UNIVERSITY DEPARTMENTS
ANNA UNIVERSITY, CHENNAI
REGULATIONS – 2013 (FULL TIME)
CURRICULUM FROM I TO IV SEMESTERS FOR
M.E CONTROL AND INSTRUMENTATION ENGINEERING

SEMESTER I

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**TOTAL NO OF CREDITS : 68**

## ELECTIVES

Control & Instrumentation

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PROGRAM OBJECTIVE

- To impart knowledge on performance specification, limitations and structure of controllers
- To impart knowledge on design of controllers using root-locus and frequency domain techniques
- To educate on concept of state space and design of controllers and observers
- To introduce the techniques of extending the theory on continuous systems to discrete time systems
- To introduce the linear quadratic regulator and estimation in the presence of noise

UNIT I  BASICS AND ROOT-LOCUS DESIGN  9
Design specifications - sensitivity and stability - Limitations - Controller structure - one and two degrees of freedom - PID controllers and Lag-lead compensators - Root locus design - Design examples

UNIT II  FREQUENCY RESPONSE BASED DESIGN  9
PID controllers and Lag-lead compensators – Design using Bode plots - use of Nyquist plots and Routh-hurwitz Criterion - Design examples

UNIT III  STATE VARIABLE DESIGN  9
Representation - solution - Controllability, observability - state and output feedback - observers - estimated state feedback – PID control via state feedback - compensator design - Design examples

UNIT IV  DESIGN IN DISCRETE DOMAIN  9
Sample and Hold devices - Discretisation - Effect of sampling on transfer function and state models - Direct discrete design - Design examples

UNIT V  LQR AND LQG DESIGN  9

L=45, T=15, TOTAL= 60 PERIODS

REFERENCES
PROGRAM OBJECTIVE

- To introduce the resistive, inductive and capacitive transducers and their transduction principles
- To educate on magnetic transducer elements
- Study of acoustic, mechanical and flow metering elements, their working principle
- To introduce various optical sensors, their transduction principles and their applications
- To introduce various advanced and miniature sensors and their applications

UNIT I RESISTIVE, INDUCTIVE AND CAPACITIVE ELEMENTS 9
Potentiometric, strain-gage and electrode elements – Inductive and Capacitive elements: structures, equivalent circuits and characteristics, single, differential and angle displacement elements, displacement to phase converters, and proximity elements, magnetostrictive elements, temperature instabilities and features.

UNIT II TRANSFORMER, ELECTRODYNAMIC, SERVO AND RESONANT ELEMENTS 9
Transformer elements: Single core, differential, rotating coil and synchro transformers, weak-field sensors - Electrodynamic elements: Moving-coil, variable-reluctance - Resonant elements: vibrating strings, vibrating beams, vibrating cylinders, piezoelectric resonators, acoustical resonators, microwave cavity resonators.

UNIT III MECHANICAL, ACOUSTICAL AND FLOWMETERING ELEMENTS 9
Stresses state of diaphragm, dynamic characteristics of diaphragm, temperature drifts, sensitivity drifts, sensitivity to acceleration – Inertial mass elements: sensing and transduction elements of flowmeters, electromagnetic flowmeters, nanoelectrode electromagnetic flowmeters -ultrasonic elements – Acoustical elements: acoustical filters.

UNIT IV OPTICAL MICROSTRUCTURE SENSORS 9
Photo detectors: Thermal detectors, pneumatic detectors, pyroelectric detectors, photoemissive devices, photo conductive detectors, photo diodes, avalanche photo diodes, schottky photo diodes, photo transistors – Fiber optic sensors: Fibers as light guides, reflection sensors, Intrinsic multimode sensor, temperature sensor, phase modulated sensor, fiber optic gyroscopes and other fiber sensors

UNIT V MISCELLANEOUS MINIATURE SENSORS 9
Magnetic sensors: Hall Effect sensors, magnetoresistors and other sensors – Solid state chemical sensors: Silicon based sensors, metal oxide sensors, solid electrolyte sensors, membranes – Electromechanical micro sensors and basic factors of design

L=45, T=15 TOTAL : 60 PERIODS
REFERENCES:

CO8151 SOFT COMPUTING TECHNIQUES LT P C 3 0 2 4

PROGRAM OBJECTIVES
- To review the fundamentals of ANN and fuzzy set theory
- To make the students understand the use of ANN for modeling and control of non-linear system and to get familiarized with the ANN tool box.
- To impart knowledge of using Fuzzy logic for modeling and control of non-linear systems and get familiarized with the FLC tool box.
- To make the students to understand the use of optimization techniques.
- To familiarize the students on various hybrid control schemes, P.S.O and get familiarized with the ANFIS tool box.

