Vision of the Department

The vision of Anna University is to be a world class institution by producing professionals with high technical knowledge, professional skills and ethical values, and remain as a preferred partner to the industry and community for their economic and social development through excellence in teaching, research and consultancy. Anna University shall be recognized as a point of reference, a catalyst, a facilitator, a trend setter and a leader in technical education.

Mission of the Department

To produce full fledged Electrical and Electronics Engineers to cater to the needs of the modern industries and be useful for building the nation.
Programme specific outcomes

After the completion of two-year Master of Engineering degree program in Control and Instrumentation (C&I) the student will have the following program specific outcomes.

1. Students will have the specialized training in classical as well as modern to pics in the broad field of system analysis and control.
2. Students will be able to derive mathematical model of the various physical systems to analyze their feasibility for the real time implementation.
3. It eventually enabling graduates to analyze, design, operates and integrates physical systems.
4. It also enables graduates to specialize in sensor synthesis, controller design and implementation.
5. Students are able to find control and instrumentation solution for power engineering, process stations and industries.

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

<p>| | |</p>
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<tbody>
<tr>
<td>I.</td>
<td>To prepare students, for having career in teaching institutions/research organizations/industries that meet the need of national and international interest</td>
</tr>
<tr>
<td>II.</td>
<td>To develop among students, the ability to analyse systems, develop controllers and work with automation systems.</td>
</tr>
<tr>
<td>III.</td>
<td>To prepare students, to work in interdisciplinary groups.</td>
</tr>
<tr>
<td>IV.</td>
<td>To provide students, good foundation in mathematical, scientific, engineering Fundamentals and artificial intelligence.</td>
</tr>
<tr>
<td>V.</td>
<td>To provide the students with knowledge to be involved with the technology advancements and future developments in process industries and automation systems.</td>
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<tr>
<td>VI.</td>
<td>To promote student awareness, for life-long learning and introduce them to professional ethics and code of practice.</td>
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2. PROGRAMME OUTCOME (POs):

On successful completion of the programme,

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<td>1.</td>
<td>Problem analysis</td>
<td>Ability to solve linear algebraic and differential equations, determine optimal solutions, apply statistical techniques</td>
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<td>System analysis</td>
<td>Capability to analyse and interpret linear and non-linear systems</td>
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<td>Design of controllers</td>
<td>Able to design controllers to meet the given specifications for linear single and multiple input-output systems</td>
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<td>4.</td>
<td>Technical development</td>
<td>Ability to review, prepare and present technical developments</td>
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<td>5.</td>
<td>Software packages</td>
<td>Skill to work on professional software packages for system analysis and design problems</td>
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<td>6.</td>
<td>Modern tool usage</td>
<td>To develop software packages for design problems in well-known professional platforms</td>
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<td>7.</td>
<td>Hardware analysis &amp; design</td>
<td>To analyse and design control and instrumentation hardware</td>
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<td>8.</td>
<td>Study of transducers</td>
<td>Competency to reproduce scientific principle of transducers and their principles</td>
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<td>9.</td>
<td>System design and automation</td>
<td>To design and conduct experiments on control system design</td>
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<td>10.</td>
<td>Ethics</td>
<td>To interact industry, business and society in a professional and ethical manner</td>
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<td>12.</td>
<td>Project development</td>
<td>To develop a research for an industrial problem or develop an innovative and usable product of societal interest</td>
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PEO/PO Mapping:

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**Mapping of Course Outcome and Programme Outcome**
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### CURRICULUM AND SYLLABUS I TO IV SEMESTERS

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*Audit Course is optional

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*Audit Course is optional
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**TOTAL NO. OF CREDITS**: 70
### PROGRAM ELECTIVE COURSE (PEC) LIST (Group–I)

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## RESEARCH METHODOLOGY AND IPR (RMC)

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## OPEN ELECTIVE COURSES [OEC]

*(Out of 6 Courses one Course must be selected)*

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## AUDIT COURSES (AC)

Registration for any of these courses is optional to students

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EMPLOYABILITY ENHANCEMENT COURSES (EEC)

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SUMMARY

Programme: M.E. Control & Instrumentation

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COURSE OBJECTIVES
To educate the students
• To understand the physical principles of sensors and transducers.
• To impart the knowledge on signal conditioning and communication protocols.

UNIT I  PHYSICAL PRINCIPLES AND ELEMENTS OF SENSORS  12
Principles: Resistive – Inductive – Capacitive - Magnetic sensing - Piezoelectric effects -
Light - Temperature based sensing, Elements: Mechanical, Thermal, Electrical elements

UNIT II  SENSORS AND TRANSDUCERS  12
Potentio metric Sensors – Gravitational Sensors – Capacitive Sensors – Inductive and
Magnetic Sensors – Optical Sensors – Ultrasonic Sensors – Radar Sensors – Thickness and
Level Sensors - Capacitive Accelerometer – Gyrosopes - optoelectronic sensors – Smart
Sensors and applications

UNIT III  SIGNAL CONDITIONING AND INTERFACE  12
Sensor linearization - Processing of Analog Measurement signals – Digital processing of
measurement signals – wide area measuring systems – Sensors with built-in interface –
Computer measuring systems and simulation studies

UNIT IV  COMMUNICATION PROTOCOLS  12
Introduction-Evolution of signal standard – HART communication protocol – Communication
modes – Networks – commands – applications OSI models - Field bus:- architecture, standard, Field bus topology, Interoperability and Interchange ability Profibus:- Introduction, protocol stack, communication model, Communication objects.– Foundation field bus & Profibus- Comparison of CANBUS,LINBUS,MODBUS,INDUSTRIAL ETHERNET.

UNIT V  SMART SENSORS  12
Definition – Integrated smart sensors - Interface electronics - Design, sensing elements and
parasitic effects, ADC, Accuracy and Dynamic range - Universal Sensor Interface – converters
- front end circuits DAQ – Design - Digital conversion techniques - Microcontrollers and digital
signal processors for smart sensors – selection - Timer, Analog comparator, ADC and DAC
modules –IEEE 1451.0 Standard for smart sensor interface.

TOTAL : 60 PERIODS

COURSE OUTCOMES:
At the end of this course, the students will demonstrate the ability
CO1 : To understand the basic elements of sensors
CO2 : To apply the principles of transducer to different applications
CO3 : To design a signal conditioning circuits for various applications
CO4 : To understand the importance of communication buses in applied automation
Engineering.
CO5 : To design and develop customized smart sensors.

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REFERENCES:
5. Gerard C.M. Meijer, Smart Sensor Systems, John Wiley and Sons, 2008

CO5151 CONTROL SYSTEM DESIGN

COURSE OBJECTIVES
To educate the students on
• Analysis and design of controllers for linear systems defined in transfer function and state space from.
• Application of optimal control and filtering concepts for linear systems continuous and discrete domain.

UNIT I ANALYSIS OF LINEAR SYSTEMS 12

UNIT II DESIGN OF SISO SYSTEM 12
Design Specifications – In continuous domain – Limitations – Controller Structure – Multiple degrees of freedom – PID controllers and Lag-lead compensators- Design – Discretization and direct discrete design - Design in continuous and discrete domain

UNIT III STATE SPACE DESIGN 12

UNIT IV OPTIMAL CONTROL 12

UNIT V OPTIMAL FILTERING 12
Filtering – Linear system and estimation – System noise smoothing and prediction – Kalman Filter – Recursive estimation.

TOTAL: 60 PERIODS
COURSE OUTCOMES:

Ability to

CO1 Analyse controllers for linear systems defined in transfer function and state space forms.
CO2 Design controllers for linear systems defined in transfer function and state space forms.
CO3 Apply state space forms to continuous and discrete systems.
CO4 Apply optimal control to linear systems in continuous and discrete systems.
CO5 Apply filtering concepts to linear systems in continuous and discrete systems.

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TEXT BOOKS:

REFERENCES:
COURSE OBJECTIVES
To educate the students on
- Design of ANN and fuzzy set theory.
- Analysis and implementation of ANN and Fuzzy logic for modeling and control of Non-linear system and to get familiarized with the Matlab toolbox.
- Impart the knowledge of various optimization techniques and hybrid schemes with the ANFIS tool box.

UNIT I OVERVIEW OF ARTIFICIAL NEURAL NETWORK (ANN) & FUZZY LOGIC

UNIT II NEURAL NETWORKS FOR MODELLING AND CONTROL
Generation of training data - optimal architecture – Model validation- Control of non linear system using ANN- Direct and Indirect neuro control schemes- Adaptive neuro controller –Case study - Familiarization of Neural Network Control Tool Box.

UNIT III FUZZY LOGIC FOR MODELLING AND CONTROL

UNIT IV GENETIC ALGORITHM
Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters. Solution of typical control problems using genetic algorithm. Concept on some other search techniques like Tabu search, Ant-colony search and Particle Swarm Optimization.

UNIT V HYBRID CONTROL SCHEMES
Fuzzification and rule base using ANN–Neuro fuzzy systems-ANFIS –Optimization of membership function and rule base using Genetic Algorithm and Particle Swarm Optimization - Case study– Familiarization of ANFIS Tool Box.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Ability to
CO1 : Understand the basic architectures of NN and Fuzzy sets
CO2 : Design and implement ANN architectures, algorithms and know their limitations. 
CO3 : Identify and work with different operations on the fuzzy sets.
CO4 : Develop ANN and fuzzy logic based models and control schemes for non-linear systems.
CO5 : Understand and explore hybrid control schemes and PSO
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REFERENCES:

CO5153 MEMS DESIGN: SENSORS AND ACTUATORS LT P C 3 0 0 3

COURSE OBJECTIVES
- To analyse the properties of materials, microstructure and fabrication methods.
- To design and modeling of Electrostatic sensors and actuators.
- To teach the characterizing thermal sensors and actuators through design and modeling.
- To understand the fundamentals of piezoelectric sensors and actuators through exposure to different MEMS and NEMS devices

UNIT I MICRO-FABRICATION, MATERIALS AND ELECTRO-MECHANICAL CONCEPTS 9
Overview of micro fabrication – Silicon and other material based fabrication processes – Concepts: Conductivity of semiconductors-Crystal planes and orientation-stress and strain-flexural beam bending analysis- torsional deflections-Intrinsic stress- resonant frequency and quality factor.

UNIT II ELECTROSTATIC SENSORS AND ACTUATION 9
Principle, material, design and fabrication of parallel plate capacitors as electrostatic sensors and actuators-Applications

UNIT III THERMAL SENSING AND ACTUATION 9
Principle, material, design and fabrication of thermal couples, thermal bimorph sensors, thermal resistor sensors-Applications.
UNIT IV PIEZOELECTRIC SENSING AND ACTUATION 9
Piezoelectric effect-cantilever piezo electric actuator model-properties of piezoelectric materials Applications.

