VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY
(Formerly Uttarakhand Technical University, Dehradun Established by Uttarakhand State Govt. wide Act no. 415 of 2005)
Suddhowala, PO-Chandanwadi, Premnagar, Dehradun, Uttarakhand (Website- www.uktech.ac.in)

SYLLABUS

For

Master of Engineering Programmes

(M.Tech. Digital Signal Processing)

(For admission in 2022-23 and onwards)

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Courses Structure and Scheme of Examination for M. Tech.- 2 Year Programme Digital Signal Processing

Semester I												
Sr. No.	**Course Type/Code**	**Course Name**	**Teaching Scheme**			**Credits**	**Internal Marks**			**External Marks**	**Total Marks**
			L	**T**	**P**		**CT**	**TA**	**Total**		
1	DPT301	AdvancedDigitalSignalProcessing	3	1	0	4	30	20	50	100	150
2	DPT302	DigitalImageandVideoProcessing	3	1	0	4	30	20	50	100	150
3	DPT303	DSPArchitecture	3	1	0	4	30	20	50	100	150
4	DPT30(4-6)	ProfessionalElective-1	3	0	0	3	30	20	50	100	150
5	DPT30(7-9)	ProfessionalElective-2	3	0	0	3	30	20	50	100	150
6	DPP301	Lab-I:AdvancedDigitalSignal ProcessingLab	0	0	3	1		25	25	25	50
7	DPP302	Lab-II:DigitalImageandVideo ProcessingLab	0	0	3	1		25	25	25	50
8	AHT302	ResearchMethodologyand IPR	2	0	0	2		50	50	50	100
9	AHT-303	Technical Writing and Presentation Skill	2	0	0	NC		50	50	0	NC
		Total	**22**	**3**	**8**	**22**	**150**	**250**	**400**	**600**	**950**
10	OET30(1-5)	OpenElective-1(Optional)	3	0	0	3	30	20	50	100	150

Semester II (M. Tech.- 2 Year Programme)											
Sr. No.	**Course Type/Code**	**Course Name**	**Teaching Scheme**			**Credits**	**Internal Marks**			**External Marks**	**Total Marks**
			L	**T**	**P**		**CT**	**TA**	**Total**		
1	DPT310	Pattern Recognition and MachineLearning	3	1	0	4	30	20	50	100	150

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2	DPT311	DetectionandEstimationTheory	3	1	0	4	30	20	50	100	150
3	DPT3(12-14)	ProfessionalElective-3	3	1	0	4	30	20	50	100	150
4	DPT3(15-17)	ProfessionalElective-4	3	0	0	3	30	20	50	100	150
5	OET30(1-5)	OpenElective-1	3	0	0	3	30	20	50	100	150
6	DPP303	Lab-III:PatternRecognitionand MachineLearningLab	0	0	3	1		25	25	25	50
7	DPP304	Lab-IV:DetectionandEstimation TheoryLab	0	0	3	1		25	25	25	50
		Total	**15**	**3**	**6**	**20**			**300**	**550**	**950**
8	OET30(1-5)	OpenElective-2(Optional)	3	0	0	3	30	20	50	100	150

Semester III (M. Tech.- 2 Year Programme)											
Sr. No.	**Course Type/Code**	**Course Name**	**Teaching Scheme**			**Credits**	**Internal Marks**			**External Marks**	**Total Marks**
			L	T	P		**CT**	**TA**	**Total**		
1	OET30(6-10)	OpenElective-2	3	0	0	3	30	20	50	100	150
2	DPP305	Seminar	0	0	4	2		100	100		100
3	DPP306	Project	0	0	10	5		100	100	150	250
4	DPP307	Dissertation-1	0	0	12	6		300	300		300
		Total	**3**	**0**	**22**	**16**		**520**	**550**	**250**	**800**

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Semester IV (M. Tech.- 2 Year Programme)												
Sr. No.	**Course Type/Code**	**Course Name**	**Teaching Scheme**			**Credits**	**Internal Marks**			**External Marks**	**Total Marks**
			L	T	P		**CT**	**TA**	**Total**		
1	DPP308	Dissertation	0	0	28	14		250	250	450	700
		Total	**0**	**0**	**28**	**14**		**250**	**250**	**450**	**700**

Abbreviations: L-No. of Lecture hours per week, T-No. of Tutorial hours per week, P-No. of Practical hours per week, CT-Class Test Marks, TA-Marks of teacher's assessment including student's class performance and attendance,

1 Hr Lecture	1 Hr Tutorial	2 or 3 Hr Practical
1 Credit	**1 Credit**	**1 Credit**

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Course Structure and Scheme of Examination for
B.Tech.-M. Tech. Dual 1 Year M.Tech. Programme
Digital Signal Processing

Semester III

Sr. No.	Course Type/Code	Course Name	Teaching Scheme			Credits	Internal Marks			External Marks	Total Marks
			L	T	P		CT	TA	Total		
1		Advanced Mathematics	3	1	0	4	30	20	50	100	150
2		AdvancedDigitalSignalProcessing	3	1	0	4	30	20	50	100	150
3		OpenElective-1	3	0	0	3	30	20	50	100	150
4		Research Methodology and IPR	2	0	0	2	30	20	50	50	100
5		Seminar	0	0	4	2		100	100		100
6		Project	0	0	10	5		100	100	150	250
7		Dissertation	0	0	12	6		300	300		300
		Total	**11**	**2**	**26**	**26**	**120**	**580**	**700**	**500**	**1200**

Semester IV (B.Tech.-M. Tech. Dual 1 Year M.Tech. Programme)

