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

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

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

PROGRAM OUTCOMES (POs)

1. An ability to independently carry out research/investigation and development work to solve practical problems
2. An ability to write and present a substantial technical report/document
3. 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
4. Students will be able to design adaptive filters for a given application and to design multi- rate DSP systems.
5. Students completing this course will have a good understanding of the DSP based real time data processing system for various DSP based high speed applications.
6. An ability to apply mathematical knowledge to solve complex signal processing algorithms.

PEO/PO Mapping:

PEO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
I.	3	3	3	3	3	2
II.	3	1	2	3	2	1
III.	2	3	3	3	3	2
IV.	-	-	-	-	-	-
V.	-	-	-	-	-	-

(3-High, 2- Medium, 1- Low)

MAPPING OF COURSE OUTCOMES AND PROGRAMME OUTCOMES

		COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6
YEAR I	SEMESTER I	Applied Mathematics For Signal Processing	3	2.4	2.4	2.4	2.4	2.4
		Research Methodology and IPR	2	2	-	-	2	-
		Digital Image and Video Processing	3		2	2	2	2
		Statistical Signal Processing	3	1.6	3	3	1.8	2.6
		Modern Communication Systems	1		2.5	2	3	3
		Speech and Audio Signal Processing	2	1.6	2	2	1.6	2
		Statistical Signal Processing Laboratory	1.8	2	1.8	1.8	2	1.8
		DSP Processor Laboratory – 1	3	2	3	3	2	3
	SEMESTER II	Multimedia Compression Techniques	3		3	2	3	2
		Mixed Signal Processing	3		2	3	2	3
		Biomedical Image Processing	3	-	2	2	3	2
		Multispectral Signal Analysis	3		3	3	3	3
		Professional Elective I						
		Professional Elective II						
		DSP Processor Lab – II	2	1.5	2	2	1.5	2
		Professional Elective III						
YEAR II	SEMESTER III	Professional Elective IV						
		Professional Elective V						
		Open Elective						
	SEMESTER IV	Project Work II						

PROFESSIONAL ELECTIVE COURSES [PEC]

S. NO.	COURSE TITLE	PO1	PO2	PO3	PO4	PO5	PO6
1.	Wavelet Transforms and Its Applications	2	3	2	2	3	3
2.	Bio Signal Processing	3	3	3	3	3	2
3.	MIMO and OFDM	3	3	2	2	2	2
4.	Embedded System Design	1		2	2	3	1
5.	Digital Control Engineering	3		3	3	3	3
6.	Neural Networks and Applications	3	3	3	2	2	2
7.	Underwater Acoustics Signal Processing	2	2	2	2	2	1
8.	Signal Integrity for High Speed IC Design	3	2	3	2	3	2
9	DSP Integrated Circuits	1	2	2	2	2	2
10.	Design and Analysis of Computer Algorithms	2	3	2	1	3	3
11.	Cryptographic Techniques	3		2	1	1	1
12.	5G / 6G Wireless Communication	3	3	2	1	1	1
13.	Model based signal processing	1	2	2	2	2	2
14.	Remote Sensing	3	3	1	2	1	1
15.	Soft Computing and Its Applications for Signal Processing	3	3	2	2	2	2
16.	Pattern Recognition	3	1	2	3	1	1
17.	Multirate Signal Processing	1		3	2	2	2
18.	VLSI Signal Processing	1		2	2	1	
19.	Array Signal Processing	3		3	2	3	3
20.	Big Data Analytics	3	3	3	3	2	1
21.	Internet of Things System Design and Security	3	3	2	2	1	1
22.	Machine Learning and Deep Learning	3	3	2	3	2	2
23.	Artificial Intelligence and optimization Techniques	3	3	2	2	2	2
24.	Signal Detection and Estimation Theory	1	2	3	1.25	2	1.4
25.	Radar Signal Processing	3	3	2	2	1	1
26.	English for Research Paper Writing	1	3	-	-	2	-
27.	Disaster Management	3	1	-	-	2	-
28.	Constitution of India	1	1	1.5			2
29.	நற்றமிழ்இலக்கியம்						

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M.E. DIGITAL SIGNAL PROCESSING
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CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULA AND SYLLABI
SEMESTER I

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

*Audit course is optional

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MU4091	Multimedia Compression Techniques	PCC	3	0	0	3	3
2.	DS4201	Mixed Signal Processing	PCC	3	0	0	3	3
3.	DS4202	Biomedical Image Processing	PCC	3	0	0	3	3
4.	DS4203	Multispectral Signal Analysis	PCC	3	0	0	3	3
5.		Professional Elective I	PEC	3	0	0	3	3
6.		Professional Elective II	PEC	3	0	0	3	3
7.		Audit Course – II*	AC	2	0	0	2	0
PRACTICALS								
8.	DS4211	Term Paper Writing and Seminar	EEC	0	0	2	2	1
9.	DS4212	DSP Processor Laboratory - II	PCC	0	0	4	4	2
			TOTAL	**20**	**0**	**6**	**26**	**21**

*Audit course is optional

SEMESTER III

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

SEMESTER IV

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

TOTAL NO. OF CREDITS: 75

PROFESSIONAL ELECTIVES
SEMESTER II, ELECTIVE I

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

SEMESTER II, ELECTIVE II

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

SEMESTER III, ELECTIVE III

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

SEMESTER III, ELECTIVE IV

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	IF4094	Pattern Recognition	PEC	3	0	0	3	3
2.	DS4013	Multirate Signal Processing	PEC	3	0	0	3	3
3.	VL4351	VLSI Signal Processing	PEC	3	0	0	3	3
4.	DS4014	Array Signal Processing	PEC	3	0	0	3	3
5.	DS4015	Big Data Analytics	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE V

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

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

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

LIST OF OPEN ELECTIVES FOR PG PROGRAMMES

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	OCE431	Integrated Water Resources Management	3	0	0	3
2.	OCE432	Water, Sanitation and Health	3	0	0	3
3.	OCE433	Principles of Sustainable Development	3	0	0	3
4.	OCE434	Environmental Impact Assessment	3	0	0	3
5.	OIC431	Blockchain Technologies	3	0	0	3
6.	OIC432	Deep Learning	3	0	0	3
7.	OME431	Vibration and Noise Control Strategies	3	0	0	3
8.	OME432	Energy Conservation and Management in Domestic Sectors	3	0	0	3
9.	OME433	Additive Manufacturing	3	0	0	3
10.	OME434	Electric Vehicle Technology	3	0	0	3
11.	OME435	New Product Development	3	0	0	3

12.	OBA431	Sustainable Management	3	0	0	3
13.	OBA432	Micro and Small Business Management	3	0	0	3
14.	OBA433	Intellectual Property Rights	3	0	0	3
15.	OBA434	Ethical Management	3	0	0	3
16.	ET4251	IoT for Smart Systems	3	0	0	3
17.	ET4072	Machine Learning and Deep Learning	3	0	0	3
18.	PX4012	Renewable Energy Technology	3	0	0	3
19.	PS4093	Smart Grid	3	0	0	3
20.	CP4391	Security Practices	3	0	0	3
21.	MP4251	Cloud Computing Technologies	3	0	0	3
22.	IF4072	Design Thinking	3	0	0	3
23.	MU4153	Principles of Multimedia	3	0	0	3
24.	CX4016	Environmental Sustainability	3	0	0	3
25.	TX4092	Textile Reinforced Composites	3	0	0	3
26.	NT4002	Nanocomposite Materials	3	0	0	3
27.	BY4016	IPR, Biosafety and Entrepreneurship	3	0	0	3

FOUNDATION COURSES (FC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	MA4102	Applied Mathematics For Signa Processing Engineers	4	0	0	4	I

PROFESSIONAL CORE COURSES (PCC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	DS4151	Digital Image and Video Processing	3	0	2	4	I
2.	DS4152	Statistical Signal Processing	3	0	0	3	I
3.	DS4101	Modern Communication	3	0	0	3	I
4.	DS4102	Speech and Audio Signal Processing	3	0	0	3	I
5.	DS4111	Statistical Signal Processing Laboratory	0	0	4	2	I
6.	DS4112	DSP Processor Laboratory - I	0	0	4	2	I
7.	DS4251	Multimedia Compression Techniques	3	0	0	3	II
8.	DS4201	Mixed Signal Processing	3	0	0	3	II
9.	DS4202	Biomedical Image Processing	3	0	0	3	II

10.	DS4203	Multispectral Signal Analysis	3	0	0	3	II
11.	DS4212	DSP Processor Laboratory - II	0	0	4	2	II

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	RM4151	Research Methodology and IPR	2	0	0	2	1

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	DS4211	Term Paper Writing and Seminar	0	0	2	1	II
2.	DS4311	Project Work I	0	0	12	6	III
3.	DS4411	Project Work II	0	0	24	12	IV

SUMMARY

Sl. No.	NAME OF THE PROGRAMME: M.E. DIGITAL SIGNAL PROCESSING					
	SUBJECT AREA	CREDITS PER SEMESTER				CREDITS TOTAL
		I	II	III	IV	
1.	FC	04	00	00	00	04
2.	PCC	17	14	00	00	31
3.	PEC	00	06	10	00	16
4.	RMC	02	00	00	00	02
5.	OEC	00	00	03	00	03
6.	EEC	00	01	06	12	19
7.	Non Credit/Audit Course	✓	✓	00	00	
8.	**TOTAL CREDIT**	**23**	**21**	**19**	**12**	**75**

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

COURSE OBJECTIVES :

This course will help the students to

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

UNIT I LINEAR ALGEBRA 12

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

UNIT II BESSEL FUNCTIONS 12

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

UNIT III LINEAR PROGRAMMING 12

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

UNIT IV NUMERICAL SOLUTION OF ALGEBRAIC EQUATIONS 12

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

UNIT V NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS 12

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

TOTAL: 60 PERIODS

COURSE OUTCOMES :

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

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

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

REFERENCES :

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

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	1	1	1	1	1
2	3	2	2	2	2	2
3	3	3	3	3	3	3
4	3	3	3	3	3	3
5	3	3	3	3	3	3
Avg	3	2.4	2.4	2.4	2.4	2.4

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

COURSE OBJECTIVES:

- To arrange the conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose
- To gather information in a measured and systematic manner to ensure accuracy and facilitate data analysis
- To transform and model the collected data to discover useful information for decision-making
- To create public awareness about the benefits of Intellectual property among students
- To Provide legal certainty to inventors/ Patent applicants

UNIT I RESEARCH DESIGN 6

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

UNIT II DATA COLLECTION AND SOURCES 6

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.

UNIT III DATA ANALYSIS AND REPORTING 6

Overview of Multivariate analysis, Hypotheses testing and Measures of Association.
Presenting Insights and findings using written reports and oral presentation.

UNIT IV INTELLECTUAL PROPERTY RIGHTS 6

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

UNIT V PATENTS 6

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

TOTAL:30 PERIODS

COURSE OUTCOMES:

- Ability to arrange the conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose
- Ability to gather information in a measured and systematic manner to ensure accuracy and facilitate data analysis
- Ability to transform and model the collected data to discover useful information for decision-making
- Ability to awareness about the benefits of Intellectual property
- Ability to take up legal certainty while applying for Patent

REFERENCES:

1. Cooper Donald R, Schindler Pamela S and Sharma JK, “Business Research Methods”, Tata McGraw Hill Education, 11e (2012).
2. Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007.
3. David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007.
4. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, “Professional Programme Intellectual Property Rights, Law and practice”, September 2013.

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	2	-	-	2	-
2	3	3	-	-	1	-
3	2	3	-	-	1	-
4	1	1	-	-	3	-
5	1	1	-	-	3	-
Avg	2	2	-	-	2	-

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

COURSE OBJECTIVES:

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

UNIT I FUNDAMENTALS OF IMAGE PROCESSING AND TRANSFORMS 9

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

UNIT II ENHANCEMENT AND RESTORATION 9

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

UNIT III SEGMENTATION AND RECOGNITION 9

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

UNIT IV BASIC STEPS OF VIDEO PROCESSING 9

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

UNIT V 2-D MOTION ESTIMATION 9

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

45 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

- Histogram Equalization
- Image Filtering (spatial-domain)
- Image Filtering (frequency-domain)

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

COURSE OUTCOMES:

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

CO1: Analyze the digital image, representation of digital image and digital images in transform Domain.

CO2: Analyze the detection of point, line and edges in images and understand the redundancy in images, various image compression techniques.

CO3: Analyze the video technology from analog color TV systems to digital video systems, how video signal is sampled and filtering operations in video processing.

CO4: Obtain knowledge in general methodologies for 2D motion estimation, various coding used in video processing.

CO5: Design image and video processing systems.

TOTAL:75 PERIODS

REFERENCES:

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

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3		2	2	2	2
2	3		2	2	2	2
3	3		2	2	2	2
4	3		2	2	2	2
5	3		2	2	2	2
Avg	3		2	2	2	2

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

COURSE OBJECTIVES:

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

UNIT I DISCRETE RANDOM SIGNAL PROCESSING 9

Discrete random processes – Ensemble averages – Wide sense stationary process – Properties - Ergodic process – Sample mean & variance - Auto-correlation and Auto-correlation matrices- Auto covariance and Cross covariance- Properties – White noise process – Wiener Khintchine relation - Power spectral density – Filtering random process – Spectral Factorization Theorem – Special types of Random Processes – AR,MA, ARMA Processes – Yule-Walker equations.

UNIT II PARAMETER ESTIMATION THEORY 9

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

UNIT III SPECTRUM ESTIMATION 9

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

UNIT IV SIGNAL MODELING AND OPTIMUM FILTERS 9

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

UNIT V ADAPTIVE FILTERS 9

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

COURSE OUTCOMES:

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

CO1: Analyze discrete time random processes
CO2: Apply appropriate model for estimation and signal modeling for the given problem
CO3: Analyze non-parametric and parametric methods for spectral estimation
CO4: Design optimum filter for the given problem
CO5: Design adaptive filters for different applications

TOTAL:45 PERIODS

REFERENCES:

1. Monson. H. Hayes, Statistical Digital Signal Processing and Modelling, John Willey and Sons, 1996 (Reprint 2008)

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

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2		3	2	3	3
2	2		3	2	3	3
3	2		3	2	3	3
4	3	2	3	2	3	3
5	3	2	3	2	3	3
Avg	3	2	3	2	3	3

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

COURSE OBJECTIVES:

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

UNIT I SPREAD SPECTRUM COMMUNICATIONS 9

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

UNIT II EQUALIZATION TECHNIQUES 9

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

UNIT III BLOCK AND CONVOLUTIONAL CODED COMMUNICATION 9

Linear block codes; Hamming; Golay; Cyclic; BCH ; Reed – Solomon codes. Space time block codes. Representation of codes using Polynomial, State diagram, Tree diagram, and Trellis

diagram –Decoding techniques using Maximum likelihood, Viterbi algorithm, Sequential and Threshold methods – Error probability performance for BPSK and Viterbi algorithm, Turbo Coding.

UNIT IV ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING **9**

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

UNIT V MIMO SYSTEMS **9**

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

COURSE OUTCOMES:

On Successful completion, students will be able to

CO1: Describe the concepts of spread spectrum communications
CO2: Apply appropriate equalization technique for the given problem
CO3: Analyze the performance of different block codes and convolutional codes.
CO4: Generate OFDM signals and analyze its performance
CO5: Describe MIMO systems

TOTAL:45 PERIODS

REFERENCES:

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

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	2	2	3	3
2	3	3	2	2	3	3

3	3	3	2	2	3	3
4	3	3	2	2	3	3
5	3	3	2	2	3	3
Avg	3	3	2	2	3	3

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

COURSE OBJECTIVES:

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

UNIT I MECHANICS OF SPEECH AND AUDIO 9

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

UNIT II TIME AND FREQUENCY DOMAIN METHODS FOR SPEECH PROCESSING 9

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

UNIT III LINEAR PREDICTIVE ANALYSIS OF SPEECH 9

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

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

Analysis- Synthesis Framework for M-band Filter Banks- Filter Banks for Audio Coding: Design Considerations- Quadrature Mirror and Conjugate Quadrature Filters- Tree-Structured QMF- Cosine Modulated "Pseudo QMF" M-band Banks - Cosine Modulated Perfect Reconstruction (PR) M-band Banks and Modified Discrete Cosine Transform (MDCT).

UNIT V SPEECH AND AUDIO SIGNAL PROCESSING ALGORITHMS 9

Algorithms: Dynamic Time Warping, Hidden Markov Model– Gaussian Mixture Model - Automatic

Speech Recognition – Feature Extraction for ASR - Speaker identification and verification – Voice response system – Speech Synthesis -Digital Audio Watermarking - Audio MPEG 4.

SUGGESTED ACTIVITIES:

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

COURSE OUTCOMES:

On Successful completion, students will be able to

CO1: Characterize Speech and audio signal production and perception mechanisms.

CO2: Analyze speech and audio signals in the time and frequency domains.

CO3: Design a LPC coder

CO4: Develop speech processing solutions based on filter banks

CO5: Design speech recognition, speaker identification and speech synthesis schemes.

TOTAL:45 PERIODS

REFERENCES:

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

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	2	3	2	3	3
2	3	2	3	2	3	3
3	3	2	3	2	3	3
4	3	2	3	2	3	3
5	3	2	3	2	3	3
Avg	3	2	3	2	3	3

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

PRACTICAL EXERCISES:

Using Simulation Software Tools

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

TOTAL:60 PERIODS

COURSE OUTCOMES:

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

CO1:Simulate standard discrete time signals and random signals
CO2:Detect signals in the presence of noise using appropriate method
CO3:Estimate signals and parameters using appropriate estimation techniques
CO4:Implement adaptive filtering concept for the given problem
CO5:Analyze the performance of detection and estimation techniques.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	2	3	3	2
2	3	3	2	3	3	2
3	3	3	2	3	3	2
4	3	3	2	3	3	2
5	3	3	2	3	3	2
Avg	3	3	2	3	3	2

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

PRACTICAL EXERCISES:

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

TOAL:60 PERIODS

COURSE OUTCOMES:
CO1:Write C & Assembly based Algorithms
CO2:Ability to implement and simulate signal processing algorithms
CO3:Ability to demonstrate the frequency domain analysis
CO4:Ability to demonstrate system realization using digital signal processor

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	2	3	2	2	3
2	3	2	3	2	2	3
3	3	2	3	2	2	3
4	3	2	3	2	2	3
5	-	-	-	-	-	-
Avg	3	2	3	2	2	3

MU4091 **MULTIMEDIA COMPRESSION TECHNIQUES** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand the basic ideas of compression algorithms related to multimedia components – Text, speech, audio, image and Video.
- To understand the principles and standards and their applications with an emphasis on underlying technologies, algorithms, and performance.
- To appreciate the use of compression in multimedia processing applications
- To understand and implement compression standards in detail

UNIT I FUNDAMENTALS OF COMPRESSION 9

Introduction To multimedia – Graphics, Image and Video representations – Fundamental concepts of video, digital audio – Storage requirements of multimedia applications – Need for compression – Taxonomy of compression Algorithms - Elements of Information Theory – Error Free Compression – Lossy Compression

UNIT II TEXT COMPRESSION 9

Huffman coding – Adaptive Huffman coding – Arithmetic coding – Shannon-Fano coding – Dictionary techniques – LZW family algorithms.

UNIT III IMAGE COMPRESSION 9

Image Compression: Fundamentals –– Compression Standards – JPEG Standard – Sub-band coding – Wavelet Based compression – Implementation using Filters – EZW, SPIHT coders – JPEG 2000 standards – JBIG and JBIG2 standards.

UNIT IV AUDIO COMPRESSION 9

Audio compression Techniques – μ law, A-Law companding – Frequency domain and filtering – Basic sub-band coding – Application to speech coding – G.722 – MPEG audio – progressive encoding – Silence compression, Speech compression – Formant and CELP vocoders.

UNIT V VIDEO COMPRESSION 9

Video compression techniques and Standards – MPEG video coding: MPEG-1 and MPEG-2 video coding: MPEG-3 and MPEG-4 – Motion estimation and compensation techniques – H.261 Standard – DVI technology – DVI real time compression – Current Trends in Compression standards.

TOTAL :45 PERIODS

COURSE OUTCOMES:

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

CO1: Implement basic compression algorithms familiar with the use of MATLAB and its equivalent open source environments

CO2: Design and implement some basic compression standards

CO3: Critically analyze different approaches of compression algorithms in multimedia related mini projects.

CO4 : Understand the various audio,speech compression techniques

CO5 :Understand and implement MPEG video coding techniques.

REFERENCES

1. Khalid Sayood: Introduction to Data Compression", Morgan Kauffman Harcourt India, Third Edition, 2010.
2. David Solomon, "Data Compression – The Complete Reference", Fourth Edition, Springer Verlog, New York, 2006.
3. Yun Q.Shi, Huifang Sun, "Image and Video Compression for Multimedia Engineering, Algorithms and Fundamentals", CRC Press, 2003.
4. Mark S. Drew, Ze-Nian Li, "Fundamentals of Multimedia", PHI, 2009.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	2	3	2	3	3
2	3	2	3	2	3	3
3	3	2	3	2	3	3
4	3	2	3	2	3	3
5	3	2	3	2	3	3
Avg	3	2	3	2	3	3

DS4201 **MIXED SIGNAL PROCESSING** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

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

UNIT I BASIC ELEMENTS OF SIGNAL PROCESSING 9

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

UNIT II ANALOG FILTERS 9

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

UNIT III DIGITAL FILTERS TOPOLOGIES 9

SPICE Models for DACs and ADCs- The Ideal DAC, The Ideal ADC, Number Representation, Sinc-Shaped Digital Filters- The Counter, Low pass Sinc Filters, Band pass and High pass Sinc Filters, Interpolation using Sinc Filters, Decimation using Sinc Filters, Filtering Topologies- FIR Filters, Stability and Overflow, The Bilinear Transfer Function, The Biquadratic Transfer Function.

UNIT IV CMOS DESIGN BASICS & DATA CONVERTER FUNDAMENTALS 9

Introduction to CMOS Design: Metal layers - CMOS fabrication - Electrical noise, Models for analog design – Inverter – Static and dynamic circuits – Dynamic and nonlinear analog circuits - Digital-to-Analog Converter (DAC) Specifications, Analog-to Digital Converter (ADC) Specifications.

UNIT V DATA CONVERTER ARCHITECTURES 9

Mixed-Signal Layout Issues. DSP Hardware, interfaces, applications. DAC Architectures- Digital Input Code, Resistor String, R-2R Ladder Networks, Current Steering, Charge-Scaling DACs, ADC Architectures- Flash, The Two-Step Flash ADC, The Pipeline ADC, Integrating ADCs, The Successive Approximation ADC, The Oversampling ADC

COURSE OUTCOMES:

CO1:Implement basic elements of signal processing
CO2: design analog filters Structures
CO3: design digital filters Structures
CO4: carry out the filters design in data conversions
CO5: design conversion architectures for DSP algorithms.

TOTAL:45 PERIODS

REFERENCES

1. R. Jacob Baker, CMOS Mixed-Signal Circuit Design, A John Wiley & Sons, Second Edition, 2008.
2. R. Jacob Baker, CMOS Circuit Design, Layout, And Simulation, A John Wiley & Sons, Third Edition, 2019.
3. S.Y.Kuang, H.J. White house, T. Kailath, VLSI and Modern Signal Processing, Prentice Hall, 1995.
4. Walt Kester, Mixed Signal and DSP Design Techniques, Analog Devices Inc, 2003.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	2	3	2	3
2	3	3	2	3	2	3
3	3	3	2	3	2	3
4	3	3	2	3	2	3
5	3	3	2	3	2	3
Avg	3	3	2	3	2	3

DS4202 BIOMEDICAL IMAGE PROCESSING L T P C
3 0 0 3

COURSE OBJECTIVES:

- To provide fundamental information about various medical imaging modalities
- To understand the basic concepts of image enhancement, image restoration, morphological image processing, image segmentation, feature recognition in medical images
- To provide information about classification and image visualization in medical image processing projects
- To familiarize the student with the image processing facilities in MATLAB and its equivalent open sourcetools
- To develop computational methods and algorithms to analyze and quantify biomedical data

UNIT I BASICS OF BIOMEDICAL IMAGE PROCESSING **9**

Objectives of biomedical image analysis - Computer aided diagnosis - Nature of medical images: X-ray imaging – Tomography - Nuclear medicine imaging - SPECT imaging - Positron imaging tomography – Ultrasonography - Magnetic resonance imaging. Removal of artifacts – Spatial domain filters - Frequency domain filters - Adaptive filters.

UNIT II IMAGE STORAGE AND RECONSTRUCTION **9**

Medical Image Storage, Archiving and Communication Systems and Formats Picture archiving and communication system (PACS); Formats: DICOM Radiology Information Systems (RIS) and Hospital Information Systems (HIS). Mathematical preliminaries and basic reconstruction methods, Radiology-The electromagnetic spectrum - Image reconstruction in CT scanners, SMRI, fMRI.