UNIT V CASE STUDIES 9
Piezoresistive sensors, Magnetic actuation, Micro fluidics applications, Medical applications, Optical MEMS.-NEMS Devices

COURSE OUTCOMES:
At the end of this course, the students will demonstrate the ability

- CO1: To analyse the learning process to design of micro sensors, embedded sensors & actuators
- CO2: To analyse the electrostatic sensors and actuators through MEMS and NEMS devices
- CO3: To analyse the thermal sensors and actuators through MEMS and NEMS devices
- CO4: To analyse the piezoelectric sensors and actuators through MEMS and NEMS
- CO5: Design of piezoresistive sensors for biomedical and micro fluidic applications

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REFERENCES

RM5151 RESEARCH METHODOLOGY AND IPR LT P C
2002

COURSE OBJECTIVES:
To impart knowledge and skills required for research and IPR:
- Problem formulation, analysis and solutions.
- Technical paper writing / presentation without violating professional ethics
- Patent drafting and filing patents.

UNIT I RESEARCH PROBLEM FORMULATION 6
Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis,
interpretation, necessary instrumentations

UNIT II LITERATURE REVIEW 6
Effective literature studies approaches, analysis, plagiarism, and research ethics.

UNIT III TECHNICAL WRITING /PRESENTATION 6
Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, a presentation and assessment by a review committee.

UNIT IV INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR) 6

UNIT V INTELLECTUAL PROPERTY RIGHTS (IPR) 6

TOTAL: 30 PERIODS

COURSE OUTCOMES:
1. Ability to formulate research problem
2. Ability to carry out research analysis
3. Ability to follow research ethics
4. Ability to understand that today’s world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
5. Ability to understand about IPR and filing patents in R & D.

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REFERENCES:
### CO5111  CONTROL SYSTEM DESIGN LAB

**COURSE OBJECTIVES**
To educate the students
- Model, simulate and analyze physical systems in analog and digital platforms
- Design and implement simple controllers in standard forms.

**LIST OF EXPERIMENTS**
1. Analog simulation of linear systems
2. Digital simulation of linear and non-linear systems
3. Modelling and analysis of physical systems
4. Tuning methods of PID controller
5. Design of Lag-Lead compensators
6. Design of state feedback and optimal controller
7. Design of optimal estimator
8. Real time simulation of physical systems
9. Hardware in loop simulation of closed loop system
10. Design a closed loop controller for a physical system

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**
At the end of this course, the students will demonstrate the ability
CO1 : Develop hardware in loop simulation of closed loop control system

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### CO5112  INTELLIGENT CONTROLLERS LAB

**COURSE OBJECTIVES**
- To familiarize the students with optimization techniques and Intelligent Controllers.
- To implement different algorithms and Intelligent Controllers for various Process.
- To analyse the system performances for different controllers.

**LIST OF EXPERIMENTS**
1. To implement adaline and madaline with bipolar inputs and outputs using NN toolbox.
2. To implement back propagation for a given input pattern using NN toolbox.
3. To implement discrete hopfield network and test for given input pattern using NN toolbox.
4. To implement fuzzy set operation and properties using FUZZY toolbox.
5. To perform max-min composition of two matrices obtained from Cartesian product using ‘m file’ in MATLAB.
6. Write a program to verify the various laws associated with fuzzy set using FUZZY toolbox.
7. Write a matlab program for maximizing f(x) =x^2 using GA, where x is ranges from 0 to 31 (Perform only 5 iterations). Find the function and ‘x’ value.
9. Design a Neuro model for an inverted pendulum using NN toolbox.
10. Design Fuzzy model for an inverted pendulum using FUZZY toolbox.
COURSE OUTCOMES:
CO1: Ability to understand and use NN & FUZZY tool box using Software Packages.
CO2: Ability to acquire knowledge on Identification of system & to work on simple application using MATLAB software.

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CO5251 \hspace{1cm} MACHINE LEARNING \hspace{1cm} LT P C

TOTAL: 60 PERIODS

COURSE OBJECTIVES
To educate the students
• On several fundamental concepts and methods for machine learning.
• Acquire knowledge in processing, analyzing and handling data sets.
• Demonstrate typical applications of various clustering based learning algorithms

UNIT I \hspace{1cm} INTRODUCTION TO MACHINE LEARNING \hspace{1cm} 12

UNIT II \hspace{1cm} DATA PREPROCESSING \hspace{1cm} 12
Data quality – Data preprocessing: - Data Cleaning:- Handling missing data and noisy data –Data integration: - Redundancy and correlation analysis – Data Reduction:- Dimensionality reduction (Linear Discriminant Analysis – Principal Components Analysis – Factor Analysis –Independent Components Analysis) – Numerosity Reduction - Data Compression - Data Normalization and Data Discretization.

UNIT III \hspace{1cm} SUPERVISED LEARNING \hspace{1cm} 12

UNIT IV \hspace{1cm} CLUSTERING AND UNSUPERVISED LEARNING \hspace{1cm} 12

UNIT V \hspace{1cm} BAYESIAN LEARNING \hspace{1cm} 12

TOTAL: 60 PERIODS
COURSE OUTCOMES:
At the end of this course, the students will demonstrate the ability
CO1: To understand the basic theory underlying machine learning.
CO2: A range of machine learning algorithms along with their strengths and weaknesses.
CO3: To formulate machine learning problems corresponding to different applications.
CO4: To apply machine learning algorithms to solve problems of moderate complexity.
CO5: To read current research papers and understand the issues raised by current research.

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REFERENCES:
3. Jiawei Han, Micheline Kamber, Jian Pei, Data Mining: Concepts and Techniques: Concepts and Techniques, Elsevier, 2011.

CO5201 NON LINEAR CONTROL

COURSE OBJECTIVES
To educate the students on
- Analysis of control non-linearities in physical systems
- Stability analysis using construction of Lyapunov functions
- Design controllers for non-linear systems using feedback linearization and sliding mode control theory

UNIT I PHASE PLANE ANALYSIS
12
Concepts of phase plane analysis- Phase portraits- singular points- Symmetry in phase plane portraits-
Constructing Phase Portraits- Phase plane Analysis of Linear and Nonlinear Systems- Existence of Limit Cycles. Analysis using computer simulations

UNIT II DESCRIBING FUNCTION
12
Describing Function: Fundamentals – Definitions – Assumptions - Computing Describing Functions - Common Nonlinearities and its Describing Functions - Nyquist Criterion and its Extension - Existence of
Limit Cycles-Stability of limit Cycles. Analysis using computer simulations

UNIT III   LYAPUNOV THEORY


UNIT IV   FEEDBACK LINEARIZATION


UNIT V   SLIDING MODE CONTROL

Sliding Surfaces - Continuous approximations of Switching Control laws - The Modeling / Performance Trade-Offs- MIMO Systems. Analysis using computer simulations

TOTAL: P=30 +L=45 75 PERIODS

COURSE OUTCOMES:

Ability to

CO1 : Analyse system performance in the presence of control non-linearity
CO2 : Analyse system performance using describing function method
CO3 : Analyse non-linear system performance by constructing Lyapunov function
CO4 : Analyse and Design robust controllers for non-linear systems for parameter variations but with stable zero-dynamics.
CO5 : Implement controllers for MIMO systems using computer simulations

REFERENCES:

2. K. P. Mohandas, Modern Control Engineering, Sanguine, India, 2006

LIST OF EXPERIMENTS

1. Construction of phase portraits for linear systems
2. Effect of saturation non-linearity on system Performance.
3. Effect of dead zone non-linearity on system Performance
4. Effect of hysteresis non-linearity on system Performance
5. Effect of back-lash non-linearity on system Performance
8. Controller design with feedback Linearization and determine the limitations.
10. Design of controllers for MIMO systems.

CO5202 INDUSTRIAL AUTOMATION SYSTEMS LT P C 4 0 0 4

COURSE OBJECTIVES:
To educate the fundamental and programming concepts of conventional electronic instrumentation and virtual instrumentation in the areas of:
- Electronic instruments
- Computer based instruments
- Virtual instrumentation programming
- Latest industrial PLCs and SCADA

UNIT I ELECTRONIC INSTRUMENTATION 12

UNIT II INSTRUMENTS IN SYSTEMS 12
Introduction to instruments in systems – Switches in automated test systems – Instrument System elements – Computer controlled instrument systems

UNIT III INTRODUCTION TO VIRTUAL INSTRUMENTATION 12

UNIT IV SOFTWARE PROGRAMMING IN VIRTUAL INSTRUMENTATION 12
Programming Techniques – Front Panel and Block diagram – Data flow programming – G programming concepts – Creating and saving VIs – Wiring, Editing and Debugging of VIs – Creating Sub VIs – Control structures – Nodes – Arrays – Cluster controls and indicators – Error handling – String controls – File I/O VIs and functions.

UNIT V PLC AND SCADA BASED INSTRUMENTATION 12

TOTAL :60 PERIODS

COURSE OUTCOMES:
In the end of the course the students will be:
CO1 :able to gain the knowledge on various types of analyzers.
CO2 :able to analyse Computer controlled instrument systems
CO3 :able to understand Virtual Instrumentation for engineering processes.
CO4 :able to gain the knowledge on various types of sensors & sensor technologies, signal conditioning for interface applications and PC based instrumentation.
CO5 : able to acquire a detailed knowledge on data acquisition system interface with systems
TEXT BOOKS:

3. Dag H. Hanssen, Programmable Logic Controllers, A Practical Approach to IEC 61131-3 using CODESYS, John Wiley & Sons Ltd., 2015

REFERENCES:

3. SrinivasMedida, Pocket Guide on Industrial Automation for Engineers and Technicians, IDC Technologies

CO5211 VIRTUAL INSTRUMENTATION LAB LT P C 0 0 4 2

COURSE OBJECTIVES
To educate the students
- To understand the concepts and configuration of Instrumentation bus protocols
- To gain adequate knowledge on applying various instrumentation simulation software packages.

LIST OF EXPERIMENTS
1. Configuration of simulation of instrumentation bus protocols.
3. Simulation of process control loop using PLC with GUI.
4. Simulation of signal conditioning and processing circuits using circuit design packages.
5. Configuration of analog and digital data acquisition systems.
6. Development of GUI application for PID control.
7. Simulation of transfer function models using Virtual Instrumentation packages.
8. Simulation of state space models using virtual Instrumentation packages.
9. Development of GUI application to mimic closed loop performance of physical systems.
10. Demonstration of discretization blocks in the virtual instrumentation package.
11. Ladder logic programming using PLC simulator software packages.
12. Simulation of SCADA based control of physical system.
13. Simulation of state diagram based application using virtual instrumentation package.
15. Mini Project

TOTAL :60 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will demonstrate the ability

CO1 : To interface processors with physical systems for control and automation purposes.
CO2 : To get hands on experience on various instrumentation protocols.