Sr. No.	Course Type/Code	Course Name	Teaching Scheme			Credits	Internal Marks			External Marks	Total Marks
			L	T	P		CT	TA	Total		
1		DigitalImageand VideoProcessing	3	1	0	4	30	20	50	100	150
2		ProfessionalElective-1	3	0	0	3	30	20	50	100	150
3		OpenElective-1	3	0	0	3	30	20	50	100	150
4		Lab-I:AdvancedDigitalSignal ProcessingLab	0	0	3	1		25	25	25	50
5		Lab-II:DigitalImageandVideo ProcessingLab	0	0	3	1		25	25	25	50
6		Dissertation	0	0	28	14		250	250	450	700
		Total	**9**	**1**	**34**	**26**	**90**	**360**	**450**	**800**	**1250**

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Abbreviations: L-No. of Lecture hours per week, T-No. of Tutorial hours per week, P-No. of Practical hours per week, CT-Class Test Marks, TA-Marks of teacher's assessment including student's class performance and attendance,

1 Hr Lecture	1 Hr Tutorial	2 or 3 Hr Practical
1 Credit	1 Credit	1 Credit

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Advanced Digital Signal Processing (DPT-301)

L:T:P:: 3:1:0 **Credits-4**

Course objectives:

When a student completes this course, s/he should be able to:

• Analyze multirate DSP systems.

• Determine coefficients for perfect reproduction filter banks and wavelets.

• Choose parameters to take a wavelet transform, and interpret and process the result.

Course outcomes:

1. Students will understand theory of different filters and algorithms.
2. Students will understand theory of multirate DSP, solve numerical problems and write algorithms.
3. Students will have knowledge of adaptive filters and their applications.
4. Students will be able to understand the applications of DSP in different fields.
5. Students will be able to solve engineering problems related to DSP.

Course content:

Unit I: **(8 hours)**

Overview of DSP, Characterization in Time and Frequency, FFT Algorithms, Digital Filter Design and Structures: Basic FIR/IIR Filter Design and Structures, Design Techniques of Linear Phase FIR Filters, IIR Filters by Impulse Invariance, Bilinear Transformation, FIR/IIR Cascaded Lattice Structures and Parallel All Pass Realization of IIR.

Unit II: **(10 hours)**

Multi-rate DSP, Decimators and Interpolators, Sampling Rate Conversion, Multistage Decimator and Interpolator, Poly phase Filters, QMF, Digital Filter Banks, Applications in Sub-band Coding.

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Unit III: **(8 hours)**

Linear Prediction and Optimum Linear Filters, Stationary Random Processes, Forward and Backward Linear Prediction, Solution of the Normal Equations, AR Lattice and ARMA Lattice-Ladder Filters, Wiener Filters for Filtering and Prediction

Unit IV: **(8 hours)**

Adaptive Filters, Applications, Direct-Form FIR Filters, Minimum Mean-Square-Error Criterion, LMS Algorithm, Direct-Form Filters – RLS Algorithm, Lattice-Ladder Filters, Recursive Least Square Algorithm.

Unit V: **(8 hours)**

Estimation of Spectra from Finite-Duration Observations of Signals, Nonparametric Methods for Power Spectrum Estimation, Parametric Methods for Power Spectrum Estimation, Minimum Variance Spectral Estimation, Eigen analysis Algorithms for Spectrum Estimation.

Text Books / References:

1. J. G. Proakis and D.G. Manolakis “Digital signal processing: Principles, Algorithm and Applications”, 4th Edition, Prentice Hall, 2007.
2. N. J. Fliege, “Multirate Digital Signal Processing: Multirate Systems -Filter Banks Wavelets”, 1st Edition, John Wiley and Sons Ltd, 1999.
3. Bruce W. Suter, “Multirate and Wavelet Signal Processing”, 1st Edition, Academic Press, 1997.
4. M. H. Hayes, “Statistical Digital Signal Processing and Modeling”, John Wiley & Sons Inc., 2002.
5. S. Haykin, “Adaptive Filter Theory”, 4th Edition, Prentice Hall, 2001.
6. D.G. Manolakis, V.K. Ingle and S. M. Kogon, “Statistical and Adaptive Signal Processing”, McGraw Hill, 2000.

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Digital Image and Video Processing (DPT-302)

L:T:P:: 3:1:0 **Credits-4**

Course Objectives:

When a student completes this course, s/he should be able to:

- Comprehend the image processing fundamentals and enhancement techniques in spatial and frequency domain.
- Describe the color image fundamentals, models and various restoration techniques.
- Design and analyze the image compression systems.
- Outline the various image segmentation and morphology operations.
- Comprehend the basics of video processing and video coding.

Course Outcomes:

1. Students will be able to understand various transforms used in digital image processing.
2. Students will be able to understand image enhancement techniques and its applications.
3. Students will have knowledge of image restoration and its applications.
4. Students will be able to understand image segmentation and compression and their practical uses.
5. Students will be capable of solving engineering problems related to digital image processing.

Course Contents:

UNIT-I **(8 hours)**

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-II **(8 hours)**

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

UNIT-III **(8 hours)**

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-IV **(8 hours)**

Colour fundamentals, Colour models, Conversion of colour models, Pseudo colour image processing, full colour processing. 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.

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UNIT-V **(8 hours)**

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.

Text Books/ Reference Books:

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

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DSP Architecture (DPT-303)

L:T:P::3:1:0 **Credits-4**

Course Objectives:

When a student completes this course, s/he should be able to:

- Comprehends the knowledge & concepts of digital signal processing techniques.
- Acquire knowledge of DSP computational building blocks and knows how to achieve speed in DSP architecture or processor.
- Develop basic DSP algorithms using DSP processors.
- Acquire knowledge about various addressing modes of DSP TMS320C54XX and are able to program DSP processor.