UNIT III SEGMENTATION AND CLASSIFICATION **9**

Medical Image Segmentation - Histogram-based methods; Region growing and watersheds; Markov Random Field models; active contours; model-based segmentation. Multi-scale segmentation; semi-automated methods; clustering-based methods; classification-based methods; atlas-guided approaches; multi-model segmentation. Medical Image Registration Intensity-based methods; cost functions; optimization techniques.

UNIT IV IMAGE REGISTRATION AND VISUALIZATION **9**

Image registration: Rigid body transformation, Affine transformation, Principal axes registration, Interactive principal axes registration, Image landmarks and Feature based registration, weighted feature based registration, Elastic deformation based registration, Image visualization – 2D display methods, 3D display methods, Surface Visualization, Volume Visualization, Virtual reality based interactive visualization

UNIT V NUCLEAR IMAGING **9**

PET and SPECT Ultrasound Imaging methods; mathematical principles; resolution; noise effect; 3D imaging; positron emission tomography; single photon emission tomography; ultrasound imaging; applications. Medical Image Search and Retrieval Current technology in medical image search, content-based image retrieval, Other Applications of Medical Imaging Validation, Image Guided Surgery, Image Guided Therapy, Computer Aided Diagnosis/Diagnostic Support Systems.

COURSE OUTCOMES:

CO1:Implement basic medical image processing algorithms
CO2:Familiar with the use of MATLAB and its equivalent open source tools
CO3:Design and implement image processing applications that incorporates different concepts of medical Image Processing
CO4:Critically analyze different approaches to implement mini projects in medical domain
CO5:Explore the possibility of applying Image processing concepts in modern hospitals

TOTAL:45 PERIODS

REFERENCES

1. Atam P.Dhawan, “Medical Image Analysis’, Wiley Interscience Publication, 2nd Edition, 2011
2. Geoff Dougherty, “Digital Image Processing for Medical Applications”, Cambridge University Press, 2010.
3. Alfred Horowitz, ‘MRI Physics for Radiologists – A Visual Approach’,Secondedition Springer Verlag Network,1995.
4. Kavyan Najarian and Robert Splerstor,” Biomedical signals and Image processing”,CRC – Taylor and Francis, New York, 2012
5. John L. Semmlow, ”Biosignal and Biomedical Image Processing Matlab Based applications” Marcel Dekker Inc., NewYork, 2004
6. Milan Sonka etal, “Image Processing, Analysis and Machine Vision”, Brooks/Cole, Vikas Publishing House, 3rd edition, 2007.
7. Wolfgang Birk fellner, “Applied Medical Image Processing – A Basic course”, RC Press, 2011.
8. Paul Suetens, "Fundamentals of Medical Imaging", Second Edition, Cambridge University Press, 2009.
9. J.Michael Fitzpatrick and Milan Sonka, "Handbook of Medical Imaging, Volume 2. Medical Image Processing and Analysis", SPIE Publications,2009.

CO-PO Mapping

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1	3	-	2	2	3	2
2	3	-	2	2	3	2
3	3	-	2	2	3	2
4	3	-	2	2	3	2
5	3	-	2	2	3	2
Avg	3	-	2	2	3	2

DS4203 MULTISPECTRAL SIGNAL ANALYSIS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To know the basics of hyperspectral sensors and applications.
- To know the concept of mutual information.
- To provide knowledge of independent component analysis
- To familiarize the student with SVM,MRF

UNIT I HYPERSPECTRAL SENSORS AND APPLICATIONS 9

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 II MUTUAL INFORMATION 9

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 III INDEPENDENT COMPONENT ANALYSIS 9

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 IV SUPPORT VECTOR MACHINES 9

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, Classification based on Decision Directed Acyclic Graph and Decision Tree Structure, optimization Methods, Applications using SVM.

UNIT V MARKOV RANDOM FIELD MODELS 9

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, IteratedConditional Modes Algorithm

COURSE OUTCOMES:

CO1: Select appropriate hyperspectral data for a particular application
CO2: Understand basic concepts of data acquisition tasks required for multi and hyperspectral data analysis.
CO3:Understand basic concepts of image processing tasks required for multi and hyperspectral data analysis
CO4: Learn techniques for classification of multi and hyperspectral data.
CO5:Learn techniques for analysis of multi and hyperspectral data.

TOTAL:45 PERIODS

REFERENCES

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
3. AAPO HYVÄRINEN, UHA KARHUNEN and ERKKI OJA,” Independent Component Analysis” John Wiley & Sons, 2001.
4. Ingo Steinwart,Andreas Christmann,”Support Vector Machines”, Springer-Verlag New York,2008.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3		3	3	3	3
2	3		3	3	3	3
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4	3		3	3	3	3
5	3		3	3	3	3
Avg	3		3	3	3	3

DS4211 **TERM PAPER WRITING AND SEMINAR** **L T P C**
0 0 2 1

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

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

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

Activity	Instructions	Submission week	Evaluation
Selection of area of interest and Topic	You are requested to select an area of interest, topic and state an objective	2nd week	**3 %** Based on clarity of thought, current relevance and clarity in writing
Stating an Objective			

Collecting Information about your area & topic	1. List 1 Special Interest Groups or professional society 2. List 2 journals 3. List 2 conferences, symposia or workshops 4. List 1 thesis title 5. List 3 web presences (mailing lists, forums, news sites) 6. List 3 authors who publish regularly in your area 7. Attach a call for papers (CFP) from your area.	3rd week	**3%** (the selected information must be area specific and of international and national standard)
Collection of Journal papers in the topic in the context of the objective – collect 20 & then filter	• You have to provide a complete list of references you will be using- Based on your objective -Search various digital libraries and Google Scholar • When picking papers to read - try to: • Pick papers that are related to each other in some ways and/or that are in the same field so that you can write a meaningful survey out of them, • Favour papers from well-known journals and conferences, • Favour "first" or "foundational" papers in the field (as indicated in other people's survey paper), • Favour more recent papers, • Pick a recent survey of the field so you can quickly gain an overview, • Find relationships with respect to each other and to your topic area (classification scheme/categorization) • Mark in the hard copy of papers whether complete work or section/sections of the paper are being considered	4th week	**6%** (the list of standard papers and reason for selection)
Reading and notes for first 5 papers	Reading Paper Process • For each paper form a Table answering the following questions: • What is the main topic of the article? • What was/were the main issue(s) the author said they want to discuss? • Why did the author claim it was important? • How does the work build on other's work, in the author's opinion? • What simplifying assumptions does the author claim to be making?	5th week	**8%** (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)

	• What did the author do? • How did the author claim they were going to evaluate their work and compare it to others? • What did the author say were the limitations of their research? • What did the author say were the important directions for future research? Conclude with limitations/issues not addressed by the paper (from the perspective of your survey)		
Reading and notes for next5 papers	Repeat Reading Paper Process	6th week	**8%** (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Reading and notes for final 5 papers	Repeat Reading Paper Process	7th week	**8%** (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Draft outline 1 and Linking papers	Prepare a draft Outline, your survey goals, along with a classification / categorization diagram	8th week	**8%** (this component will be evaluated based on the linking and classification among the papers)
Abstract	Prepare a draft abstract and give a presentation	9th week	**6%** (Clarity, purpose and conclusion) **6%** Presentation & Viva Voce
Introduction Background	Write an introduction and background sections	10th week	**5%** (clarity)
Sections of the paper	Write the sections of your paper based on the classification / categorization diagram in keeping with the goals of your survey	11thweek	**10%** (this component will be evaluated based on the linking and classification among the papers)
Your conclusions	Write your conclusions and future work	12th week	**5%** (conclusions – clarity and your

			ideas)
Final Draft	Complete the final draft of your paper	13th week	**10%** (formatting, English, Clarity and linking) **4%** Plagiarism Check Report
Seminar	A brief 15 slides on your paper	14th & 15th week	**10%** (based on presentation and Viva-voce)

TOTAL: 30 PERIODS

DS4212 DSP PROCESSOR LAB – II L T P C
0 0 4 2

COURSE OBJECTIVES:

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

PRACTICAL EXERCISES: **TOTAL: 60 PERIODS**

1. Complex Number Multiplication using TDSK
2. Computation of Radix-2 and Radix-4 FFT using DSK
3. MATLAB–DSK Interface Using RTDX
4. MATLAB–DSK Interface Using RTDX for FIR Filter Implementation
5. Adaptive Filter for Sinusoidal Noise Cancellation
6. Adaptive Predictor for Cancellation of Narrowband Interference Added to a Desired Wideband Signal
7. DSK Interface Using RTDX with MATLAB Functions for FFT and Plotting
8. Interfacing of multimedia data
9. RTDX Using LabVIEW to Provide Interface Between PC and DSK
10. Radix-4 FFT with RTDX Using Visual C++ and MATLAB for Plotting
11. Audio Effects (Echo and Reverb, Harmonics, and Distortion)
12. Mini-project based on the Matlab/Simulink-DSK

COURSE OUTCOMES:

CO1: Review the Matlab/Simulink software interface
CO2:Examine the Digital Signal Processor Kit & Matlab/Simulink hardware interface.
CO3: Develop Real Time Applications in Filters

LIST OF EQUIPMENT FOR A BATCH OF 25 STUDENTS:

SL. NO.	DESCRIPTION OF EQUIPMENT	QUANTITY REQUIRED
1	TMS 320 C67X Kits	10
2	MATLAB or Equivalent Licensed or Open Source S/W with	15

	Signal Processing Tool box	
3	CRO 50 MHz	10
4	function Generator 1 MHz	10
5	Speakers	10

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	2	1	1	2	1
2	2	1	2	2	1	2
3	3	-	3	3	-	3
4	-	-	-	-	-	-
5	-	-	-	-	-	-
Avg	2	1.5	2	2	1.5	2

DS4072 WAVELET TRANSFORMS AND ITS APPLICATIONS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To study the basics of signal representation and Fourier theory
- To understand Multi Resolution Analysis and Wavelet concepts
- To study the wavelet transform in both continuous and discrete domain
- To understand the design of wavelets using Lifting scheme
- To understand the applications of Wavelet transform

UNIT I FUNDAMENTALS 9

Vector Spaces – Properties– Dot Product – Basis – Dimension, Orthogonality and Orthonormality – Relationship Between Vectors and Signals – Signal Spaces – Concept of Convergence – Hilbert Spaces for Energy Signals- Fourier Theory: Fourier series expansion,Fourier transform, Short time Fourier transform, Time-frequency analysis

UNIT II MULTI RESOLUTION ANALYSIS 9

Definition of Multi Resolution Analysis (MRA) – Haar Basis – Construction of General Orthonormal MRA – Wavelet Basis for MRA – Continuous Time MRA Interpretation for the DTWT – Discrete Time MRA – Basis Functions for the DTWT – PRQMF Filter Banks.

UNIT III CONTINUOUS WAVELET TRANSFORMS 9

Wavelet Transform – Definition and Properties – Concept of Scale and its Relation with Frequency – Continuous Wavelet Transform (CWT) – Scaling Function and Wavelet Functions(DaubechiesCoiflet, Mexican Hat, Sinc, Gaussian, Bi Orthogonal)– Tiling of Time – Scale Plane for CWT

UNIT IV DISCRETE WAVELET TRANSFORM 9

Filter Bank and Sub Band Coding Principles – Wavelet Filters – Inverse DWT Computation by Filter Banks – Basic Properties of Filter Coefficients – Choice of WaveletFunction Coefficients – Derivations of Daubechies Wavelets – Mallat's Algorithm for DWT –Multi Band Wavelet Transforms Lifting Scheme- Wavelet Transform Using PolyphaseMatrixFactorization – Geometrical Foundations of Lifting Scheme – Lifting Scheme in Z –Domain.

UNIT V APPLICATIONS 9

Wavelet methods for signal processing- Adaptive wavelet techniques in signal acquisition, Detection of signal changes, analysis and classification of audio signals using CWT, Signal and Image compression Techniques: EZW–SPIHT Coding– Image Denoising Techniques: Noise Estimation – Shrinkage Rules – Shrinkage Functions –Edge Detection and Object Isolation, Image Fusion, and Object Detection. Wavelet based signal de-noising and energy compaction, Wavelets in adaptive filtering, Digital Communication and Multicarrier Modulation, Trans multiplexers.

COURSE OUTCOMES:

CO1: Use Fourier tools to analyse signals
CO2: Gain knowledge about MRA and representation using wavelet bases
CO3: Acquire knowledge about various wavelet transforms and design wavelet transform
CO4:Apply wavelet transform for various signal &communication applications
CO5:Apply wavelet transform for various image processing applications

TOTAL:45 PERIODS

REFERENCES:

1. Rao R M and A S Bopardikar, —Wavelet Transforms Introduction to theory and Applications, Pearson Education, Asia, 2012.
2. L.PrasadS.S.Iyengar, Wavelet Analysis with Applications to Image Processing, CRCPress, 1997.
3. J. C. Goswami and A. K. Chan, Fundamentals of wavelets: Theory, Algorithms and Applications, WileyIntersciencePublication,John Wiley & Sons Inc., 2011.
4. M. Vetterli, J. Kovacevic, Wavelets and subband coding, Prentice Hall Inc, 2013.
5. Stephen G. Mallat, A wavelet tour of signal processing, 2 nd Edition Academic Press,2009.
6. Soman K P and Ramachandran K I, Insight into Wavelets From Theory to practice,Prentice Hall, 2010.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	2	1	1	2	2
2	1	2	1	3	3	2
3	2	2	3	2	3	3
4	2	3	3	3	3	3
5	3	3	3	3	3	3
Avg	2	3	2	2	3	3

BM4151 **BIO SIGNAL PROCESSING** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To introduce the characteristics of different biosignals
- To discuss linear and non-linear filtering techniques to extract desired information
- To demonstrate the significance of wavelet detection applied in biosignal processing.
- To extract the features from the biosignal
- To introduce techniques for automated classification and decision making to aid diagnosis

UNIT I SIGNAL, SYSTEM AND SPECTRUM 9

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

UNIT II TIME SERIES ANALYSIS AND SPECTRAL ESTIMATION 9

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

UNIT III ADAPTIVE FILTERING AND WAVELET DETECTION 9

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

UNIT IV ANALYSIS OF BIOSIGNAL 9

Removal of artifact – ECG, Event detection –ECG, P Wave, QRS complex, T wave,
Correlation analysis of ECG signals, Average of Signals-PCG, ECG and EMG.

UNIT V BIOSIGNAL CLASSIFICATION AND RECOGNITION 9

Statistical signal classification, linear discriminate function, direct feature selection and ordering, Back propagation neural network based classification.
Case study: 1. Various methods used to extract features from EEG signal
Case Study 2: Diagnosis and monitoring of sleep apnea

COURSE OUTCOMES:

Upon Completion of the course, the students will be able to:
CO1: Analyse the different types of signals & systems
CO2: Analyse signals in time series domain & estimate the spectrum
CO3: Understand the significance of wavelet detection applied in biosignal processing
CO4: Extract the features from biosignal
CO5: Describe the performance of the classification of biosignals

TOTAL:45 PERIODS

REFERENCES:

1. P.Ramesh Babu, “Digital Signal Processing, Sixth Edition, Scitech publications, Chennai, 2014.
2. Raghuveer M. Rao and AjithS.Bopardikar, Wavelets transform – Introduction to theory and its applications, Pearson Education, India 2000

3. Rangaraj M. Rangayyan, 2nd edition "Biomedical Signal Analysis-A case study approach", Wiley- Interscience /IEEE Press, 2015
4. Emmanuel C. Ifeachor, Barrie W.Jervis, second edition, "Digital Signal processing- A Practical Approach" Pearson education Ltd., 2002
5. Willis J.Tompkins, Biomedical Digital Signal Processing, Prentice Hall of India, New Delhi, 2006

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	3	3	3	2
2	3	3	3	3	3	2
3	3	3	3	3	3	2
4	3	3	3	3	3	2
5	3	3	3	3	3	2
Avg	3	3	3	3	3	2

DS4001 MIMO AND OFDM L T P C
3 0 0 3

COURSE OBJECTIVES:

- Understand Concepts of diversity and spatial multiplexing in MIMO systems.
- Learn Massive MIMO system.
- Understand the concepts of OFDM and MIMO-OFDM systems.

UNIT I THEORETIC ASPECTS OF MIMO 9

Review of SISO fading communication channels, MIMO Channel models, Classical i.i.d. and extended channels, Frequency selective and correlated channels models, Capacity of MIMO channels, Erogodic and outage capacity, capacity bounds and influence of channel properties on the capacity.

UNIT II MIMO DIVERSITY AND SPATIAL MULTIPLEXING 9

Sources and types of diversity, analysis under Rayleigh fading, Diversity and channel knowledge. Alamouti space time code. MIMO spatial multiplexing: Space time receivers, ML, ZF, MMSE and Sphere decoding, BLAST receivers and Diversity multiplexing trade - off.

UNIT III MASSIVE MIMO SYSTEM 9

Introduction - MIMO for LTE, capacity of massive MIMO, Pilot Design for massive MIMO, Resource allocation and transceivers design, Baseband and RF implementation, Channel Models, power control principles.

UNIT IV OFDM SYSTEM 9

Orthogonal Frequency Division Multiplexing (OFDM), Modulation and demodulation in an OFDM system, An FFT algorithmic implementation of an OFDM system, Synchronization in schene , Peak power reduction technique.

UNIT V ST OFDM, SPREAD SPECTRUM AND MIMO MULTIUSER DETECTION 9

SISO-OFDM modulation, MIMO-OFDM modulation, Signalling and receivers for MIMO-OFDM, MIMO-SS modulation, Signalling and receivers for MIMO-SS, MIMOMAX, MIMO-BC, Outage performance for MIMO-MU, MIMO-MU with OFDM.

COURSE OUTCOMES:

CO1:Analyze MIMO and Massive MIMO systems.
CO2Understand the concepts of OFDM
CO3: knowledge on MIMO and Spatial diversity schemes.
CO4: realize the generation of OFDM signals.
CO5: knowledge on various types of MIMO-OFDM modulation schemes.
CO6: Impairments of WC to OFDM signals.

TOTAL:45 PERIODS

REFERENCES

1. David Tse and PramodViswanath, Fundamentals of Wireless Communication, Cambridge University Press2005.
2. Hamid Jafarkhani, Space - Time Coding: Theory and Practices, Cambridge University Press 2005.
3. MischaDohler, Jose F. Monserrat Afif Osseiran, 5G Mobile and Wireless Communication Technology, Cambridge University Press2016.
4. Mieczysław M Kokar, Leszek Lechowicz, Cognitive Radio Interoperability through Waveform Reconfiguration, ARTECH House2016.
5. A. Paulraj, RohitNabar, Dhananjay Gore., Introduction to Space Time Wireless Communication Systems, Cambridge University Press, 2008.
6. Claude Oestges, Bruno Clerckx., MIMO Wireless Communications: From Real-World Propagation to Space-Time Code Design , Academic Press, 2010.
7. H. Bölcskei, D. Gesbert, Constantinos, B. Papadias A.-J. van der Veen., Space-Time Wireless Systems: From Array Processing to MIMO Communications , Cambridge University Press, 2008.
8. Tolga M. Duman, Ali Ghrayeb., Coding for MIMO Communication Systems, John Wiley & Sons, 2008.
9. Richard Van Nee & Ramjee Prasad, OFDM for Multimedia Communications, Artech House Publication, 2001.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	2	2	2	2
2	3	3	2	2	2	2
3	3	3	2	2	2	2
4	3	3	2	2	2	2
5	3	3	2	2	2	2
Avg	3	3	2	2	2	2

VE4152 **EMBEDDED SYSTEM DESIGN** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand the design challenges in embedded systems.
- To program the Application Specific Instruction Set Processors.
- To understand the bus structures and protocols.
- To model processes using a state – machine model.
- To design a real time embedded system.

UNIT I EMBEDDED SYSTEM OVERVIEW **9**

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

UNIT II GENERAL AND SINGLE PURPOSE PROCESSOR **9**

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

UNIT III BUS STRUCTURES **9**

Basic Protocol Concepts, Microprocessor Interfacing – I/O Addressing, Port and Bus - based I/O, Arbitration, Serial Protocols, I2C, CAN and USB, Parallel Protocols – PCI and ARM bus, Wireless Protocols – IRDA, Bluetooth, IEEE 802.11.

UNIT IV STATE MACHINE AND CONCURRENT PROCESS MODELS **9**

Basic State Machine Model, Finite-State Machine with Data path Model, Capturing State Machine in Sequential Programming Language, Program-State Machine Model, Concurrent Process Model, Communication among Processes, Synchronization among processes, RTOS – System design using RTOS.

UNIT V SYSTEM DESIGN **9**

Burglar alarm system-Design goals -Development strategy-Software development-Relevance to more complex designs- Need for emulation -Digital echo unit-Creating echo and reverb-Design requirements-Designing the codecs -The overall system design

SUGGESTED ACTIVITIES:

1: Do microcontroller based design experiments.
2: Create program –state models for different embedded applications.
3: Design and develop embedded solutions for real world problems.

COURSE OUTCOMES:

CO1: Knowledge of different protocols
CO2: Apply state machine techniques and design process models.
CO3: Apply knowledge of embedded sotware development tools and RTOS
CO4: Apply networking principles in embedded devices.
CO5: Design suitable embedded systems for real world applications.

TOTAL:45 PERIODS

REFERENCES:

1. Frank Vahid and Tony Gwargie, "Embedded System Design", John Wiley & Sons, 2009.

2. Steve Heath, “Embedded System Design”, Elsevier, Second Edition, 2004.
3. Bruce Powel Douglas, “Real Time UML, Second Edition: Developing Efficient Objects for Embedded Systems”, 3rd Edition 2004, Pearson Education
4. Daniel W.Lewis, “Fundamentals of Embedded Software where C and Assembly Meet”, Pearson Education, 2004
5. Bruce Powel Douglas, “Real Time UML; Second Edition: Developing Efficient Objects for Embedded Systems”, 3rd Edition 1999, Pearson Education.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1		2	2	3	1
2	1		2	2	3	1
3	1		2	2	3	1
4	1		2	2	3	1
5	1		2	2	3	1
Avg	(5/5)=1		(10/5)=2	(10/5)=2	(15/5)=3	(5/5)=1

DS4002 DIGITAL CONTROL ENGINEERING L T P C
3 0 0 3

COURSE OBJECTIVES:

- To introduce continuous time systems, analysis and various controllers
- To introduce time and frequency response of digital control systems with modeling techniques.
- To introduce the design of digital controllers and analyze
- To represent state space modeling of digital systems
- To design state space based controllers for digital systems.

UNIT I PRINCIPLES OF CONTROLLERS 9

Review of frequency and time response analysis and specifications of control systems, need for controllers, continuous time compensations, continuous time PI, PD, PID controllers, digital PID controllers.

UNIT II SIGNAL PROCESSING IN DIGITAL CONTROL 9

Sampling, time and frequency domain description, aliasing, hold operation, mathematical model of sample and hold, zero and first order hold, factors limiting the choice of sampling rate, reconstruction

UNIT III MODELING AND ANALYSIS OF SAMPLED DATA CONTROL SYSTEM 9

Difference equation description, Z-transform method of description, pulse transfer function, time and frequency response of discrete time control systems, stability of digital control systems, Jury's stability test, state variable concepts, first companion, second companion, Jordan canonical models, discrete state variable models, elementary principles.

UNIT IV DESIGN OF DIGITAL CONTROL ALGORITHMS **9**

Review of principle of compensator design, Z-plane specifications, digital compensator design using frequency response plots, discrete integrator, discrete differentiator, development of digital PID controller, transfer function, design in the Z-plane.

UNIT V PRACTICAL ASPECTS OF DIGITAL CONTROL ALGORITHMS 9

Algorithm development of PID control algorithms, software implementation, implementation using microprocessors and microcontrollers, finite word length effects, choice of data acquisition systems, microcontroller based temperature control systems, microcontroller based motor speed control systems

TOTAL:45 PERIODS

COURSE OUTCOMES:

CO1: Understand the concepts of discrete system science related mathematics and principles of controllers.

CO2: Explain the discrete system, component or process to meet desired needs for signal processing in digital control systems.

CO3:Understand the Z-transform to process time sequences and solve difference equations to characterize the stability, frequency response, transient time response and steady-state error of a digital control system.

CO4: Design digital controllers in the z-domain and by approximation of S-domain design to solve discrete control engineering problems.

CO5: Understand the techniques, tools and skills related to discrete signals, computer science and modern discrete control engineering in modern engineering practice.