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CO5071 ADVANCED NON-LINEAR CONTROL

COURSE OBJECTIVES

To educate the students on

- Theory of perturbation
- Gain scheduling and feedback linearization
- Input-output stability and passivity
- Theory and design of back stepping controllers.

UNIT I PERTURBATION THEORY

UNIT II SINGULAR PERTURBATIONS
Standard singular perturbation model – Time scale properties – Singular perturbation on the infinite interval – Slow and fast manifolds – stability analysis – exercises

UNIT III GAIN SCHEDULING AND FEEDBACK LINEARIZATION

UNIT IV INPUT-OUTPUT STABILITY

UNIT V BAKSTEPPING CONTROL ALGORITHMS
Passivity based control – High gain observers – stabilization – Regulation via integral control - exercises

TOTAL : 45 PERIODS

COURSE OUTCOMES

CO1 : Understanding different types of perturbation models.
CO2 : Analysis of Stability of various perturbation models.
CO3 : Apply gain schedule all kind of perturbation systems.
CO4: Apply L stability and lyapunov stability conditions for systems
CO5: Apply Bakstepping control algorithms.

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1. Hasan Khalil," Nonlinear systems and control", 3rd ed, PHI,

CO5072 CONTROL OF ELECTRICAL DRIVES LT P C 3003

COURSE OBJECTIVES
- To introduce the PWM converters and their analysis.
- To educate on modeling of dc motor, drives and control techniques
- To educate on dynamic modeling of Induction motor drive.
- To educate on the V/f and vector control of Induction motor.
- To educate on generation of firing pulses and control algorithms in embedded platforms.

UNIT I POWER ELECTRONIC CONVERTERS FOR DRIVES

UNIT II CONTROL OF DC DRIVES

UNIT III ANALYSIS AND MODELLING OF INDUCTION MOTOR DRIVE

UNIT IV CONTROL OF INDUCTION MOTOR DRIVE
VSI fed induction motor drives- waveforms for 1-phase, 3-phase Non-PWM and PWM VSI fed induction motor drives -principles of V/F control- principle of vector control-direct vector control- space vector modulation- indirect vector control.
UNIT V  EMBEDDED CONTROL OF DRIVES
Generation of firing pulses- generation of PWM pulses using embedded processors-IC control of DC drives- fixed frequency/variable frequency/current control- V/F control using PIC microcontroller-vector control using embedded processors.

TOTAL : 45 PERIODS

COURSE OUTCOMES
CO1 : understand Power Electronic Converter Switches and different PWM approach.
CO2 : design and analyze converter and chopper driven dc drives.
CO3 : analyze converter and chopper driven dc drives.
CO4 : understand conventional control techniques of Induction motor drive.
CO5 : understand V/f Control using PIC Micro Controller and Vector control using Embedded processor.

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CO5073  OPTIMAL CONTROL AND FILTERING  LT P C
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COURSE OBJECTIVES
• To educate on formulation of optimal control problems and introduce the minimum principle.
• To educate on Linear Quadratic tracking problems- in continuous and discrete domain.
• To introduce the numerical techniques used for solving optimal control problems
• To educate on the concepts of filtering in the presence of noise.
• To educate on the theory and design of Kalman filter.

UNIT I  INTRODUCTION
UNIT II  LINEAR QUADRATIC TRACKING PROBLEMS  

UNIT III  NUMERICAL TECHNIQUES FOR OPTIMAL CONTROL  
Numerical solution of 2-point boundary value problem by steepest descent and Fletcher Powell method - solution of Ricatti equation by negative exponential and interactive Methods

UNIT IV  FILTERING AND ESTIMATION  

UNIT V  KALMAN FILTER AND PROPERTIES  

TOTAL : 45 PERIODS

COURSE OUTCOMES

Ability to
CO1 : Understand the concept of Optimal Control problem.
CO2 : Identify, Formulate and measure the performance of Optimal Control.
CO3 : Understand the Linear Quadratic Tracking Problems and implement dynamic programming application for discrete and continuous systems.
CO4 : Solve Numerical solution of 2-point boundary value problem by steepest descent and Fletcher Powell method.
CO5 : Understand Filtering problem their properties, linear estimator property of Kalman Filter and Time invariance and asymptotic stability of filters.

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CO5074 SYSTEM IDENTIFICATION AND ADAPTIVE CONTROL LT P C 3 0 0 3

COURSE OBJECTIVES

- To introduce various model structures for system identification.
- To impart knowledge on parametric and non-parametric identification.
- To introduce non-linear identification techniques.
- To introduce the concept of adaptation techniques and control.
- To illustrate the identification and adaptive control techniques through case studies.

UNIT I MODELS FOR IDENTIFICATION 9

UNIT II NON-PARAMETRIC AND PARAMETRIC IDENTIFICATION 9

UNIT III NON-LINEAR IDENTIFICATION 9

UNIT IV ADAPTIVE CONTROL AND ADAPTATION TECHNIQUES 9

UNIT V CASE STUDIES 9
Inverted Pendulum, Robot arm, process control application: heat exchanger, Distillation column, application to power system, Ship steering control.

TOTAL : 45 PERIODS

COURSE OUTCOMES

Ability to

CO1 : model LTI system and to analyse the Non-linear state-space model of a black box.
CO2 : analyse frequency, spectral, correlation and transient response of a system.
CO3 : Identify the Open & closed Loop of a Non-linear system by Neural network and Fuzzy Logic controller.
CO4 : Realize different tuning parameters for adaptive control and adaptive technique.
CO5 : Apply different control techniques to various applications

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3. Astrom and Wittenmark,” Adaptive Control “, PHI

CO5075 SYSTEM THEORY

COURSE OBJECTIVES

- To educate on modeling and representing systems in state variable form.
- To educate on solving linear and non-linear state equations.
- To illustrate the role of controllability and observability.
- To educate on stability analysis of systems using Lyapunov’s theory.
- To educate on modal concepts and design of state and output feedback controllers and estimators.

UNIT I STATE VARIABLE REPRESENTATION
Introduction-Concept of State-State equation for Dynamic Systems -Time invariance and linearity-Non uniqueness of state model-State Diagrams - Physical System and State Assignment.

UNIT II SOLUTION OF STATE EQUATIONS

UNIT III CONTROLLABILITY AND OBSERVABILITY
Controllability and Observability-Stabilizability and Detectability-Test for Continuous time Systems-Time varying and Time invariant case-Output Controllability-Reducibility-System Realizations.

UNIT IV STABILITY

UNIT V MODAL CONTROL
Introduction-Controlable and Observable Companion Forms-SISO and MIMO Systems – The Effect of State Feedback on Controllability and Observability-Pole Placement by State Feedback for both SISO and MIMO Systems-Full Order and Reduced Order Observers.

TOTAL : 45 PERIODS

COURSE OUTCOMES

CO1 :To understand the concept of State-State equation for Dynamic Systems and the uniqueness of state model.
CO2 :To understand the concept of the uniqueness of state model.
CO3 :Analyse Controllability and Observability for Time varying and Time invariant case
CO4 :Analyse the linear systems in state space
CO5: Design controllers in state space

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CO5001    MULTI SENSOR DATA FUSION    LT P C
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COURSE OBJECTIVES

- To educate on sensor data inference hierarchy and fusion models.
- To educate on the algorithms used for data fusion.
- To educate on Kalman filter and its application to decision identity fusion.
- To educate on advanced filtering and sensor fusion concepts.
- To introduce various high performance data structures.

UNIT I    MULTISENSOR DATA FUSION INTRODUCTION    9

UNIT II    ALGORITHMS FOR DATA FUSION    9
Taxonomy of algorithms for multisensor data fusion. Data association. Identity declaration.

UNIT III    ESTIMATION:    9
UNIT IV ADVANCED FILTERING

UNIT V HIGH PERFORMANCE DATA STRUCTURES:
Tessellated, trees, graphs and function. Representing ranges and uncertainty in data structures. Designing optimal sensor systems within dependability bounds. Implementing data fusion system.

TOTAL : 45 PERIODS

COURSE OUTCOMES

CO1: Ability to explain and use multiple sensor data in data fusion model.
CO2: Capable to use algorithms for data fusion.
CO3: Ability to estimate using kalman filter.
CO4: Ability to estimate using advance filtering such as data, extended information filtering.
CO5: Ability to handle various high performance data structures.

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CO5002

ROBOTICS AND CONTROL

LT P C

3 0 0 3

COURSE OBJECTIVES

- To introduce robot terminologies and robotic sensors
- To educate direct and inverse kinematic relations
- To educate on formulation of manipulator Jacobians and introduce path planning techniques
- To educate on robot dynamics
- To introduce robot control techniques

UNIT I INTRODUCTION AND TERMINOLOGIES

Definition-Classification-History- Robots components-Degrees of freedom-Robot joints-coordinates-Reference frames-workspace-Robot languages-actuators-sensors-Position, velocity and acceleration sensors-Torque sensors-tactile and touch sensors-proximity and range sensors- vision system-social issues

UNIT II KINEMATICS

Mechanism-matrix representation-homogenous transformation-DH representation-Inverse kinematics-solution and programming-degeneracy and dexterity

UNIT III DIFFERENTIAL MOTION AND PATH PLANNING

Jacobian-differential motion of frames-Interpretation-calculation of Jacobian-Inverse Jacobian- Robot Path planning

UNIT IV DYNAMIC MODELLING

Lagrangian mechanics- Two-DOF manipulator- Lagrange-Euler formulation – Newton- Euler formulation – Inverse dynamics

UNIT V ROBOT CONTROL SYSTEM

- Linear control schemes- joint actuators- decentralized PID control- computed torque control – force control- hybrid position force control- Impedance/ Torque control

TOTAL : 45 PERIODS

COURSE OUTCOMES:

Ability to

CO1 : understand the components and basic terminology of Robotics
CO2 : understand kinematic relations and dynamic model of robots
CO3 : understand differential motion, path planning and dynamic model of robots
CO4 : develop kinematic and dynamic models for two degrees of freedom
CO5 : apply control techniques for robot position and force control.

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COURSE OBJECTIVES

- To introduce norms, random spaces and robustness measures
- To educate on $H_2$ optimal control and estimation techniques.
- To educate on $H_{\infty}$ optimal control techniques
- To educate on the LMI approach of $H_{\infty}$ control.
- To educate on synthesis techniques for robust controllers and illustrate through case studies.

UNIT I       INTRODUCTION  9
Norms of vectors and Matrices – Norms of Systems – Calculation of operator Norms – vector
Random spaces– Specification for feedback systems – Co-prime factorization and Inner functions –
structured and unstructured uncertainty- robustness.

