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
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:

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

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ANNA UNIVERSITY, CHENNAI  
NON - AUTONOMOUS COLLEGES AFFILIATED ANNA UNIVERSITY  
M.E. DIGITAL SIGNAL PROCESSING  
REGULATIONS – 2021  
CHOICE BASED CREDIT SYSTEM  
I TO IV SEMESTERS CURRICULA AND SYLLABI

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### AUDIT COURSES (AC)

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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 linear equations using an appropriate numerical methods.
- study the numerical solution of differential equations by single and multistep methods.

UNIT I    LINEAR ALGEBRA   12

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

UNIT IV   NUMERICAL SOLUTION OF ALGEBRAIC EQUATIONS   12

UNIT V    NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS   12

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.

TOTAL: 60 PERIODS
• numerical solution of differential equations by single and multistep methods.

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RM4151 RESEARCH METHODOLOGY AND IPR L T P C
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

UNIT V PATENTS 6

TOTAL: 30 PERIODS

REFERENCES:

DS4151 DIGITAL IMAGE AND VIDEO PROCESSING

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

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


UNIT III SEGMENTATION AND RECOGNITION

UNIT IV  BASIC STEPS OF VIDEO PROCESSING

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

Optical flow, optical flow constraints, General Methodologies, Pixel Based Motion Estimation, Block-Matching Algorithm, Mesh based Motion Estimation, Global Motion Estimation, Region based Motion Estimation, 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:
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

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

UNIT V  ADAPTIVE FILTERS  9
FIR Adaptive filters - Newton’s steepest descent method – Widrow Hoff LMS Adaptive algorithm –

**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

**REFERENCES:**


**CO-PO Mapping**

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**DS4101 MODERN COMMUNICATION SYSTEMS**

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**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**

Spreading sequences- Properties of Spreading Sequences, Pseudo- noise sequence, Gold

UNIT II EQUALIZATION TECHNIQUES 9

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

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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


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

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


UNIT V SPEECH AND AUDIO SIGNAL PROCESSING ALGORITHMS


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:
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
5. Estimation of PSD using different methods (Bartlett, Welch, Blackman-Tukey).
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
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.

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DS4111 STATISTICAL SIGNAL PROCESSING LABORATORY

PRACTICAL EXERCISES:

CO-PO Mapping
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

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

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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

UNIT II  TEXT COMPRESSION

UNIT III  IMAGE COMPRESSION

UNIT IV  AUDIO COMPRESSION

UNIT V  VIDEO COMPRESSION

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.

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DS4201 MIXED SIGNAL PROCESSING  LT 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

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


UNIT V DATA CONVERTER ARCHITECTURES

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
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


UNIT II IMAGE STORAGE AND RECONSTRUCTION

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 IIISEGMENTATION AND CLASSIFICATION

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

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

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

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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

UNIT II  
MUTUAL INFORMATION  9

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
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

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DS4211 TERM PAPER WRITING AND SEMINAR

