formulate documents.*

Syllabus Contents:

The students are required to search / gather the material / information on a specific a topic comprehend it and present / discuss in the class.

Semester III & IV

SP33D& SP41D (Dissertation) Dissertation Work Phase - I, Phase - II and Viva-Voce

Instruction Hours/week : 24+20(P) **Credits : 12+16**
Sessional Marks : 40+40 **Semester-end Examination :60+60**

Course Outcomes:

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

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

Syllabus Contents:

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

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

The student should complete the following:

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

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

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

work.

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

- *As per the AICTE directives, the dissertation is a yearlong activity, to be carried out and evaluated in two phases i.e. Phase – I: July to December and Phase – II: January to June.*
- *The dissertation may be carried out preferably in-house i.e. department‟s laboratories and centers OR in industry allotted through department‟s T & P coordinator.*
- *After multiple interactions with guide and based on comprehensive literature survey, the student shall identify the domain and define dissertation objectives. The referred literature should preferably include IEEE/IET/IETE/Springer/Science Direct/ACM journals in the areas of Computing and Processing (Hardware and Software), Circuits-Devices and Systems, Communication-Networking and Security, Robotics and Control Systems, Signal Processing and Analysis and any other related domain. In case of Industry sponsored projects, the relevant application notes, while papers, product catalogues should be referred and reported.*
- *Student is expected to detail out specifications, methodology, resources required, critical issues involve*d in design and implementation and phase wise work distribution, and submit the proposal within a month from the date of registration.*
- *Phase – I deliverables: A document report comprising of summary of literature survey, detailed objectives, project specifications, paper and/or computer aided design, proof of concept/functionality, part results, A record of continuous progress.*
- *Phase – I evaluation: A committee comprising of guides of respective specialization shall assess the progress/performance of the student based on report, presentation and Q & A. In case of unsatisfactory performance, committee may recommend repeating the Phase-I work.*
- *During phase – II, student is expected to exert on design, development and testing of the proposed work as per the schedule. Accomplished results/contributions/innovations should be published in terms of research papers in reputed journals and reviewed focused conferences OR IP/Patents.*
- *Phase – II deliverables: A dissertation report as per the specified format, developed system in the form of hardware and/or software, a record of continuous progress.*
- *Phase – II evaluation: Guide along with appointed external examiner shall assess the*
- *progress/performance of the student based on report, presentation and Q & A. In case of unsatisfactory performance, committee may*

  recommend for extension or repeating the work.

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