UNIT II      $H_2$ OPTIMAL CONTROL  9
Linear Quadratic Controllers – Characterization of $H_2$ optimal controllers – $H_2$ optimal estimation-
Kalman Bucy Filter – LQG Controller.

UNIT III     $H_{\infty}$ OPTIMAL CONTROL-RICCATI APPROACH  9
Formulation – Characterization of $H_{\infty}$ sub-optimal controllers by means of Riccati equations –
$H_{\infty}$ control with full information – $H_{\infty}$ estimation.

UNIT IV      $H_{\infty}$ OPTIMAL CONTROL- LMI APPROACH  9
Formulation – Characterization of $H_{\infty}$ sub-optimal controllers by means of LMI Approach –
Properties of $H_{\infty}$ sub-optimal controllers – $H_{\infty}$ infinity synthesis with pole-placement constraints

UNIT V       SYNTHESIS OF ROBUST CONTROLLETS & CASE STUDIES  9
Synthesis of Robust Controllers – Small Gain Theorem – D-K –iteration- Control of Inverted
Pendulum- Control of CSTR – Control of Aircraft – Robust Control of Second-order Plant-Robust
Control of Distillation Column.

TOTAL : 45 PERIODS

COURSE OUTCOMES

Ability to

CO1 : Understand the structured and unstructured uncertainty of robustness.
CO2 : Design an $H_2$ optimal controller and to implement kalman Bucy filter.
CO3 : Design an $H_{\infty}$ optimal control using Riccati and LMI Approach.
CO4 : Synthesis of Robust Controller and application of small gain theorem.
CO5 : Implement robust Controller for CSTR and Distillation Column.
REFERENCES

CO5004 DYNAMICS AND CONTROL OF INDUSTRIAL PROCESS LT P C 3 0 0 3

COURSE OBJECTIVES
- To give an overview of the features associated with Industrial Type PID Controller such as reset windup, bumpless auto-manual transfer, proportional kick and derivative kick.
- Design and analysis of various PID tuning methods
- To elaborate different types of control schemes such as cascade control, feed-forward control etc.
- To educate on multi variable systems and multi loop control
- To education various industrial processes

UNIT I PROCESS DYNAMICS & CONTROL 9

UNIT II PID CONTROLLER TUNING – SINGLE LOOP REGULATORY CONTROL 9
UNIT III ENHANCEMENT TO SINGLE LOOP REGULATORY CONTROL & MODEL BASED CONTROL SCHEMES

UNIT IV MULTIVARIABLE SYSTEMS & MULTI-LOOP REGULATORY CONTROL

UNIT V CASE STUDIES
Introduction to Multivariable control – Multivariable PID Controller – Predictive PID Control - Control Schemes for Distillation Column, CSTR, Four-tank system and pH.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1 : Ability to Apply knowledge of mathematics, science, and engineering to the build and analyze models for flow, level, and thermal processes.
CO2 : Ability to determine the advanced Features supported by the Industrial Type PID Controller.
CO3 : Ability to Design, tune and implement SISO P/PI/PID Controllers to achieve desired Performance for various processes.
CO4 : Ability to Analyze Multivariable Systems and Design Multi-variable and Multi-loop Control Schemes for various processes namely four-tank system, pH process, bio-reactor, distillation column.
CO5 : Ability to Identify, formulate, and solve problems in the process control domain.

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REFERENCES
COURSE OBJECTIVES:
- To expose the students to the fundamentals of wired embedded networking techniques.
- To expose the students to the fundamentals of wireless embedded networking
- To study on design of automation tools to model instrumentation
- To introduce design wireless networking for monitoring grid
- To involve Discussions/ Practice/Exercise onto revising & familiarizing the concepts acquired over the 5 Units of the subject for improved employability skills

UNIT I  DIGITAL METER INFRASTRUCTURE  

UNIT II  DIGITAL METERING OF PROCESS  
Introduction – sensors and Digital Meters for vibration, temperature, pressure measurement of system-Multichannel DSO -Data loggers -meter data analytics -PC based process measurements -Digital Signal Sources- automating meter with Data analysis & display control.

UNIT III  METERING WITH VIRTUAL INSTRUMENTATION  
VI-Introduction, Block diagram and Architecture –VI for testing Real time process– Graphical programming using GUI – ADC/DAC – Digital I/O – Counter , Timer-I/O GUI-VI for Intelligent metering and control – Software and hardware of I/O communication blocks-peripheral interface

UNIT IV  METERING BASED ON WIRELESS NETWORK  

UNIT V  AUTOMATED METERING OF ELECTRICAL SYSTEMS  
Digital meters and Instrumentation for electrical measurements- metering to test electrical components -meters for Smart grid management-AMI needs in smart grid- Meter data management -communication enabled metering.

NOTE : Miniproject / Discussions/ Practice on Workbench : on Digital meter ,Control of Relays/Solenoids, DC/ STEPPER motor, Battery,Display Interface; modeling process metering and control /designing of Digital meter with wired /wireless communication interface suites / Virtual Laboratory tools.

COURSE OUTCOMES:
At the end of this course, the students will demonstrate the ability in

CO1: The concepts of Time and frequency analysis of Signal Transforms based on signal types.
CO2: The fundamentals of Time-Frequency Transforms are introduced
CO3: Analyze the quality and properties of speech based on DSP
CO4: Study through comparison on commercial available DSProcessors
CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design.

TOTAL: 45 PERIODS
REFERENCES:

ET5072 AUTOMOTIVE EMBEDDED SYSTEM

COURSE OBJECTIVES:
- To expose the students to the fundamentals and building of Electronic Engine Control systems.
- To teach on functional components and circuits for vehicles.
- To discuss on programmable controllers for vehicles management systems.
- To teach logics of automation & commercial techniques for vehicle communication.
- To introduce the embedded systems concepts for E-vehicle system development.

UNIT I BASIC OF ELECTRONIC ENGINE CONTROL SYSTEMS
Overview of Automotive systems, fuel economy, air-fuel ratio, emission limits and vehicle performance; Automotive microcontrollers- Electronic control Unit- Hardware & software selection and requirements for Automotive applications – open source ECU- RTOS - Concept for Engine management- Standards; Introduction to AUTOSAR and Introduction to Society SAE- Functional safety ISO 26262- Simulation and modeling of automotive system components.

UNIT II SENSORS AND ACTUATORS FOR AUTOMOTIVES
Review of sensors- sensors interface to the ECU, conventional sensors and actuators, Modern sensor and actuators - LIDAR sensor- smart sensors- MEMS/NEMS sensors and actuators for automotive applications.
UNIT III VEHICLE MANAGEMENT SYSTEMS 9

UNIT IV ONBOARD DIAGNOSTICS AND TELEMATICS 9

UNIT V ELECTRIC VEHICLES 9

NOTE: Miniproject/Discussions/Practice on Workbench/AUTOSAR/ Vehicle simulators/ modeling packages on the basics of interfacing sensors, actuators specific to automobile-microcontrollers/ special automobile-microcontrollers for i/o port communication applicable to vehicles

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1: The learning process delivers insight into the significance of the role of embedded system for automotive applications.
CO2: Understanding the need, selection of sensors and actuators and interfacing with ECU
CO3: Applying the Embedded concepts for vehicle management and control systems.
CO4: Understanding the need of Electrical vehicle and able to apply the embedded system technology for various aspects of EVs
CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design and its application in automotive systems.

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REFERENCES:
5. Electronic Engine Control technology – Ronald K Jurgen Chilton’s guide to Fuel Injection – Ford

ET5075 EMBEDDED NETWORKING AND AUTOMATION OF ELECTRICAL SYSTEM

COURSE OBJECTIVES:
- To discuss the fundamentals building blocks of a digital instrument.
- Introduce wired, WSN for configuring metering network
- Discuss requirements for grid automation using meters.
- To discuss networking configuration to develop PAN.
- To discuss the functions of digital instrument Power quality monitoring.

UNIT I BUILDING SYSTEM AUTOMATION

UNIT II EMBEDDED NETWORKING OF INSTRUMENT CLUSTER

UNIT III AUTOMATION OF SUBSTATION

UNIT IV METERING OF SMART GRID
Characteristics of Smart Grid- Generation by Renewable Energy Sources based on solar grid- Challenges in Smart Grid and Microgrids- electrical measurements with AMI -Smart meters for EV plug in electric vehicles power management -Home Area Netmetering and Demand side Energy Management applications.

UNIT V SMART METERS FOR PQ MONITORING
Power Quality issues of Grid connected Renewable Energy Sources -Smart meters for Power Quality monitoring and Control - Power Quality issues -Surges – Flicker - Interharmonics - Transients – Power Quality Benchmarking – Power Quality Meters- Meter data management In Smart Grid-, communication enabled Power Quality metering
NOTE: Mini project/Discussions/Exercise on Workbench/simulators: on the basics interface of sensors, actuators to microcontrollers, role of virtual Instrumentation software packages simulators/special microcontrollers for I/O port communication etc

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1: The criteria of choice of sensors, components to build meters.
CO2: The demand for BUS communication protocols are introduced
CO3: Analyze the need and standards in Substation automation
CO4: Deployment of PAN for metering networked commercial applications
CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded networked communications

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REFERENCES:
1. Control and automation of electrical power distribution systems, James Northcote-Green, Robert Wilson, CRC, Taylor and Francis, 2006
ET5251 VLSI DESIGN AND ARCHITECTURE LT P C 4 0 0 4

COURSE OBJECTIVES:
- To understand the basic concepts of VLSI and CMOS design.
- To introduce the IC fabrication methods
- To study the architectures of various RPLDs.
- To introduce the basics of analog VLSI design and its importance.
- To learn about the programming of Programmable device using Hardware description Language.

UNIT I CMOS DESIGN 12
Review of switching devices and logics- MOSFET Scaling- MOS Transistor Model-CMOS inverter-determination of pull up / pull down ratios, Nano MOSFET- CMOS based combinational logic & sequential design- Dynamic CMOS & clocking –Transmission Gates- BiCMOS- Low power VLSI.

UNIT II IC FABRICATION 12
Overview of IC Fabrication -NMOS, PMOS, CMOS, SOI ,BiCMOS fabrication- Stick Diagrams, Design Rules and Layout - recent trends in IC fabrication.

UNIT III PROGRAMMABLE LOGIC DEVICES AND ASIC DESIGN 12
Programming techniques- Architecture of CPLD and FPGA – advanced FPGA devices- ASIC physical design– Logic Implementation with PLDs.

UNIT IV ANALOG VLSI DESIGN 12
Introduction to analog VLSI- Design of CMOS 2stage-3 stage Op-Amp –High Speed and High frequency op-amps-Super MOS- Analog primitive cells-realization of neural networks- Introduction to FPAA.