REFERENCES:

1. M.Gopal, Digital Control and State Variable Methods, Tata McGraw Hill, New Delhi, 4th edition, 2017.
2. John J. D'Azzo, Constantine H. Houpis, Linear Control System Analysis and Design, McGraw Hill, 5th edition, 2003.
3. Kenneth J. Ayala, The 8051 Microcontroller- Architecture, Programming and Applications, Penram International, 2nd Edition, 1996.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3		3	3	3	3
2	3		3	3	3	3
3	3		3	3	3	3
4	3		3	3	3	3
5	3		3	3	3	3
Avg	3		3	3	3	3

DS4003 **NEURAL NETWORKS AND APPLICATIONS** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

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

UNIT I BASIC LEARNING ALGORITHMS 9

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

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

Cover's Theorem on the Separability of Patterns - Exact Interpolator – Regularization Theory – Generalized Radial Basis Function Networks - Learning in Radial Basis Function Networks Applications: XOR Problem – Image Classification. Optimal Hyperplane for Linearly Separable Patterns and Nonseparable Patterns – Support Vector Machine for Pattern Recognition – XOR Problem -insensitive Loss Function –Support Vector Machines for Nonlinear Regression.

UNIT III COMMITTEE MACHINES AND NEURODYNAMICS SYSTEMS 9

Ensemble Averaging - Boosting – Associative Gaussian Mixture Model – Hierarchical Mixture of Experts Model(HME) – Model Selection using a Standard Decision Tree – A Priori and Posteriori Probabilities – Maximum Likelihood Estimation – Learning Strategies for the HME Model – EM Algorithm – Applications of EM Algorithm to HME Model.Dynamical Systems – Attractors and Stability – Non-linear Dynamical Systems- Lyapunov Stability – Neurodynamical Systems – The Cohen-GrossbergT theorem.

UNIT IV ATTRACTOR NEURAL NETWORKS AND ADAPTIVE RESONANCE THEORY 9

Associative Learning – Attractor Neural Network Associative Memory – Linear Associative Memory – Hopfield Network – Content Addressable Memory – Strange Attractors and Chaos- Error Performance of Hopfield Networks - Applications of Hopfield Networks – Simulated Annealing – Boltzmann Machine – Bidirectional Associative Memory – BAM Stability Analysis – Error Correction in BAMs - Memory Annihilation of Structured Maps in BAMS – Continuous BAMs – Adaptive BAMs – Applications.Noise-Saturation Dilemma - Solving Noise-Saturation Dilemma – Recurrent On-center – Off surround Networks – Building Blocks of Adaptive Resonance – Adaptive Resonance Theory – Applications.

UNIT V SELF ORGANISING MAPS AND PULSED NEURON MODELS 9

Self-organizing Map – Maximal Eigenvector Filtering – Sanger's Rule – Generalized Learning Law – Competitive Learning - Vector Quantization – Mexican Hat Networks – Self - organizing Feature Maps – Applications.Spiking Neuron Model – Integrate-and-Fire Neurons – Conductance Based Models – Computing with Spiking Neurons.

TOTAL:45 PERIODS

COURSE OUTCOMES:

CO1:deduce the basic Computational Algorithms
CO2:explore mathematical based computational Algorithms
CO3:knowledge of computational and dynamical systems using neural networks,
CO4:perform algorithmic training of various neural networks and training of learning self organizing systems
CO5:understand Use different methods for the various applications

REFERENCES

1. James A. Freeman and David M. Skapura, "Neural Networks Algorithms, Applications,and Programming Techniques, Pearson Education (Singapore) Private Limited, Delhi,2003.
2. Martin T.Hagan, Howard B. Demuth, and Mark Beale, "Neural Network Design", Thomson Learning, New Delhi, second edition 2014.
3. Satish Kumar, "Neural Networks: A Classroom Approach", Tata McGraw-Hill Publishing Company Limited, New Delhi, 2017.
4. Simon Haykin, "Neural Networks: A Comprehensive Foundation", 2ed., Addison Wesley Longman (Singapore) Private Limited, Delhi, 2001.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	3	2	2	2
2	3	3	3	2	2	2
3	3	3	3	2	2	2
4	3	3	3	2	2	2
5	3	3	3	2	2	2
Avg	3	3	3	2	2	2

DS4004 UNDERWATER ACOUSTICS SIGNAL PROCESSING L T P C
3 0 0 3

COURSE OBJECTIVES:

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

UNIT I UNDERWATER ACOUSTIC CHANNEL 9

Underwater Channel Characterization – Sound Transmission Losses-Acoustic Characteristics of surface layer-Ambient Noise in the ocean- Correlation properties of Ambient Noise

UNIT II SONAR 9

Basics of SONAR- correlation and ambiguities-Wideband Synthetic Aperture SONAR processing-Discrete Spatial arrays-Beam steering- Target Angle Estimation –Array Shading.

UNIT III TARGET DETECTION 9

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

UNIT IV STATISTICAL PROCESSING & ADAPTIVE SPATIAL FILTERING 9

Monostatic Sounding of Single point Targets-Target strength estimation from Echo ensemble-Optimum Filter for Maximum SNR-High Resolution Beam Forming .

UNIT V UNDERWATER ACOUSTIC COMMUNICATION 9

Underwater BioTelemetry System -system Design principle-Speech Coding and Decoding-Transmission and Detection of speech.

TOTAL:45 PERIODS

COURSE OUTCOMES:

CO1:recognize the characteristics of Underwater Channel
CO2: design underwater signal processing systems
CO3: understand the principles of SONAR
CO4: analyze the performance of underwater signal processing systems.
CO5: analyze the performance ofunderwater acoustic communication

REFERENCES:

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

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	1	2	1	1	1
2	1	1	2	2	2	1
3	2	2	2	2	2	1
4	2	2	2	2	3	1
5	2	2	2	2	3	1
Avg	2	2	2	2	2	1

DS4005 SIGNAL INTEGRITY FOR HIGH SPEED IC DESIGN L T P C 3 0 0 3

COURSE OBJECTIVES:

- To identify sources affecting the speed of digital circuits.
- To introduce methods to improve the signal transmission characteristics.
- To identify the power consideration factor during the system design

UNIT I SIGNAL PROPAGATION ON TRANSMISSION LINES 9

Transmission line equations, wave solution, wave *vs*. circuits, initial wave, delay time,

Characteristic impedance , wave propagation, reflection, and bounce diagrams Reactive terminations – L, C , static field maps of micro strip and strip line cross-sections, per unit length parameters, PCB layer stackups and layer/Cu thicknesses, cross-sectional analysis tools, Zo and Td equations for microstrip and stripline Reflection and terminations for logic gates, fan-out, logic switching , input impedance into a transmission-line section, reflection coefficient, skin-effect, dispersion.

UNIT II MULTI-CONDUCTOR TRANSMISSION LINES AND CROSS-TALK 9

Multi-conductor transmission-lines, coupling physics, per unit length parameters ,Near and far-end cross-talk, minimizing cross-talk (strip line and microstrip) Differential signalling, termination, balanced circuits ,S-parameters, Lossy and Lossless models

UNIT III NON-IDEAL EFFECTS 9

Non-ideal signal return paths – gaps, BGA fields, via transitions , Parasitic inductance and capacitance , Transmission line losses – Rs, tanδ , routing parasitic, Common-mode current, differential-mode current , Connectors

UNIT IV POWER CONSIDERATIONS AND SYSTEM DESIGN 9

SSN/SSO , DC power bus design , layer stack up, SMT decoupling ,, Logic families, power consumption, and system power delivery , Logic families and speed Package types and parasitic ,SPICE, IBIS models ,Bit streams, PRBS and filtering functions of link-path components , Eye diagrams , jitter , inter-symbol interference Bit-error rate ,Timing analysis.

UNIT V CLOCK DISTRIBUTION AND CLOCK OSCILLATORS 9

Timing margin, Clock slew, low impedance drivers, terminations, Delay Adjustments, canceling parasitic capacitance, Clock jitter.

TOTAL:45 PERIODS

COURSE OUTCOMES:

CO1: Identify the wave propagation in transmission line to find sources affecting the speed of digital circuits.
CO2: Identify methods to improve the signal transmission characteristics
CO3:Identify methods to recover non-ideal effects
CO4:Analyze fundamental power considerations and system design
CO5:Understand the various modules clock distribution and clock oscillators

REFERENCES:

1. H. W. Johnson and M. Grahm, High Speed Digital Design:A hand book of Black Magic, Prentice Hall, 1 edition 2003.
2. John D Ryder, Networks lines and field", Prentice Hall of India, 2nd edition 2015
3. Douglas Brooks, Signal Integrity Issues and Printed Circuit Board Design, Prentice Hall PTR , 2012.
4. S. Hall, G. Hall, and J. McCall, High-Speed Digital System Design: A Handbook of Interconnect Theory and Design Practices, Wiley-Interscience, 2014.
5. Eric Bogatin , Signal Integrity – Simplified , Prentice Hall PTR, 2003.

TOOLS REQUIRED

1. SPICE, source - http://www-cad.eecs.berkeley.edu/Software/software.html

2.HSPICE from synopsis, www.synopsys.com/products/ mixedsignal/hspice/hspice.html
3. SPECCTRAQUEST from Cadence, http://www.specctraquest.com

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	2	3	2	3	2
2	3	2	3	2	3	2
3	3	2	3	2	3	2
4	3	2	3	2	3	2
5	3	2	3	2	3	2
Avg	3	2	3	2	3	2

DS4006 **L T P C**

DSP INTEGRATED CIRCUITS **3 0 0 3**

COURSE OBJECTIVES:

- To impart knowledge on fundamental signal processing algorithms and systems.
- To expose digital filter concepts, structures and hardware issues.
- To understand the various modules used in general purpose digital signal processors.
- To introduce various implementation strategies for signal processing algorithms.
- To gain knowledge for tuning signal processing algorithms for VLSI.

UNIT I INTRODUCTION TO DSP INTEGRATED CIRCUITS 9

Sampling of analog signals, Selection of sample frequency, Signal- processing systems, Frequency response, Transfer functions, FFT-The Fast Fourier Transform Algorithm, Discrete cosine transforms, Image coding, Adaptive DSP algorithms, Standard digital signal processors, Application specific IC"s for DSP, DSP system design, Integrated circuit design

UNIT II DIGITAL FILTERS AND FINITE WORD LENGTH EFFECTS 9

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

UNIT III DSP ARCHITECTURES 9

DSP system architectures, Standard DSP architecture-Harvard and Modified Harvard architecture. TMS320C54x and TMS320C6x architecture, Multiprocessors and multicomputers, Systolic and Wavefro

UNIT IV SYNTHESIS OF DSP ARCHITECTURES & ARITHMETIC UNIT **9**

Synthesis: Mapping of DSP algorithms into hardware, Implementation based on complex PEs, Shared memory architecture with Bit – serial PEs.Arithmetic Unit : Conventional number system, Redundant Number system, Residue Number System, Bit-parallel and Bit-Serial arithmetic, Digit Serial arithmetic, CORDIC Algorithm, Basic shift accumulator, Reducing the memory size, Complex multipliers, Improved shift-accumulator

UNIT V CASE STUDY-INTEGRATED CIRCUIT DESIGN **9**

Layout of VLSI circuits, Layout Styles, Case Study : FFT processor, DCT processor and Interpolator.

TOTAL:45 PERIODS

COURSE OUTCOMES:

CO1: Ability to analyze and design fundamental signal processing algorithms and systems.
CO2: Adequacy to design and analyze digital filter concepts and structures.
CO3: Equipped to design general purpose digital signal processors.
CO4: Ability to use various implementation strategies for signal processing algorithms.
CO5: Equipped to design signal processing VLSI systems

REFERENCES:

1. Lars Wanhammer, DSP Integrated Circuits, Academic press, New York, 2012.
2. John J. Proakis, Dimitris G. Manolakis, Digital Signal Processing, Pearson Education, Fourth edition. 2007.
3. Avtar Singh, S.Srinivasan, Digital Signal Processing Implementations: Using DSP Microprocessors (with examples from TMS320C54XX), Thomson Publications, 2004.
4. RulphChassaing , Donald Reay, Digital Signal Processing and Applications with the TMS320C6713 and TMS320C6416 DSK, John Wiley & Sons, 2008.
5. B.Venkatramani, M.Bhaskar, Digital Signal Processors, Tata McGraw-Hill, 2002.
6. KeshabK.Parhi, VLSI Digital Signal Processing Systems design and Implementation, John Wiley & Sons, 2007.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	-	1	2	1	2	2
2	1	2	2	2	2	2
3	1	2	2	2	3	2
4	1	2	2	2	3	3
5	2	3	3	3	2	3
Avg	1	2	2	2	2	2

DS4007 DESIGN AND ANALYSIS OF COMPUTER ALGORITHMS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the usage of algorithms in computing.
- To learn the usage of graphs and its applications.
- To select and design data structures and algorithms that is appropriate for problems.
- To study the main classes of fundamental parallel algorithms.
- To study the design of algorithms.

UNIT I ROLE OF ALGORITHMS IN COMPUTING 9

Basics of algorithm: Writing – Analysis – Design, Mathematical analysis of recursive algorithm - Growth of Functions: Asymptotic Notation – Standard Notations and Common Functions- Recurrences: The Substitution Method – The Recursion-Tree Method

UNIT II DATA STRUCTURE FOR SET MANIPULATION 9

Binary Search Trees: Basics – Querying a Binary search tree – Insertion and Deletion - Red-Black trees: Properties of Red-Black Trees – Rotations – Insertion – Deletion -B- Trees: Definition of B Trees – Basic operations on B-Trees – Deleting a key from a B-Tree- Fibonacci Heaps: structure – Mergeable-heap operations- Decreasing a key and deleting a node-Bounding The Maximum Degree.

UNIT III GRAPHS 9

Elementary Graph Algorithms: Representations of Graphs – Breadth-First Search – Depth-First Search – Topological Sort – Strongly Connected Components- Minimum Spanning Trees: Growing a Minimum Spanning Tree – Kruskal and Prim- Single-Source Shortest Paths: The Bellman-Ford algorithm – Single-Source Shortest paths in Directed Acyclic Graphs – Dijkstra‘s Algorithm; All-Pairs Shortest Paths: Shortest Paths and Matrix Multiplication – The Floyd Warshall Algorithm.

UNIT IV INTRODUCTION TO PARALLEL ALGORITHMS 9

Introduction – Models of computation – Selection – Merging on EREW and CREW – Median of two sorted sequence – Fast Merging on EREW – Analyzing Parallel Algorithms

UNIT V ALGORITHM DESIGN TECHNIQUES 9

Dynamic Programming: Matrix-Chain Multiplication – Elements of Dynamic Programming – Longest Common Subsequence- Greedy Algorithms: An Activity-Selection Problem – Elements of the Greedy Strategy- Huffman Codes.

COURSE OUTCOMES:

CO1: Design data structures and algorithms to solve computing problems.
CO2: Design algorithms using graph structure and various string matching algorithms to solve real-life problems.
CO3: Understand the difference between sequential and parallel algorithms.
CO4: Design parallel algorithms in various models of parallel computation.
CO5: Apply suitable design strategy for problem solving.

TOTAL:45 PERIODS

REFERENCES

1. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, “Data Structures and Algorithms”, Pearson Education, Reprint 2006.
2. Robert Sedgewick and Kevin Wayne, “ALGORITHMS”, Fourth Edition, Pearson Education.
3. S.Sridhar,”Design and Analysis of Algorithms”, First Edition, Oxford University Press. 2014.
4. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, “Introduction to Algorithms”, Third Edition, Prentice-Hall, 2011.
5. Selim G. Akl, “The Design and Analysis of Parallel Algorithms”, Prentice Hall, New Jersey,1989.
6. Michael J. Quinn, “Parallel Computing: Theory & Practice”, Tata McGraw Hill Edition, 2003.
7. Joseph JaJa, “Introduction to Parallel Algorithms”, Addison-Wesley, 1992

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	2	2	1	3	3
2	2	3	2	1	3	3
3	2	3	2	1	2	3
4	2	3	2	1	3	3
5	2	3	2	1	3	3
Avg	2	3	2	1	3	3

DS4008 CRYPTOGRAPHIC TECHNIQUES L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand about encryption and key generation techniques
- To learn about Authentication and security measures
- To understand various attacks present over encryption and authentications techniques
- To study security system and wireless security analysis

UNIT I OVERVIEW OF ENCRYPTION AND CIPHER 9

Overview: Classical Encryption – Substitution Cipher – One-time-pad Encryption – Block Ciphers – DES – Key Recovery Attacks on Block Ciphers – Iterated-DES and DESX – AES – Limitations of Key- recovery based Security - Contemporary Symmetric Ciphers – Confidentiality using Symmetric Encryption.

UNIT II PUBLIC-KEY ENCRYPTION, HASH FUNCTIONS AND MESSAGE AUTHENTICATION **9**

Introduction: Public-Key Cryptography and RSA – Key Management – Diffie-Hellman Key Exchange – Elliptic Curve Cryptography – Hash Functions – Hash Algorithms – Hash Function SHA1 – Collision resistant Hash Functions – Collision Finding Attacks - MD Transform – Syntax for message Authentication – PRF as a MAC Paradigm – CBC MAC – Universal-hashing Approach – Authenticated Encryption - Digital Signatures and Authentication Protocols

UNIT III NETWORK SECURITY PRACTICE **9**

Authentication Applications – Kerberos – X.509 Authentication Service – Electronic mail Security – Pretty Good Privacy – S/MIME – IP Security architecture – Authentication Header – Encapsulating Security Payload – KeyManagement - Digital cash – Schnorr's Identification protocol and Signature – Blind Signature – Distributed Ledger bitcoin – Secret Sharing – Shamir threshold scheme – Security in routing – Mixnet

UNIT IV SYSTEM SECURITY TECHNIQUES **9**

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

UNIT V WIRELESS SECURITY TECHNIQUES **9**

Introduction to Wireless LAN Security Standards – Wireless LAN Security Factors and Issues. Hacking Attacking 802.11i wireless technologies- Hacking hotspots, client attacks resources, threats of Bluetooth advanced attacks.

TOTAL:45 PERIODS

COURSE OUTCOMES:

CO1: Demonstrate the various classical encryption techniques and the adversarycapabilities.
CO2: To be able to present Encryption techniques and key generation techniques
CO3: Has practice in Authentication and security measures
CO4: Having exposure of network, security system and wireless security standards
CO5: Having coverage of wireless security standards

REFERENCES

1. AtulKahate, "Cryptography and Network Security", Tata McGraw Hill, 2003
1. Bruce Schneier, "Applied Cryptography", John Wiley and Sons Inc, 2001.
2. Charles B. Pfleeger, Shari Lawrence Pfleeger, "Security In Computing", 3rdEdition, PearsonEducation, 2003.
3. Mao, "Modern Cryptography: Theory and Practice" , First Edition, Pearson Education, 2003.
4. Stewart S. Miller, "Wi-Fi Security", McGraw Hill , 2003.
5. William Stallings, "Cryptography And Network Security – Principles And Practices", Pearson Education, 3rd Edition, 2003.
6. MihirBellare and Phillip Rogaway, "Introduction to Modern Cryptography",2005.
7. Jonathan Katz and Yehuda Lindell, "Introduction to Modern Cryptography", Chapman and Hall, CRC Press Second Edition,2015.
8. Hans Delfts and Helmut Knebl, "Introduction to Cryptography – Principles and Applications", Springer, Third Edition,2015.
9. Wolfgang Osterhage, "Wireless Security", CRC Press, 2011.
10. Michael E.Whitman and Herbert J.Mattord, "Principles of Information Security," Cengage

Learning, 4th Edition, 2011.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3		2	1	1	1
2	3		2	1	1	1
3	3		2	1	1	1
4	3		2	1	1	1
5	3		2	1	1	1
Avg	3		2	1	1	1

DS4009 **5G/6G WIRELESS COMMUNICATION** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- Get exposed to about 5G/6G communication.
- To identify the challenges and modeling of 5G propagation channels
- Will get knowledge about design techniques for 5G.
- To know the Benefits of 6G over 5G.

UNIT I INTRODUCTION TO 5G 9

Introduction–Evaluation of mobile technologies 1G to 4G (LTE, LTEA, LTEA Pro), An Overview of 5G requirements, Regulations for 5G, Spectrum Analysis and Sharing for 5G.
- Challenges in 5G Networks – Emerging Trends in 5G Networks - - Channel State Information Feedback Concepts of 3GPP LTE - Channel State Information Feedback Concepts for 5G.

UNIT II THE 5G WIRELESS PROPAGATION CHANNELS 9

Channel modelling requirements, propagation scenarios and challenges in the 5G modelling, Channel Models for mm Wave MIMO Systems.

UNIT III TRANSMISSION AND DESIGN TECHNIQUES FOR 5G 9

Basic requirements of transmission over 5G,Modulation Techniques – Orthogonal frequency division multiplexing (OFDM), generalized frequency division multiplexing (GFDM), filter bank multi-carriers (FBMC) and universal filtered multi-carrier (UFMC), Multiple Accesses Techniques – orthogonal frequency division multiple accesses (OFDMA), generalized frequency division multiple accesses (GFDMA), non orthogonal multiple accesses (NOMA).

UNIT IV ENERGY-EFFICIENT FOR 4G AND BEYOND USING HETNETS 9

Introduction - 4G and 5G HetNets System Design Components and ConsiderationsRadio Resource Management Schemes for HetNets - Energy-Efficient Schemes for HetNetsProposed Energy-Efficient RRM Design for HetNets - Energy Efficiency Improvements UsingHetNets - Numerical Results.

UNIT V CONSIDERATIONS FOR 6G 9

Requirements and use cases: Coverage – speed - capacity –power consumption – cost – latency – massive connectivity and sensing.

TOTAL:45 PERIODS

COURSE OUTCOMES:

CO1: To be able to familiar with the 5G Technology advances and their benefits.
CO2:Find out 6G Technology advances and their benefits
CO3: Understand the key RF, PHY, MAC and air interface changes required to support 5G.
CO4: Implementation options for 5G/6G.
CO5:Able to determine the Requirements and uses of 6G

REFERENCES

1. Martin Sauter, From GSM From GSM to LTE–Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband, Wiley-Blackwell, 4th edition 2021
2. AfifOsseiran, Jose.F.Monserrat, Patrick Marsch, Fundamentals of 5G Mobile Networks , Cambridge University Press, 2016.
3. Athanasios.Kanata, KonstantinaS.Nikita, PanagiotisMathiopoulos, New Directions in Wireless Communication Systems from Mobile to 5G, CRC Press, 2017.
4. Theodore S.Rappaport, Robert W.Heath, Robert C.Daniels, James N.Murdock Millimeter Wave Wireless Communications, Prentice Hall Communications, 2014.
5. Jonathan Rodriguez, Fundamentals of 5G Mobile Networks, John Wiley & Sons, 2015.
6. Amitabha Ghosh and Rapeepat Ratasuk, Essentials of LTE and LTE-A" Cambridge University Press, 2011.
7. Jochen H. Schiller, Mobile Communications, Second Edition, Pearson Education, New Delhi, 2nd edition 2014.
8. Juha Korhonen, Introduction to 4G Mobile Communications, Artech House Publishers, 2014.
9. M. Bala Krishna, Jaime LloretMauri, Advances in Mobile Computing and Communications: Perspectives and Emerging Trends in 5G Networks, CRC 2016.
10. White Paper 5G Evolution and 6G, NTT DOCOMO, INC. January 2020.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	2	1	1	1
2	3	3	2	1	1	1
3	3	3	2	1	1	1
4	3	3	2	1	1	1
5	3	3	2	1	1	1
Avg	3	3	2	1	1	1

DS4010 MODEL BASED SIGNAL PROCESSING L T P C
3 0 0 3

COURSE OBJECTIVES:

- To know the fundamentals of model based Processing
- To get familiar in Discrete Random Signals and systems
- To use State-Space Adaptation Algorithms in signal processing
- Applied Physics-Based Processors

UNIT I DISCRETE RANDOM SIGNALS AND SYSTEMS 9

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

UNIT II ESTIMATION THEORY AND MODEL-BASED PROCESSORS 9

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

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

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

UNIT IV ADAPTIVE STATE-SPACE MODEL-BASED PROCESSORS 9

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

UNIT V APPLIED PHYSICS-BASED PROCESSORS 9

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

TOTAL:45 PERIODS

OUTCOMES:

CO1:To be able to understand the fundamentals of model based Processing
CO1: To be able to learn estimation theory and model-based processors
CO3:Can implement the State-Space Adaptation Algorithms
CO4: Can be able to Apply Physics-Based Processors in real time
CO5: Students can become a Model Based Signal Developer

REFERENCES

1. James V. Candy, Model-based signal processing, IEEE Press: Wiley-Interscience, 2006.
2. J. Candy, Signal Processing: The Modern Approach, New York: McGraw-Hill, 1989.
3. S. Kay, Modern Spectral Estimation: Theory and Applications, Englewood Cliffs, NJ: Prentice-Hall, 1999.
4. S. Kay, Fundamentals of Statistical Signal Processing: Estimation Theory, Englewood Cliffs, NJ: Prentice-Hall, 1993.
5. Monson H. Hayes, Statistical Digital Signal Processing and Modeling, John Wiley and Sons, Inc, Singapore, 2012.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	-	1	2	1	2	1
2	-	1	2	1	2	1
3	1	2	2	2	2	3
4	2	3	3	3	3	3
5	3	3	3	3	3	3
Avg	1	2	2	2	2	2

DS4011 REMOTE SENSING L T P C
3 0 0 3

OBJECTIVES

- To introduce the concepts of remote sensing processes and its components.
- To Enhance knowledge about optical, thermal and microwaves based Remote Sensing and Applications.
- To expose the various remote sensing platform and sensors and to introduce the elements of data interpretation

UNIT I BASIC CONCEPTS OF REMOTE SENSING 9

History, Development, Definition, Concept & Principles, Electromagnetic Radiation (EMR) and Its Characteristics, Wavelength Regions and their Significance, Interaction of EMR with Atmosphere and Earth‟s Surface: Absorption, Reflectance and Scattering, Atmospheric Windows, Energy Balance Equation, Spectral Response and Spectral Signature, Spectral, Spatial, Temporal and Radiometric resolutions.