Course Outcomes:

1. Students will be able to identify architectural level characterization of P-DSP hardware.
2. Students will be able to design, programming (assembly and C), and testing code using Code Composer Studio environment.
3. Students will be able to deploy the DSP hardware for Control, Audio and Video Signal processing applications.
4. Students must be able to understanding of major areas and challenges in DSP based embedded systems.
5. Students will be capable of solving engineering problems related to DSP.

Course Contents:

Unit-I **(8 hours)**

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-II **(8 hours)**

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-III **(8 hours)**

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**.**

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Unit-IV **(8 hours)**

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, Open MP Constructs for work sharing like for loop, sections, TI TMS320C6678 (Eight Core subsystem).

Unit-V **(8 hours)**

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, Open MP, multicore DSP as HPC infrastructure.

Books and 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, Jeff McDonald,"Parallel Programming in Open MP", 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.

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COMPUTER VISION(DPT-304)

L:T:P:: 3:0:0 **Credits-3**

Course Objectives:

When a student completes this course, s/he should be able to:

- To introduce students the fundamentals of image formation.
- To introduce students the major ideas, methods, and techniques of computer vision and pattern recognition.
- To develop an appreciation for various issues in the design of computer vision and object recognition systems.

To provide the student with programming experience from implementing computer vision and object recognition applications

Course Outcomes:

1. Students will acquire knowledge of image formation models and feature extraction.
2. Students will be able to understand the segmentation and motion detection and estimation techniques.
3. Students will be able to develop programs for DSP applications
4. Students will be able to detect the objects in various applications.
5. Students will be capable of solving engineering problems related to computer vision applications.

Syllabus Contents:

UNIT I: **(8 hours)**

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: **(8 hours)**

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: **(8 hours)**

SHAPE REPRESENTATION AND SEGMENTATION: Deformable curves and surfaces, Snakes and active contours, 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.

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Unit 4: **(8 hours)**

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: **(8 hours)**

OBJECT RECOGNITION AND COMPUTER VISION APPLICATIONS: Hough transforms and other simple object recognition methods, Shape correspondence and shape matching, Principal Component analysis, Shape priors for recognition. Automated Visual Inspection, Inspection of Cereal Grains, Surveillance, In-Vehicle Vision Systems, CBIR, CBVR, Activity Recognition, computational photography, Biometrics, stitching and document processing.

Reference Books:

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. E. R. Davies, “Computer and Machine Vision: Theory, Algorithms, Practicalities”, 4th Edition, Elsevier Inc, 2012.
7. B.K. P. Horn, “Robot Vision”, 1st Edition, McGraw-Hill, 1986.

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REMOTE SENSING (DPT-305)

L:T:P::3:0:0 **Credits-3**

Course Objectives:

When a student completes this course, s/he should be able to:

- To provide exposure to students in gaining knowledge on concepts and applications leading to modeling of earth resources management using Remote Sensing.
- To acquire skills in storing, managing digital data for planning and development.
- To acquire skills in advance techniques such as hyper spectral, thermal and LiDAR scanning for mapping, modeling and monitoring.

Course Outcomes:

1. Students will be able to understand concepts, principles and applications of remote sensing.
2. Students will be able to understand geometric and radiometric principles.
3. Students will be able to acquire knowledge related to data collection, radiation, resolution, and sampling.
4. Students will acquire knowledge of various scanning techniques used in remote sensing.
5. Students will be capable of solving engineering problems related to remote sensing.

Course Contents:

Unit-I **(8 hours)**

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.

Unit-II **(8 hours)**

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

Unit-III **(8 hours)**

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

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Unit-IV **(8 hours)**

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

Unit-V **(8 hours)**

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.

Text / References Books:

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 Physics and Techniques of Remote Sensing", 2nd Edition, Wiley Series, 2006.
6. Sabins, F. F. Jr, "Remote Sensing Principles and Image Interpretation", 3rd Edition, W. H. Freeman & Co, 1978.

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VOICE AND DATA NETWORKS (DPT-306)

L:T:P::3:0:0 Credits-3

Course Objectives

When a student completes this course, s/he should be able to:

- Protocol, algorithms, trade-offs rationale.
- Routing, transport, DNS resolutions.
- Network extensions and next generation architectures.

Course Outcomes

1. Students will understand Protocol, algorithms, trade-offs rationale.
2. Students will be able to identify routing, transport, DNS resolutions.
3. Students will be able to find network extensions and next generation architectures
4. Students will acquire knowledge of various layers and models used in voice data networks.
5. Students will be capable of solving engineering problems related to voice data networks.

Course Contents

Unit-I (8 hours)

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

Unit-II (8 hours)

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-III (8 hours)

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-IV (8 hours)

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-V (8 hours)

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.

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Text/ References Books:

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.

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AUDIO VIDEO CODING & COMPRESSION (DPT-307)

L:T:P::3:0:0 **Credits-3**

Course Objectives:

When a student completes this course, s/he should be able to:

- Describe and apply various techniques for text compression and also evaluate performance of the coding techniques.
- Explain digital audio, companding ,perceptual audio coding and MPEG audio compression standard
- Describe different lossless and lossy image and video compression techniques and standards.

Course Outcomes:

1. Students will be familiar to lossy and lossless compression systems.
2. Students will be able to understand the video coding techniques and standards.
3. Students will be able to understand audio coding and multimedia synchronization techniques.
4. Students will know various standards of video coding and their applications.
5. Students will be capable of solving engineering problems related to video coding techniques.