UNIT V HDL PROGRAMMING 12
Overview of digital design with HDL, structural, data flow and behavioural modeling- logic synthesis-simulation-Combinational and Sequential logic design examples, Ripple carry Adders, Carry Look ahead adders, Multiplier, ALU, Test Bench.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
- CO1: The learning process delivers insight into developing CMOS design techniques and development of low power VLSI logic circuits.
- CO2: Insight into IC fabrication methods.
- CO3: Improved skill set in RPLD/SOC usage for real time applications.
- CO4: Design and development of reprogrammable analog devices and its usage for embedded applications.
- CO5: Understanding and usage of HDL computational processes with improved design strategies.

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ET5071 ADVANCED DIGITAL SIGNAL PROCESSING LT P C 3 0 0 3

COURSE OBJECTIVES:
- To expose the fundamentals of digital signal processing in frequency domain & its application
- To teach the fundamentals of digital signal processing in time-frequency domain & its application
- To teach the fundamentals of audio signal processing & its application
- To discuss on Application development with commercial family of DS Processors
- To involve Discussions/ Practice/ Exercise onto revising & familiarizing the concepts acquired over the 5 Units of the subject for improved employability skills

UNIT I INTRODUCTION TO DIGITAL SIGNAL PROCESSING 6

UNIT II WAVELET TRANSFORM 9
Introduction to continuous wavelet transform- discrete wavelet transform -orthogonal wavelet decomposition- Multiresolution Analysis-Wavelet function-DWT,bases,orthogonal Basis-Scaling function, Wavelet coefficients- Multirate signal processing and their relationship to filter banks- Digital filtering interpolation(i) Decomposition filters, (ii) reconstruction, the signal- Example MRA- Haar & Daubechies wavelet.

UNIT III AUDIO SIGNAL PROCESSING 12

UNIT IV ARCHITECTURES OF COMMERCIAL DIGITAL SIGNAL PROCESSORS 12
Introduction, categorisation of DSP Processors-one case example Architecture Processor for Fixed Point (Blackfin), Floating Point & Speech Processor- Basics of Architecture – study of functional variations of Computational building blocks(with comparison onto their MAC, Bus Architecture , I/O interface, application).
UNIT V IMPLEMENTATION OF DSP BASED SYSTEMS

Introduction- Interfacing processor- Memory Interface-I/O Interface-Mapping of DSP algorithm onto hardware -Design of Filter-FFT Algorithm- Application with DSP based Interfacing- Power Meter; DSP as motor control

NOTE: Discussions/Miniproject/Practice on Workbench : Signal analysis transforms, Filter design concepts with simulation tools as Matlab /Labview/ VLSI/CCS/other suites to understand the commercial DSP processor technology and practice in programming.

TOTAL: 45 PERIODS

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ET5073  CRYPTOGRAPHY AND NETWORK SECURITY  LT P C  3 0 0 3

COURSE OBJECTIVES:
- To expose the students to the fundamentals of data security.
- To teach the fundamentals of mathematical aspects in creating Encryption keys
- To teach the fundamentals of Security in data & wireless communication.
- To teach the fundamentals of Secured system operation.
- To involve Discussions/ Practice/Exercise onto revising & familiarizing the concepts acquired over the 5 Units of the subject for improved employability skills

UNIT I  SYMMETRIC CIPHERS  9

UNIT II  PUBLIC-KEY ENCRYPTION AND HASH FUNCTIONS  9

UNIT III  NETWORK SECURITY PRACTICE  9

UNIT IV  SYSTEM SECURITY  9

UNIT V  WIRELESS SECURITY  9

NOTE: Discussions/Exercice/Practice on Workbench: on the basics /numerical design aspects of encryption, decryption keys/password creation etc

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Understanding the significance of security for communication
CO2: Delivers Insight of security mechanism and architecture.
CO3: Applying the security algorithms for real time applications.
CO4: The learning process delivers insight onto role of security aspects during data transfer and communication systems like electrical grid
CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems and secured systm design.

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ET5073  NANO ELECTRONICS  LT P C  3 0 0 3

COURSE OBJECTIVES:
- To introduce the properties of electron and its implication for electronics
- To teach the importance and the issues of Nanoscale CMOS technology.
- To introduce the characteristics and applications of Nano electronic devices, methods and techniques.
- To teach the circuits and architectural features of nano memory devices.
- To introduce the various fabrication techniques for nano electronic devices.

UNIT I  INTRODUCTION  9
Overview of nanotechnology – Implication on science, engineering and technology- Particles-, waves, Wave mechanics, schrodinger equation- Electron transport in semiconductors and nanostructures, Nano materials and its properties- Electrical and Electronics Applications of Nanotechnology.

UNIT II  NANOSCALE CMOS  9
Survey of modern electronics and trends towards nano electronics CMOS scaling, challenges and limits, static power, device variability, interconnect - CNT-FET, FinFET, FerroFET - Surround gate FET nanoscale CMOS circuit design and analysis

UNIT III  NANOELECTRONIC DEVICES  9

UNIT IV  NANOELECTRONIC COMPUTATION AND MEMORIES  9

UNIT V  FABRICATION TECHNIQUES  9

NOTE: Class room discussions and tutorials can include the following guidelines for improved teaching /learning process :Discussions/Practice on Workbench : on modelling of nano/micro analog &digital devices.

TOTAL : 45 PERIODS

COURSE OUTCOMES: After the completion of this course the student will be able to:
CO1: Understand the properties of electron and the significance of nanotechnology.
CO2: Concept of nanoscale CMOS devices and its various issues.
CO3: Apply the concept of nanotechnology and understand the significance of nano electronic devices.
CO4: Understand the nano configurations of computational processors and memories with improved design strategies.
CO5: Learn and understand the nano fabrication techniques.

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2. Rainer Waser, “Nanoelectronics and Information Technology”, Wiley 2005
6. George W. Hanson, Fundamental of nanoelectronics, Pearson education.

HV5151 ELECTROMAGNETIC FIELD COMPUTATION AND MODELLING

COURSE OBJECTIVES:
- To refresh the fundamentals of Electromagnetic Field Theory
- To provide foundation in formulation and computation of Electromagnetic Fields using analytical and numerical methods.
- To impart knowledge in fundamentals of FEM
- To compute and analyze the field quantities using FEM
- To formulate, solve, analyze and optimize the design of electrical components

UNIT I INTRODUCTION
Review of basic field theory – Maxwell’s equations – Constitutive relationships and Continuity equations – Laplace, Poisson and Helmholtz equation – principle of energy conversion – force/torque calculation

UNIT II BASIC SOLUTION METHODS FOR FIELD EQUATIONS
Limitations of the conventional design procedure, need for the field analysis based design, problem definition, boundary conditions, solution by analytical methods-direct integration method – variable separable method – method of images, solution by numerical methods- Finite Difference Method
UNIT III  FORMULATION OF FINITE ELEMENT METHOD (FEM)  
Variational Formulation – Energy minimization – Discretisation – Shape functions – Stiffness matrix – 1D and 2D planar and axial symmetry problems

UNIT IV  COMPUTATION OF BASIC QUANTITIES USING FEM PACKAGES  

UNIT V  DESIGN APPLICATIONS  

COURSE OUTCOMES:
CO1 Ability to understand the field theory concepts
CO2 Ability to formulate and compute Electromagnetic Fields from Maxwell’s equations.
CO3 Ability to formulate FEM problems from the fundamental concepts
CO4 Ability to compute the respective field using FEM (post processing)
CO5 Ability to check and optimize the design of electrical power equipment

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REFERENCES
COURSE OBJECTIVES

Students will be able to:

- Understand concept of smart grid and its advantages over conventional grid
- Know smart metering techniques
- Learn wide area measurement techniques
- Understanding the problems associated with integration of distributed generation & its solution through smart grid.
- To familiarize the high performance computing 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, National and International Initiatives in Smart Grid.

UNIT II SMART GRID TECHNOLOGIES (Transmission)
Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control

UNIT III SMART GRID TECHNOLOGIES (Distribution)
DMS, Volt/VAr control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, and Plug in Hybrid Electric Vehicles (PHEV).

UNIT IV 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), Intelligent Electronic Devices (IED) & their application for monitoring & protection.

UNIT V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS
Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), IP based Protocols, Computing algorithms for Smart grid, IOT, Cyber Security for Smart Grid.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Students will be able to:

- CO1: Understand on the concepts of Smart Grid and its present developments.
- CO2: Analyze about different Smart Grid transmission technologies.
- CO3: Analyze about different Smart Grid distribution technologies.
- CO4: Acquire knowledge about different smart meters and advanced metering infrastructure.
- CO5: Develop more understanding on LAN, WAN and Cloud Computing for Smart Grid applications.
REFERENCES
4. Xi Fang, Satyajayant Misra, Guoliang Xue, and Dejun Yang “Smart Grid – The New and Improved Power Grid: A Survey”, IEEE Transaction on Smart Grid

PS5076 WIND ENERGY CONVERSION SYSTEM LT P C 3 0 0 3
COURSE OBJECTIVES
- To learn about the basic concepts of wind energy conversion system
- To learn the design and control principles of Wind turbine.
- To understand the concepts of fixed speed wind energy conversion systems.
- To understand the concepts of Variable speed wind energy conversion systems.
- To analyze the grid integration issues.

UNIT I INTRODUCTION
Components of WECS-WECS schemes-Power obtained from wind-simple momentum theory-Power coefficient-Sabinin’s theory-Aerodynamics of Wind turbine

UNIT II WINDTURBINES
HAWT-VAWT-Power developed-Thrust-Efficiency-Rotor selection-Rotor design considerations- Tip speed ratio-No. Of Blades-Blade profile-Power Regulation-yaw control-Pitch angle control- stall control-Schemes for maximum power extraction.

UNIT III FIXEDSPEEDSYSTEMS
Generating Systems- Constant speed constant frequency systems -Choice of Generators-Deciding factors-Synchronous Generator-Squirrel Cage Induction Generator- Model of Wind Speed- Model wind turbine rotor - Drive Train model- Generator model for Steady state and Transient stability analysis.
UNIT IV  VARIABLESPEED SYSTEMS  9
Need of variable speed systems-Power-wind speed characteristics-Variable speed constant frequency systems synchronous generator- DFIG- PMSG -Variable speed generators modelling - Variable speed variable frequency schemes.

UNIT V  GRIDCONNECTED SYSTEMS  9
Wind interconnection requirements, low-voltage ride through (LVRT), ramp rate limitations, and supply of ancillary services for frequency and voltage control, current practices and industry trends wind interconnection impact on steady-state and dynamic performance of the power system including modelling issue.

COURSE OUTCOMES

Students will be able to:

CO1: Attain knowledge on the basic concepts of Wind energy conversion system.
CO2: Attain the knowledge of the mathematical modelling and control of the Wind turbine
CO3: Develop more understanding on the design of Fixed speed system
CO4: Study about the need of Variable speed system and its modelling.
CO5: Learn about Grid integration issues and current practices of wind interconnections with power system.