UNIT II DATA ACQUISITION 9

Platform: Balloon, Rocket, Helicopter, Aircraft and Spacecraft, Aerial vs. Satellite Remote Sensing, Satellites and their Specifications: LANDSAT, SPOT, ENVISAT, RADARSAT, IRS, IKONOS, Sensors and their Specifications: MSS, TM, LISS(I,II,III,IV), PAN, WiFS, AWiFS, MODIS, Weather& Communication Satellites.

UNIT III **OPTICAL, THERMAL AND MICROWAVE REMOTE SENSING** **9**

Imaging and Non-Imaging, Active and Passive, Multispectral, Super Spectral and Hyperspectral Sensors, Electro-Optical Systems, Opto-Mechanical Scanners, Infrared Scanners, Scatterometer, Thermal Properties of Terrain, Thermal IR Environmental Considerations, Thermal Infrared and Thermal Scanners, Microwave Remote sensing concepts:, Backscattering, Range Direction, Azimuth Direction, Incident Angle, Depression Angle, Polarization, Dielectric Properties, Surface Roughness and Interpretation, Speckle and Its Reduction, Applications of optical, thermal and microwave remote sensing.

UNIT IV **HYPERSPECTRAL REMOTE SENSING AND IMAGE ANALYSIS** **9**

Diffraction principles - field spectrum – BDRF and spectral reflectance & imaging spectrometry sensors - virtual dimensionality – Hughe's phenomenon - Data reduction, Calibration and normalization – library matching. Spectral library – response functions – MNF transformation –- library matching, spectral angle mapper, BBMLC-spectral mixture analysis – end member extraction – spectral unmixing- MIA analysis concepts - PCF, PCA, WPCA spectral transformation – band detection, reduction and selection principles – Applications.

UNIT V **LIDAR** **9**

Principles and Properties- different LiDAR System- Space Borne and airborne LiDAR missions – Typical parameters of LiDAR system. Data Processing – geometric correction-data quality enhancement – filtering LiDAR mapping applications – hydrology, Disaster mitigation and management.

OUTCOMES:

CO1: To understand the physical principles in remote sensing.

CO2:To understand the sensing process in remote sensing

CO3: To understand the different type of sensors (optical, microwave, thermal and LIDAR) and their characteristics.

CO4: To understand the types and configuration of various satellites and sensors

CO5: To understand the concepts of hyperspectral remote sensing and their applications

TOTAL:45 PERIODS

REFERENCES:

1. Richards, Remote sensing digital Image Analysis-An Introduction Springer - Verlag, 5th edition 2012.
2. Lillesand, T.M. and Kiefer R.W. Remote Sensing and Image interpretation, John Wiley andSons, Inc, New York, Sixth edition 2011.
3. Ulaby, F.T., Moore, R.K, Fung, A.K, Microwave Remote Sensing; active and passive, Vol.1,2 and 3, Addison - Wesley publication company 2001
4. Janza, F.Z., Blue H.M. and Johnson,J.E. Manual of Remote Sensing. Vol.I, American Society of Photogrammetry, Virginia, USA, 2002.
5. Verbyla, David, Satellite Remote Sensing of Natural Resources. CRC Press, 2022.
6. Paul Curran P.J. Principles of Remote Sensing. Longman, RLBS, 2003.
7. Woodhouse lain.H, Introduction to Microwave Remote Sensing Taylor & Francis 2006.
8. Joseph,George and Jeganathan, C. "Fundamentals of Remote Sensing", 3 rdEdition, Universities press (India) Pvt. Ltd., Hyderabad.2017.

9. Jensen, J.R. “Remote Sensing of the Environment – An Earth Resources Perspective”, Pearson Education, Inc. (Singapore) Pvt. Ltd., Indian edition, Delhi. (2006).
10. Lillesand, Thomas M. and Kiefer, Ralph, W. “Remote Sensing and Image Interpretation”, 4th Edition, John Wiley and Sons, New York. (2007).

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	1	2	1	1
2	3	3	1	2	1	1
3	3	3	1	2	1	1
4	3	3	1	2	1	1
5	3	3	1	2	1	1
Avg	3	3	1	2	1	1

DS4012 SOFT COMPUTING AND ITS APPLICATIONS FOR SIGNAL PROCESSING **L T P C 3 0 0 3**

COURSE OBJECTIVES:

- To learn various Soft computing frameworks.
- To understand the concept of fuzzy set and fuzzy logic.
- To familiarize with the design of various artificial neural networks.
- To gain insight onto stochastic techniques.
- To gain knowledge in rough set and hybrid systems.
- To understand the various optimization techniques.

UNIT I FUZZY SETS AND FUZZY LOGIC **9**

Soft Computing: Introduction, requirement, different tools and techniques, Fuzzy sets versus crisp sets, Operations on fuzzy sets, Extension principle, Fuzzy relations and relation equations, Fuzzy numbers, Linguistic variables, Fuzzy logic, fuzzy logic controllers

UNIT II ARTIFICIAL NEURAL NETWORK **9**

Introduction, basic models, Hebb's learning, ADALINE, Perceptron, Multilayer feed forward network, Back propagation, Different issues regarding convergence of Multilayer Perceptron, Competitive learning, Self - Organizing Feature Maps, Adaptive Resonance Theory, Associative Memories, Applications.

UNIT III EVOLUTIONARY AND STOCHASTIC TECHNIQUES **9**

Genetic Algorithm (GA), different operators of GA, analysis of selection operations, Hypothesis of building blocks, Schema theorem and convergence of Genetic Algorithm, Simulated annealing and Stochastic models, Boltzmann Machine, Applications.

UNIT IV ROUGH SET AND HYBRID SYSTEMS **9**

Introduction, Imprecise Categories Approximations and Rough Sets, Decision Tables and Applications. Neural Network - based Fuzzy Systems, Fuzzy Logic - Based Neural Networks, Genetic Algorithm for Neural Network Design and Learning, Fuzzy Logic and Genetic Algorithm for Optimization, Applications.

UNIT V OPTIMIZATION TECHNIQUES **9**

Introduction to optimization techniques, Statement of an optimization problem, classification, Unconstrained optimization-gradient search method-Gradient of a function, steepest descent, Newton's Method,Marquardt Method, Constrained optimization –sequential linear programming, Interior penalty function method, external penalty function method.

COURSE OUTCOMES:

CO1: Develop a Fuzzy expert system.
CO2: Implement machine learning through artificial Neural networks
CO3: Develop aGenetic Algorithm (GA) for different operators
CO4: Model hybrid systems signal processing.
CO5: Able to use the optimization techniques to solve the real world problems

TOTAL:45 PERIODS

REFERENCES:

1. Neural Fuzzy Systems, Chin - Teng Lin & C. S. George Lee, Prentice Hall ,2000.
2. Fuzzy Sets and Fuzzy Logic: Theory and A: Theory and Applications , Klir & Yuan, PHI, 2015.
3. Neural Networks, S. Haykin, Pearson Education, 2ed, 2001.
4. Genetic Algorithms in Search and Optimization, and Machine Learning, D. E. Goldberg, Addison - Wesley, 1989.
5. Neural Networks, Fuzzy logic, and Genetic Algorithms, S. Rajasekaran& G. A. VijayalakshmiPai, PHI, 2011.
6. Neuro - Fuzzy and Soft Computing, Jang, Sun, and Mizutani, Prentice Hall,1997
7. Learning and SoftComputing, V. Kecman, MIT Press, 2001.
8. Rough Sets, Z. Pawlak, Kluwer Academic Publisher, 1991.
9. Intelligent Hybrid Systems, DaRuan, Kluwer Academic Publisher, 1997.
10. Venkata Rao and Vimal J. Savsani, Mechanical Design Optimization Using Advanced Optimization Techniques, springer 2012

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	2	2	2	2
2	3	3	2	2	2	2
3	3	3	2	2	2	2
4	3	3	2	2	2	2
5	3	3	2	2	2	2
Avg	3	3	2	2	2	2

IF4094 **PATTERN RECOGNITION** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- Understand the in-depth concept of Pattern Recognition
- Implement Bayes Decision Theory
- Understand the in-depth concept of Perception and related Concepts
- Understand the concept of ML Pattern Classification
- Understand the concept of DL Pattern Recognition

UNIT I PATTERN RECOGNITION 8

Induction Algorithms. Rule Induction. Decision Trees. BayesianMethods. Overview. NaiveBayes. The Basic Na¨ıve Bayes Classifier. Naive Bayes Induction for Numeric Attributes. Correction to the Probability Estimation. Laplace Correction. No Match. Other Bayesian Methods. Other Induction Methods. Neural Networks. Genetic Algorithms. Instance-based Learning. Support Vector Machines.

UNIT II STATISTICAL PATTERN RECOGNITION 8

About Statistical Pattern Recognition. Classification and regression. Features, Feature Vectors, and Classifiers. Pre-processing and feature extraction. The curse of dimensionality. Polynomial curve fitting. Model complexity. Multivariate non-linear functions. Bayes' theorem. Decision boundaries. Parametric methods. Sequential parameter estimation. Linear discriminant functions. Fisher's linear discriminant. Feed-forward network mappings.

UNIT III BAYES DECISION THEORY CLASSIFIERS 11

Bayes Decision Theory. Discriminant Functions and Decision Surfaces. The Gaussian Probability Density Function. The Bayesian Classifier for Normally Distributed Classes. Exact interpolation. Radial basis function networks. Network training. Regularization theory. Noisy interpolation theory. Relation to kernel regression. Radial basis function networks for classification. Comparison with the multi-layer perceptron. Basis function optimization.

UNIT IV LINEAR DISCRIMINANT FUNCTIONS 9

Linear Discriminant Functions and Decision Surfaces. The Two-Category Case. The Multicategory Case. The Perceptron Criterion Function. Batch Perceptron. Perceptron Algorithm Convergence. The Pocket Algorithm. Mean Square Error Estimation. Stochastic Approximation and the LMS Algorithm. Convergence Proof for Single-Sample Correction. Fixed increment descent. Some Direct Generalizations. Fixed increment descent. Batch variable increment Perceptron. Balanced Winnow algorithm. Relaxation Procedures. The Descent Algorithm.

UNIT V NONLINEAR CLASSIFIERS 9

The Two Layer Perception. The Three Layer Perception. Algorithms Based On Exact Classification Of The Training Set. Feedforward operation and classification. General feedforward operation. Expressive power of multilayer networks. Backpropagation algorithm. Network learning. Training protocols. Stochastic Backpropagation. Batch Backpropagation. Radial basis function networks (RBF). Special bases. Time delay neural networks (TDNN). Recurrent networks. Counter propagation. Cascade-Correlation. Cascade-correlation. Neocognitron

SUGGESTED ACTIVITIES:

1: Car Sales Pattern Classification using Support Vector Classifier
2: Avocado Sales Pattern Recognition using Linear regression
3: Tracking Movements by implementing Pattern Recognition
4: Detecting Lanes by implementing Pattern Recognition
5: Pattern Detection in SAR Images

COURSE OUTCOMES:

CO1: Discover imaging, and interpretation of temporal patterns
CO2: Identify Structural Data Patterns
CO3: Implement Pattern Classification using Machine Learning Classifiers
CO4: Implement Pattern Recognition using Deep Learning Models
CO5: Implement Image Pattern Recognition

TOTAL:45 PERIODS

REFERENCES

1. Pattern Classification, 2nd Edition, Richard O. Duda, Peter E. Hart, and David G. Stork. Wiley, 2000
2. Pattern Recognition, Jürgen Beyerer, Matthias Richter, and Matthias Nagel. **2018**
3. Pattern Recognition and Machine Learning, Christopher M. Bishop. Springer, 2010
4. Pattern Recognition and Classification, Dougherty, and Geoff. Springer, 2013
5. Practical Machine Learning and Image Processing, Himanshu Singh. Apress, 2019

CO-PO Mapping

CO	POs					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
1	3	1	2	3	1	1
2	3	1	2	3	1	1
3	3	1	2	3	1	1
4	3	1	2	3	1	1
5	3	1	2	3	1	1
Avg	(15/5)=3	(5/5)=1	(10/5)=2	(15/5)=3	(5/5)=1	(5/5)=1

DS4013 MULTIRATE SIGNAL PROCESSING L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the need of multi-rate systems and its applications.
- To understand the theory of maximally decimated filter banks.
- To provide knowledge of para-unitary perfect reconstruction and (NPR) filter banks
- To know about multirate filter banks and applications of multirate signal processing.

UNIT I FUNDAMENTALS OF MULTIRATE SYSTEMS 9

Basic multi-rate operations: up sampling and downsampling – time domain and frequency domain analysis; Aliasing and imaging, Interpolator and decimator design, Identities of multi-rate operations, Fractional sampling Rate operation, poly-phase representation. Interconnection of building blocks, multistage implementation, applications ofmulti-rate systems, special filters and filter banks.

UNIT II MAXIMALLY DECIMATED FILTER BANKS 9

Errors created in theQMF bank, alias-free QMF system, power symmetric QMFbanks, M-channel filter banks, poly-phase representation, perfect reconstruction systems, alias-free filter banks, uniform and non-uniform tree structured filter banks., trans-multiplexers, Design of uniform DFT Perfect Reconstruction (PR) QMF banks.

UNIT III PARA-UNITARY PERFECT RECONSTRUCTION FILTER BANKS 9

Lossless transfer matrices, filter bank properties induced by paraunitariness, two channel Para-unitary lattices, M-channel FIR Para-unitary QMF banks, transform coding. Two channel FIR paraunitary QMF Bank- Linear phase PR Filter banks-Necessary conditions for Linear phase property-, Lattice structures for linear phase FIR PR QMF banks, Formal synthesis of linear phase FIR PR QMF lattice; Quantization Effects: -Types of quantization effects in filter banks. – coefficient sensitivity effects, dynamic range and scaling.

UNIT IV NEAR PERFECT RECONSTRUCTION (NPR) FILTER BANKS 9

Design of uniform and non-uniform cosine modulatedfilter banks and modified DFT filter banks, Pseudo-QMF bank and its design, efficient poly-phase structures, properties of cosine matrices, cosine modulated perfect reconstruction systems, Reducing amplitude distortion-meta heuristic optimization techniques Use of Interpolated FIR (IFIR) filters, Frequency response masking (FRM) filters and Farrow structure filters in filter banks, Multiplier-less filter banks to reduce hardware complexity, implementation.

UNIT V MULTIRATE FILTER BANKS AND APPLICATIONS OF MULTIRATE SIGNAL PROCESSING 9

The short time fourier transform, wavelet transform,DiscretetimeOrthonormal wavelets, Continuous – time Orthonormal wavelet basis,Multidimensional signals, Minimum sampling density,alias-freedecimation, Multirate filter design, Applications of filter banks in Signal Processing and Communication such as hearing aids, cognitive radio, Software design radio channelizers,Analysis of audio, Speech, Image and video signals.

COURSE OUTCOMES:

CO1: Can analyze multirate systems
CO2: To be able to design decimated filter banks.
CO3: To be able to design Paraunitary Perfect Reconstruction (PR) Filter Banks.
CO4: To be able to Design Linear Phase Perfect Reconstruction QMF Banks.
CO5: Can Design and analyze Cosinemodulated Filter Banks
CO6: Can design and analyze a Multirate filter bank..

TOTAL:45 PERIODS

REFERENCE:

1. P. P. Vaidyanathan, Multirate Systems and Filter Banks, Pearson-Education, Delhi, 2004.
2. Li Tan,JeanJiang, Digital Signal Processing fundamentals and applications, Academic Press, 3rd edition 2018
3. Sanjit K Mitra ,Digital Signal Processing, Tata McGraw Hill, Fourth edition, 2011.
4. A. Spanias, T. Painter and V. Atti, Audio Signal Processing & Coding, Wiley-Interscience, NJ, USA, 2007.
5. Gilbert Strang and Truong Nguyen, "Wavelets and Filter Banks", Wellesley-Cambridge Press,1996.
6. N. J. Fliege, Multirate Digital Signal Processing, John Wiley & Sons,USA,2000.
7. VikramGadre& Aditya Abhyankar, Multiresolution and Multirate Signal Processing: Introduction, Principles and Applications, McGrawHill Education, First edition,2017.
8. Steven M. Kay , Modern Spectral Estimation, Pearson Education, First edition,2017.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1		2	1	2	1
2	1		2	2	2	2
3	1		3	2	2	2
4	2		3	2	3	2
5	2		3	2	3	3
Avg	1		3	2	2	2

VL4351 VLSI SIGNAL PROCESSING L T P C
3 0 0 3

COURSE OBJECTIVES:

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

UNIT I INTRODUCTION TO DSP SYSTEMS, PIPELINING AND PARALLEL PROCESSING OF FIR FILTERS 9

Introduction to DSP systems – typical DSP algorithms, data flow and dependence graphs – critical path, loop bound, iteration bound, longest path matrix algorithm, pipelining and parallel processing of FIR filters, pipelining and parallel processing for low power.

UNIT II RETIMING, ALGORITHMIC STRENGTH REDUCTION 9

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

UNIT III FAST CONVOLUTION, PIPELINING AND PARALLEL PROCESSING OF IIR FILTERS 9

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

UNIT IV BIT-LEVEL ARITHMETIC ARCHITECTURES 9

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

UNIT V NUMERICAL STRENGTH REDUCTION, SYNCHRONOUS AND ASYNCHRONOUS PIPELINING 9

Numerical strength reduction – sub-expression elimination, multiple constant multiplication, iterative matching, synchronous pipelining and clocking styles, clock skew in edge triggered single phase clocking, two-phase clocking, wave pipelining. Asynchronous pipelining - Bundled Data versus Dual-Rail protocol.

TOTAL:45 PERIODS

COURSE OUTCOMES:

CO1: Ability to determine the parameters influencing the efficiency of DSP architectures and apply pipelining and parallel processing techniques to alter FIR structures for efficiency

CO2: Ability to analyse and modify the design equations leading to efficient DSP architectures for transforms apply low power techniques for low power dissipation

CO3: Ability to speed up convolution process and develop fast and area efficient IIR structures

CO4: Ability to develop fast and area efficient multiplier architectures

CO5: Ability to reduce multiplications and build fast hardware for synchronous digital systems

REFERENCES

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

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1		2	2	1	
2	1		2	2	1	
3	1		2	2	1	
4	1		2	2	1	
5	1		2	2	1	

Avg	(5/5)=1		(10/5)=2	(10/5)=2	(5/5)=1	

DS4014 ARRAY SIGNAL PROCESSING L T P C
3 0 0 3

COURSE OBJECTIVES:

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

UNIT I ARRAY FUNDAMENTALS 9

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

UNIT II SPATIAL SIGNALS AND SENSOR ARRAYS 9

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

UNIT III SPATIAL FREQUENCY 9

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

UNIT IV DIRECTION OF ARRIVAL ESTIMATION 9

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

UNIT V APPLICATIONS OF ARRAY SIGNAL PROCESSING 9

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

COURSE OUTCOMES:

CO1:recognize basis of the Antenna Signals and its types
CO2: design Antenna based signal Acquisition System
CO3understand statistical techniques of the signal representation
CO4: develop different mathematical techniques for signal acquired from the Antenna Receiver system
CO5: understand different Antenna Acquisition Applications

TOTAL:45 PERIODS

REFERENCES:

1. White Paper: Bass J, McPheeters C, Finnigan J, Rodriguez E. Array Signal Processing, February 2005.
2. Dan E. Dudgeon and Don H. Johnson. Array Signal Processing: Concepts and Techniques. Prentice Hall. 1993.
3. Petre Stoica and Randolph L. Moses, Spectral Analysis of Signals. Prentice Hall. 2005
4. Simon Haykins and K. J. Ray Liu, Handbook on Array Signal Processing and Sensor Networks, Wiley, 2010.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3		3	2	3	3
2	3		3	2	3	3
3	3		3	2	3	3
4	3		3	2	3	3
5	3		3	2	3	3
Avg	3		3	2	3	3

DS4015 BIG DATA ANALYTICS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the basics of big data analytics
- To understand the search methods and visualization
- To learn mining data streams
- To learn frameworks
- To gain knowledge on R language

UNIT I INTRODUCTION TO BIG DATA 9

Introduction to Big Data Platform – Challenges of Conventional Systems - Intelligent data analysis –Nature of Data - Analytic Processes and Tools - Analysis Vs Reporting - Modern Data Analytic Tools- Statistical Concepts: Sampling Distributions - Re-Sampling - Statistical Inference - Prediction Error.

UNIT II SEARCH METHODS AND VISUALIZATION 9

Search by simulated Annealing – Stochastic, Adaptive search by Evaluation – Evaluation Strategies –Genetic Algorithm – Genetic Programming – Visualization – Classification of Visual Data Analysis Techniques – Data Types – Visualization Techniques – Interaction techniques – Specific Visual data analysis Techniques

UNIT III MINING DATA STREAMS 9

Introduction To Streams Concepts – Stream Data Model and Architecture - Stream Computing - Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating Moments – Counting Oneness in a Window – Decaying Window - Real time Analytics Platform(RTAP) Applications - Case Studies - Real Time Sentiment Analysis, Stock Market Predictions

UNIT IV FRAMEWORKS 9

MapReduce – Hadoop, Hive, MapR – Sharding – NoSQL Databases - S3 - Hadoop Distributed File Systems – Case Study- Preventing Private Information Inference Attacks on Social Networks- Grand Challenge: Applying Regulatory Science and Big Data to Improve Medical Device Innovation

UNIT V R LANGUAGE 9

Overview, Programming structures: Control statements -Operators -Functions -Environment and scope issues -Recursion -Replacement functions, R data structures: Vectors -Matrices and arrays - Lists -Data frames -Classes, Input/output, String manipulations

COURSE OUTCOMES:

CO1:understand the basics of big data analytics

CO2: Ability to use Hadoop, Map Reduce Framework.

CO3: Ability to identify the areas for applying big data analytics for increasing the business outcome.

CO4:gain knowledge on R language

CO5: Contextually integrate and correlate large amounts of information to gain faster insights.

TOTAL:45 PERIODS

REFERENCE:

1. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.
2. Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press, 3rd edition 2020.
3. Norman Matloff, The Art of R Programming: A Tour of Statistical Software Design, No Starch Press, USA, 2011.
4. Bill Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics, John Wiley & sons, 2012.
5. Glenn J. Myatt, Making Sense of Data, John Wiley & Sons, 2007.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	3	3	2	1
2	3	3	3	3	2	1
3	3	3	3	3	2	1
4	3	3	3	3	2	1
5	3	3	3	3	2	1
Avg	3	3	3	3	2	1

DS4016 INTERNET OF THINGS SYSTEM DESIGN AND SECURITY L T P C
3 0 2 4

COURSE OBJECTIVES:

- To understand the basics of IoT.
- To get an idea about the various services provided by IoT.
- To familiarize themselves with various communication techniques.
- To get an idea of some application areas where IoT can be applied.
- To understand the various issues in IoT.

UNIT I INTRODUCTION TO INTERNET OF THINGS 9

Rise of the machines – Evolution of IoT – Web 3.0 view of IoT – Definition and characteristics of IoT – Physical design of IoT – Logical design of IoT – IoT enabling technologies – IoT levels and deployment templates – A panoramic view of IoT applications.

UNIT II ARCHITECTURE OF IoT 9

Identification and Access to objects and services in the IoT environment(Current technologies for IoT naming-Solutions proposed by research projects-Research and Future development trends and forecast) – Middleware technologies for IoT system (IoT Ecosystem Overview – Horizontal Architecture Approach for IoT Systems-SOA-based IoT Middleware)Middleware architecture of RFID,WSN,SCADA,M2M–Challenges Introduced by 5G in IoT Middleware(Technological Requirements of 5G Systems-5G-based IoT Services and Applications Requirements-5G-based Challenges for IoT Middleware) - Perspectives and a Middleware Approach Toward 5G (COMPasS Middleware) – Resource management in IoT.

UNIT III SECURITY CONSIDERATIONS IN IOT SMART AMBIENT SYSTEMS 9

Security in Smart Grids and Smart Spaces for Smooth IoT Deployment in 5G (5G and the Internet of Things-Smart Spaces-Smart Grids Security and Privacy - Services that Need to Be Secure - Security Requirements -Security Attacks-Security Measures and Ongoing Research) - Security Challenges in 5G-Based IoT Middleware Systems(Security in 5G-Based IoT Middleware-Security Challenges Toward 5G).