UNIT I OVERVIEW OF ARTIFICIAL NEURAL NETWORK (ANN) & FUZZY LOGIC 9

UNIT II NEURAL NETWORKS FOR MODELLING AND CONTROL 9
Modeling of non linear systems using ANN- NARX,NNSS,NARMAX - 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 9

UNIT IV GENETIC ALGORITHM 9
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 IV HYBRID CONTROL SCHEMES

TOTAL : 45+30 = 75 PERIODS

Soft Computing Techniques - Lab
To implement adaline and madaline with bipolar inputs and outputs using NN toolbox.
To implement back propagation for a given input pattern using NN toolbox.
To implement discrete hopfield network and test for given input pattern using NN toolbox.
To implement fuzzy set operation and properties using FUZZY toolbox.
To perform max-min composition of two matrices obtained from Cartesian product using ‘m file’ in MATLAB.
Write a program to verify the various laws associated with fuzzy set using FUZZY toolbox.
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 objective function and ‘x’ value.
Design FLC for a FOPDT process using FUZZY toolbox.
Design a Neuro model for an inverted pendulum using NN toolbox.
Design Fuzzy model for an inverted pendulum using FUZZY toolbox.

REFERENCES
OBJECTIVES:
- To develop the ability to apply the concepts of Matrix theory and Linear programming in Electrical Engineering problems.
- To achieve an understanding of the basic concepts of one dimensional random variables and apply in electrical engineering problems.
- To familiarize the students in calculus of variations and solve problems using Fourier transforms associated with engineering applications.

UNIT I MATRIX THEORY (9+3)
The Cholesky decomposition - Generalized Eigen vectors, Canonical basis - QR factorization - Least squares method - Singular value decomposition.

UNIT II CALCULUS OF VARIATIONS (9+3)
Concept of variation and its properties – Euler’s equation – Functional dependant on first and higher order derivatives – Functionals dependant on functions of several independent variables – Variational problems with moving boundaries – problems with constraints - Direct methods: Ritz and Kantorovich methods.

UNIT III ONE DIMENSIONAL RANDOM VARIABLES (9+3)

UNIT IV LINEAR PROGRAMMING (9+3)
Formulation – Graphical solution – Simplex method – Two phase method - Transportation and Assignment Models

UNIT V FOURIER SERIES (9+3)

BOOKS FOR STUDY:
REFERENCES:

CO8111 CONTROL SYSTEM DESIGN LAB

1. Simulation of transfer function models and obtain time and frequency response
2. Simulation of state space models for linear continuous and discrete time systems and obtain the time response
3. Mathematical modeling and simulation of a mechanical system
4. Mathematical modeling and simulation of an electrical mechanical system
5. Mathematical modeling and simulation of a power electronic system
6. Mathematical modeling and simulation of a chemical process
7. Design and performance analysis of PID controlled physical systems using Root-locus technique
8. Design and performance analysis of PID controlled physical systems using Bode plots
9. Design and performance analysis of PID controlled physical systems using Zeigler Nichols approach
10. Design and performance analysis of Lag-lead compensator controlled physical systems using Bode plots
11. Solution of Ricatti’s equation in continuous and discrete domain
12. Design and performance analysis of state and output feedback control of physical systems
13. Design and performance analysis of estimator and estimated feedback control of physical systems
14. Design and performance analysis of optimal control of physical systems
15. Design and performance analysis of optimal estimation and control of physical systems

TOTAL : 45 PERIODS
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.
- To make the students understand the various PID tuning methods
- To elaborate different types of control schemes such as cascade control, feed-forward control etc.
- To educate on multivariable systems and multi-loop control
- To educate on various industrial processes

UNIT I PROCESS DYNAMICS & CONTROL ACTIONS

UNIT II PID CONTROLLER TUNING – SINGLE LOOP REGULATORY CONTROL

UNIT III ENHANCEMENT TO SINGLE LOOP REGULATORY CONTROL & MODEL BASED CONTROL SCHEMES
- Cascade control – Split-range - Feed-forward control – Ratio control – Inferential control — override control - Smith predictor control scheme - Internal Model Controller - IMC PID controller – Single Loop Dynamic Matrix Control – Generalized Predictive Control

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.