Course Contents:

Unit-I **(8 hours)**
Introduction to Multimedia Systems and Processing, Lossless Image Compression Systems Image Compression Systems, Huffman Coding, Arithmetic and Lempel-Ziv Coding, Other Coding Techniques

Unit-II **(8 hours)**
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-III **(8 hours)**
Video Coding and Motion Estimation: Basic Building Blocks & Temporal Redundancy, Block based motion estimation algorithms, other fast search motion estimation algorithms

Unit-IV **(8 hours)**
Video Coding Standards MPEG-1 standards, MPEG-2 Standard, MPEG-4 Standard, H.261, H.263 Standards, H.264 standard, Audio Coding, Basic of Audio Coding, Audio Coding, Transform and Filter banks, Poly-phase filter implementation, Audio Coding, Format and encoding, Psychoacoustic Models.

Unit-V **(8 hours)**
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.

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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 Codes: 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

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INFORMATION THEORY AND CODING (DPT-308)

L:T:P::3:0:0 **Credits-3**

Course Objectives

When a student completes this course, s/he should be able to:

- To provide an insight into the concept of information in the context of communication theory and its significance in the design of communication receivers.
- To explore in detail, the calculations of channel capacity to support error-free transmission and also, the most commonly used source coding and channel coding algorithms.
- To encourage and train to design coding schemes for data compression and error correction, and they will also get an overall perspective of how this impacts the design of an optimum communication receiver.

Course Outcomes

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

1. Characterize and apply probabilistic techniques in modern decision systems, such as Information systems, receivers and statistical operations.
2. Demonstrate mathematical modeling and problem solving using such models.
3. Comparatively evolve key results developed in this course for applications to signal processing, communications systems.
4. Develop frameworks based in probabilistic and stochastic themes for a secure communication.
5. Able to develop the codes for having control over the error free information processing.

Unit-I **(8 hours)**

ELEMENTS OF INFORMATION THEORY: Source coding theorem, Huffman coding, channel coding theorem, channel capacity theorem, Shannon fanon theorem, Entropy, Run length, Variable length, Lossy/ Lossless compression.

Unit-II **(8 hours)**

SAMPLING PROCESS: Base band and band pass sampling theorems, reconstruction from samples, carrier recovery, multiplexing.

Unit-III **(8 hours)**

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WAVEFORM CODING TECHNIQUES: PCM channel noise and error probability, DPCM, DM coding speech at low bit rates prediction, PAM signals and their power spectra, eye pattern, jitter.

Unit-IV **(8 hours)**

DIGITAL MODULATION TECHNIQUES: Binary and M-Ary modulation techniques, coherent and Non coherent detection, Bit vs symbol error probability and bandwidth efficiency, concept of orthogonality, OFDM systems, Difference between wired and wireless OFDM systems.

Unit-V **(8 hours)**

ERROR CONTROL CODING: Rationale for coding, linear block codes, cyclic codes, convolution codes, Viterbi decoding algorithms and trellis codes.

References:

1. J. Dass, S.K Malik & P.K Chatterjee, " Principles of digitals communication" Wiley-Blackwel, 1991.
2. Vera Pless, "Introduction to the theory correction codes", Edition 3, July 2015.
3. Robert G. Gallanger, " Information Theory and reliable communication", McGraw Hill, 2002
4. R G. Gallager, "Information theory and reliable communication", Wiley, 1stedition, 1968.
5. F. J. McWilliams and N. J. A. Sloane, "The theory of Error-Correcting Codes", New York, North-Holland, 1977.

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AUDIO PROCESSING (DPT-309)

L:T:P::3:0:0 **Credits-3**

Course Objectives

When a student completes this course, s/he should be able to:

- To familiarize the basic mechanism of speech production and the basic concepts of methods for speech analysis and parametric representation of speech.
- To give an overall picture about various applications of speech processing.
- To impart ideas of Perception of Sound, Psycho-acoustic analysis, Spatial Audio Perception and rendering.
- To introduce Audio Compression Schemes.

Course Outcomes

1. Students will be able to understand different characteristics of speech signals.
2. Students will be able to identify and analyze different speech analysis systems.
3. Students will be able to write algorithms for recognition of speech.
4. Students will be able to understand the coding techniques used in audio processing.
5. Students will be capable of solving engineering problems related to audio processing.

Unit-I **(8 hours)**

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-II **(8 hours)**

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-III **(8 hours)**

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-IV **(8 hours)**

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-V **(8 hours)**

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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.

Text Book:

1. Sadaoki Furui, "Digital Speech Processing, Synthesis and Recognition" 2nd Edition, Taylor & Francis, 2000.

2. Rabiner and Schafer, "Digital Processing of Speech Signals", Pearson Education, 1979.

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Pattern Recognition and Machine Learning (DPT-310)

L:T:P::3:1:0 **Credits-4**

Course Objectives

When a student completes this course, s/he should be able to:

- Understand, describe and critique pattern recognition, machine learning and deep learning techniques;
- Identify and select suitable modelling, learning and prediction techniques to solve a problem;
- Design and implement a machine learning solution.

Course Outcomes

1. Students will be able to study the parametric and linear models for classification.
2. Students will be able to design neural network and SVM for classification.
3. Students will be able to develop machine independent.
4. Students will understand the unsupervised learning techniques.
5. Students will be capable of solving engineering problems related to pattern recognition and machine learning.

Unit-I **(8 hours)**

INTRODUCTION TO PATTERN RECOGNITION: Problems, applications, design cycle, learning and adaptation, examples, Probability Distributions, Parametric Learning - Maximum likelihood and Bayesian Decision Theory- Bayes rule, discriminant functions, loss functions and Bayesian error analysis.

Unit-II **(8 hours)**

LINEAR MODELS: Linear Models for Regression, linear regression, logistic regression Linear Models for Classification.

Unit-III **(8 hours)**

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-IV **(8 hours)**

LINEAR DISCRIMINANT FUNCTIONS: Decision surfaces, two-category, multi-category, minimum-squared error procedures, the Ho-Kashyap procedures, linear programming algorithms, Support vector machine.