UNIT IV IOT ENABLERS AND THEIR SECURITY AND PRIVACY ISSUES 9

Internet of Things layer wise Protocols and Standards- EPCglobal(architecture, specifications, industry adaptation, security and vulnerabilities , advantages and disadvantages)-WirelessHART-Zigbee-Near Field Communication-6LoWPAN-Dash7-Comparative Analysis.

UNIT V APPLICATIONS AND CASE STUDIES 9

Home automations - Smart cities – Environment – Energy – Retail – Logistics – Agriculture – Industry - Health and lifestyle – Case study.

PRACTICAL EXERCISES: 30 PERIODS

1. Familiarization with Arduino/Raspberry Pi and perform necessary software installation.
2. To interface Push button/Digital sensor (IR/LDR) with Arduino/Raspberry Pi and write a program to turn ON LED when push button is pressed or at sensor detection.
3. To interface DHT11 sensor with Arduino/Raspberry Pi and write a program to print temperature and humidity readings.
4. To interface OLED with Arduino/Raspberry Pi and write a program to print temperature and humidity readings on it.
5. To interface Bluetooth with Arduino/Raspberry Pi and write a program to turn LED ON/OFF when '1'/'0' is received from smartphone using Bluetooth.
6. Write a program on Arduino/Raspberry Pi to upload temperature and humidity data to thingspeak cloud.
7. Write a program on Arduino/Raspberry Pi to retrieve temperature and humidity data from thingspeak cloud.
8. Write a program on Arduino/Raspberry Pi to publish temperature data to MQTT broker.
9. Write a program to create TCP server on Arduino/Raspberry Pi and respond with humidity data to TCP client when requested.
10. Write a program to create UDP server on Arduino/Raspberry Pi and respond with humidity data to UDP client when requested.

COURSE OUTCOMES:

CO1: Articulate the main concepts, key technologies, strength and limitations of IoT.
CO2: Identify the architecture, infrastructure models of IoT.
CO3: Analyze the core issues of IoT such as security, privacy and interoperability.
CO4: Analyze and design different models for network dynamics.
CO5: Identify and design the new models for market strategic interaction.

TOTAL:75 PERIODS

REFERENCES:

1. Honbo Zhou, "Internet of Things in the cloud: A middleware perspective", CRC press 2012.
2. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on Approach)", VPT, 1st Edition, 2015.
3. Constandinos X. Mavromoustakis, George Mastorakis, Jordi MongayBatalla, "Internet of Things (IoT) in 5G Mobile Technologies" Springer International Publishing, Switzerland, 2016.
4. Dieter Uckelmann, Mark Harrison, Florian Michahelles, "Architecting the Internet of Things", Springer-Verlag Berlin Heidelberg, 2011.
5. http://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	2	2	1	1
2	3	3	2	2	1	1
3	3	3	2	2	1	1
4	3	3	2	2	1	1
5	3	3	2	2	1	1

Avg	**3**	**3**	**2**	**2**	**1**	**1**

DS4017 MACHINE LEARNING AND DEEP LEARNING L T P C
3 0 2 4

COURSE OBJECTIVES:

- To study in various learning techniques
- To develop the appropriate machine learning techniques.
- To Understand the basics concepts of deep learning.
- To Understanding CNN and RNN to model for real world applications.
- To Understand the various challenges involved in designing deep learning algorithms for varied applications.

UNIT I CONCEPT LEARNING AND DECISION-TREE LEARNING 9

Machine learning -Basics of Machine Learning applications-Learning Associations-Classification-Regression-Unsupervised Learning-Reinforcement Learning-Supervised learning-Regression-Model Selection and Generalization. Concept Learning **-**Finding a maximally specific hypothesis – Version Spaces and Candidate elimination Algorithm –Inductive Bias Decision Tree Learning - Decision Tree representation –Problems for Decision Tree Learning – Hypothesis Search space – Inductive Bias in Decision Tree Learning – Issues in Decision Tree Learning .

UNIT II CLUSTERING AND REINFORCEMENT LEARNING 9

Similarity-Based Clustering-Unsupervised learning problems-Hierarchical Agglomerative Clustering (HAC)-Single-link, complete-link, group-average similarity- k-Means and Mixtures of Gaussians-Flat clustering k-Means algorithms-Mixture of Gaussian model-EM-algorithm for mixture of Gaussian model domain.Learning task – Q learning – The Q function – Algorithm for Q learning –convergence – experimentation strategies – updating sequence –Non deterministic rewards and actions –Temporal difference learning.

UNIT III INTRODUCTON TO DEEP LEARNING 9

Biological Neuron, Idea of computational units, McCulloch–Pitts unit and Thresholding logic, Linear Perceptron, Perceptron Learning Algorithm, Linear separability. Convergence theorem for Perceptron Learning Algorithm.Feedf orward Networks: Multilayer Perceptron, Backpropagation,Radial basis function networks.

UNIT IV CONVOLUTIONAL AND RECURRENT NEURAL NETWORKS 9

Convolutional Networks: The Convolution Operation - Variants of the Basic Convolution Function -Structured Outputs - Data Types - Efficient Convolution Algorithms - Random or Unsupervised Features- LeNet, AlexNet.Recurrent Neural Networks: Bidirectional RNNs - Deep Recurrent Networks Recursive Neural Networks - The Long Short-Term Memory and Gated RNNs, Autoencoders.

UNIT V DEEP GENERATIVE MODELS 9

Deep Generative Models: Boltzmann Machines - Restricted Boltzmann Machines - Introduction to MCMC and Gibbs Sampling- gradient computations in RBMs - Deep Belief Networks- Deep Boltzmann Machines.Applications: Large-Scale Deep Learning - Computer - Speech

Recognition - Natural Language Processing.

PRACTICAL EXERCISES: 30 PERIODS

1. Development of k- nearest neighbors algorithm for classification of image data.
2. Implementation of k-means clustering algorithm for binary and multi-class classification of image data.
3. Development of expectation maximization (EM) algorithm for binary classification of the data and find the probabilities, means and variances of the respective classes.
4. Implement principle component analysis (PCA) technique on 2-D data and determine the Eigen vectors. Plot PCA space of the first two PCs.
5. Implement linear discriminant analysis (LDA) technique for data classification.
6. Design a feature map of a given data using convolution and pooling operation of convolutional neural network (CNN).
7. Implementation of AND/OR/NOT Gate using Single Layer Perceptron
8. Implement the finite words classification system using Back-propagation algorithm
9. construct a Bayesian network considering medical data
10. Use of machine learning and deep learning techniques for solving image related problems

COURSE OUTCOMES:

CO1: Acquire Knowledge in various learning techniques like decision tree, Analytical, Inductive and Reinforced learning.

CO2: Development of techniques in information science applications and appropriate machine learning techniques.

CO3: Understanding the basics concepts of deep learning.

CO4: Understanding of CNN and RNN to model for real world applications.

CO5: Understanding the various challenges involved in designing deep learning algorithms for varied applications.

TOTAL:75 PERIODS

REFERENCES:

1. EthemAlpaydin, "Introduction to Machine Learning", The MIT Press, September 2014,ISBN 978-0-262-02818-9
2. Mitchell, Tom, "Machine Learning", New York, McGraw-Hill, First Edition, 2017.
3. Ian GoodFellow,YoshuaBengio,AaronCourville ,"Deep Learning (Adaptive Computation and Machine Learning series)",MIT Press 2016.
4. Stephen Marshland, "Machine Learning: An Algorithmic Perspective", Chapman & Hall/CRC 2009.
5. MehryarMohri, AfshinRostamizadeh, AmeetTalwalkar, "Foundations of Machine Learning",MIT Press (MA) 2012.
6. Bengio, Yoshua. "Learning deep architectures for AI." Foundations and trends in Machine Learning, now publishers Inc.,2009.
7. N.D.Lewis, "Deep Learning Made Easy with R: A Gentle Introduction for Data Science",January 2016.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	2	3	2	2

2	**3**	**3**	**2**	**3**	**2**	**2**
3	**3**	**3**	**2**	**3**	**2**	**2**
4	**3**	**3**	**2**	**3**	**2**	**2**
5	**3**	**3**	**2**	**3**	**2**	**2**
Avg	**3**	**3**	**2**	**3**	**2**	**2**

DS4018 ARTIFICIAL INTELLIGENCE AND OPTIMIZATION TECHNIQUES **L T P C 3 0 2 4**

COURSE OBJECTIVES:

- To introduce the techniques of computational methods inspired by nature, such as neural networks, genetic algorithms and other evolutionary computation systems, ant swarm optimization and artificial immune systems.
- To present the main rules underlying these techniques.
- To present selected case-studies.
- To adopt these techniques in solving problems in the real world.

UNIT I NEURAL NETWORKS **9**

Neural Networks: Back Propagation Network, generalized delta rule, Radial Basis Function Network, interpolation and approximation RBFNS, comparison between RBFN and BPN, Support Vector Machines: Optimal hyperplane for linearly separable patterns, optimal hyperplane for nonlinearly separable patterns, Inverse Modeling.

UNIT II FUZZY LOGIC SYSTEMS **9**

Fuzzy Logic System: Basic of fuzzy logic theory , crisp and fuzzy sets, Basic set operation like union , interaction , complement , T-norm , T-conorm , composition of fuzzy relations, fuzzy if-then rules , fuzzy reasoning, Neuro-Fuzzy Modeling: Adaptive Neuro-Fuzzy Inference System (ANFIS) , ANFIS architecture , Hybrid Learning Algorithm.

UNIT III EVOLUTIONARY COMPUTATION & GENETIC ALGORITHMS **9**

Evolutionary Computation (EC) – Features of EC – Classification of EC – Advantages – Applications. Genetic Algorithms: Introduction – Biological Background – Operators in GA-GA Algorithm – Classification of GA – Applications

UNIT IV ANT COLONY OPTIMIZATION **9**

Ant Colony Optimization: Introduction – From real to artificial ants- Theoretical considerations – Convergence proofs – ACO Algorithm – ACO and model based search – Application principles of ACO.

UNIT V PARTICLE SWARM OPTIMIZATION **9**

Particle Swarm Optimization: Introduction – Principles of bird flocking and fish schooling – Evolution of PSO – Operating principles – PSO Algorithm – Neighborhood Topologies – Convergence criteria – Applications of PSO, Honey Bee Social Foraging Algorithms, Bacterial Foraging Optimization Algorithm.

PRACTICAL EXERCISES: 30 PERIODS

1. Data preprocessing and annotation and creation of datasets.
2. Learn existing datasets and Treebanks
3. Implementation of searching techniques in AI.
4. Implementation of Knowledge representation schemes.
5. Natural language processing tool development.
6. implement DFS and BFS
7. solution for travelling salesman Problem
8. implement Simulated Annealing Algorithm.
9. implement Hill Climbing Algorithm
10. implement Honey Bee Social Foraging Algorithms

COURSE OUTCOMES:

CO1: Ability to design and train neural networks with different rules
CO2: Ability to devise fuzzy logic rules
CO3: Ability to implement genetic algorithms
CO4: Ability to implement ANT colony optimization technique for various problems
CO5: Ability to use PSO technique

TOTAL:75 PERIODS

REFERENCES:

1. Wolfgang Ertel, “Introduction to Artificial Intelligence”, Springer, 2nd Edition, 2017
2. NelloCristianini, John Shawe-Taylor, "An Introduction to Support Vector Machines and Other Kernel-based Learning Methods”,Cambridge University Press. 2013
3. Christopher M. Bishop, “Neural Networks for Pattern Recognition”, Oxford University Press, 2005
4. H.-J. Zimmermann, “Fuzzy Set Theory and its Applications”, Springer Science+Business Media New York, 4th edition, 2006
5. David E. Goldberg, “Genetic Algorithms in search, Optimization & Machine Learning”, Pearson Education, 2006
6. Kenneth A DeJong,“Evolutionary Computation A Unified Approach”, Prentice Hall of India, New Delhi, 2006.
7. Marco Dorigo and Thomas Stutzle, “Ant Colony optimization”, Prentice Hall of India, New Delhi, 2004.
8. N P Padhy, “Artificial Intelligence and Intelligent Systems”, Oxford University Press, 2005.
9. Engelbrecht, A.P., “Fundamentals of Computational Swarm Intelligence”, Wiley, 2005.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	2	2	2	2
2	3	3	2	2	2	2
3	3	3	2	2	2	2
4	3	3	2	2	2	2
5	3	3	2	2	2	2
Avg	3	3	2	2	2	2

DS4019 SIGNAL DETECTION AND ESTIMATION THEORY L T P C
3 0 2 4

COURSE OBJECTIVES:

- To understand the basics of statistical decision theory used for signal detection and estimation.
- To learn the detection of deterministic and random signals using statistical models.
- To understand the performance of signal parameters
- To learn the basics of multi-user detection theory
- To understand Wiener filter and Kalman filter in detail

UNIT I STATISTICAL DECISION THEORY 9

Gaussian variables and processes, problem formulation and objective of signal detection and signal parameter estimation in discrete-time domain. 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 II DETECTION OF DETERMINISTIC AND RANDOM SIGNALS 9

Matched filter detector and its performance; generalized matched filter; detection of sinusoid with known and unknown amplitude, phase, frequency and arrival time, linear model,energy detectors.Detection Of Random Signals: Estimator-correlator, linear model, general Gaussian detection, detection of Gaussian random signal with unknown parameters, weak signal detection.

UNIT III ESTIMATION OF SIGNAL PARAMETERS 9

Formulation of the General Parameter Estimation Problem, Relationship between Detection and Estimation Theory, Types of Estimation Problems, Properties of Estimators, maximum likelihood estimation, Minimax Estimation ,invariance principle; estimation efficiency; Bayesian estimation: philosophy, nuisance parameters, risk functions, minimum mean square error estimation, maximum a posteriori estimation. Comparison of Estimators of Parameters.

UNIT IV SAMPLE DETECTION AND FILTERS 9

Hypothesis Testing and the MAP Criterion, Bayes Criterion, Minimax Criterion, Neyman-Pearson Criterion, Sequential Detection, The Optimum Digital Detector in Additive Gaussian Noise , Performance of Binary Receivers in AWGN. Orthogonality Principle, Autoregressive Techniques, Discrete Wiener Filter, Continuous Wiener Filter, Generalization of Discrete and Continuous Filter Representations , Linear Least-Squares Methods, Minimum-Variance Weighted Least-Squares Methods, Minimum-Variance, LeastSquares, Kalman Algorithm - Computational Considerations, Signal Estimation, Continuous Kalman Filter, Extended Kalman Filter.

UNIT V APPLICATIONS 9

Detector Structures in Non-Gaussian Noise , Examples of Noise Models, Receiver Structures, and Error-Rate Performance, Estimation of Non-Gaussian Noise Parameters Fading Multipath Channel Models, Receiver Structures with Known Channel Parameters, Receiver Structures without Knowledge of Phase, Receiver Structures without Knowledge of Amplitude or Phase, Receiver Structures and Performance with No Channel Knowledge. Complex and vector extensions of detectors: known deterministic signal in CWGN, spatially/temporally uncorrelated noise, random signal in CWGN.

PRACTICAL EXERCISES: 30 PERIODS

1. Experiment on maximum likelihood estimation
2. Experiment on Bayesian estimation
3. Experiment on FIR Wiener filter like in linear prediction of speech signals.
4. Experiment on Kalman filtering
5. detection of deterministic signals in Gaussian noise
6. estimation of signal parameters
7. detection of random signals in Gaussian noise
8. Estimation of Non-Gaussian Noise Parameters
9. Performance of Binary Receivers in AWGN
10. Detector Structures and Receiver Structures

COURSE OUTCOMES:

CO1: Acquire basics of statistical decision theory used for signal detection and estimation.
CO2: Examine the detection of deterministic and random signals using statistical models.
CO3: Examine the performance of signal parameters using optimal estimators.
CO4: To design Wiener and Kalman filters to solve linear estimation problems
CO5: designing statistical algorithms for varied applications.

TOTAL:75 PERIODS

REFERENCES:

1. Harry L. Van Trees, Detection, Estimation and Modulation Theory, Part I John Wiley and Sons, New York, 2016.
2. H. V. Poor, An Introduction to Signal Detection and Estimation, Springer, 2/e, 1998.
3. S. M. Kay, Fundamentals of Statistical Signal Processing: Estimation Theory, Prentice Hall PTR, 1993.
4. S. M. Kay, Fundamentals of Statistical Signal Processing: Detection Theory, Prentice Hall PTR, 1998.
5. Ludeman, Lonnie C., Random processes: filtering, estimation, and detection, John Wiley & Sons, Inc., 2003
6. Sergio Verdu , MultiUser Detection, Cambridge University Press, 2011.
7. Thomas Schonhoff, Detection and Estimation Theory, Prentice Hall, New Jersey, 2007.
8. Monson H. Hayes, Statistical Digital Signal Processing and Modeling, John Wiley and Sons, Inc, Singapore, 2012.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	-	2	3	-	2	1
2	-	2	3	1	2	1
3	-	2	3	1	2	1
4	-	2	3	1	2	2
5	1	2	3	2	2	2
Avg	1	2	3	1.25	2	1.4

DS4071 **RADAR SIGNAL PROCESSING** **L T P C**
3 0 2 4

COURSE OBJECTIVES:

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

UNIT I INTRODUCTION TO RADAR SYSTEMS 9

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

UNIT II SIGNAL MODELS 9

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

UNIT III SAMPLING AND QUANTIZATION OF PULSED RADAR SIGNALS 9

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

UNIT IV RADAR WAVEFORMS 9

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

UNIT V DOPPLER PROCESSING 9

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

PRACTICAL EXERCISES: 30 PERIODS

1.Matched filtering operation
2.Modeling the Propagation of Radar Signals
3.Modeling of radar targets
4. Density-based algorithm for clustering data.
5.MTI radar design, target detection in noise
6.Estimation of bearing angle in noise, clutter modelling
7.Frequency modulated radar signal generation
8.Doppler shift Signal strength
9.SNR loss measurement in pulse compression
10.detection performance of a radar system

TOTAL:75 PERIODS

COURSE OUTCOMES:

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

CO1: perform radar signal acquisition and sampling
CO2: perform algorithm on radar processing
CO3 design basic radar algorithm
CO4: design on aperture imaging and array processing
CO5: Illustrate theoretical results are derived and applied in practice

REFERENCES

1. Michael O Kolawole, "Radar systems, Peak Detection and Tracking", Elseveir. 2003
2. Introduction To Radar Systems 3/E, Skolnik, McGraw Hill. 2017
3. Radar Principles, Peyton Z. Peebles, Wiley India 2009
4. And Marvin N. Cohen, Fred E. Nathanson, Radar Design Principles-Signal Processing and the environment PHI, 2nd edition, 2006.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	2	2	1	1
2	3	3	2	2	1	1
3	3	3	2	2	1	1
4	3	3	2	2	1	1
5	3	3	2	2	1	1
Avg	3	3	2	2	1	1

AUDIT COURSES

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

COURSE OBJECTIVES:

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

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING **6**

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS 6

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

UNIT IV RESULT WRITING SKILLS 6

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS 6

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

TOTAL: 30 PERIODS

COURSE OUTCOMES:

CO1 –Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

REFERENCES:

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

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	3	-	-	2	-
2	1	3	-	-	2	-
3	1	3	-	-	2	-
4	1	3	-	-	2	-
5	1	3	-	-	2	-
Avg	1	3	-	-	2	-

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

COURSE OBJECTIVES:

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

UNIT I INTRODUCTION **6**

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS **6**

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

UNIT III DISASTER PRONE AREAS IN INDIA **6**

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT **6**

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT **6**

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

TOTAL : 30 PERIODS

COURSE OUTCOMES:

CO1: Ability to summarize basics of disaster

CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO5: Ability to develop the strengths and weaknesses of disaster management approaches

REFERENCES:

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

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	1	-	-	2	-
2	3	1	-	-	2	-
3	3	1	-	-	2	-
4	3	1	-	-	2	-
5	3	1	-	-	2	-
Avg	3	1	-	-	2	-

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

COURSE OBJECTIVES:

Students will be able to:

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

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION

History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION

Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION

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

UNIT VI ELECTION COMMISSION

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

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Students will be able to:

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

SUGGESTED READING

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

5. CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	1				
2			2			
3			1			
4						
5						2
Avg	1	1	1.5			2

AX4094 நற்றமிழ் இலக்கியம் L T P C

2 0 0 0

UNIT I சங்க இலக்கியம் 6

1. தமிழின் துவக்க நூல் தொல்காப்பியம்

– எழுத்து, சொல், பொருள்

2. அகநானூறு (82)
   - இயற்கை இன்னிசை அரங்கம்
3. குறிஞ்சிப் பாட்டின் மலர்க்காட்சி
4. புறநானூறு (95,195)
   - போரை நிறுத்திய ஔவையார்

UNIT II **அறநெறித் தமிழ்** **6**

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

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

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

UNIT IV **அருள்நெறித் தமிழ்** **6**

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

ஆகியவை பற்றிய செய்திகள்

UNIT V **நவீன தமிழ் இலக்கியம்** **6**

1. உரைநடைத் தமிழ்,
   - தமிழின் முதல் புதினம்,
   - தமிழின் முதல் சிறுகதை,

- கட்டுரை இலக்கியம்,
- பயண இலக்கியம்,
- நாடகம்,

2. நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும்,
3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும்,
4. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும்,
5. அறிவியல் தமிழ்,
6. இணையத்தில் தமிழ்,
7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.

TOTAL: 30 PERIODS

தமிழ் இலக்கிய வெளியீடுகள் / புத்தகங்கள்

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

OPEN ELECTIVES

OCE431 INTEGRATED WATER RESOURCES MANAGEMENT L T P C
3 0 0 3

OBJECTIVE

- Students will be introduced to the concepts and principles of IWRM, which is inclusive of the economics, public-private partnership, water & health, water & food security and legal & regulatory settings.

UNIT I CONTEXT FOR IWRM 9

Water as a global issue: key challenges – Definition of IWRM within the broader context of development – Key elements of IWRM - Principles – Paradigm shift in water management - Complexity of the IWRM process – UN World Water Assessment - SDGs.

UNIT II WATER ECONOMICS 9

Economic view of water issues: economic characteristics of water good and services – Non-market monetary valuation methods – Water economic instruments – Private sector involvement in water resources management: PPP objectives, PPP models, PPP processes, PPP experiences through case studies.

UNIT III LEGAL AND REGULATORY SETTINGS 9

Basic notion of law and governance: principles of international and national law in the area of water management - Understanding UN law on non-navigable uses of international water courses – International law for groundwater management – World Water Forums – Global Water Partnerships - Development of IWRM in line with legal and regulatory framework.

UNIT IV WATER AND HEALTH WITHIN THE IWRM CONTEXT 9

Links between water and health: options to include water management interventions for health – Health protection and promotion in the context of IWRM – Global burden of Diseases - Health impact assessment of water resources development projects – Case studies.

UNIT V AGRICULTURE IN THE CONCEPT OF IWRM 9

Water for food production: 'blue' versus 'green' water debate – Water foot print - Virtual water trade for achieving global water and food security –- Irrigation efficiencies, irrigation methods - current water pricing policy– scope to relook pricing.

TOTAL: 45 PERIODS

OUTCOMES

- On completion of the course, the student is expected to be able to

CO1	Describe the context and principles of IWRM; Compare the conventional and integrated ways of water management.
CO2	Select the best economic option among the alternatives; illustrate the pros and cons of PPP through case studies.
CO3	Apply law and governance in the context of IWRM.
CO4	Discuss the linkages between water-health; develop a HIA framework.
CO5	Analyse how the virtual water concept pave way to alternate policy options.

REFERENCES:

1. Cech Thomas V., Principles of water resources: history, development, management and policy. John Wiley and Sons Inc., New York. 2003.
2. Mollinga .P. etal " Integrated Water Resources Management", Water in South Asia Volume I, Sage Publications, 2006.
3. Technical Advisory Committee, Integrated Water Resources management, Technical Advisory Committee Background Paper No: 4. Global water partnership, Stockholm, Sweden. 2002.
4. Technical Advisory Committee, Dublin principles for water as reflected in comparative assessment of institutional and legal arrangements for Integrated Water Resources Management, Technical Advisory Committee Background paper No: 3. Global water partnership, Stockholm, Sweden. 1999.
5. Technical Advisory Committee, Effective Water Governance". Technical Advisory Committee Background paper No: 7. Global water partnership, Stockholm, Sweden, 2003.