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

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<tr>
<th>Activity</th>
<th>Instructions</th>
<th>Submission week</th>
<th>Evaluation</th>
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<tbody>
<tr>
<td>Selection of area of interest and Topic</td>
<td>You are requested to select an area of interest, topic and state an objective</td>
<td>2nd week</td>
<td>3 % Based on clarity of thought, current relevance and clarity in writing</td>
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<td>Stating an Objective</td>
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<tr>
<td>Collecting Information about your area &amp; topic</td>
<td>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.</td>
<td>3rd week</td>
<td>3% (the selected information must be area specific and of international and national standard)</td>
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<tr>
<td>Collection of Journal papers in the context of the objective – collect 20 &amp; then filter</td>
<td>• 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)</td>
<td>4th week</td>
<td>6% (the list of standard papers and reason for selection)</td>
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<tr>
<td>Reading and notes for first 5 papers</td>
<td>Reading Paper Process</td>
<td>5th week</td>
<td>8% (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)</td>
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<td>For each paper form a Table answering the following questions:</td>
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<td>• How does the work build on other’s work, in the author’s opinion?</td>
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<td>• What simplifying assumptions does the author claim to be making?</td>
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<td>• What did the author do?</td>
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<td>• How did the author claim they were going to evaluate their work and compare it to others?</td>
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<td>• What did the author say were the limitations of their research?</td>
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<td>• What did the author say were the important directions for future research?</td>
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<td>Conclude with limitations/issues not addressed by the paper (from the perspective of your survey)</td>
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<td>Reading and notes for next 5 papers</td>
<td>Repeat Reading Paper Process</td>
<td>6th week</td>
<td>8% (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)</td>
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<tr>
<td>Reading and notes for final 5 papers</td>
<td>Repeat Reading Paper Process</td>
<td>7th week</td>
<td>8% (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)</td>
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- Mark in the hard copy of papers whether complete work or section/sections of the paper are being considered
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<tr>
<th>Draft outline 1 and Linking papers</th>
<th>Prepare a draft Outline, your survey goals, along with a classification / categorization diagram</th>
<th>8&lt;sup&gt;th&lt;/sup&gt; week</th>
<th>8% (this component will be evaluated based on the linking and classification among the papers)</th>
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<tr>
<td>Abstract</td>
<td>Prepare a draft abstract and give a presentation</td>
<td>9&lt;sup&gt;th&lt;/sup&gt; week</td>
<td>6% (Clarity, purpose and conclusion) 6% Presentation &amp; Viva Voce</td>
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<td>Introduction Background</td>
<td>Write an introduction and background sections</td>
<td>10&lt;sup&gt;th&lt;/sup&gt; week</td>
<td>5% (clarity)</td>
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<td>Sections of the paper</td>
<td>Write the sections of your paper based on the classification / categorization diagram in keeping with the goals of your survey</td>
<td>11&lt;sup&gt;th&lt;/sup&gt; week</td>
<td>10% (this component will be evaluated based on the linking and classification among the papers)</td>
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<td>Your conclusions</td>
<td>Write your conclusions and future work</td>
<td>12&lt;sup&gt;th&lt;/sup&gt; week</td>
<td>5% (conclusions – clarity and your ideas)</td>
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<td>Final Draft</td>
<td>Complete the final draft of your paper</td>
<td>13&lt;sup&gt;th&lt;/sup&gt; week</td>
<td>10% (formatting, English, Clarity and linking) 4% Plagiarism Check Report</td>
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<tr>
<td>Seminar</td>
<td>A brief 15 slides on your paper</td>
<td>14&lt;sup&gt;th&lt;/sup&gt; &amp; 15&lt;sup&gt;th&lt;/sup&gt; week</td>
<td>10% (based on presentation and Viva-voce)</td>
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**TOTAL: 30 PERIODS**

**DS4212 DSP PROCESSOR LAB – II**

**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: Design a Digital Signal Processor based applications
CO2: Design a Digital Signal Processor & Matlab/Simulink based various applications
CO3: Design & Develop a Digital Signal Processor based various applications in real time

LIST OF EQUIPMENT FOR A BATCH OF 25 STUDENTS:

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<th>DESCRIPTION OF EQUIPMENT</th>
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<td>1</td>
<td>TMS 320 C67X Kits</td>
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<td>MATLAB or Equivalent Licensed or Open Source S/W with Signal Processing Tool box</td>
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DS4072 WAVELET TRANSFORMS AND ITS APPLICATIONS L T P C
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32
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

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

UNIT V  
**APPLICATIONS**  
9

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**
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BM4151 BIO SIGNAL PROCESSING L T P C
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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

UNIT II TIME SERIES ANALYSIS AND SPECTRAL ESTIMATION 9
UNIT III  ADAPTIVE FILTERING AND WAVELET DETECTION  9
Filtering – LMS adaptive filter, adaptive noise cancelling in ECG, improved adaptive filtering in
FECEG, 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:
5. Willis J.Tompkins, Biomedical Digital Signal Processing, Prentice Hall of India, New Delhi, 2006

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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 scheme, 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.
CO2: Understand 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

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CO-PO Mapping

VE4152 EMBEDDED SYSTEM DESIGN

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
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
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

UNIT IV  STATE MACHINE AND CONCURRENT PROCESS MODELS

UNIT V  SYSTEM DESIGN
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 software development tools and RTOS
CO4: Apply networking principles in embedded devices.
CO5: Design suitable embedded systems for real world applications.

TOTAL:45 PERIODS

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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
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
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
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
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
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.
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.