Unit-V **(8 hours)**

ALGORITHM INDEPENDENT MACHINE LEARNING: – Lack of inherent superiority of any classifier, bias and variance, re-sampling for classifier design, combining classifiers.

UNSUPERVISED LEARNING AND CLUSTERING: – k-means clustering, fuzzy k-means clustering, hierarchical clustering.

Text Book:

1. Richard O. Duda, Peter E. Hart, David G. Stork, “Pattern Classification”, 2nd Edition John Wiley & Sons, 2001.

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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.

Detection and Estimation Theory (DPT-311)

L:T:P::3:1:0 **Credits-4**

Course Objectives

When a student completes this course, s/he should be able to:

- To Analyse the need for estimation techniques in Communication and Signal Processing
- To analyse estimation problems and apply suitable estimation and detection techniques.
- To Analyse signal or parameter estimation techniques are preferred and develop estimation techniques that are suitable for the context from a wider perspective
- To Analyse impact of white Gaussian noise on Detection of Signals

Course Outcomes

1. Students will be able to understand the mathematical background of signal detection and estimation.
2. Students will be able to use classical and Bayesian approaches to formulate and solve problems for signal detection and parameter estimation from noisy signals.
3. Students will be able to derive and apply filtering methods for parameter estimation.
4. Students will be able to understand the stochastic processes.
5. Students will be capable of solving engineering problems related to signal detection and estimation.

Unit-I **(8 hours)**
Review of Vector Spaces: Vectors and matrices: notation and properties, orthogonality and linear independence, bases, distance properties, matrix operations, Eigen values and eigenvectors.

Unit-II **(8 hours)**
Properties of Symmetric Matrices: Diagonalization of symmetric matrices, symmetric positive definite and semi definite matrices, principal component analysis (PCA), and singular value decomposition.

Unit-III **(8 hours)**
Stochastic Processes: Time average and moments, WSS, ergodicity, power spectral density, covariance matrices, response of LTI system to random process, cyclostationary process, and spectral factorization.

Unit-IV **(8 hours)**
Detection Theory: Detection in white Gaussian noise, correlator and matched filter interpretation, Bayes,, criterion of signal detection, MAP, LMS, entropy detectors, detection in colored Gaussian noise, Karhunen-Loeve expansions and whitening filters.

Unit-V **(8 hours)**
Estimation Theory: Minimum variance estimators, Cramer-Rao lower bound, examples of linear models, system identification, Markov classification, clustering algorithms. Kalman Filtering: Discrete Kalman filter extended Kalman filter, examples. Estimation: Spectral estimation methods like MUSIC, ESPIRIT, DOA Estimation

Text Book:

1. Steven M. Kay, "Fundamentals of Statistical Signal Processing, Volume I: Estimation Theory", Prentice Hall, 1993.
2. Steven M. Kay, "Fundamentals of Statistical Signal Processing, Volume II: Detection Theory", 1st Edition, Prentice Hall, 1998
3. Thomas Kailath, Babak Hassibi, Ali H. Sayed, "Linear Estimation", Prentice Hall, 2000.
4. H. Vincent Poor, "An Introduction to Signal Detection and Estimation", 2nd Edition, Springer, 1998

BIOMEDICAL SIGNAL PROCESSING (DPT-312)

L:T:P::3:1:0 **Credits-4**

Course Objectives

When a student completes this course, s/he should be able to:

- Demonstrate an advanced understanding of the principles of analog and digital signal processing.
- Know the fundamental tools that are used to describe, analyze and process biomedical signals.
- Systematically apply methods to extract relevant information from biomedical signal measurements.
- Aware about the fundamental principles in the analysis and design of filters, power spectral density estimation and non-stationary signal processing techniques with applications to biomedical signals.

Course Outcomes

1. Students will be able to understand different types of biomedical signal.
2. Students will be able to identify and analyze different biomedical signals.
3. Students will be able to understand the systems used in biomedical signal processing.
4. Students will be able to know the applications related to biomedical signal processing.
5. Students will be capable of solving engineering problems related to biomedical signal processing.

Unit-I **(8 hours)**

Acquisition, Generation of Bio-signals, Origin of bio-signals, Types of bio-signals, Study of Diagnostically significant bio-signal parameters.

Unit-II **(8 hours)**

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-III **(8 hours)**

Biomedical signal processing by Fourier analysis, biomedical signal processing by wavelet (time frequency) analysis, Analysis (Computation of signal parameters that are diagnostically significant).

Unit-IV **(8 hours)**

Classification of signals and noise, Spectral analysis of deterministic, stationary random signals and non-stationary signals, Coherent treatment of various biomedical signal processing methods and applications.

Unit-V **(8 hours)**

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Principal component analysis, Correlation and regression, Analysis of chaotic signals Application areas of Bio–Signals analysis Multi-resolution analysis (MRA) and wavelets, Principal component analysis (PCA), Independent component analysis (ICA), Pattern classification supervised and unsupervised classification, Neural networks, Support vector Machines, Hidden Markov models, Examples of biomedical signal classification.

Text Book:

1. D C Reddy, "Biomedical Signal Processing", McGraw Hill, 2005.

2. W. J. Tompkins, "Biomedical Digital Signal Processing", Prentice Hall, 1993.

3. Eugene N Bruce, "Biomedical Signal processing and Signal Modeling", John Wiley & Son‟s Publication, 2001.

4. Myer Kutz, "Biomedical Engineering and Design Handbook, Volume I", McGraw Hill, 2009.

5. Katarzyn J. Blinowska, Jaroslaw Zygierewicz, "Practical Biomedical Signal Analysis Using

MATLAB", 1st Edition, CRC Press, 2011

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DIGITAL DESIGN AND VERIFICATION (DPT-313)

L:T:P::3:1:0 **Credits-4**

Course Objectives

When a student completes this course, s/he should be able to:

- To introduce digital logic design, system-level design using current state of the art in EDA tools.
- To design large-scale logic circuits from fundamental building blocks and methods.
- Ability to devise, select, and use modern techniques and tools needed for digital system design.
- To discuss various simulator architectures and introduce the concept of test bench in verification.