OCE432 WATER, SANITATION AND HEALTH L T P C

3 0 0 3

OBJECTIVES:

• Understand the accelerating health impacts due to the present managerial aspects and initiatives in water and sanitation and health sectors in the developing scenario

UNIT I FUNDAMENTALS WASH 9

Meanings and Definition: Safe Water- Health, Nexus: Water- Sanitation - Health and Hygiene – Equity issues-Water security - Food Security. Sanitation And Hygiene (WASH) and Integrated Water Resources Management (IWRM) - Need and Importance of WASH

UNIT II MANAGERIAL IMPLICATIONS AND IMPACT 9

Third World Scenario – Poor and Multidimensional Deprivation--Health Burden in Developing Scenario -Factors contribute to water, sanitation and hygiene related diseases-Social: Social Stratification and Literacy Demography: Population and Migration- Fertility - Mortality-Environment: Water Borne-Water Washed and Water Based Diseases - Economic: Wage - Water and Health Budgeting -Psychological: Non-compliance - Disease Relapse - Political: Political Will.

UNIT III CHALLENGES IN MANAGEMENT AND DEVELOPMENT 9

Common Challenges in WASH - Bureaucracy and Users- Water Utilities -Sectoral Allocation:-Infrastructure- Service Delivery: Health services: Macro and Micro- level: Community and Gender Issues- Equity Issues - Paradigm Shift: Democratization of Reforms and Initiatives.

UNIT IV GOVERNANCE 9

Public health -Community Health Assessment and Improvement Planning (CHA/CHIP)-Infrastructure and Investments on Water, (WASH) - Cost Benefit Analysis – Institutional Intervention-Public Private Partnership - Policy Directives - Social Insurance -Political Will vs Participatory Governance -

UNIT V INITIATIVES 9

Management vs Development -Accelerating Development- Development Indicators -Inclusive Development-Global and Local- Millennium Development Goal (MDG) and Targets - Five Year Plans - Implementation - Capacity Building - Case studies on WASH.

TOTAL: 45 PERIODS

OUTCOMES:

CO1	Capture to fundamental concepts and terms which are to be applied and understood all through the study.
CO2	Comprehend the various factors affecting water sanitation and health through the lens of third world scenario.
CO3	Critically analyse and articulate the underlying common challenges in water, sanitation and health.
CO4	Acquire knowledge on the attributes of governance and its say on water sanitation and health.
CO5	Gain an overarching insight in to the aspects of sustainable resource management in the absence of a clear level playing field in the developmental aspects.

REFERENCES

1. Bonitha R., Beaglehole R.,Kjellstorm, 2006, “Basic Epidemiology”, 2nd Edition, World Health Organization.

2. Van Note Chism, N. and Bickford, D. J. (2002), Improving the environment for learning: An expanded agenda. New Directions for Teaching and Learning, 2002: 91–98. doi: 10.1002/tl.83Improving the Environment for learning: An Expanded Agenda

3. National Research Council. *Global Issues in Water, Sanitation, and Health: Workshop Summary***.** Washington, DC: The National Academies Press, 2009.

4. Sen, Amartya 1997. On Economic Inequality. Enlarged edition, with annex by JamesFoster and Amartya Sen, Oxford: Claredon Press, 1997.

5. Intersectoral Water Allocation Planning and Management, 2000, World Bank Publishers www. Amazon.com

6. Third World Network.org (www.twn.org).

OCE433 PRINCIPLES OF SUSTAINABLE DEVELOPMENT L T P C
3 0 0 3

OBJECTIVES:

- To impart knowledge on environmental, social and economic dimensions of sustainability and the principles evolved through landmark events so as to develop an action mindset for sustainable development.

UNIT I SUSTAINABILITY AND DEVELOPMENT CHALLEGES 9

Definition of sustainability – environmental, economical and social dimensions of sustainability - sustainable development models – strong and weak sustainability – defining development-millennium development goals – mindsets for sustainability: earthly, analytical, precautionary, action and collaborative– syndromes of global change: utilisation syndromes, development syndromes, and sink syndromes – core problems and cross cutting Issues of the 21 century - global, regional and local environmental issues – social insecurity - resource degradation –climate change – desertification.

UNIT II PRINCIPLES AND FRAME WORK 9

History and emergence of the concept of sustainable development - our common future - Stockholm to Rio plus 20– Rio Principles of sustainable development – Agenda 21 natural step-peoples earth charter – business charter for sustainable development –UN Global Compact - Role of civil society, business and government – United Nations' 2030 Agenda for sustainable development – 17 sustainable development goals and targets, indicators and intervention areas

UNIT III SUSTAINABLE DEVELOPMENT AND WELLBEING 9

The Unjust World and inequities - Quality of Life - Poverty, Population and Pollution - Combating Poverty - - Demographic dynamics of sustainability - Strategies to end Rural and Urban Poverty and Hunger – Sustainable Livelihood Framework- Health, Education and Empowerment of Women, Children, Youth, Indigenous People, Non-Governmental Organizations, Local Authorities and Industry for Prevention, Precaution , Preservation and Public participation.

UNIT IV SUSTAINABLE SOCIO-ECONOMIC SYSTEMS 10

Sustainable Development Goals and Linkage to Sustainable Consumption and Production – Investing in Natural Capital- Agriculture, Forests, Fisheries - Food security and nutrition and sustainable agriculture- Water and sanitation - Biodiversity conservation and Ecosystem integrity – Ecotourism - Sustainable Cities – Sustainable Habitats- Green Buildings - Sustainable Transportation –– Sustainable Mining - Sustainable Energy– Climate Change –Mitigation and Adaptation - Safeguarding Marine Resources - Financial Resources and Mechanisms

UNIT V ASSESSING PROGRESS AND WAY FORWARD 8

Nature of sustainable development strategies and current practice**-** Sustainability in global, regional and national context –Approaches to measuring and analysing sustainability– limitations of GDP- Ecological Footprint- Human Development Index- Human Development Report – National initiatives for Sustainable Development - Hurdles to Sustainability - Science and Technology for sustainable development –Performance indicators of sustainability and Assessment mechanism – Inclusive Green Growth and Green Economy – National Sustainable Development Strategy Planning and National Status of Sustainable Development Goals

TOTAL: 45 PERIODS

OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1	Explain and evaluate current challenges to sustainability, including modern world social, environmental, and economic structures and crises.
CO2	Identify and critically analyze the social environmental, and economic dimensions of sustainability in terms of UN Sustainable development goals
CO3	Develop a fair understanding of the social, economic and ecological linkage of Human well being, production and consumption
CO4	Evaluate sustainability issues and solutions using a holistic approach that focuses on connections between complex human and natural systems.
CO5	Integrate knowledge from multiple sources and perspectives to understand environmental limits governing human societies and economies and social justice dimensions of sustainability.

REFERENCES:

1. Tom Theis and Jonathan Tomkin, Sustainability: A Comprehensive Foundation, Rice University, Houston, Texas, 2012
2. A guide to SDG interactions:from science to implementation, International Council for Science, Paris,2017
3. Karel Mulder, Sustainable Development for Engineers - A Handbook and Resource Guide, Rouledge Taylor and Francis, 2017.
4. The New Global Frontier - Urbanization, Poverty and Environmentin the 21st Century - *George Martine,Gordon McGranahan,Mark Montgomery and Rogelio Fernández-Castilla,* IIED and UNFPA, Earthscan, UK, 2008
5. Nolberto Munier, Introduction to Sustainability: Road to a Better Future, Springer, 2006
6. Barry Dalal Clayton and Stephen Bass, Sustainable Development Strategies- a resource book", Earthscan Publications Ltd, London, 2002.

OCE434 ENVIRONMENTAL IMPACT ASSESSMENT L T P C

3 0 0 3

OBJECTIVES:

- To make the students to understand environmental clearance, its legal requirements and to provide knowledge on overall methodology of EIA, prediction tools and models, environmental management plan and case studies.

UNIT I INTRODUCTION 9

Historical development of Environmental Impact Assessment (EIA). Environmental Clearance- EIA in project cycle. legal and regulatory aspects in India – types and limitations of EIA –EIA process-screening – scoping - terms of reference in EIA- setting – analysis – mitigation. Cross sectoral issues –public hearing in EIA- EIA consultant accreditation.

UNIT II IMPACT INDENTIFICATION AND PREDICTION 10

Matrices – networks – checklists – cost benefit analysis – analysis of alternatives – expert systems in EIA. prediction tools for EIA – mathematical modeling for impact prediction – assessment of impacts – air – water – soil – noise – biological — cumulative impact assessment

UNIT III SOCIO-ECONOMIC IMPACT ASSESSMENT 8

Socio-economic impact assessment - relationship between social impacts and change in community and institutional arrangements. factors and methodologies- individual and family level impacts. communities in transition-rehabilitation

UNIT IV EIA DOCUMENTATION AND ENVIRONMENTAL MANAGEMENT PLAN 9

Environmental management plan - preparation, implementation and review – mitigation and rehabilitation plans – policy and guidelines for planning and monitoring programmes – post project audit – documentation of EIA findings – ethical and quality aspects of environmental impact assessment

UNIT V CASE STUDIES 9

Mining, power plants, cement plants, highways, petroleum refining industry, storage & handling of hazardous chemicals, common hazardous waste facilities, CETPs, CMSWMF, building and construction projects

TOTAL: 45 PERIODS

OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1	Understand need for environmental clearance, its legal procedure, need of EIA, its types, stakeholders and their roles
CO2	Understand various impact identification methodologies, prediction techniques and model of impacts on various environments
CO3	Understand relationship between social impacts and change in community due to development activities and rehabilitation methods
CO4	Document the EIA findings and prepare environmental management and monitoring plan
CO5	Identify, predict and assess impacts of similar projects based on case studies

REFERENCES:

1. EIA Notification 2006 including recent amendments, by Ministry of Environment, Forest and Climate Change, Government of India

2. Sectoral Guidelines under EIA Notification by Ministry of Environment, Forest and Climate Change, Government of India

3. Canter, L.W., Environmental Impact Assessment, McGraw Hill, New York. 1996

4. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Interscience, New Jersey. 2003

5. Lee N. and George C. 2000. Environmental Assessment in Developing and Transitional Countries. Chichester: Willey

6. World Bank –Source book on EIA ,1999

7. Sam Mannan, Lees' Loss Prevention in the Process Industries, Hazard Identification Assessment and Control, 4th Edition, Butterworth Heineman, 2012.

OIC431 BLOCKCHAIN TECHNOLOGIES L T P C
3 0 0 3

COURSE OBJECTIVES:

- This course is intended to study the basics of Blockchain technology.
- During this course the learner will explore various aspects of Blockchain technology like application in various domains.
- By implementing, learners will have idea about private and public Blockchain, and smart contract.

UNIT I INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN 9

Introduction to Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins, Objective of Blockchain, Blockchain Challenges, Transactions and Blocks, P2P Systems, Keys as Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Blockchain.

UNIT II BITCOIN AND CRYPTOCURRENCY 9

Introduction to Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Blockchain and Digital Currency, Transactional Blocks, Impact of Blockchain Technology on Cryptocurrency.

UNIT III INTRODUCTION TO ETHEREUM 9

Introduction to Ethereum, Consensus Mechanisms, Metamask Setup, Ethereum Accounts, , Transactions, Receiving Ethers, Smart Contracts.

UNIT-IV INTRODUCTION TO HYPERLEDGER AND SOLIDITY PROGRAMMING 10

Introduction to Hyperledger, Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer. Solidity - Language of Smart Contracts, Installing Solidity & Ethereum Wallet, Basics of Solidity, Layout of a Solidity Source File & Structure of Smart Contracts, General Value Types.

UNIT V BLOCKCHAIN APPLICATIONS 8

Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After the completion of this course, student will be able to

CO1: Understand and explore the working of Blockchain technology

CO2: Analyze the working of Smart Contracts

CO3: Understand and analyze the working of Hyperledger

CO4: Apply the learning of solidity to build de-centralized apps on Ethereum

CO5: Develop applications on Blockchain

REFERENCES:

1. Imran Bashir, “Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained”, Second Edition, Packt Publishing, 2018.

2. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, “Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction” Princeton University Press, 2016

3. Antonopoulos, Mastering Bitcoin, O’Reilly Publishing, 2014. .

4. Antonopoulos and G. Wood, “Mastering Ethereum: Building Smart Contracts and Dapps”, O’Reilly Publishing, 2018.

5. D. Drescher, Blockchain Basics. Apress, 2017.

OIC432	DEEP LEARNING	L T P C
		3 0 0 3

COURSE OBJECTIVES:

- Develop and Train Deep Neural Networks.
- Develop a CNN, R-CNN, Fast R-CNN, Faster-R-CNN, Mask-RCNN for detection and recognition
- Build and train RNNs, work with NLP and Word Embeddings
- The internal structure of LSTM and GRU and the differences between them
- The Auto Encoders for Image Processing

UNIT I DEEP LEARNING CONCEPTS **6**

Fundamentals about Deep Learning. Perception Learning Algorithms. Probabilistic modelling. Early Neural Networks. How Deep Learning different from Machine Learning. Scalars. Vectors. Matrixes, Higher Dimensional Tensors. Manipulating Tensors. Vector Data. Time Series Data. Image Data. Video Data.

UNIT II NEURAL NETWORKS **9**

About Neural Network. Building Blocks of Neural Network. Optimizers. Activation Functions. Loss Functions. Data Pre-processing for neural networks, Feature Engineering. Overfitting and Underfitting. Hyperparameters.

UNIT III CONVOLUTIONAL NEURAL NETWORK **10**

About CNN. Linear Time Invariant. Image Processing Filtering. Building a convolutional neural network. Input Layers, Convolution Layers. Pooling Layers. Dense Layers. Backpropagation Through the Convolutional Layer. Filters and Feature Maps. Backpropagation Through the Pooling Layers. Dropout Layers and Regularization. Batch Normalization. Various Activation Functions.

Various Optimizers. LeNet, AlexNet, VGG16, ResNet. Transfer Learning with Image Data. Transfer Learning using Inception Oxford VGG Model, Google Inception Model, Microsoft ResNet Model. R-CNN, Fast R-CNN, Faster R-CNN, Mask-RCNN, YOLO

UNIT IV NATURAL LANGUAGE PROCESSING USING RNN 10

About NLP & its Toolkits. Language Modeling . Vector Space Model (VSM). Continuous Bag of Words (CBOW). Skip-Gram Model for Word Embedding. Part of Speech (PoS) Global Co-occurrence Statistics–based Word Vectors. Transfer Learning. Word2Vec. Global Vectors for Word Representation GloVe. Backpropagation Through Time. Bidirectional RNNs (BRNN) . Long Short Term Memory (LSTM). Bi-directional LSTM. Sequence-to-Sequence Models (Seq2Seq). Gated recurrent unit GRU.

UNIT V DEEP REINFORCEMENT & UNSUPERVISED LEARNING 10

About Deep Reinforcement Learning. Q-Learning. Deep Q-Network (DQN). Policy Gradient Methods. Actor-Critic Algorithm. About Autoencoding. Convolutional Auto Encoding. Variational Auto Encoding. Generative Adversarial Networks. Autoencoders for Feature Extraction. Auto Encoders for Classification. Denoising Autoencoders. Sparse Autoencoders

COURSE OUTCOMES:

CO1: Feature Extraction from Image and Video Data
CO2: Implement Image Segmentation and Instance Segmentation in Images
CO3: Implement image recognition and image classification using a pretrained network (Transfer Learning)
CO4: Traffic Information analysis using Twitter Data
CO5: Autoencoder for Classification & Feature Extraction

TOTAL : 45 PERIODS

REFERENCES

1. Deep Learning A Practitioner's Approach Josh Patterson and Adam Gibson O'Reilly Media, Inc.2017
2. Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress,2018
3. Deep Learning Projects Using TensorFlow 2, Vinita Silaparasetty, Apress, 2020
4. Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND,2017
5. Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress,2017

OME431 VIBRATION AND NOISE CONTROL STRATEGIES L T P C
3 0 0 3

OBJECTIVES

- To appreciate the basic concepts of vibration in damped and undamped systems
- To appreciate the basic concepts of noise, its effect on hearing and related terminology
- To use the instruments for measuring and analyzing the vibration levels in a body
- To use the instruments for measuring and analyzing the noise levels in a system
- To learn the standards of vibration and noise levels and their control techniques

UNIT- I BASICS OF VIBRATION 9

Introduction – Sources and causes of Vibration-Mathematical Models - Displacement, velocity and Acceleration - Classification of vibration: free and forced vibration, undamped and damped

vibration, linear and non-linear vibration - Single Degree Freedom Systems - Vibration isolation - Determination of natural frequencies

UNIT- II BASICS OF NOISE 9

Introduction - Anatomy of human ear - Mechanism of hearing - Amplitude, frequency, wavelength and sound pressure level - Relationship between sound power, sound intensity and sound pressure level - Addition, subtraction and averaging decibel levels - sound spectra -Types of sound fields - Octave band analysis - Loudness.

UNIT- III INSTRUMENTATION FOR VIBRATION MEASUREMENT 9

Experimental Methods in Vibration Analysis.- Vibration Measuring Instruments - Selection of Sensors - Accelerometer Mountings - Vibration Exciters - Mechanical, Hydraulic, Electromagnetic and Electrodynamics – Frequency Measuring Instruments -. System Identification from Frequency Response -Testing for resonance and mode shapes

UNIT- IV INSTRUMENTATION FOR NOISE MEASUREMENT AND ANALYSIS 9

Microphones - Weighting networks - Sound Level meters, its classes and calibration - Noise measurements using sound level meters - Data Loggers - Sound exposure meters - Recording of noise - Spectrum analyser - Intensity meters - Energy density sensors - Sound source localization.

UNIT- V METHODS OF VIBRATION CONTROL, SOURCES OF NOISE AND ITS CONTROL 9

Specification of Vibration Limits – Vibration severity standards - Vibration as condition Monitoring Tool – Case Studies - Vibration Isolation methods - Dynamic Vibration Absorber – Need for Balancing - Static and Dynamic Balancing machines – Field balancing - Major sources of noise - Noise survey techniques – Measurement technique for vehicular noise - Road vehicles Noise standard – Noise due to construction equipment and domestic appliances – Industrial noise sources and its strategies – Noise control at the source – Noise control along the path – Acoustic Barriers – Noise control at the receiver -- Sound transmission through barriers – Noise reduction Vs Transmission loss - Enclosures

TOTAL: 45 PERIODS

OUTCOMES:

On Completion of the course the student will be able to

1. apply the basic concepts of vibration in damped and undamped systems
2. apply the basic concepts of noise and to understand its effects on systems
3. select the instruments required for vibration measurement and its analysis
4. select the instruments required for noise measurement and its analysis.
5. recognize the noise sources and to control the vibration levels in a body and to control noise under different strategies.

REFERENCES:

1. Singiresu S. Rao, “Mechanical Vibrations”, Pearson Education Incorporated, 2017.
2. Graham Kelly. Sand Shashidhar K. Kudari, “Mechanical Vibrations”, Tata McGraw –Hill Publishing Com. Ltd., 2007.
3. Ramamurti. V, “Mechanical Vibration Practice with Basic Theory”, Narosa Publishing House, 2000.
4. William T. Thomson, “Theory of Vibration with Applications”, Taylor & Francis, 2003.
5. G.K. Grover, “Mechanical Vibrations”, Nem Chand and Bros.,Roorkee, 2014.
6. A.G. Ambekar, “Mechanical Vibrations and Noise Engineering”, PHI Learning Pvt. Ltd., 2014.

7. David A. Bies and Colin H. Hansen, “Engineering Noise Control – Theory and Practice”, Spon Press, London and New York, 2009.

OME432 ENERGY CONSERVATION AND MANAGEMENT IN DOMESTIC SECTORS

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COURSE OBJECTIVES:

1. To learn the present energy scenario and the need for energy conservation.
2. To understand the different measures for energy conservation in utilities.
3. Acquaint students with principle theories, materials, and construction techniques to create energy efficient buildings.
4. To identify the energy demand and bridge the gap with suitable technology for sustainable habitat
5. To get familiar with the energy technology, current status of research and find the ways to optimize a system as per the user requirement

UNIT I ENERGY SCENARIO 9

Primary energy resources - Sectorial energy consumption (domestic, industrial and other sectors), Energy pricing, Energy conservation and its importance, Energy Conservation Act-2001 and its features – Energy star rating.

UNIT II HEATING, VENTILLATION & AIR CONDITIONING 9

Basics of Refrigeration and Air Conditioning – COP / EER / SEC Evaluation – SPV system design & optimization for Solar Refrigeration.

UNIT III LIGHTING, COMPUTER, TV 9

Specification of Luminaries – Types – Efficacy – Selection & Application – Time Sensors – Occupancy Sensors – Energy conservation measures in computer – Television – Electronic devices.

UNIT IV ENERGY EFFICIENT BUILDINGS 9

Conventional versus Energy efficient buildings – Landscape design – Envelope heat loss and heat gain – Passive cooling and heating – Renewable sources integration.

UNIT V ENERGY STORAGE TECHNOLOGIES 9

Necessity & types of energy storage – Thermal energy storage – Battery energy storage, charging and discharging– Hydrogen energy storage & Super capacitors – energy density and safety issues – Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Understand technical aspects of energy conservation scenario.
2. Energy audit in any type for domestic buildings and suggest the conservation measures.
3. Perform building load estimates and design the energy efficient landscape system.
4. Gain knowledge to utilize an appliance/device sustainably.

5. Understand the status and current technological advancement in energy storage field.

REFERENCES:

1. Yogi Goswami, Frank Kreith, Energy Efficiency and Renewable energy Handbook, CRC Press, 2016
2. ASHRAE Handbook 2020 – HVAC Systems & Equipment
3. Paolo Bertoldi, Andrea Ricci, Anibal de Almeida, Energy Efficiency in Household Appliances and Lighting, Conference proceedings, Springer, 2001
4. David A. Bainbridge, Ken Haggard, Kenneth L. Haggard, Passive Solar Architecture: Heating, Cooling, Ventilation, Daylighting, and More Using Natural Flows, Chelsea Green Publishing, 2011.
5. Guide book for National Certification Examination for Energy Managers and Energy Auditors
(Could be downloaded from www.energymanagertraining.com)
6. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2002.
7. Robert Huggins, Energy Storage: Fundamentals, Materials and Applications, 2nd edition, Springer, 2015
8. Ru-shiliu, Leizhang, Xueliang sun, Electrochemical technologies for energy storage and conversion, Wiley publications, 2012.

OME433 ADDITIVE MANUFACTURING L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Need - Development - Rapid Prototyping Rapid Tooling – Rapid Manufacturing – Additive Manufacturing. AM Process Chain- Classification – Benefits.

UNIT II DESIGN FOR ADDITIVE MANUFACTURING 9

CAD Model Preparation - Part Orientation and Support Structure Generation -Model Slicing - Tool Path Generation Customized Design and Fabrication - Case Studies.

UNIT III VAT POLYMERIZATION 9

Stereolithography Apparatus (SLA)- Materials -Process -Advantages Limitations- Applications. Digital Light Processing (DLP) - Materials – Process - Advantages - Applications. Multi Jet Modelling (MJM) - Principles - Process - Materials - Advantages and Limitations.

UNIT IV MATERIAL EXTRUSION AND SHEET LAMINATION 9

Fused Deposition Modeling (FDM)- Process-Materials - Applications and Limitations. Sheet Lamination Process: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding – Thermal Bonding- Materials- Application and Limitation - Bio-Additive Manufacturing Computer Aided Tissue Engineering (CATE) – Case studies

POWDER BASED PROCESS

Selective Laser Sintering (SLS): Process –Mechanism– Typical Materials and Application- Multi Jet Fusion - Basic Principle-– Materials- Application and Limitation - Three Dimensional Printing -

Materials -Process - Benefits and Limitations. Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Materials – Process - Advantages and Applications. Beam Deposition Process: Laser Engineered Net Shaping (LENS)- Process -Material Delivery - Process Parameters - Materials -Benefits -Applications.

UNIT V CASE STUDIES AND OPPORTUNITIES ADDITIVE MANUFACTURING PROCESSES 9

Education and training - Automobile- pattern and mould - tooling - Building Printing-Bio Printing - medical implants -development of surgical tools Food Printing -Printing Electronics. Business Opportunities and Future Directions - Intellectual Property.

TOTAL: 45 PERIODS

REFERENCES:

1. Andreas Gebhardt and Jan-Steffen Hötter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2015, ISBN: 978-1- 56990-582-1.
2. Ian Gibson, David W. Rosen and Brent Stucker “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, 2nd edition, Springer., United States, 2015, ISBN13: 978-1493921126.
3. Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590
4. Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing”, Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521.
5. Chua C.K., Leong K.F., and Lim C.S., “Rapid prototyping: Principles and applications”, Third edition, World Scientific Publishers, 2010.

OME434 ELECTRIC VEHICLE TECHNOLOGY L T P C
3 0 0 3

UNIT I NEED FOR ELECTRIC VEHICLES 9

History and need for electric and hybrid vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies, comparison of diesel, petrol, electric and hybrid vehicles, limitations, technical challenges

UNIT II ELECTRIC VEHICLE ARCHITECHTURE 9

Electric vehicle types, layout and power delivery, performance – traction motor characteristics, tractive effort, transmission requirements, vehicle performance, energy consumption, Concepts of hybrid electric drive train, architecture of series and parallel hybrid electric drive train, merits and demerits, mild and full hybrids, plug-in hybrid electric vehicles and range extended hybrid electric vehicles, Fuel cell vehicles.