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5. N. Jenkins,” Wind Energy Technology” John Wiley &Sons,1997
COURSE OBJECTIVES:

- To understand the probability concepts.
- To provide knowledge on the demand analysis and forecasting techniques.
- To emphasis the optimization for energy management.
- To provide knowledge about the selection of optimization techniques for real time problems and to analyze the solutions.
- To analyze and comprehend the various operating modes of different configurations at different applications.

UNIT I PROBABILITY THEORY 12
The nature of random variables: populations and samples, parameters and statistics. Probability concepts; properties of random variables, probability distribution functions.

UNIT II DEMAND ANALYSIS AND FORECASTING 12
Drivers of energy demand, Sectoral energy demand: domestic, commercial, industrial, agricultural. Projections for future demands.

UNIT III INTRODUCTION TO OPTIMIZATION 12

UNIT IV LINEAR PROGRAMMING AND APPLICATION 12
Assumptions, problems formulation and solutions, graphical methods, simplex algorithm, duality concept, sensitivity analysis. Power system planning using optimization techniques, case study.

UNIT V DYNAMIC PROGRAMMING AND APPLICATION 12
Introduction, multi stage decision problems, recursive equations, principle of optimality, discrete dynamic programming. Optimal energy resource, technology mix in micro and macro level energy planning exercises. Power generation expansion planning, case study.

COURSE OUTCOMES:
CO1: Ability to define and use optimization techniques and concepts.
CO2: Understand the concept of optimization methods for energy system planning.
CO3: Able to define an optimization problem and exploring the solution by applying optimization methods and interpreting results.
CO4: Excel the selection of optimization techniques for real time problems and to analyze the solutions.
CO5: Analyze the various operating modes of different configurations in different applications.

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PW5077 RENEWABLE ENERGY TECHNOLOGY LT P C
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COURSE OBJECTIVES
- To provide knowledge about various renewable energy technologies
- To enable students to understand and design a PV system.
- To provide knowledge about wind energy system.
- To provide knowledge about various possible hybrid energy systems
- To gain knowledge about application of various renewable energy technologies

UNIT I INTRODUCTION
Primary energy sources, renewable vs. non-renewable primary energy sources, renewable energy resources in India, Current usage of renewable energy sources in India, future potential of renewable energy in power production and development of renewable energy technologies.

UNIT II SOLAR ENERGY

UNIT III WIND ENERGY
Wind energy principles, wind site and its resource assessment, wind assessment, Factors influencing wind, wind turbine components, wind energy conversion systems (WECS), Classification of WECS devices, wind electric generating and control systems, characteristics and applications. Hybrid systems - safety and environmental aspects, economic aspects.

UNIT IV BIO-ENERGY

UNIT V OTHER TYPES OF ENERGY
Energy conversion from Hydrogen and Fuel cells, Geo thermal energy Resources, types of wells, methods of harnessing the energy, potential in India. OTEC, Principles utilization, setting of OTEC
plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini-hydel power plants and their economics.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1: Attained knowledge about various renewable energy technologies
CO2: Ability to understand and design a PV system.
CO3: Understand the concept of various wind energy system.
CO4: Gained knowledge about various possible hybrid energy systems
CO5: Attained knowledge about various application of renewable energy technologies

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2. Tiwari and Ghosal/ Narosa, ‘Renewable energy resources’.

PW5071 ELECTRIC VEHICLES AND POWER MANAGEMENT

COURSE OBJECTIVES:
- To provide knowledge about electric vehicle architecture and power train components.
- To know the concepts of dynamics of electrical vehicles.
- To impart knowledge on vehicle control for standard drive cycles of hybrid electrical vehicles (HEVs).
- To understand the concept of energy storage systems.
- To provide knowledge about different energy sources and energy management in HEVs.

UNIT I HYBRID ELECTRIC VEHICLE ARCHITECTURE AND POWER TRAIN COMPONENTS
9

UNIT II MECHANICS OF HYBRID ELECTRIC VEHICLES
9
Fundamentals of vehicle mechanics - tractive force, power and energy requirements for standard drive cycles of HEV’s - motor torque and power rating and battery capacity.
UNIT III  CONTROL OF DC AND AC MOTOR DRIVES  
Speed control for constant torque, constant HP operation of all electric motors - DC/DC chopper based four quadrant operation of DC motor drives, inverter based V/f Operation (motoring and braking) of induction motor drives, vector control operation of Induction motor and PMSM, Brushless DC motor drives, Switched reluctance motor (SRM) drives

UNIT IV  ENERGY STORAGE SYSTEMS  

UNIT V  HYBRID VEHICLE CONTROL STRATEGY AND ENERGY MANAGEMENT  
HEV supervisory control - Selection of modes - power spilt mode - parallel mode - engine brake mode - regeneration mode - series parallel mode - energy management of HEV's.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1: Learned the electric vehicle architecture and power train components.
CO2: Acquired the concepts of dynamics of electrical vehicles
CO3: Able to understand the vehicle control for standard drive cycles of hybrid electrical vehicles (HEVs).
CO4: Ability to design and select energy storage systems.
CO5: Acquired the knowledge of different energy sources and energy management in HEVs.

REFERENCES:

PW5075  GRID INTEGRATION OF RENEWABLE ENERGY SOURCES  
LT P C  3 0 0 3

COURSE OBJECTIVES:
• To study about the integration of various renewable energy sources into the grid.
• To analyse various grid issues due to renewable energy sources.
• To analyse the dynamics of network due to wind farm
• To provide knowledge about power system stabilizers.
• To provide knowledge about grid connected and standalone PV system
UNIT I INTRODUCTION
Introduction to renewable energy grid integration - Concept of mini/micro grids and Smart grids - Different types of grid interfaces - Issues related to grid integration of small and large scale of synchronous generator based - induction generator based and converter based sources together - Network voltage management - Power quality management (voltage dips, harmonics, flickers, and reactive power control) - Frequency management - Influence of WECS on system transient response - Interconnection standards and grid code requirements for integration.

UNIT II NETWORK INFLUENCE OF GENERATION TYPE

UNIT III INFLUENCE OF WIND FARMS ON NETWORK DYNAMIC PERFORMANCE

UNIT IV POWER SYSTEM STABILIZERS AND NETWORK DAMPING CAPABILITY OF WIND
A Power System Stabilizer for a Synchronous Generator - A Power System Stabilizer for a DFIG - A Power System Stabilizer for a FRC Wind Farm.

UNIT V STAND ALONE AND GRID CONNECTED PV SYSTEM

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1: Know about the integration of various renewable energy sources into the grid.
CO2: Able to analyze various grid issues due to renewable energy sources.
CO3: Able to analyze the dynamics of network due to windfarm
CO4: Know about power system stabilizers.
CO5: Able to design the grid connected and standalone PV system.

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PW5079 WASTE MANAGEMENT AND ENERGY RECOVERY TECHNIQUES

COURSE OBJECTIVES:

• To provide information on various methods of waste management.
• To impart knowledge about separation techniques & Transformation Technologies.
• To detail on the recent technologies of waste disposal.
• To familiarize students with recent energy generation techniques.
• To make students realize on the importance of healthy environment.

UNIT I CHARACTERISTICS AND PERSPECTIVES

UNIT II UNIT OPERATIONS & TRANSFORMATION TECHNOLOGIES

UNIT III WASTE DISPOSAL

UNIT IV TRANSFORMATION TECHNOLOGIES AND VALUE ADDITION

UNIT V HAZARDOUS WASTE MANAGEMENT & WASTE RECYCLING

COURSE OUTCOMES:

CO1: Acquired basic knowledge about the Methods of Waste Management.
CO2: Understand the concept of Segregation & Transformation Techniques.
CO3: Learned the technologies that are available for effective waste disposal along with pros
CO4: Ability to develop various Energy generation Techniques.
CO5: Able to predict the waste related problems (Hazardous Waste, Pharma Waste, Biomedical Waste etc).

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PW5078 SCADA SYSTEM AND APPLICATIONS MANAGEMENT L T P C 3 0 0 3

COURSE OBJECTIVES:
- To understand the basic concepts and components of SCADA
- To introduce the SCADA communication protocols
- To apply the SCADA technology to power systems for automation
- To provide knowledge about SCADA based energy management centre.
- To emphasis the role of SCADA monitoring and control concepts.

UNIT I INTRODUCTION TO SCADA
SCADA overview, general features, SCADA architecture, SCADA Applications, Benefits, Remote Terminal Unit (RTU), Human- Machine Interface Units (HMI), Display Monitors/Data Logger Systems, Intelligent Electronic Devices (IED), Communication Network, SCADA Server, SCADA Control systems and Control panels
UNIT II SCADA COMMUNICATION
SCADA Communication requirements, Communication protocols: Past, Present and Future, Structure of a SCADA Communications Protocol, Comparison of various communication protocols, IEC61850 based communication architecture, Communication media like Fiber optic, PLCC etc. Interface provisions and communication extensions, synchronization with NCC, DCC, IOT, Cyber cell, Redundancy of Network.

UNIT III SCADA IN POWER SYSTEM AUTOMATION
Applications in Generation, Transmission and Distribution sector, Substation SCADA system Functional description, System specification, System selection such as Substation configuration, IEC61850 ring configuration, SAS cubicle concepts, gateway interoperability list, signal naming concept. System Installation, Testing and Commissioning,

CASE STUDIES: SCADA Design for 66/11KV and 132/66/11KV or 132/66 KV any utility Substation and IEC 61850 based SCADA Implementation issues in utility Substations

UNIT IV ENERGY MANAGEMENT CENTRE
Functions, production control and load management, economic despatch, distributed centres and power pool management, energy management system and its role.

UNIT V SCADA MONITORING AND CONTROL
Online monitoring the event and alarm system, trends and reports, Blocking list, Event disturbance recording. Control function: Station control, bay control, breaker control and disconnector control.

TOTAL: 45 PERIODS

COURE OUTCOMES:
CO1: Students will learn the SCADA system components and its significance.
CO2: Students will understand the need and advantages of communication protocols for SCADA
CO3: Students will get implementation knowledge about the application of SCADA to Power System.
CO4: Students will get exposure to the best operating mechanism for Energy centre based on SCADA concepts
CO5: Students will understand the need and importance of monitoring and control logic for SCADA based power systems.

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PW5072 ENERGY EFFICIENT BUILDINGS LT P C 3 0 0 3

COURSE OBJECTIVES:

- To understand the different climate zones and modelling methods.
- To understand about the principle of energy conscious building design.
- To understand about the concept of passive solar heating and efficient technologies in electrical system.
- To provide knowledge about the energy conservation techniques in buildings.
- To provide knowledge about energy efficient technologies.