Course Outcomes

1. Students will be able to understand the front end design and verification techniques.
2. Students will be able to verify increasingly complex designs more efficiently and effectively.
3. Students will be able to write programs for implementation of various digital systems.
4. Students will be able to use modern EDA tools.
5. Students will be capable of solving engineering problems related to digital design.

Unit-I **(8 hours)**

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-II **(8 hours)**

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-III **(8 hours)**

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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-IV **(8 hours)**

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 & Electro migration, 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.

Unit-V **(8 hours)**

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.

Text Book:

1. Christophe Bobda, “Introduction to Reconfigurable Computing, Architectures, Algorithms and Applications”, Springer, 2007.

2. Janick Bergeron, “Writing Test benches: Functional Verification of HDL Models”, Second Edition, Springer, 2003.

3. Douglas Smith, “HDL Chip Design: A Practical Guide for Designing, Synthesizing & Simulating ASICs & FPGAs Using VHDL or Verilog”, Doone publications, 1998.

4. Samir Palnitkar, “Verilog HDL: A guide to Digital Design and Synthesis”, Prentice Hall, 2nd Edition, 2003.

5. Doug Amos, Austin Lesea, Rene Richter, “FPGA based Prototyping Methodology Manual”, Synopsys Press, 2011.

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JOINT TIME FREQUENCY ANALYSIS & MULTI RESOLUTION ANALYSIS (DPT-314)

L:T:P::3:1:0 **Credits-4**

Course Objectives

When a student completes this course, s/he should be able to:

- To mathematical building blocks from time-frequency analysis (e.g. Fourier series, wavelets, sampling theorems) that can be used for signal and image processing, numerical analysis, and statistics.
- To emphasize the connection between the analog world and the discrete world, and focus on approximation and compression of functions and data.

Course Outcomes

1. Students will be able to understand various transforms used in signal processing.
2. Students will be able to understand time -frequency analysis
3. Students will acquire knowledge of multi-resolution analysis.
4. Students will acquire knowledge of wavelets and its applications.
5. Students will be capable of solving engineering problems related to joint time-frequency analysis and multi-resolution analysis.

Unit-I **(8 hours)**

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-II **(8 hours)**

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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-III **(8 hours)**

Multi-resolution Analysis: Haar Multi-resolution 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-IV **(8 hours)**

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-V **(8 hours)**

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

Text Book:

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. I. 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.

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MODELLING AND SIMULATION TECHNIQUES (DPT-315)

L:T:P::3:0:0 **Credits-3**

Course Objectives

When a student completes this course, s/he should be able to:

- To understand the techniques of modeling in the context of hierarchy of knowledge about a system and develop the capability to apply the same to study systems through available software.
- To learn different types of simulation techniques.
- To simulate the models for the purpose of optimum control by using software.

Course Outcomes

1. Students will be able to understand the numerical simulation methods.
2. Students will be able to understand the statistical methods.
3. Students will be able to understand the probability and random processes.
4. Students will be able to understand modeling and simulation techniques to characterize systems/processes.
5. Students will be capable of solving engineering problems.

Unit-I **(8 hours)**

Introduction Circuits as dynamic systems, 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-II **(8 hours)**

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

Unit-III **(8 hours)**

Probability and Random Processes, Discrete and Continuous Distribution, Central Limit theorem, Measure of Randomness, Monte-Carlo Methods, Stochastic Processes and Markov Chains, Time Series Models.

Unit-IV **(8 hours)**

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

Unit-V **(8 hours)**

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

Text Book:

1. R. L. Woods and K. L. Lawrence, “Modeling and Simulation of Dynamic Systems”, Prentice-Hall, 1997.
2. Z. Navalih, “VHDL Analysis and Modelling of Digital Systems”, McGraw-Hill, 1993.

3. J. Banks, JS. Carson and B. Nelson, "Discrete-Event System Simulation", 2nd Edition, Prentice-Hall of India, 1996.

MULTISPECTRAL SIGNAL ANALYSIS (DPT-316)

L:T:P::3:0:0 **Credits-3**

Course Objectives

When a student completes this course, s/he should be able to:

- To provide an introduction to hyper spectral remote sensing methods, systems for the collection of data at high spectral resolution and unique approaches and algorithms to the processing of such data.
- To introduce the concepts of image processing, data acquisition and basic analytical methods to be used in image processing and data acquisition.
- To familiarize students to understand the support vector machines.

Course Outcomes

1. Students will be able to select appropriate hyper spectral data for a particular application.
2. Students will be able to understand concepts of data acquisition and image processing tasks required for multi and hyper spectral data analysis.
3. Students will be able to learn techniques for classification and analysis of multi and hyper spectral data.
4. Students will be able to understand the support vector machines.
5. Students will be capable of solving engineering problems related to multispectral signal analysis.

Unit-I **(8 hours)**

Hyper spectral Sensors and Applications: Multi-spectral Scanning Systems (MSS), Hyper spectral Systems, Airborne sensors, Space borne sensors, Ground Spectroscopy, Software for Hyper spectral Processing, Applications, Atmosphere and Hydrosphere, Vegetation, Soils and Geology.

Unit-II **(8 hours)**

Overview of Image Processing: Image File Formats, Image Distortion and Rectification, Radiometric Distortion, Geometric Distortion and Rectification, Image Registration, Crisp Classification Algorithms, Fuzzy Classification Algorithms, Classification Accuracy Assessment, Image Change Detection, Image Fusion, Automatic Target Recognition.