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DS4003 NEURAL NETWORKS AND APPLICATIONS

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
Biological Neuron – Artificial Neural Model - Types of activation functions – Architecture: Feedforward and Feedback – Learning Process: Error Correction Learning – Memory Based Learning – Hebbian

UNIT II RADIAL-BASIS FUNCTION NETWORKS AND SUPPORT VECTOR MACHINES

UNIT III COMMITTEE MACHINES AND NEURODYNAMICS SYSTEMS

UNIT IV ATTRACTOR NEURAL NETWORKS AND ADAPTIVE RESONANCE THEORY

UNIT V SELF ORGANISING MAPS AND PULSED NEURON MODELS

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

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### DS4004 UNDERWATER ACOUSTICS SIGNAL PROCESSING

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

### UNIT II SONAR

### UNIT III TARGET DETECTION
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
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
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 of underwater acoustic communication

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DS4005  SIGNAL INTEGRITY FOR HIGH SPEED IC DESIGN

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
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 microstrip 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

43
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
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
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
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:
2. John D Ryder, Networks lines and field", Prentice Hall of India, 2nd edition 2015

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

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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

UNIT II
DIGITAL FILTERS AND FINITE WORD LENGTH EFFECTS

UNIT III
DSP ARCHITECTURES
DSP system architectures, Standard DSP architecture-Harvard and Modified Harvard architecture, TMS320C54x and TMS320C6x architecture, Multiprocessors and multicomputers, Systolic and Wavefront arrays, Shared memory architectures.

UNIT IV
SYNTHESIS OF DSP ARCHITECTURES & ARITHMETIC UNIT
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
Layout of VLSI circuits, Layout Styles, Case Study: FFT processor, DCT processor and Interpolator.
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

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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

UNIT II DATA STRUCTURE FOR SET MANIPULATION


UNIT III GRAPHS


UNIT IV INTRODUCTION TO PARALLEL ALGORITHMS


UNIT V ALGORITHM DESIGN TECHNIQUES


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

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**DS4008 CRYPTOGRAPHIC TECHNIQUES**

**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**

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


UNIT III  NETWORK SECURITY PRACTICE


UNIT IV  SYSTEM SECURITY TECHNIQUES


UNIT V  WIRELESS SECURITY TECHNIQUES


TOTAL:45 PERIODS

COURSE OUTCOMES:

CO1: Demonstrate the various classical encryption techniques and the adversary capabilities.
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

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
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
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
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

UNIT V CONSIDERATIONS FOR 6G

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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

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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

UNIT II  ESTIMATION THEORY AND MODEL-BASED PROCESSORS  9

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, 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

UNIT V  APPLIED PHYSICS-BASED PROCESSORS  9

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

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**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**


**UNIT II DATA ACQUISITION**

UNIT III  OPTICAL, THERMAL AND MICROWAVE REMOTE SENSING

UNIT IV  HYPERSPECTRAL REMOTE SENSING AND IMAGE ANALYSIS

UNIT V  LIDAR
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

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TOTAL:45 PERIODS

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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
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
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
UNIT IV
ROUGH SET AND HYBRID SYSTEMS


UNIT V
OPTIMIZATION TECHNIQUES


COURSE OUTCOMES:

CO1: Develop a Fuzzy expert system.
CO2: Implement machine learning through artificial Neural networks
CO3: Develop a Genetic 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

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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

UNIT II  STATISTICAL PATTERN RECOGNITION  8

UNIT III  BAYES DECISION THEORY CLASSIFIERS  11

UNIT IV  LINEAR DISCRIMINANT FUNCTIONS  9

UNIT V  NONLINEAR CLASSIFIERS  9

**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**
2. Pattern Recognition, Jürgen Beyerer, Matthias Richter, and Matthias Nagel. 2018

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**CO-PO Mapping**

**DS4013**
MULTIRATE SIGNAL PROCESSING
LTPC
3003

58
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
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 of multi-rate systems, special filters and filter banks.

UNIT II  MAXIMALLY DECIMATED FILTER BANKS
Errors created in the QMF bank, alias-free QMF system, power symmetric QMF banks, 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
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
Design of uniform and non-uniform cosine modulated filter 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
The short time fourier transform, wavelet transform, Discretetime Orthonormal 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

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VL4351 VLSI SIGNAL PROCESSING

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

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


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


UNIT IV BIT-LEVEL ARITHMETIC ARCHITECTURES

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

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

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

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

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
CO3: understand 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

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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

UNIT II
SEARCH METHODS AND VISUALIZATION
9

UNIT III
MINING DATA STREAMS
9

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

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
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DS4016 INTERNET OF THINGS SYSTEM DESIGN AND SECURITY

UNIT I INTRODUCTION TO INTERNET OF THINGS

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
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


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


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:**


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**DS4017 MACHINE LEARNING AND DEEP LEARNING**

**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**

UNIT II  CLUSTERING AND REINFORCEMENT LEARNING  9

UNIT III  INTRODUCTION TO DEEP LEARNING  9

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.Recursive 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

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.