UNIT I CLIMATE AND SHELTER

UNIT II PRINCIPLES OF ENERGY CONSCIOUS BUILDING DESIGN

UNIT III PASSIVE SOLAR HEATING

UNIT IV ENERGY CONSERVATION IN BUILDING

UNIT V EFFICIENT TECHNOLOGIES IN ELECTRICAL SYSTEMS
Maximum demand controllers, automatic power factor controllers, energy efficient motors, and soft starters – Energy efficient Lighting and Transformers.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1: Able to understand the different climate zones and modelling methods.
CO2: Able to design energy conscious building design.
CO3: Able to understand about the concept of passive solar heating and efficient technologies in electrical system.
CO4: Able to gain knowledge about the energy conservation techniques in buildings.
CO5: Know about different energy efficient technologies.
REFERENCES

PW5074 ENERG Y STORAGE TECHNOLOGIES

COURSE OBJECTIVES:
- To understand the various types of energy storage Technologies.
- To analyze thermal storage system.
- To analyze different battery storage technologies
- To analyze the thermodynamics of Fuel Cell
- To study the various applications of energy storage systems.

UNIT I INTRODUCTION
Necessity of energy storage – types of energy storage – comparison of energy storage technologies – Applications.

UNIT II THERMAL STORAGE SYSTEM
Thermal storage – Types – Modeling of thermal storage units – Simple water and rock bed storage system – pressurized water storage system – Modelling of phase change storage system – Simple units, packed bed storage units - Modelling using porous medium approach, Use of TRNSYS.

UNIT III ELECTRICAL ENERGY STORAGE
Fundamental concept of batteries – measuring of battery performance, charging and is charging of a battery, storage density, energy density, and safety issues. Types of batteries – Lead Acid, Nickel – Cadmium, Zinc Manganese dioxide - Mathematical Modelling for Lead Acid Batteries – Flow Batteries.

UNIT IV FUEL CELL

UNIT V ALTERNATE ENERGY STORAGE TECHNOLOGIES
COURSE OUTCOMES:
CO1: Gained knowledge of various storage technologies.
CO2: Able to design a thermal storage system.
CO3: Ability to model battery storage system.
CO4: Learned to analyze the thermodynamics of fuel cell.
CO5: Gained Knowledge of various applications of storage technologies and perform the selection based on techno-economic viewpoint.

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UNIT II  THREE PHASE AC-DC CONVERTER  12

UNIT III  SINGLE PHASE INVERTERS  12
Introduction to self-commutated switches : MOSFET and IGBT - Principle of operation of half and full bridge inverters – Performance parameters – Voltage control of single phase inverters using various PWM techniques – various harmonic elimination techniques – Design of UPS-VSR operation

UNIT IV  THREE PHASE INVERTERS  12
180 degree and 120 degree conduction mode inverters with star and delta connected loads – voltage control of three phase inverters: single, multi pulse, sinusoidal, space vector modulation techniques – VSR operation-Application to drive system – Current source inverters.

UNIT V  MODERN INVERTERS  12

TOTAL : 60 PERIODS

COURSE OUTCOMES:

CO1 Ability to acquire and apply knowledge of mathematics in power converter analysis
CO2 Ability to model, analyze and understand power electronic systems and equipment
CO3 Ability to formulate, design and simulate phase controlled rectifiers for generic load and for machine loads
CO4 Ability to formulate, design, simulate switched mode inverters for generic load and for machine loads
CO5 Ability for device selection and calculation of performance parameters of power converters under various operating modes

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REFERENCES:

COURSE OBJECTIVES:
- To provide knowledge about the fundamentals of magnetic circuits, energy, force and torque of multi-excited systems.
- To analyze the steady state and dynamic state operation of DC machine through mathematical modeling and simulation in digital computer.
- To provide the knowledge of theory of transformation of three phase variables to two phase variables.
- To analyze the steady state and dynamic state operation of three-phase induction machines using transformation theory based mathematical modeling and digital computer simulation.
- To analyze the steady state and dynamic state operation of three-phase synchronous machines using transformation theory based mathematical modeling and digital computer simulation.

UNIT I    PRINCIPLES OF ELECTROMAGNETIC ENERGY CONVERSION  12
Magnetic circuits, permanent magnet, stored magnetic energy, co-energy - force and torque in singly and doubly excited systems – machine windings and air gap mmf– determination of winding resistances and inductances of machine windings – determination of friction coefficient and moment of inertia of electrical machines.

UNIT II    DC MACHINES  12

UNIT III    REFERENCE FRAME THEORY  12
Historical background of Clarke and Park transformations – power invariance and phase transformation and commutator transformation – transformation of variables from stationary to arbitrary reference frame - variables observed from several frames of reference.

UNIT IV    INDUCTION MACHINES  12
Three phase induction machine, equivalent circuit and analysis of steady state operation – free acceleration characteristics – voltage and torque equations in machine variables and arbitrary reference frame variables – analysis of dynamic performance for load torque

UNIT V SYNCHRONOUS MACHINES


TOTAL: 60 PERIODS

COURSE OUTCOMES:

CO1 Ability to optimally design magnetics required in power supplies and drive systems.

CO2 Ability to acquire and apply knowledge of mathematics of machine dynamics in Electrical engineering.

CO3 Ability to model, simulate and analyze the dynamic performance of electrical machines using computational software.

CO4 Ability to formulate, design, simulate power supplies and loads for complete electrical machine performance.

CO5 Ability to verify the results of the dynamic operation of electrical machine systems.

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TEXT BOOKS:


2. R Ramanujam, “Modelling and Analysis of Electrical Machines”, I.K International Publishing Pvt. Ltd., New Delhi, 2018

REFERENCES:


COURSE OBJECTIVES:

- To review the fundamental concepts of permanent magnets and the operation of permanent magnet brushless DC motors.
- To introduce the concepts of permanent magnet brushless synchronous motors and synchronous reluctance motors.
- To develop the control methods and operating principles of switched reluctance motors.
• To introduce the concepts of stepper motors and its applications.
• To understand the basic concepts of other special machines.

UNIT I PERMANENT MAGNET BRUSHLESS DC MOTORS

UNIT II PERMANENT MAGNET SYNCHRONOUS MOTORS

UNIT III SWITCHED RELUCTANCE MOTORS
Constructional features –Principle of operation- Torque prediction–Characteristics Power controllers – Control of SRM drive- Sensorless operation of SRM – Applications.

UNIT IV STEPPER MOTORS

UNIT V OTHER SPECIAL MACHINES
Principle of operation and characteristics of Hysteresis motor – AC series motors – Linear motor – Applications.

TOTAL : 45 PERIODS

COURSE OUTCOMES:
CO1 Ability to model and analyze power electronic systems and equipment using computational software.
CO2 Ability to optimally design magnetics required in special machines based drive systems using FEM based software tools.
CO3 Ability to analyse the dynamic performance of special electrical machines
CO4 Ability to understand the operation and characteristics of other special electrical machines.
CO5 Ability to design and conduct experiments towards research.

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COURSE OBJECTIVES:
- To get introduced to the fundamentals of microcontroller based system design.
- To learn I/O and other built-in features available in microcontroller.
- To know Microcontroller based system design, applications.
- To learn I/O interface in system Design
- To involve Discussions/ Practice/Exercise onto revising & familiarizing the concepts acquired for improved employability skills

UNIT I  8051 ARCHITECTURE  9

UNIT II  8051 PROGRAMMING  9

UNIT III  PIC MICROCONTROLLER  9

UNIT IV  PERIPHERAL OF PIC MICROCONTROLLER  9

UNIT V  SYSTEM DESIGN – CASE STUDY  9
Interfacing LCD Display – Keypad Interfacing - Generation of Gate signals for converters and Inverters - Motor Control – Controlling DC/ AC appliances – Measurement of frequency - Standalone Data Acquisition System.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1 Ability to understand the features of microcontroller 8051
CO2 Ability to write programs using 8051 assemble language, utilizing its build in features
CO3 Ability to understand the features of PIC microcontroller.
CO3 Ability to use the peripherals built-in the PIC microcontroller through programming
CO4 Ability to grasp the interfacing concepts involving in the design of microcontroller based systems.
TEXTBOOKS:

REFERENCES:

OPEN ELECTIVE COURSES (OEC)

OE5091 BUSINESS DATA ANALYTICS 3 0 0 3

OBJECTIVES:
- To understand the basics of business analytics and its life cycle.
- To gain knowledge about fundamental business analytics.
- To learn modeling for uncertainty and statistical inference.
- To understand analytics using Hadoop and Map Reduce frameworks.
- To acquire insight on other analytical frameworks.

UNIT I OVERVIEW OF BUSINESS ANALYTICS

Suggested Activities:
- Case studies on applications involving business analytics.
- Converting real time decision making problems into hypothesis.
- Group discussion on entrepreneurial opportunities in Business Analytics.

Suggested Evaluation Methods:
- Assignment on business scenario and business analytical life cycle process.
- Group presentation on big data applications with societal need.
- Quiz on case studies.
UNIT II ESSENTIALS OF BUSINESS ANALYTICS


Suggested Activities:
- Solve numerical problems on basic statistics.
- Explore chart wizard in MS Excel Case using sample real time data for data visualization.
- Use R tool for data visualization.

Suggested Evaluation Methods:
- Assignment on descriptive analytics using benchmark data.
- Quiz on data visualization for univariate, bivariate data.

UNIT III MODELING UNCERTAINTY AND STATISTICAL INFEERENCE


Suggested Activities:
- Solving numerical problems in sampling, probability, probability distributions and hypothesis testing.
- Converting real time decision making problems into hypothesis.

Suggested Evaluation Methods:
- Assignments on hypothesis testing.
- Group presentation on real time applications involving data sampling and hypothesis testing.
- Quizzes on topics like sampling and probability.

UNIT IV ANALYTICS USING HADOOP AND MAPREDUCE FRAMEWORK


Suggested Activities:
- Practical – Install and configure Hadoop.
- Practical – Use web based tools to monitor Hadoop setup.
- Practical – Design and develop MapReduce tasks for word count, searching involving text corpus etc.

Suggested Evaluation Methods:
- Evaluation of the practical implementations.
- Quizzes on topics like HDFS and extensions to MapReduce.

UNIT V OTHER DATA ANALYTICAL FRAMEWORKS

Overview of Application development Languages for Hadoop – PigLatin – Hive – Hive Query Language (HQL) – Introduction to Pentaho. JAQL – Introduction to Apache: Sqoop, Drill and Spark, Cloudera Impala – Introduction to NoSQL Databases – Hbase and MongoDB.
Suggested Activities:
- Practical – Installation of NoSQL database like MongoDB.
- Practical – Demonstration on Sharding in MongoDB.
- Practical – Install and run Pig
- Practical – Write PigLatin scripts to sort, group, join, project, and filter data.
- Design and develop algorithms to be executed in Map Reduce involving numerical methods for analytics.