Unit-III **(8 hours)**

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-IV **(8 hours)**

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

Unit-V **(8 hours)**

Support Vector Machines : 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.

Text Book:

1. Pramod K. Varshney, Manoj K. Arora, "Advanced Image Processing Techniques for Remotely Sensed Hyperspectral Data", Springer, 2013.

2. S. Svanberg, "Multi-spectral Imaging– from Astronomy to Microscopy – from Radio waves to Gamma rays", Springer Verlag, 2009

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OPTIMIZATION TECHNIQUES (DPT-317)

L:T:P::3:0:0 **Credits-3**

Course Objectives

When a student completes this course, s/he should be able to:

- 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.
- The stochastic models for discrete and continuous variables to control inventory and simulation of manufacturing models for the production decision making.
- Formulation of mathematical models for quantitative analysis of managerial problems in industry.

Course Outcomes

1. Students will be able to understand importance of optimization
2. Students will be able to apply concepts of mathematics to formulate an optimization problem
3. Students will be able to analyze and appreciate variety of performance measures for various optimization problems.
4. Students will acquire the knowledge of different optimization techniques. 5. Students will be capable of solving optimization problems.

Unit-I **(8 hours)**

INTRODUCTION TO OPTIMIZATION: Introduction, historical Development, engineering applications of optimization, statement of an Optimization Problem, design Vector, design Constraints, constraint Surface, objective Function, objective Function Surfaces, classification of optimization problems, classification Based on the existence of Constraints, Classification Based on the Nature of the Design Variables, classification Based on the Physical Structure of the Problem, classification Based on the Nature of the Equations Involved, classification Based on the Permissible Values of the Design Variables, classification based on the deterministic nature of the variables, classification Based on the separability of the Functions, classification Based on the Number of Objective functions, optimization Techniques.

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Unit-II **(8 hours)**

CLASSICAL OPTIMIZATION TECHNIQUES: Introduction, Single-Variable Optimization, Multivariable Optimization with No Constraints, Semi definite Case, Saddle Point, Multivariable Optimization with Equality Constraints, Solution by Direct Substitution, Solution by the Method of Constrained Variation, Solution by the Method of Lagrange Multipliers, Multivariable Optimization with Inequality Constraints, Kuhn-Tucker Conditions, Constraint Qualification, Convex Programming Problem.

Unit-III **(8 hours)**

LINEAR PROGRAMMING I: SIMPLEX METHOD: Introduction, Applications of Linear Programming, Standard Form of a Linear Programming Problem, Geometry of Linear Programming Problems, Definitions and Theorems, Solution of a System of Linear Simultaneous Equations, Pivotal Reduction of a General System of Equations, Motivation of the Simplex Method, Simplex Algorithm, Identifying an Optimal Point, Improving a Nonoptimal Basic Feasible Solution, Two Phases of the Simplex Method.

Unit-IV **(8 hours)**

NONLINEAR PROGRAMMING I: ONE-DIMENSIONAL MINIMIZATION METHODS: Introduction, Unimodal Function, Elimination Methods, Unrestricted Search, Search with Fixed Step Size, Search with Accelerated Step Size, Exhaustive Search, Dichotomous Search Interval Halving Method, Fibonacci Method, Golden Section Method.

Unit-V **(8 hours)**

NONLINEAR PROGRAMMING II: UNCONSTRAINED OPTIMIZATION TECHNIQUES: Newton's Method, Quasi-Newton Methods, Hooke and Jeeves' Method, Indirect Search (Descent) Methods, Steepest Descent (Cauchy) Method.

Text Book:

1. S. S. Rao, "Engineering Optimization: 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", Addison-Wesley Longman Publishing, 1989.

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Advanced Mathematics (AHT-301)

L:T:P::3:1:0 **Credits-4**

Course Objectives

From this course, students will be able to:

1. learn distinct methods of solving simultaneous equations.
2. well-versed with partial differential equations and their solutions and applications.
3. acquire the knowledge of transformation to ease the complex problems.
4. acquaintance with basics of random variables and their distribution for dealing with events by chance.
5. study different mathematical domains to deal with real-time engineering problems.

Learning outcomes:

1. Comprehend with engineering problems in different mathematical realm.
2. Learn analytical and numerical methods to deal with mathematical problems.
3. Understand how to model the engineering problems and their solutions.
4. Implement the solutions to real-time complex engineering problems.
5. Apprehend with mathematical methodology.

Course content:

Unit I: Solution of linear simultaneous equations: **(8 hours)**

Consistency, Iterative method, Convergence, Cholesky's (Crout's) method, Gauss-Jordan method, Gauss-Seidel iteration and relaxation methods, Solution of Eigenvalue problems, Smallest, largest, and intermediate Eigen values

Computer based algorithm and programme for these methods (non-evaluative)

Unit II: Partial differential equation and its applications: **(10 hours)**

Introduction and classification of partial differential equation, Four standard forms of non-linear partial differential equations and their solutions, linear equations with constant coefficients. Applications of partial differential equationsone and two-dimensional wave equation, one and two-dimensional heat equation, Two-dimensional Laplace's equation.