**REFERENCES:**


**CO-PO Mapping**

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**DS4018 ARTIFICIAL INTELLIGENCE AND OPTIMIZATION TECHNIQUES**

**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**

UNIT II  
FUZZY LOGIC SYSTEMS  

UNIT III  
EVOLUTIONARY COMPUTATION & GENETIC ALGORITHMS  

UNIT IV  
ANT COLONY OPTIMIZATION  
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  

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:
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


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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

UNIT IV SAMPLE DETECTION AND FILTERS 9

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
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DS4071 RADAR SIGNAL PROCESSING

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
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
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
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
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
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
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
2. Introduction To Radar Systems 3/E, Skolnik, McGrad Hill. 2017
3. Radar Principles, Peyton Z. Peebles, Wiley India 2009

CO-PO Mapping

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74
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
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

UNIT III TITLE WRITING SKILLS
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
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
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

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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

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

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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 nationhood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and 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

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

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.

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.

TOTAL: 30 PERIODS
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.

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2. குறுக்கை விளக்கச்செய்யப்பட்டுள்ளது
- மூக்குலைக்கணம் அத்தாளத்திலிருந்து

UNIT IV  அதி சிற்றிகள் குறிப்பிட்டு
1. இசுப்பார்க்கும் பகுதியில்
- பார்வை, முதன்மைகள், பாலன்மைகள், பாளிகள், அருள்பாடுகள், இன்னும் தூண்டும் பதைகளிற்கு
2. பலகைத்தல
- அரசியல்களின் பலகைத்தல்
3. இயக்குநர் (617, 618)
- மேலும் இயக்குநர் கிளைகள்
4. குருநாடகக் கல்வியியல் மையங்களுக்கு
5. பொழுதுகை
- இயக்குநர் மையங்களாக
6. அரசியல்கள் (4) - மேலும்
   குருநாடகக் கல்வியியல் (11) - மேலும்
   குருநாடகக் கல்வியியல் (11) - பலகைத்தல், புதுப்பு
   குருநாடகக் கல்வியியல் 50 (27) - பலகை
அரசியல் பதைகள் நோட்டங்கள்

UNIT V  தொரை குறிப்பிட்டு
1. தொரைகளுக்கு வகைப்படுத்து
- குறிப்பிட்டுகள் புதுப்பு
- குறிப்பிட்டுகள் மேலும்
- குறிப்பிட்டுகள் நோட்டங்கள்
- பலகைத்தல், புது
- பலகைத்தல்
2. தொரைகளுக்கு பலகைத்தலைகள்
3. மேலும் குறிப்பிட்டுகளின் வகைப்படுத்து
4. பலகைத்தலைகளுக்கு தொரைகள், தொரைகளின் குறிப்பிட்டுகள்
5. குறிப்பிட்டுகள்
6. தொரைகளின் வகைப்படுத்து
7. மேலும் குறிப்பிட்டுகள்

TOTAL: 30 PERIODS

தமிழ் விளக்கத் தொகுப்புத்துறை / புத்தகங்கள்
1. தமிழ் விளக்கத் தொகுப்புத்துறை (Tamil Virtual University)
   - www.tamilvu.org
2. தமிழ் விளக்கத் தொகுப்புத்துறை (Tamil Wikipedia)
   - https://ta.wikipedia.org
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
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
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
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
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
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:

CO – PO Mapping - INTEGRATED WATER RESOURCES MANAGEMENT

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<td>gender, legal and environmental aspects in the context of integrated water resources management</td>
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<td>PSO2 Formulate, analyze and comprehend the differences in social and environmental variability in South Indian context with their peers and strive to work towards sustainability</td>
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<td>PSO3 Produce and publish professional reports, peer-reviewed journal, on contemporary and state of the art research in integrated water</td>
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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

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


UNIT III CHALLENGES IN MANAGEMENT AND DEVELOPMENT


UNIT IV GOVERNANCE

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

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:

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<th>CO1</th>
<th>Capture to fundamental concepts and terms which are to be applied and understood all through the study.</th>
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<td>CO2</td>
<td>Comprehend the various factors affecting water sanitation and health through the lens of third world scenario.</td>
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<td>Critically analyse and articulate the underlying common challenges in water, sanitation and health.</td>
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<td>CO4</td>
<td>Acquire knowledge on the attributes of governance and its say on water sanitation and health.</td>
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<td>CO5</td>
<td>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.</td>
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REFERENCES


**CO PO MAPPING : WATER, SANITATION AND HEALTH**

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**PSO1**

| Explain the concepts of water management, field research methodology, gender, legal and environmental aspects in the context of integrated water resources management | 3       | 3       | 3      | 3      | 3     |

**PSO2**

| Formulate, analyse and comprehend the differences in social and economic variability in South Asian context with their peers and strive to work towards sustainability. | 3       | 2       | 3      | 3      | 3     |

**PSO3**

| Produce and publish professional reports, peer reviewed journal on contemporary and state of art research in water resources Engineering. | 3       | 3       | 3      | 2      | 3     |

**OCE433**

**PRINCIPLES OF SUSTAINABLE DEVELOPMENT**

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**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 CHALLENGES


UNIT II PRINCIPLES AND FRAMEWORK


UNIT III SUSTAINABLE DEVELOPMENT AND WELLBEING


UNIT IV SUSTAINABLE SOCIO-ECONOMIC SYSTEMS


UNIT V ASSESSING PROGRESS AND WAY FORWARD


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:

CO – PO Mapping – Principles of Sustainable Development

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OCE434 ENVIRONMENTAL IMPACT ASSESSMENT

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

UNIT II IMPACT IDENTIFICATION AND PREDICTION

UNIT III SOCIO-ECONOMIC IMPACT ASSESSMENT
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
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
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
7. Sam Mannan, Lees' Loss Prevention in the Process Industries, Hazard Identification
**CO – PO Mapping- ENVIRONMENTAL IMPACT ASSESSMENT**

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**OIC431 BLOCKCHAIN TECHNOLOGIES**

**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**
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**

**UNIT III INTRODUCTION TO ETHEREUM**
Introduction to Ethereum, Consensus Mechanisms, Metamask Setup, Ethereum Accounts, Transactions, Receiving Ethers, Smart Contracts.
UNIT-IV  INTRODUCTION TO HYPERLEDGER AND SOLIDITY PROGRAMMING  10

UNIT V  BLOCKCHAIN APPLICATIONS  8
Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins.

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

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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
Video Data.

UNIT II  NEURAL NETWORKS  9

UNIT III  CONVOLUTIONAL NEURAL NETWORK  10

UNIT VI  NATURAL LANGUAGE PROCESSING USING RNN  10

UNIT V  DEEP REINFORCEMENT & UNSUPERVISED LEARNING  10

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
4. Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND,2017

OME431  VIBRATION AND NOISE CONTROL STRATEGIES  L T P C
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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**

- 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**

- 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**

- 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**

- 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**

- 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.

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OME432 ENERGY CONSERVATION AND MANAGEMENT IN DOMESTIC SECTORS

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

UNIT II HEATING, VENTILLATION & AIR CONDITIONING

UNIT III LIGHTING, COMPUTER, TV

UNIT IV ENERGY EFFICIENT BUILDINGS

UNIT V ENERGY STORAGE TECHNOLOGIES
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.

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OME433 ADDITIVE MANUFACTURING

UNIT I INTRODUCTION

UNIT II DESIGN FOR ADDITIVE MANUFACTURING

UNIT III VAT POLYMERIZATION

UNIT IV MATERIAL EXTRUSION AND SHEET LAMINATION
POWDER BASED PROCESS

UNIT V CASE STUDIES AND OPPORTUNITIES ADDITIVE MANUFACTURING PROCESSES

TOTAL: 45 PERIODS

REFERENCES:
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

TOTAL: 45 PERIODS

REFERENCES:

OME435        NEW PRODUCT DEVELOPMENT        L T P C
3 0 0 3

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. Identifying 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. Applying the principles of Industrial design and prototype for new product design and development.

UNIT I     INTRODUCTION TO PRODUCT DESIGN & DEVELOPMENT  9
UNIT II OPPORTUNITY IDENTIFICATION & PRODUCT PLANNING 9

UNIT III IDENTIFYING CUSTOMER NEEDS & PRODUCT SPECIFICATIONS 9

UNIT IV CONCEPT GENERATION, SELECTION & TESTING 9

UNIT V INDUSTRIAL DESIGN & PROTOTYPING 9

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.