UNIT III ENERGY STORAGE 9

Batteries – types – lead acid batteries, nickel based batteries, and lithium based batteries, electrochemical reactions, thermodynamic voltage, specific energy, specific power, energy efficiency, Battery modeling and equivalent circuit, battery charging and types, battery cooling, Ultra-capacitors, Flywheel technology, Hydrogen fuel cell, Thermal Management of the PEM fuel cell

UNIT IV ELECTRIC DRIVES AND CONTROL 9

Types of electric motors – working principle of AC and DC motors, advantages and limitations, DC motor drives and control, Induction motor drives and control, PMSM and brushless DC motor - drives and control , AC and Switch reluctance motor drives and control – Drive system efficiency – Inverters – DC and AC motor speed controllers

UNIT V DESIGN OF ELECTRIC VEHICLES 9

Materials and types of production, Chassis skate board design, motor sizing, power pack sizing, component matching, Ideal gear box – Gear ratio, torque–speed characteristics, Dynamic equation of vehicle motion, Maximum tractive effort – Power train tractive effort Acceleration performance, rated vehicle velocity – maximum gradability, Brake performance, Electronic control system, safety and challenges in electric vehicles. Case study of Nissan leaf, Toyota Prius, tesla model 3, and Renault Zoe cars.

TOTAL: 45 PERIODS

REFERENCES:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, 2nd edition CRC Press, 2011.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
3. James Larminie, John Lowry, Electric Vehicle Technology Explained - Wiley, 2003.
4. Ehsani, M, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design”, CRC Press, 2005

OME435	NEW PRODUCT DEVELOPMENT	L	T	P	C
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COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. Applying the principles of generic development process; and understanding the organization structure for new product design and development.

2. Identfying opportunity and planning for new product design and development.

3. Conducting customer need analysis; and setting product specification for new product design and development.

4. Generating, selecting, and testing the concepts for new product design and development.

5. Appling the principles of Industrial design and prototype for new product design and development.

UNIT I INTRODUCTION TO PRODUCTDESIGN & DEVELOPMENT 9

Introduction – Characteristics of Successful Product Development – People involved in Product Design and Development – Duration and Cost of Product Development – The Challenges of Product Development – The Product Development Process – Concept Development: The Front-End Process – Adapting the Generic Product Development Process – Product Development Process Flows – Product Development Organizations.

UNIT II OPPORTUNITY DENTIFICATION & PRODUCT PLANNING 9

Opportunity Identification: Definition – Types of Opportunities – Tournament Structure of Opportunity Identification – Effective Opportunity Tournaments – Opportunity Identification Process – Product Planning: Four types of Product Development Projects – The Process of Product Planning.

UNIT III IDENTIFYING CUSTOMER NEEDS & PRODUCT SPECIFICATIONS 9

Identifying Customer Needs: The Importance of Latent Needs – The Process of Identifying Customer Needs. Product Specifications: Definition – Time of Specifications Establishment – Establishing Target Specifications – Setting the Final Specifications

UNIT IV CONCEPT GENERATION, SELECTION & TESTING 9

Concept Generation: Activity of Concept Generation – Structured Approach – Five step method of Concept Generation. Concept Selection: Methodology – Concept Screening and Concepts Scoring. Concept testing: Seven Step activities of concept testing.

UNITV INDUSTRIAL DESIGN & PROTOTYPING 9

Industrial Design: Need and Impact–Industrial Design Process. Prototyping – Principles of Prototyping – Prototyping Technologies – Planning for Prototypes.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Apply the principles of generic development process; and understand the organization structure for new product design and development.

2. Identify opportunity and plan for new product design and development.

3. Conduct customer need analysis; and set product specification for new product design and development.

4. Generate, select, and test the concepts for new product design and development.

5. Apply the principles of Industrial design and prototype for design and develop new products.

TEXT BOOK:

1. Ulrich K.T., Eppinger S. D. and Anita Goyal, “Product Design and Development “McGraw-Hill Education; 7 edition, 2020.

REFERENCES:

1. Belz A., 36-Hour Course: “Product Development” McGraw-Hill, 2010.

2. Rosenthal S.,“Effective Product Design and Development”, Business One Orwin,Homewood, 1992,ISBN1-55623-603-4.

3. Pugh.S,“Total Design Integrated Methods for Successful Product Engineering”, Addison Wesley Publishing,1991,ISBN0-202-41639-5.

4. Chitale, A. K. and Gupta, R. C., Product Design and Manufacturing, PHI Learning, 2013.

5. Jamnia, A., Introduction to Product Design and Development for Engineers, CRC Press, 2018.

OBA431 **SUSTAINABLE MANAGEMENT** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To provide students with fundamental knowledge of the notion of corporate sustainability.
- To determine how organizations impacts on the environment and socio-technical systems, the relationship between social and environmental performance and competitiveness, the approaches and methods.

UNIT I MANAGEMENT OF SUSTAINABILITY 9

Management of sustainability -rationale and political trends: An introduction to sustainability management, International and European policies on sustainable development, theoretical pillars in sustainability management studies.

UNIT II CORPORATE SUSTAINABILITY AND RESPONSIBILITY 9

Corporate sustainability parameter, corporate sustainability institutional framework, integration of sustainability into strategic planning and regular business practices, fundamentals of stakeholder engagement.

UNIT III SUSTAINABILITY MANAGEMENT: STRATEGIES AND APPROACHES 9

Corporate sustainability management and competitiveness: Sustainability-oriented corporate strategies, markets and competitiveness, Green Management between theory and practice, Sustainable Consumption and Green Marketing strategies, Environmental regulation and strategic postures; Green Management approaches and tools; Green engineering: clean technologies and innovation processes; Sustainable Supply Chain Management and Procurement.

UNIT IV SUSTAINABILITY AND INNOVATION 9

Socio-technical transitions and sustainability, Sustainable entrepreneurship, Sustainable pioneers in green market niches, Smart communities and smart specializations.

UNIT V SUSTAINABLE MANAGEMENT OF RESOURCES, COMMODITIES AND COMMONS 9

Energy management, Water management, Waste management, Wild Life Conservation, Emerging trends in sustainable management, Case Studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: An understanding of sustainability management as an approach to aid in evaluating and minimizing environmental impacts while achieving the expected social impact.
CO2: An understanding of corporate sustainability and responsible Business Practices
CO3: Knowledge and skills to understand, to measure and interpret sustainabilityperformances.
CO4: Knowledge of innovative practices in sustainable business and community management
CO5: Deep understanding of sustainable management of resources and commodities

REFERENCES:

1. Daddi, T., Iraldo, F., Testa, Environmental Certification for Organizations and Products: Management, 2015
2. Christian N. Madu, Handbook of Sustainability Management 2012

3. Petra Molthan-Hill, The Business Student's Guide to Sustainable Management: Principles and Practice, 2014
4. Margaret Robertson, Sustainability Principles and Practice, 2014
5. Peter Rogers, An Introduction to Sustainable Development, 2006

OBA432 MICRO AND SMALL BUSINESS MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVES

- To familiarize students with the theory and practice of small business management.
- To learn the legal issues faced by small business and how they impact operations.

UNIT I INTRODUCTION TO SMALL BUSINESS 9

Creation, Innovation, entrepreneurship and small business - Defining Small Business –Role of Owner – Manager – government policy towards small business sector –elements of entrepreneurship –evolution of entrepreneurship –Types of Entrepreneurship – social, civic, corporate - Business life cycle - barriers and triggers to new venture creation – process to assist start ups – small business and family business.

UNIT II SCREENING THE BUSINESS OPPORTUNITY AND FORMULATING THE BUSINESS PLAN 9

Concepts of opportunity recognition; Key factors leading to new venture failure; New venture screening process; Applying new venture screening process to the early stage small firm Role planning in small business – importance of strategy formulation – management skills for small business creation and development.

UNIT III BUILDING THE RIGHT TEAM AND MARKETING STRATEGY 9

Management and Leadership – employee assessments – Tuckman's stages of group development - The entrepreneurial process model - Delegation and team building - Comparison of HR management in small and large firms - Importance of coaching and how to apply a coaching model.

Marketing within the small business - success strategies for small business marketing - customer delight and business generating systems, - market research, - assessing market performance-sales management and strategy - the marketing mix and marketing strategy.

UNIT IV FINANCING SMALL BUSINESS 9

Main sources of entrepreneurial capital; Nature of 'bootstrap' financing - Difference between cash and profit - Nature of bank financing and equity financing - Funding-equity gap for small firms. Importance of working capital cycle - Calculation of break-even point - Power of gross profit margin- Pricing for profit - Credit policy issues and relating these to cash flow management and profitability.

UNIT V VALUING SMALL BUSINESS AND CRISIS MANAGEMENT 9

Causes of small business failure - Danger signals of impending trouble - Characteristics of poorly performing firms - Turnaround strategies - Concept of business valuation - Different valuation measurements - Nature of goodwill and how to measure it - Advantages and disadvantages of buying an established small firm - Process of preparing a business for sale.

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1. Familiarise the students with the concept of small business
CO2. In depth knowledge on small business opportunities and challenges
CO3. Ability to devise plans for small business by building the right skills and marketing strategies
CO4. Identify the funding source for small start ups
CO5. Business evaluation for buying and selling of small firms

REFERENCES

1. Hankinson,A.(2000). "The key factors in the profile of small firm owner-managers that influence business performance. The South Coast Small Firms Survey, 1997-2000." Industrial and Commercial Training 32(3):94-98.
2. Parker,R.(2000). "Small is not necessarily beautiful: An evaluation of policy support for small and medium-sized enterprise in Australia." Australian Journal of Political Science 35(2):239-253.
3. Journal articles on SME's.

OBA433 INTELLECTUAL PROPERTY RIGHTS L T P C
3 0 0 3

COURSE OBJECTIVE

- To understand intellectual property rights and its valuation.

UNIT I INTRODUCTION 9

Intellectual property rights - Introduction, Basic concepts, Patents, Copyrights, Trademarks, Trade Secrets, Geographic Indicators; Nature of Intellectual Property, Technological Research, Inventions and Innovations, History - the way from WTO to WIPO, TRIPS.

UNIT II PROCESS 9

New Developments in IPR, Procedure for grant of Patents, TM, GIs, Patenting under Patent Cooperation Treaty, Administration of Patent system in India, Patenting in foreign countries.

UNIT III STATUTES 9

International Treaties and conventions on IPRs, The TRIPs Agreement, PCT Agreement, The Patent Act of India, Patent Amendment Act (2005), Design Act, Trademark Act, Geographical Indication Act, Bayh- Dole Act and Issues of Academic Entrepreneurship.

UNIT IV STRATEGIES IN INTELLECTUAL PROPERTY 9

Strategies for investing in R&D, Patent Information and databases, IPR strength in India, Traditional Knowledge, Case studies.

UNIT V MODELS 9

The technologies Know-how, concept of ownership, Significance of IP in Value Creation, IP Valuation and IP Valuation Models, Application of Real Option Model in Strategic Decision Making, Transfer and Licensing.

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1: Understanding of intellectual property and appreciation of the need to protect it
CO2: Awareness about the process of patenting
CO3: Understanding of the statutes related to IPR
CO4: Ability to apply strategies to protect intellectual property
CO5: Ability to apply models for making strategic decisions related to IPR

REFERENCES

1. V. Sople Vinod, Managing Intellectual Property by (Prentice hall of India Pvt.Ltd), 2006.
2. Intellectual Property rights and copyrights, EssEss Publications.
3. Primer, R. Anita Rao and Bhanoji Rao, Intellectual Property Rights, Lastain Book company.
4. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2006.
5. WIPO Intellectual Property Hand book.

OBA434 ETHICAL MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVE

- To help students develop knowledge and competence in ethical management and decision making in organizational contexts.

UNIT I ETHICS AND SOCIETY 9

Ethical Management- Definition, Motivation, Advantages-Practical implications of ethical management. Managerial ethics, professional ethics, and social Responsibility-Role of culture and society's expectations- Individual and organizational responsibility to society and the community.

UNIT II ETHICAL DECISION MAKING AND MANAGEMENT IN A CRISIS 9

Managing in an ethical crisis, the nature of a crisis, ethics in crisis management, discuss case studies, analyze real-world scenarios, develop ethical management skills, knowledge, and competencies. Proactive crisis management.

UNIT III STAKEHOLDERS IN ETHICAL MANAGEMENT 9

Stakeholders in ethical management, identifying internal and external stakeholders, nature of stakeholders, ethical management of various kinds of stakeholders: customers (product and service issues), employees (leadership, fairness, justice, diversity) suppliers, collaborators, business, community, the natural environment (the sustainability imperative, green management, Contemporary issues).

UNIT IV INDIVIDUAL VARIABLES IN ETHICAL MANJAGEMENT 9

Understanding individual variables in ethics, managerial ethics, concepts in ethical psychology-ethical awareness, ethical courage, ethical judgment, ethical foundations, ethical emotions/intuitions/intensity. Utilization of these concepts and competencies for ethical decision-making and management.

UNIT V PRACTICAL FIELD-GUIDE, TECHNIQUES AND SKILLS 9

Ethical management in practice, development of techniques and skills, navigating challenges and dilemmas, resolving issues and preventing unethical management proactively. Role modelling and creating a culture of ethical management and human flourishing.

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1: Role modelling and influencing the ethical and cultural context.
CO2: Respond to ethical crises and proactively address potential crises situations.
CO3: Understand and implement stakeholder management decisions.
CO4: Develop the ability, knowledge, and skills for ethical management.
CO5: Develop practical skills to navigate, resolve and thrive in management situations

REFERENCES

1. Brad Agle, Aaron Miller, Bill O' Rourke, The Business Ethics Field Guide: the essential companion to leading your career and your company, 2016.

2. Steiner & Steiner, Business, Government & Society: A managerial Perspective, 2011.

3. Lawrence & Weber, Business and Society: Stakeholders, Ethics, Public Policy, 2020.

ET4251 IoT FOR SMART SYSTEMS L T P C
3 0 0 3

COURSE OBJECTIVES:

1. To study about **Internet of Things** technologies and its role in real time applications.
2. To introduce the infrastructure required for IoT
3. To familiarize the accessories and communication techniques for IoT.
4. To provide insight about the embedded processor and sensors required for IoT
5. To familiarize the different platforms and Attributes for IoT

UNIT I INTRODUCTION TO INTERNET OF THINGS 9

Overview, Hardware and software requirements for IOT, Sensor and actuators, Technology drivers, Business drivers, Typical IoT applications, Trends and implications.

UNIT II IOT ARCHITECTURE 9

IoT reference model and architecture -Node Structure - Sensing, Processing, Communication, Powering, Networking - Topologies, Layer/Stack architecture**,** IoT standards, Cloud computing for IoT, Bluetooth, Bluetooth Low Energy beacons.

UNIT III PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT 9

PROTOCOLS:

NFC, SCADA and RFID, Zigbee MIPI, M-PHY, UniPro, SPMI, SPI, M-PCIe GSM, CDMA, LTE, GPRS, small cell.

Wireless technologies for IoT: WiFi (IEEE 802.11), Bluetooth/Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN, Proprietary systems-Recent trends.

UNIT IV IOT PROCESSORS 9

Services/Attributes: Big-Data Analytics for IOT, Dependability,Interoperability, Security, Maintainability.

Embedded processors for IOT :Introduction to Python programming -Building IOT with RASPERRY PI and Arduino.

UNIT V CASE STUDIES 9

Industrial IoT, Home Automation, smart cities, Smart Grid, connected vehicles, electric vehicle charging, Environment, Agriculture, Productivity Applications, IOT Defense

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Analyze the concepts of IoT and its present developments.
CO2: Compare and contrast different platforms and infrastructures available for IoT
CO3: Explain different protocols and communication technologies used in IoT
CO4: Analyze the big data analytic and programming of IoT
CO5: Implement IoT solutions for smart applications

REFERENCES:

1. ArshdeepBahga and VijaiMadisetti : A Hands-on Approach “Internet of Things”,Universities Press 2015.
2. Oliver Hersent , David Boswarthick and Omar Elloumi “ The Internet of Things”, Wiley,2016.
3. Samuel Greengard, “ The Internet of Things”, The MIT press, 2015.
4. Adrian McEwen and Hakim Cassimally“Designing the Internet of Things “Wiley,2014.
5. Jean- Philippe Vasseur, Adam Dunkels, “Interconnecting Smart Objects with IP: The Next Internet” Morgan Kuffmann Publishers, 2010.
6. Adrian McEwen and Hakim Cassimally, “Designing the Internet of Things”, John Wiley and sons, 2014.
7. Lingyang Song/DusitNiyato/ Zhu Han/ Ekram Hossain,” Wireless Device-to-Device Communications and Networks, CAMBRIDGE UNIVERSITY PRESS,2015.
8. OvidiuVermesan and Peter Friess (Editors), “Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems”, River Publishers Series in Communication, 2013.
9. Vijay Madisetti , ArshdeepBahga, “Internet of Things (A Hands on-Approach)”, 2014.
10. Zach Shelby, Carsten Bormann, “6LoWPAN: The Wireless Embedded Internet”, John Wiley and sons, 2009.
11. Lars T.Berger and Krzysztof Iniewski, “Smart Grid applications, communications and security”, Wiley, 2015.
12. JanakaEkanayake, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama and Nick Jenkins, “ Smart Grid Technology and Applications”, Wiley, 2015.
13. UpenaDalal,”Wireless Communications & Networks,Oxford,2015.

ET4072 MACHINE LEARNING AND DEEP LEARNING L T P C
3 0 0 3

COURSE OBJECTIVES:

The course is aimed at

1. Understanding about the learning problem and algorithms
2. Providing insight about neural networks
3. Introducing the machine learning fundamentals and significance
4. Enabling the students to acquire knowledge about pattern recognition.
5. Motivating the students to apply deep learning algorithms for solving real life problems.

UNIT I LEARNING PROBLEMS AND ALGORITHMS 9

Various paradigms of learning problems, Supervised, Semi-supervised and Unsupervised algorithms

UNIT II NEURAL NETWORKS 9

Differences between Biological and Artificial Neural Networks - Typical Architecture, Common Activation Functions, Multi-layer neural network, Linear Separability, Hebb Net, Perceptron, Adaline, Standard Back propagation Training Algorithms for Pattern Association - Hebb rule and Delta rule, Hetero associative, Auto associative, Kohonen Self Organising Maps, Examples of Feature Maps, Learning Vector Quantization, Gradient descent, Boltzmann Machine Learning.

UNIT III MACHINE LEARNING – FUNDAMENTALS & FEATURE SELECTIONS & CLASSIFICATIONS 9

Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1- Score, the curse of dimensionality, training, testing, validation, cross validation, overfitting, under-fitting the data, early stopping, regularization, bias and variance. Feature Selection, normalization, dimensionality reduction, Classifiers: KNN, SVM, Decision trees, Naïve Bayes, Binary classification, multi class classification, clustering.

UNIT IV DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS 9

Feed forward networks, Activation functions, back propagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, Examples of CNNs.

UNIT V DEEP LEARNING: RNNS, AUTOENCODERS AND GANS 9

State, Structure of RNN Cell, LSTM and GRU, Time distributed layers, Generating Text, Autoencoders: Convolutional Autoencoders, Denoising autoencoders, Variational autoencoders, GANs: The discriminator, generator, DCGANs

TOTAL : 45 PERIODS

COURSE OUTCOMES (CO):

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

CO1 : Illustrate the categorization of machine learning algorithms.

CO2: Compare and contrast the types of neural network architectures, activation functions

CO3: Acquaint with the pattern association using neural networks

CO4: Elaborate various terminologies related with pattern recognition and architectures of convolutional neural networks

CO5: Construct different feature selection and classification techniques and advanced neural network architectures such as RNN, Autoencoders, and GANs.

REFERENCES:

1. J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence, 2012, PHI learning
2. Deep Learning, Ian Good fellow, YoshuaBengio and Aaron Courville, MIT Press, ISBN: 9780262035613, 2016.
3. The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009.
4. Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006.
5. Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.

PX4012 RENEWABLE ENERGY TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:

To impart knowledge on

- Different types of renewable energy technologies
- Standalone operation, grid connected operation of renewable energy systems

UNIT I INTRODUCTION 9

Classification of energy sources – Co2 Emission - Features of Renewable energy - Renewable energy scenario in India -Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment Per Capital Consumption - CO_2 Emission - importance of renewable energy sources, Potentials – Achievements– Applications.

UNIT II SOLAR PHOTOVOLTAICS 9

Solar Energy: Sun and Earth-Basic Characteristics of solar radiation- angle of sunrays on solar collector-Estimating Solar Radiation Empirically - Equivalent circuit of PV Cell- Photovoltaic cell-characteristics: P-V and I-V curve of cell-Impact of Temperature and Insolation on I-V characteristics-Shading Impacts on I-V characteristics-Bypass diode -Blocking diode.

UNIT III PHOTOVOLTAIC SYSTEM DESIGN 9

Block diagram of solar photo voltaic system : Line commutated converters (inversion mode) - Boost and buck-boost converters - selection of inverter, battery sizing, array sizing - PV systems classification- standalone PV systems - Grid tied and grid interactive inverters- grid connection issues.

UNIT IV WIND ENERGY CONVERSION SYSTEMS 9

Origin of Winds: Global and Local Winds- Aerodynamics of Wind turbine-Derivation of Betz's limit-Power available in wind-Classification of wind turbine: Horizontal Axis wind turbine and Vertical axis wind turbine- Aerodynamic Efficiency-Tip Speed-Tip Speed Ratio-Solidity-Blade Count-Power curve of wind turbine - Configurations of wind energy conversion systems: Type A, Type B, Type C and Type D Configurations- Grid connection Issues - Grid integrated SCIG and PMSG based WECS.

UNIT V OTHER RENEWABLE ENERGY SOURCES 9

Qualitative study of different renewable energy resources: ocean, Biomass, Hydrogen energy systems, Fuel cells, Ocean Thermal Energy Conversion (OTEC), Tidal and wave energy, Geothermal Energy Resources.

TOTAL : 45 PERIODS

OUTCOMES:

After completion of this course, the student will be able to:

CO1: Demonstrate the need for renewable energy sources.

CO2: Develop a stand-alone photo voltaic system and implement a maximum power point tracking in the PV system.

CO3: Design a stand-alone and Grid connected PV system.

CO4: Analyze the different configurations of the wind energy conversion systems.

CO5: Realize the basic of various available renewable energy sources

REFERENCES:

1. S.N.Bhadra, D. Kastha, & S. Banerjee “Wind Electrical Systems”, Oxford UniversityPress, 2009.
2. Rai. G.D, “Non conventional energy sources”, Khanna publishes, 1993.
3. Rai. G.D,” Solar energy utilization”, Khanna publishes, 1993.
4. Chetan Singh Solanki, “Solar Photovoltaics: Fundamentals, Technologies and Applications”, PHI Learning Private Limited, 2012.
5. John Twideu and Tony Weir, “Renewal Energy Resources” BSP Publications, 2006
6. Gray, L. Johnson, “Wind energy system”, prentice hall of India, 1995.
7. B.H.Khan, " Non-conventional Energy sources", , McGraw-hill, 2nd Edition, 2009.
8. Fang Lin Luo Hong Ye, " Renewable Energy systems", Taylor & Francis Group,2013.

PS4093 SMART GRID L T P C

3 0 0 3

COURSE OBJECTIVES

- To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure.
- To know about the function of smart grid.
- To familiarize the power quality management issues in Smart Grid.
- To familiarize the high performance computing for Smart Grid applications
- To get familiarized with the communication networks for Smart Grid applications

UNIT I INTRODUCTION TO SMART GRID 9

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Comparison of Micro grid and Smart grid, Present development & International policies in Smart Grid, Smart Grid Initiative for Power Distribution Utility in India – Case Study.

UNIT II SMART GRID TECHNOLOGIES 9

Technology Drivers, Smart Integration of energy resources, Smart substations, Substation Automation, Feeder Automation ,Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/Var control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV) – Grid to Vehicle and Vehicle to Grid charging concepts.

UNIT III SMART METERS AND ADVANCED METERING INFRASTRUCTURE 9

Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU) & their application for monitoring & protection. Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing.

UNIT IV POWER QUALITY MANAGEMENT IN SMART GRID 9

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Unit V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9

Architecture and Standards -Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), PLC, Zigbee, GSM, IP based Protocols, Basics of Web Service and CLOUD Computing, Cyber Security for Smart Grid.