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Unit III: Transform calculus-I: (8 hours)

Laplace transform, Properties of Laplace transform, Inverse Laplace transform,Applications of Laplace transform, Fourier integral theorem, Fourier transforms, Application of Fourier transform

Unit IV: Transform calculus-II: (8 hours)

Z-transform, Properties of Z-transform, Shifting theorems, Initial and final value theorem, Convolution theorems, Inverse Z-transform, Application of Z-transform

Unit V: Basic probability theory: (8 hours)

Concept and laws of probability,Discrete and continuous random variable and their distributions; Some special distributions such as Binomial, Poisson, Negative Binomial, Geometric, Continuous uniform, Normal, Exponential, Weibull, Moments,Moment generating functions, Expectation and variance

Practical demo with statistical software like R, SPSS, SAS, etc. (non-evaluative)

Text Books / References:

1. B.S. Grewal, Engineering Mathematics, Khanna Publications, 44th edition.
2. F.B. Hilderbrand, Method of Applied Mathematics, PHI Publications, 2nd edition.
3. M.D. Raisinghania, Ordinary and Partial Differential Equations, S. Chand Publication, 20th edition.
4. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathmematical Statistics, S. Chand Publication, 4th edition.
5. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 10th edition.
6. S. Ross, A First Course in Probability, Pearson Education, 8th edition.

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Research Methodology and IPR (AHT-302)

L:T:P:: 2:0:0 **Credits-2**

Course Objectives: Students will be able to:

1. To understand the fundaments of research in today's world controlled by technology, ideas, concept, and creativity.
2. To understand different methods of research designing and data collections.
3. To understand the methods of report writing and its different methods of interpretations.
4. To understand research ethics and methods of research publications
5. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and inturn brings about, economic growth and social benefits.

Course Outcomes:

1. To understand research problem formulation.
2. To study research design and method of data collections.
3. To study methods of report writing.
4. To follow research ethics.
5. To enhance student's competence to discover new inventions.

Syllabus Contents:

UNIT I: FUNDAMENTAL OF RESEARCH **(8 hours)**

Meaning of research; objectives of research; basic steps of research; criteria of good research; Research methods vs. Methodology. Types of research –criteria of good research; Meaning of research problem; selection of research problem; Approaches of investigation of solutions for research problem, Errors in selecting a research problem, Scope and objectives of research problem, Review of related literature-Meaning, necessity and sources.

Unit 2: RESEARCH DESIGN AND DATA COLLECTION **(8 hours)**

Research design: Types of research design- exploratory, descriptive, diagnostic and experimental;Variables- Meaning and types; Hypothesis- Meaning, function and types of hypothesis; Null/Alternative hypothesis; Sampling- Meaning and types of sampling; Probability and Non-Probability; Tools and techniques of data collection- questionnaire, schedule, interview, observation, case study, survey etc.

Unit 3:REPORT WRITING AND ITS INTERPRETATION **(8 hours)**

Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports, Conclusions.

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Unit 4:RESEARCH ETHICS AND SCHOLARY PUBLISHING (8 hours)

Ethics-ethical issues, ethical committees (human & animal); scholarly publishing- IMRAD concept and design of research paper, citation and acknowledgement, plagiarism and its concept and importance for scholar.

Unit 5: INTELLECTUAL PROPERTY RIGHT (IPR) (8 hours)

IPR- intellectual property rights and patent law, commercialization, New developments in IPR; copy right, royalty, trade related aspects of intellectual property rights (TRIPS); Process of Patenting and Development; Procedure for grants of patents, Patenting under PCT;Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases.

Reference Books:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science &engineeringstudents'"
2. WayneGoddardandStuartMelville,"ResearchMethodology:AnIntroduction"
3. RanjitKumar,2ndEdition,"ResearchMethodology:AStepbyStepGuideforbeginners"
4. Halbert,"ResistingIntellectualProperty",Taylor&FrancisLtd,2007.
5. Mayall,"IndustrialDesign",McGrawHill,1992.
6. Niebel,"ProductDesign",McGrawHill,1974.
7. Asimov,"IntroductiontoDesign",PrenticeHall,1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age",2016.
9. T.Ramappa,"IntellectualPropertyRightsUnderWTO",S.Chand,2008

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Technical Writing and Presentation Skills (AHT-303)

L:T:P::2:0:0 Non-credits

Course Objectives:

- To develop effective writing and presentation skills in students.
- To develop textual, linguistic and presentation competencies instudents appropriate for their professional careers.

Course Outcomes:

After the successful completion of course, the students will be able to:

CO1: Write clearly and fluently to produce effective technical documents.

CO2: Demonstrate an appropriate communication style to different types of audiences both orally and written as per demand of their professional careers.

CO3: Communicate in an ethically responsible manner.

Course Contents:

WRITING SKILLS

Unit-I **(4 hours)**

Technical Writing-Basic Principles: Words-Phrases-Sentences, Construction of Cohesive Paragraphs, Elements of Style.

Unit-II **(4 hours)**

Principles of Summarizing: Abstract, Summary, Synopsis

Unit-III **(6 hours)**

Technical Reports: Salient Features, Types of Reports, Structure of Reports, Data Collection, Use of Graphic Aids, Drafting and Writing

PRESENTATION SKILLS

Unit-IV **(6 hours)**

Speaking Skills: Accuracy vs. Fluency, The Audience, Pronunciation Guidelines, Voice Control.

Unit-V **(8 hours)**

Professional Presentations: Planning, Preparing, Presentation Strategies, Overcoming, Communication Barriers, Using Technology, Effective Presentations.

References:

1. Kumar, Sanjay & Pushp Lata, “Communication Skills”, Oxford UniversityPress,2011.
2. Quirk & Randolph, “A University Grammar of English”, Pearson,2006.
3. Rutherford, Andrea J., “Basic Communication Skills for Technology”, Pearson 2007.
4. Rizvi, M Ashraf, “Effective Technical Communication”, McGraw Hill,2009.

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5. Leigh, Andrew & Maynard, Michael, "The Perfect Presentation", Random House.
6. Barker, Larry L., "Communication", Prentice-Hall.
7. Lesikar&Flatley, "Basic Business Communication-Skills for Empowering the Internet Generation", Tata McGraw-Hill.