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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
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
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
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
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

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 sustainability performances.
CO4: Knowledge of innovative practices in sustainable business and community management
CO5: Deep understanding of sustainable management of resources and commodities

REFERENCES:
4. Margaret Robertson, Sustainability Principles and Practice, 2014
5. Peter Rogers, An Introduction to Sustainable Development, 2006
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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


UNIT II SCREENING THE BUSINESS OPPORTUNITY AND FORMULATING THE BUSINESS PLAN

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

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

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

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
3. Journal articles on SME’s.

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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

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
2. Intellectual Property rights and copyrights, EssEss Publications.

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OBA434 ETHICAL MANAGEMENT

COURSE OBJECTIVE
➢ To help students develop knowledge and competence in ethical management and decision making in organizational contexts.

UNIT I ETHICS AND SOCIETY
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
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
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 MANAGEMENT
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
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

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ET4251 IoT FOR SMART SYSTEMS

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

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

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ET4072 MACHINE LEARNING AND DEEP LEARNING

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

UNIT II NEURAL NETWORKS

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

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PX4012 RENEWABLE ENERGY TECHNOLOGY L T P C
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OBJECTIVES:
To impart knowledge on
- Different types of renewable energy technologies
- Standalone operation, grid connected operation of renewable energy systems

UNIT I INTRODUCTION
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 - CO₂ Emission - importance of renewable energy sources, Potentials – Achievements– Applications.

UNIT II SOLAR PHOTOVOLTAICS

UNIT III PHOTOVOLTAIC SYSTEM DESIGN
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

UNIT V OTHER RENEWABLE ENERGY SOURCES
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.

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:
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
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
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
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
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

MAPPING OF CO’S WITH PO’S

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CP4391  SECURITY PRACTICES

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

UNIT II NETWORK SECURITY

UNIT III SECURITY MANAGEMENT

UNIT IV CYBER SECURITY AND CLOUD SECURITY

UNIT V PRIVACY AND STORAGE SECURITY

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

CO-PO Mapping
108
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MP4251 | CLOUD COMPUTING TECHNOLOGIES | L T P C
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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

UNIT II | CLOUD PLATFORM ARCHITECTURE | 12

UNIT III | AWS CLOUD PLATFORM - IAAS | 9

UNIT IV | PAAS CLOUD PLATFORM | 9

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

IF4072 DESIGN THINKING

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

UNIT II CONTEXTUAL INQUIRY
History of affinity diagrams.

UNIT III DESIGN THINKING, IDEATION, AND SKETCHING

UNIT IV UX GOALS, METRICS, AND TARGETS

UNIT V ANALYSING USER EXPERIENCE

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
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
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

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
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.

Suggested Evaluation Methods:
1. Demonstration on after effects animations.
2. Quizzes on file formats and color models.

UNIT III MULTIMEDIA 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


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


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

UNIT II CONCEPT OF SUSTAINABILITY
Sustainable Development: Defining the Concept, the Population Problem, Natural Resource Economics: An Overview, Energy, Water, Agriculture

UNIT III SIGNIFICANCE OF BIODIVERSITY
Biodiversity, Forest Habitat, Commercially Valuable Species, Stationary - Source Local Air Pollution, Acid Rain and Atmospheric Modification, Transportation

UNIT IV POLLUTION IMPACTS
Water Pollution, Solid Waste and Recycling, Toxic Substances and Hazardous Wastes, Global Warming.

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

TOTAL : 45 PERIODS

REFERENCES

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

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

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

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

UNIT IV TESTING
Fibre volume and weight fraction, specific gravity of composites, tensile, flexural, 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

NT4002  NANOCOMPOSITE MATERIALS  L T P C
3 0 0 3

UNIT I  BASICS OF NANOCOMPOSITES  9

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
REFERENCES:
5. The search for novel, superhard materials- Stan Vepřek (Review Article) JVST A, 1999

UNIT I IPR, BIOSAFETY AND ENTREPRENEURSHIP

UNIT I IPR
9

UNIT II AGREEMENTS, TREATIES AND PATENT FILING PROCEDURES
9

UNIT III BIOSAFETY
9

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 Cartagena Protocol.
UNIT V ENTREPRENEURSHIP DEVELOPMENT


TOTAL : 45 PERIODS

REFERENCES