TOTAL : 45 PERIODS

COURSE OUTCOME:

Students able to

CO1: Relate with the smart resources, smart meters and other smart devices.
CO2: Explain the function of Smart Grid.
CO3: Experiment the issues of Power Quality in Smart Grid.
CO4: Analyze the performance of Smart Grid.
CO5**:** Recommend suitable communication networks for smart grid applications

REFERENCES

1. Stuart Borlase ‘Smart Grid: Infrastructure, Technology and Solutions’, CRC Press 2012.
2. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, ‘Smart Grid: Technology and Applications’, Wiley, 2012.
3. Mini S. Thomas, John D McDonald, ‘Power System SCADA and Smart Grids’, CRC Press, 2015
4. Kenneth C.Budka, Jayant G. Deshpande, Marina Thottan, ‘Communication Networks for Smart Grids’, Springer, 2014
5. SMART GRID Fundamentals of Design and Analysis, James Momoh, IEEE press, A John Wiley & Sons, Inc., Publication.

CP4391 SECURITY PRACTICES L T P C

3 0 0 3

COURSE OBJECTIVES:

- To learn the core fundamentals of system and web security concepts

- To have through understanding in the security concepts related to networks
- To deploy the security essentials in IT Sector
- To be exposed to the concepts of Cyber Security and cloud security
- To perform a detailed study of Privacy and Storage security and related Issues

UNIT I SYSTEM SECURITY 9

Model of network security – Security attacks, services and mechanisms – OSI security architecture -A Cryptography primer- Intrusion detection system- Intrusion Prevention system - Security web applications- Case study: OWASP - Top 10 Web Application Security Risks.

UNIT II NETWORK SECURITY 9

Internet Security - Intranet security- Local Area Network Security - Wireless Network Security - Wireless Sensor Network Security- Cellular Network Security - Mobile security - IOT security - Case Study - Kali Linux.

UNIT III SECURITY MANAGEMENT 9

Information security essentials for IT Managers- Security Management System - Policy Driven System Management- IT Security - Online Identity and User Management System. Case study: Metasploit

UNIT IV CYBER SECURITY AND CLOUD SECURITY 9

Cyber Forensics- Disk Forensics – Network Forensics – Wireless Forensics – Database Forensics – Malware Forensics – Mobile Forensics – Email Forensics- Best security practices for automate Cloud infrastructure management – Establishing trust in IaaS, PaaS, and SaaS Cloud types. Case study: DVWA

UNIT V PRIVACY AND STORAGE SECURITY 9

Privacy on the Internet - Privacy Enhancing Technologies - Personal privacy Policies - Detection of Conflicts in security policies- privacy and security in environment monitoring systems. Storage Area Network Security - Storage Area Network Security Devices - Risk management - Physical Security Essentials.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Understand the core fundamentals of system security
CO2: Apply the security concepts to wired and wireless networks
CO3: Implement and Manage the security essentials in IT Sector
CO4: Explain the concepts of Cyber Security and Cyber forensics
CO5: Be aware of Privacy and Storage security Issues.

REFERENCES

1. John R. Vacca, Computer and Information Security Handbook, Third Edition, Elsevier 2017

2. Michael E. Whitman, Herbert J. Mattord, Principles of Information Security, Seventh Edition, Cengage Learning, 2022

3. Richard E. Smith, Elementary Information Security, Third Edition, Jones and Bartlett Learning, 2019

4. Mayor, K.K.Mookhey, Jacopo Cervini, Fairuzan Roslan, Kevin Beaver, Metasploit Toolkit for Penetration Testing, Exploit Development and Vulnerability Research, Syngress publications, Elsevier, 2007. ISBN : 978-1-59749-074-0

5. John Sammons, “The Basics of Digital Forensics- The Primer for Getting Started in Digital Forensics”, Syngress, 2012

6. Cory Altheide and Harlan Carvey, “Digital Forensics with Open Source Tools”,2011 Syngress, ISBN: 9781597495875.

7. Siani Pearson, George Yee "Privacy and Security for Cloud Computing" Computer Communications and Networks, Springer, 2013.

MP4251 CLOUD COMPUTING TECHNOLOGIES L T P C
3 0 0 3

COURSE OBJECTIVES:

- To gain expertise in Virtualization, Virtual Machines and deploy practical virtualization solution
- To understand the architecture, infrastructure and delivery models of cloud computing.
- To explore the roster of AWS services and illustrate the way to make applications in AWS
- To gain knowledge in the working of Windows Azure and Storage services offered by Windows Azure
- To develop the cloud application using various programming model of Hadoop and Aneka

UNIT I VIRTUALIZATION AND VIRTUALIZATION INFRASTRUCTURE 6

Basics of Virtual Machines - Process Virtual Machines – System Virtual Machines –Emulation – Interpretation – Binary Translation - Taxonomy of Virtual Machines. Virtualization –Management Virtualization — Hardware Maximization – Architectures – Virtualization Management – Storage Virtualization – Network Virtualization- Implementation levels of virtualization – virtualization structure – virtualization of CPU, Memory and I/O devices – virtual clusters and Resource Management – Virtualization for data center automation

UNIT II CLOUD PLATFORM ARCHITECTURE 12

Cloud Computing: Definition, Characteristics - Cloud deployment models: public, private, hybrid, community – Categories of cloud computing: Everything as a service: Infrastructure, platform, software- A Generic Cloud Architecture Design – Layered cloud Architectural Development – Architectural Design Challenges

UNIT III AWS CLOUD PLATFORM - IAAS 9

Amazon Web Services: AWS Infrastructure- AWS API- AWS Management Console - Setting up AWS Storage - Stretching out with Elastic Compute Cloud - Elastic Container Service for Kubernetes- AWS Developer Tools: AWS Code Commit, AWS Code Build, AWS Code Deploy, AWS Code Pipeline, AWS code Star - AWS Management Tools: Cloud Watch, AWS Auto Scaling, AWS control Tower, Cloud Formation, Cloud Trail, AWS License Manager

UNIT IV PAAS CLOUD PLATFORM 9

Windows Azure: Origin of Windows Azure, Features, The Fabric Controller – First Cloud APP in

Windows Azure- Service Model and Managing Services: Definition and Configuration, Service runtime API- Windows Azure Developer Portal- Service Management API- Windows Azure Storage Characteristics-Storage Services- REST API- Blops

UNIT V PROGRAMMING MODEL 9

Introduction to Hadoop Framework - Mapreduce, Input splitting, map and reduce functions, specifying input and output parameters, configuring and running a job –Developing Map Reduce Applications - Design of Hadoop file system –Setting up Hadoop Cluster- Aneka: Cloud Application Platform, Thread Programming, Task Programming and Map-Reduce Programming in Aneka

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Employ the concepts of virtualization in the cloud computing
CO2: Identify the architecture, infrastructure and delivery models of cloud computing
CO3: Develop the Cloud Application in AWS platform
CO4: Apply the concepts of Windows Azure to design Cloud Application
CO5: Develop services using various Cloud computing programming models.

REFERENCES

1. Bernard Golden, Amazon Web Service for Dummies, John Wiley & Sons, 2013.

2. Raoul Alongi, AWS: The Most Complete Guide to Amazon Web Service from Beginner to Advanced Level, Amazon Asia- Pacific Holdings Private Limited, 2019.

3. Sriram Krishnan, Programming: Windows Azure, O'Reilly,2010.

4. Rajkumar Buyya, Christian Vacchiola, S.Thamarai Selvi, Mastering Cloud Computing , MCGraw Hill Education (India) Pvt. Ltd., 2013.

5. Danielle Ruest, Nelson Ruest, —Virtualization: A Beginner"s Guide‖, McGraw-Hill Osborne Media, 2009.

6. Jim Smith, Ravi Nair , "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005.

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8. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", McGraw-Hill Osborne Media, 2009.

9. Tom White, "Hadoop: The Definitive Guide", Yahoo Press, 2012.

IF4072 DESIGN THINKING L T P C
3 0 0 3

COURSE OBJECTIVES:

- To provide a sound knowledge in UI & UX
- To understand the need for UI and UX
- Research Methods used in Design
- Tools used in UI & UX
- Creating a wireframe and prototype

UNIT I UX LIFECYCLE TEMPLATE 8

Introduction. A UX process lifecycle template. Choosing a process instance for your project. The system complexity space. Meet the user interface team. Scope of UX presence within the team. More about UX lifecycles. Business Strategy. Value Innovation. Validated User Research. Killer UX Design. The Blockbuster Value Proposition. What Is a Value Proposition?.

UNIT II CONTEXTUAL INQUIRY 10

The system concept statement. User work activity data gathering. Look for emotional aspects of work practice. Abridged contextual inquiry process. Data-driven vs. model-driven inquiry. Organizing concepts: work roles and flow model. Creating and managing work activity notes. Constructing your work activity affinity diagram (WAAD). Abridged contextual analysis process. History of affinity diagrams.

UNIT III DESIGN THINKING, IDEATION, AND SKETCHING 9

Design-informing models: second span of the bridge . Some general “how to” suggestions. A New example domain: slideshow presentations. User models. Usage models. Work environment models. Barrier summaries. Model consolidation. Protecting your sources. Abridged methods for design-informing models extraction. Design paradigms. Design thinking. Design perspectives. User personas. Ideation. Sketching

UNIT IV UX GOALS, METRICS, AND TARGETS 8

Introduction. UX goals. UX target tables. Work roles, user classes, and UX goals. UX measures. Measuring instruments. UX metrics. Baseline level. Target level. Setting levels. Observed results. Practical tips and cautions for creating UX targets. How UX targets help manage the user experience engineering process.

UNIT V ANALYSING USER EXPERIENCE 10

Sharpening Your Thinking Tools. UX Research and Strength of Evidence. Agile Personas. How to Prioritize Usability Problems. Creating Insights, Hypotheses and Testable Design Ideas. How to Manage Design Projects with User Experience Metrics. Two Measures that Will Justify Any Design Change. Evangelizing UX Research. How to Create a User Journey Map. Generating Solutions to Usability Problems. Building UX Research Into the Design Studio Methodology. Dealing with Common objections to UX Research. The User Experience Debrief Meeting. Creating a User Experience Dashboard.

SUGGESTED ACTIVITIES:

1: Hands on Design Thinking process for a product
2: Defining the Look and Feel of any new Project
3: Create a Sample Pattern Library for that product (Mood board, Fonts, Colors based on UI principles)
4: Identify a customer problem to solve.
5: Conduct end-to-end user research - User research, creating personas, Ideation process (User stories, Scenarios), Flow diagrams, Flow Mapping

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Build UI for user Applications
CO2: Use the UI Interaction behaviors and principles
CO3: Evaluate UX design of any product or application

CO4: Demonstrate UX Skills in product development
CO5: Implement Sketching principles

REFERENCES

1. UX for Developers: How to Integrate User-Centered Design Principles Into Your Day-to-Day Development Work, Westley Knight. Apress, 2018

2. The UX Book: Process and Guidelines for Ensuring a Quality User Experience, Rex Hartson, Pardha Pyla. Morgan Kaufmann, 2012

3. UX Fundamentals for Non-UX Professionals: User Experience Principles for Managers, Writers, Designers, and Developers, Edward Stull. Apress, 2018

4. Lean UX: Designing Great Products with Agile Teams, Gothelf, Jeff, Seiden, and Josh. O'Reilly Media, 2016

5. Designing UX: Prototyping: Because Modern Design is Never Static, Ben Coleman, and Dan Goodwin. SitePoint, 2017

MU4153	PRINCIPLES OF MULTIMEDIA	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To get familiarity with gamut of multimedia and its significance
- To acquire knowledge in multimedia components.
- To acquire knowledge about multimedia tools and authoring.
- To acquire knowledge in the development of multimedia applications.
- To explore the latest trends and technologies in multimedia

UNIT I INTRODUCTION 9

Introduction to Multimedia – Characteristics of Multimedia Presentation – Multimedia Components – Promotion of Multimedia Based Components – Digital Representation – Media and Data Streams – Multimedia Architecture – Multimedia Documents, Multimedia Tasks and Concerns, Production, sharing and distribution, Hypermedia, WWW and Internet, Authoring, Multimedia over wireless and mobile networks.

Suggested Activities:

1. Flipped classroom on media Components.
2. External learning – Interactive presentation.

Suggested Evaluation Methods:

1. Tutorial – Handling media components
2. Quizzes on different types of data presentation.

UNIT II ELEMENTS OF MULTIMEDIA 9

Text-Types, Font, Unicode Standard, File Formats, Graphics and Image data representations – data types, file formats, color models; video – color models in video, analog video, digital video, file formats, video display interfaces, 3D video and TV: Audio – Digitization, SNR, SQNR, quantization, audio quality, file formats, MIDI; Animation- Key Frames and Tweening, other Techniques, 2D and 3D Animation.

Suggested Activities:

1. Flipped classroom on different file formats of various media elements.
2. External learning – Adobe after effects, Adobe Media Encoder, Adobe Audition.

Suggested Evaluation Methods:

1. Demonstration on after effects animations.
2. Quizzes on file formats and color models.

UNIT III MULTIMEDIA TOOLS 9

Authoring Tools – Features and Types – Card and Page Based Tools – Icon and Object Based Tools – Time Based Tools – Cross Platform Authoring Tools – Editing Tools – Painting and Drawing Tools – 3D Modeling and Animation Tools – Image Editing Tools – Sound Editing Tools – Digital Movie Tools.

Suggested Activities:

1. Flipped classroom on multimedia tools.
2. External learning – Comparison of various authoring tools.

Suggested Evaluation Methods:

1. Tutorial – Audio editing tool.
2. Quizzes on animation tools.

UNIT IV MULTIMEDIA SYSTEMS 9

Compression Types and Techniques: CODEC, Text Compression: GIF Coding Standards, JPEG standard – JPEG 2000, basic audio compression – ADPCM, MPEG Psychoacoustics, basic Video compression techniques – MPEG, H.26X – Multimedia Database System – User Interfaces – OS Multimedia Support – Hardware Support – Real Time Protocols – Play Back Architectures – Synchronization – Document Architecture – Hypermedia Concepts: Hypermedia Design – Digital Copyrights, Content analysis.

Suggested Activities:

1. Flipped classroom on concepts of multimedia hardware architectures.
2. External learning – Digital repositories and hypermedia design.

Suggested Evaluation Methods:

1. Quizzes on multimedia hardware and compression techniques.
2. Tutorial – Hypermedia design.

UNIT V MULTIMEDIA APPLICATIONS FOR THE WEB AND MOBILE PLATFORMS 9

ADDIE Model – Conceptualization – Content Collection – Storyboard–Script Authoring Metaphors – Testing – Report Writing – Documentation. Multimedia for the web and mobile platforms. Virtual Reality, Internet multimedia content distribution, Multimedia Information sharing – social media sharing, cloud computing for multimedia services, interactive cloud gaming. Multimedia information retrieval.

Suggested Activities:

1. External learning – Game consoles.
2. External learning – VRML scripting languages.

Suggested Evaluation Methods:

1. Demonstration of simple interactive games.
2. Tutorial – Simple VRML program.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Handle the multimedia elements effectively.
CO2: Articulate the concepts and techniques used in multimedia applications.
CO3: Develop effective strategies to deliver Quality of Experience in multimedia applications.
CO4: Design and implement algorithms and techniques applied to multimedia objects.
CO5: Design and develop multimedia applications following software engineering models.

REFERENCES:

1. Li, Ze-Nian, Drew, Mark, Liu, Jiangchuan, “Fundamentals of Multimedia”, Springer, Third Edition, 2021.
2. Prabhat K.Andleigh, Kiran Thakrar, “MULTIMEDIA SYSTEMS DESIGN”, Pearson Education, 2015.
3. Gerald Friedland, Ramesh Jain, “Multimedia Computing”, Cambridge University Press, 2018. (digital book)
4. Ranjan Parekh, “Principles of Multimedia”, Second Edition, McGraw-Hill Education, 2017

CX4016	ENVIRONMENTAL SUSTAINABILITY	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION 9

Valuing the Environment: Concepts, Valuing the Environment: Methods, Property Rights, Externalities, and Environmental Problems

UNIT II CONCEPT OF SUSTAINABILITY 9

Sustainable Development: Defining the Concept, the Population Problem, Natural Resource Economics: An Overview, Energy, Water, Agriculture

UNIT III SIGNIFICANCE OF BIODIVERSITY 9

Biodiversity, Forest Habitat, Commercially Valuable Species, Stationary - Source Local Air Pollution, Acid Rain and Atmospheric Modification, Transportation

UNIT IV POLLUTION IMPACTS 9

Water Pollution, Solid Waste and Recycling, Toxic Substances and Hazardous Wastes, Global Warming.

UNIT V ENVIRONMENTAL ECONOMICS 9

Development, Poverty, and the Environment, Visions of the Future, Environmental economics and policy by Tom Tietenberg, Environmental Economics

TOTAL : 45 PERIODS

REFERENCES

1. Andrew Hoffman, Competitive Environmental Strategy - A Guide for the Changing Business Landscape, Island Press.
2. Stephen Doven, Environment and Sustainability Policy: Creation, Implementation, Evaluation, the Federation Press, 2005
3. Robert Brinkmann., Introduction to Sustainability, Wiley-Blackwell., 2016

4. Niko Roorda., Fundamentals of Sustainable Development, 3rd Edn, Routledge, 2020
5. Bhavik R Bakshi., Sustainable Engineering: Principles and Practice, Cambridge University Press, 2019

TX4092 TEXTILE REINFORCED COMPOSITES L T P C
3 0 0 3

UNIT I REINFORCEMENTS 9

Introduction – composites –classification and application; reinforcements- fibres and its properties; preparation of reinforced materials and quality evaluation; preforms for various composites

UNIT II MATRICES 9

Preparation, chemistry, properties and applications of thermoplastic and thermoset resins; mechanism of interaction of matrices and reinforcements; optimization of matrices

UNIT III COMPOSITE MANUFACTURING 9

Classification; methods of composites manufacturing for both thermoplastics and thermosets- Hand layup, Filament Winding, Resin transfer moulding, prepregs and autoclave moulding, pultrusion, vacuum impregnation methods, compression moulding; post processing of composites and composite design requirements

UNIT IV TESTING 9

Fibre volume and weight fraction, specif ic gravity of composites, tensile, f lexural, impact, compression, inter laminar shear stress and fatigue properties of thermoset and thermoplastic composites.

UNIT V MECHANICS 9

Micro mechanics, macro mechanics of single layer, macro mechanics of laminate, classical lamination theory, failure theories and prediction of inter laminar stresses using at ware

TOTAL: 45 PERIODS

REFERENCES

1. BorZ.Jang,“Advanced Polymer composites”,ASM International,USA,1994.

2. Carlsson L.A. and Pipes R.B., “Experimental Characterization of advanced composite Materials”,SecondEdition,CRCPress,NewJersey,1996.

3. George LubinandStanley T.Peters, “Handbook of Composites”, Springer Publications,1998.

4. Mel. M. Schwartz, “Composite Materials”, Vol. 1 &2, Prentice Hall PTR, New Jersey,1997.

5. RichardM.Christensen,“Mechanics of compositematerials”,DoverPublications,2005.

6. Sanjay K. Mazumdar, “Composites Manufacturing: Materials, Product, and Process Engineering”,CRCPress,2001

NT4002 NANOCOMPOSITE MATERIALS L T P C
3 0 0 3

UNIT I BASICS OF NANOCOMPOSITES 9

Nomenclature, Properties, features and processing of nanocomposites. Sample Preparation and Characterization of Structure and Physical properties. Designing, stability and mechanical properties and applications of super hard nanocomposites.

UNIT II METAL BASED NANOCOMPOSITES 9

Metal-metal nanocomposites, some simple preparation techniques and their properties. Metal-Oxide or Metal-Ceramic composites, Different aspects of their preparation techniques and their final properties and functionality. Fractal based glass-metal nanocomposites, its designing and fractal dimension analysis. Core-Shell structured nanocomposites

UNIT III POLYMER BASED NANOCOMPOSITES 9

Preparation and characterization of diblock Copolymer based nanocomposites; Polymer Carbon nanotubes based composites, their mechanical properties, and industrial possibilities.

UNIT IV NANOCOMPOSITE FROM BIOMATERIALS 9

Natural nanocomposite systems - spider silk, bones, shells; organic-inorganic nanocomposite formation through self-assembly. Biomimetic synthesis of nanocomposites material; Use of synthetic nanocomposites for bone, teeth replacement.

UNIT V NANOCOMPOSITE TECHNOLOGY 9

Nanocomposite membrane structures- Preparation and applications. Nanotechnology in Textiles and Cosmetics-Nano-fillers embedded polypropylene fibers – Soil repellence, Lotus effect - Nano finishing in textiles (UV resistant, anti-bacterial, hydrophilic, self-cleaning, flame retardant finishes), Sun-screen dispersions for UV protection using titanium oxide – Colour cosmetics. Nanotechnology in Food Technology - Nanopackaging for enhanced shelf life - Smart/Intelligent packaging.

TOTAL : 45 PERIODS

REFERENCES:

1. Introduction to Nanocomposite Materials. Properties, Processing, Characterization- Thomas E. Twardowski. 2007. DEStech Publications. USA.
2. Nanocomposites Science and Technology - P. M. Ajayan, L.S. Schadler, P. V.Braun 2006.
3. Physical Properties of Carbon Nanotubes- R. Saito 1998.
4. Carbon Nanotubes (Carbon , Vol 33) - M. Endo, S. Iijima, M.S. Dresselhaus 1997.
5. The search for novel, superhard materials- Stan Vepr¡ek (Review Article) JVST A, 1999
6. Nanometer versus micrometer-sized particles-Christian Brosseau, Jamal BeN Youssef, Philippe Talbot, Anne-Marie Konn, (Review Article) J. Appl. Phys, Vol 93, 2003
7. Diblock Copolymer, - Aviram (Review Article), Nature, 2002
8. Bikramjit Basu, Kantesh Balani Advanced Structural Ceramics, A John Wiley & Sons, Inc.,
9. P. Brown and K. Stevens, Nanofibers and Nanotechnology in Textiles, Woodhead publication, London, 2006

BY4016 IPR, BIOSAFETY AND ENTREPRENEURSHIP L T P C
3 0 0 3

UNIT I IPR 9

Intellectual property rights – Origin of the patent regime – Early patents act & Indian pharmaceutical industry – Types of patents – Patent Requirements – Application preparation filing and prosecution – Patentable subject matter – Industrial design, Protection of GMO's IP as a factor in R&D,IP's of relevance to biotechnology and few case studies.

UNIT II AGREEMENTS, TREATIES AND PATENT FILING PROCEDURES 9

History of GATT Agreement – Madrid Agreement – Hague Agreement – WIPO Treaties – Budapest Treaty – PCT – Ordinary – PCT – Conventional – Divisional and Patent of Addition – Specifications – Provisional and complete – Forms and fees Invention in context of "prior art" – Patent databases – Searching International Databases – Country-wise patent searches (USPTO,espacenet(EPO) – PATENT Scope (WIPO) – IPO, etc National & PCT filing procedure – Time frame and cost – Status of the patent applications filed – Precautions while patenting – disclosure/non-disclosure – Financial assistance for patenting – Introduction to existing schemes Patent licensing and agreement Patent infringement – Meaning, scope, litigation, case studies

UNIT III BIOSAFETY 9

Introduction – Historical Backround – Introduction to Biological Safety Cabinets – Primary Containment for Biohazards – Biosafety Levels – Biosafety Levels of Specific Microorganisms – Recommended Biosafety Levels for Infectious Agents and Infected Animals – Biosafety guidelines – Government of India.

UNIT IV GENETICALLY MODIFIED ORGANISMS 9

Definition of GMOs & LMOs – Roles of Institutional Biosafety Committee – RCGM – GEAC etc. for GMO applications in food and agriculture – Environmental release of GMOs – Risk Analysis – Risk Assessment – Risk management and communication – Overview of National Regulations and relevant International Agreements including Cartegana Protocol.

UNIT V ENTREPRENEURSHIP DEVELOPMENT 9

Introduction – Entrepreneurship Concept – Entrepreneurship as a career – Entrepreneurial personality – Characteristics of successful Entrepreneur – Factors affecting entrepreneurial growth – Entrepreneurial Motivation – Competencies – Mobility – Entrepreneurship Development Programmes (EDP) - Launching Of Small Enterprise - Definition, Characteristics – Relationship between small and large units – Opportunities for an Entrepreneurial career – Role of small enterprise in economic development – Problems of small scale industries – Institutional finance to entrepreneurs - Institutional support to entrepreneurs.

TOTAL : 45 PERIODS

REFERENCES

1. Bouchoux, D.E., "Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets for the Paralegal", 3rd Edition, Delmar Cengage Learning, 2008.

2. Fleming, D.O. and Hunt, D.L., "Biological Safety: Principles and Practices", 4th Edition, American Society for Microbiology, 2006.

3. Irish, V., "Intellectual Property Rights for Engineers", 2nd Edition, The Institution of Engineering

and Technology, 2005.

4. Mueller, M.J., “Patent Law”, 3rd Edition, Wolters Kluwer Law & Business, 2009.

5. Young, T., “Genetically Modified Organisms and Biosafety: A Background Paper for Decision-Makers and Others to Assist in Consideration of GMO Issues” 1st Edition, World Conservation Union, 2004.

6. S.S Khanka, “Entrepreneurial Development”, S.Chand & Company LTD, New Delhi, 2007.