Suggested Evaluation Methods:
- Mini Project (Group) – Real time data collection, saving in NoSQL, implement analytical techniques using Map-Reduce Tasks and Result Projection.

OUTCOMES:
On completion of the course, the student will be able to:
- Identify the real world business problems and model with analytical solutions.
- Solve analytical problem with relevant mathematics background knowledge.
- Convert any real world decision making problem to hypothesis and apply suitable statistical testing.
- Write and Demonstrate simple applications involving analytics using Hadoop and MapReduce
- Use open source frameworks for modeling and storing data.
- Apply suitable visualization technique using R for visualizing voluminous data.

REFERENCES:
OBJECTIVES:
- Summarize basics of industrial safety
- Describe fundamentals of maintenance engineering
- Explain wear and corrosion
- Illustrate fault tracing
- Identify preventive and periodic maintenance

UNIT I INTRODUCTION
9
Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT II FUNDAMENTALS OF MAINTENANCE ENGINEERING
9
Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT III WEAR AND CORROSION AND THEIR PREVENTION
9

UNIT IV FAULT TRACING
9
Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, i. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT V PERIODIC AND PREVENTIVE MAINTENANCE
9
Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: i. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

TOTAL: 45 PERIODS

OUTCOMES:
- CO1: Ability to summarize basics of industrial safety
- CO2: Ability to describe fundamentals of maintenance engineering
- CO3: Ability to explain wear and corrosion
- CO4: Ability to illustrate fault tracing
- CO5: Ability to identify preventive and periodic maintenance
REFERENCES:

OE5093 OPERATIONS RESEARCH LT P C 3 0 0 3

OBJECTIVES:
- Solve linear programming problem and solve using graphical method.
- Solve LPP using simplex method
- Solve transportation, assignment problems
- Solve project management problems
- Solve scheduling problems

UNIT I LINEAR PROGRAMMING 9
Introduction to Operations Research – assumptions of linear programming problems - Formulations of linear programming problem – Graphical method

UNIT II ADVANCES IN LINEAR PROGRAMMING 9
Solutions to LPP using simplex algorithm- Revised simplex method - primal dual relationships – Dual simplex algorithm - Sensitivity analysis

UNIT III NETWORK ANALYSIS – I 9
Transportation problems -Northwest corner rule, least cost method, Voges’s approximation method - Assignment problem -Hungarian algorithm

UNIT IV NETWORK ANALYSIS – II 9
Shortest path problem: Dijkstra’s algorithms, Floyds algorithm, systematic method -CPM/PERT

UNIT V NETWORK ANALYSIS – III 9
Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models

TOTAL: 45 PERIODS
OUTCOMES:
CO1: To formulate linear programming problem and solve using graphical method.
CO2: To solve LPP using simplex method
CO3: To formulate and solve transportation, assignment problems
CO4: To solve project management problems
CO5: To solve scheduling problems

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OE5094 COST MANAGEMENTOF ENGINEERING PROJECTS L T P C
3 0 0 3

OBJECTIVES:
- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management

UNIT I INTRODUCTION TO COSTING CONCEPTS
Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.

UNIT II INTRODUCTION TO PROJECT MANAGEMENT
Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts.

UNIT III PROJECT EXECUTION AND COSTING CONCEPTS
UNIT IV  COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL  
Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity-Based Cost Management, Benchmarking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

UNIT V  QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT  
Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

TOTAL: 45 PERIODS

OUTCOMES
CO1 – Understand the costing concepts and their role in decision making
CO2 – Understand the project management concepts and their various aspects in selection
CO3 – Interpret costing concepts with project execution
CO4 – Gain knowledge of costing techniques in service sector and various budgetary control techniques
CO5 - Become familiar with quantitative techniques in cost management

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2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988

OE5095  COMPOSITE MATERIALS  
LT P C  
3 0 0 3

OBJECTIVES:
- Summarize the characteristics of composite materials and effect of reinforcement in composite materials.
- Identify the various reinforcements used in composite materials.
- Compare the manufacturing process of metal matrix composites.
- Understand the manufacturing processes of polymer matrix composites.
- Analyze the strength of composite materials.

UNIT I  INTRODUCTION  
Definition – Classification and characteristics of Composite materials - Advantages and application of composites - Functional requirements of reinforcement and matrix - Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.
UNIT II REINFORCEMENTS 9
Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers - Properties and applications of whiskers, particle reinforcements - Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures - Isostrain and Isostress conditions.

UNIT III MANUFACTURING OF METAL MATRIX COMPOSITES 9

UNIT IV MANUFACTURING OF POLYMER MATRIX COMPOSITES 9

UNIT V STRENGTH 9
Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TOTAL: 45 PERIODS

OUTCOMES:
• CO1 - Know the characteristics of composite materials and effect of reinforcement in composite materials.
• CO2 – Know the various reinforcements used in composite materials.
• CO3 – Understand the manufacturing processes of metal matrix composites.
• CO4 – Understand the manufacturing processes of polymer matrix composites.
• CO5 – Analyze the strength of composite materials.

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OBJECTIVES:
- Interpret the various types of wastes from which energy can be generated
- Develop knowledge on biomass pyrolysis process and its applications
- Develop knowledge on various types of biomass gasifiers and their operations
- Invent knowledge on biomass combustors and its applications on generating energy
- Summarize the principles of bio-energy systems and their features

UNIT I INTRODUCTION TO EXTRACTION OF ENERGY FROM WASTE 9
Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNIT II BIOMASS PYROLYSIS 9
Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT III BIOMASS GASIFICATION 9

UNIT IV BIOMASS COMBUSTION 9
Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT V BIO ENERGY 9
Properties of biogas (Calorific value and composition), Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production -Urban waste to energy conversion - Biomass energy programme in India.

TOTAL: 45 PERIODS

OUTCOMES:
- CO1 – Understand the various types of wastes from which energy can be generated
- CO2 – Gain knowledge on biomass pyrolysis process and its applications
- CO3 – Develop knowledge on various types of biomass gasifiers and their operations
- CO4 – Gain knowledge on biomass combustors and its applications on generating energy
- CO5 – Understand the principles of bio-energy systems and their features

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AX5091 ENGLISH FOR RESEARCH PAPER WRITING L T P C
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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

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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AX5092 DISASTER MANAGEMENT L T P C

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
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

UNIT III DISASTER PRONE AREAS IN INDIA
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
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
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

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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AX5093  Sanskrit For Technical Knowledge  L  T  P  C  2 0 0 0

OBJECTIVES
- Illustrate the basic sanskrit language.
- Recognize sanskrit, the scientific language in the world.
- Appraise learning of sanskrit to improve brain functioning.
- Relate sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
- Extract huge knowledge from ancient literature.

UNIT I  ALPHABETS  6
Alphabets in Sanskrit

UNIT II  TENSES AND SENTENCES  6
Past/Present/Future Tense - Simple Sentences
UNIT III ORDER AND ROOTS 6
Order - Introduction of roots

UNIT IV SANSKRIT LITERATURE 6
Technical information about Sanskrit Literature

UNIT V TECHNICAL CONCEPTS OF ENGINEERING 6
Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

OUTCOMES
• CO1 - Understanding basic Sanskrit language.
• CO2 - Write sentences.
• CO3 - Know the order and roots of Sanskrit.
• CO4 - Know about technical information about Sanskrit literature.
• CO5 - Understand the technical concepts of Engineering.

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REFERENCES
1. “Abhyaspustakam” – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2. “Teach Yourself Sanskrit” Pratham Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication

AX5094 VALUE EDUCATION L T P C
2 0 0 0

OBJECTIVES
Students will be able to
• Understand value of education and self-development
• Imbibe good values in students
• Let the should know about the importance of character

UNIT I

UNIT II

UNIT III
Universal brother hood and religious tolerance. True friendship. Happiness Vs suffering, love for

UNIT IV

TOTAL: 30 PERIODS

OUTCOMES
Students will be able to
- Knowledge of self-development.
- Learn the importance of Human values.
- Developing the overall personality.

Suggested reading
OBJECTIVES
Students will be able to:

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

UNIT I  HISTORY OF MAKING OF THE INDIAN CONSTITUTION:
History, Drafting Committee, (Composition & Working)

UNIT II  PHILOSOPHY OF THE INDIAN CONSTITUTION:
Preamble, Salient Features

UNIT III  CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES:

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.

TOTAL: 30 PERIODS

OUTCOMES
Students will be able to:

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

Suggested reading
1. The Constitution of India,1950(Bare Act),Government Publication.

AX5096 PEDAGOGY STUDIES L T P C 2 0 0 0

OBJECTIVES
Students will be able to:
- Review existing evidence on there view topic to inform programme design and policy
- Making under taken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

UNIT I INTRODUCTION AND METHODOLOGY:
Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions - Overview of methodology and Searching.

UNIT II THEMATIC OVERVIEW
Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT III EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES
Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers’ attitudes and beliefs and Pedagogic strategies.

UNIT IV PROFESSIONAL DEVELOPMENT
Professional development: alignment with classroom practices and follow up support - Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes

UNIT V RESEARCH GAPS AND FUTURE DIRECTIONS
Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

TOTAL: 30 PERIODS

OUTCOMES
Students will be able to understand:
- What pedagogical practices are being used by teachers informal and informal classrooms in developing countries?
What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
• How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

Suggested reading

AX5097 STRESS MANAGEMENT BY YOGA

OBJECTIVES
• To achieve overall health of body and mind
• To overcome stress

UNIT I
Definitions of Eight parts of yoga.(Ashtanga)

UNIT II
Yam and Niyam - Do’s and Don’t’s in life - i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Ahinsa, satya, astheya, bramhacharya and aparigraha.

UNIT III
Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects-Types of pranayam

TOTAL: 30 PERIODS

OUTCOMES
Students will be able to:
• Develop healthy mind in a healthy body thus improving social health also
• Improve efficiency

SUGGESTED READING
1. ‘Yogic Asanas for Group Tarining-Part-I”:Janardan Swami Yoga bhyasi Mandal, Nagpur
2. “Rajayoga or conquering the Internal Nature” by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata
OBJECTIVES
- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

UNIT I
Neetisatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses- 29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (don’ts) - Verses- 71,73,75,78 (do’s)

UNIT II
Approach to day to day work and duties - Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.

UNIT III
Statements of basic knowledge - Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 Chapter 12 - Verses 13, 14, 15, 16,17, 18 - Personality of role model - shrimad bhagwad geeta - Chapter2-Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

TOTAL: 30 PERIODS

OUTCOMES
Students will be able to
- Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and man kind to peace and prosperity
- Study of Neet is hatakam will help in developing versatile personality of students.

Suggested reading
1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari’s Three Satakam, Niti-sringar-vairagya, New Delhi,2010