REFERENCES
CO8202 INDUSTRIAL PROCESS AUTOMATION LT P C 3 1 0 4

PROGRAM OBJECTIVE

- To educate on design of signal conditioning circuits for various applications
- To educate on signal transmission techniques and their design
- Study of components used in data acquisition systems interface techniques
- To educate on the components used in distributed control systems
- To introduce the communication buses namely field bus and profibus.

UNIT I DESIGN OF SIGNAL CONDITIONING AND TRANSMISSION


UNIT II DATA ACQUISITION AND INSTRUMENT INTERFACE

Programming and simulation of Building block of instrument Automation system – Signal analysis, I/O port configuration with instrument bus protocols - ADC, DAC, DIO, counters & timers, PC hardware structure, timing, interrupts, DMA, software and hardware installation, current loop, RS 232/RS485, GPIB, USB protocols,

UNIT III PLC AND SCADA


SCADA:- Remote terminal units, Master station, Communication architectures and Open SCADA protocols.
UNIT IV DISTRIBUTED CONTROL SYSTEM
Evolution - Different architectures - Local control unit - Operator Interface – Displays - Engineering interface - Study of any one DCS available in market - Factors to be considered in selecting DCS.

UNIT V COMMUNICATION PROTOCOLS

L:45 + T: 15 TOTAL: 60 PERIODS

REFERENCES

CO8251 NON LINEAR CONTROL L T P C
3 0 2 4

PROGRAM OBJECTIVES
• To impart knowledge on phase plane analysis of non-linear systems.
• To impart knowledge on Describing function based approach to non-linear systems.
• To educate on stability analysis of systems using Lyapunov’s theory.
• To introduce the concept of sliding mode control.

UNIT I PHASE PLANE ANALYSIS
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. simulation of phase portraits in matlab

UNIT II DESCRIBING FUNCTION
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. simulation of sliding mode controller in matlab

L=45, P=30  TOTAL : 75 PERIODS

PRACTICALS
1. Development of state trajectories and phase portraits
2. Development of algorithms to construct Describing functions
3. Performance analysis of non-linear systems using Describing function approach
4. Simulation and performance evaluation using Input-Output Linearization
5. Simulation and performance evaluation using Feedback Linearization
7. Design of controllers for MIMO systems
8. Design of controllers for chemical process loops
9. Design of controllers for power converters
10. Design of controllers for electro-mechanical systems

REFERENCES
CO8211 AUTOMATION LAB

1. Simulation and performance analysis of transfer function models using virtual Instrumentation packages
2. Simulation and performance analysis of state space models using virtual Instrumentation packages
3. Simulation of signal conditioning and processing circuits using circuit design packages
4. Demonstration of discretisation blocks in the virtual instrumentation package
5. Configuration of analog and digital data acquisition systems
6. Development of GUI application for PID control
7. Development of GUI application to mimic closed loop performance of a physical system
8. Ladder logic programming using PLC simulator software packages
9. Simulation of process control loop using PLC with GUI
10. Simulation of SCADA based control of physical system
11. Development of PID and Lag-lead control algorithms for microcontroller application
12. Configuration of simulation of RS232 and SPI interface protocols
13. Configuration of simulation of instrumentation bus protocols
14. Simulation of state diagram based application using virtual instrumentation package
15. Design of complete automation system for a given application
16. Design of Feed Forward Controller for a given application

TOTAL : 45 PERIODS

CO8001 ADVANCED NON-LINEAR SYSTEMS

COURSE OBJECTIVES

- To educate on the theory of perturbation
- To educate on stability analysis and theory of singular perturbation
- To educate on gain scheduling and feedback linearization techniques
- To educate on the concepts input-output stability and passivity
- To educate on the 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 9

UNIT IV INPUT-OUTPUT STABILITY 9

UNIT V BAKSTEPPING CONTROL ALGORITHMS 9
Passivity based control – High gain observers – stabilization – Regulation via integral control - exercises

TOTAL : 45 PERIODS

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

CO8002 CONTROL OF ELECTRICAL DRIVES L T P C 3 0 0 3

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 9
Power electronic switches-state space representation of switching converters-Fixed frequency PWM-variable frequency PWM- space vector PWM- Hysteresis current control-dynamic analysis of switching converters-PWM modulator model

UNIT II CONTROL OF DC DRIVES 9
Modelling of DC machines-block diagram/transfer function-phase control-1phase/3phase converter fed DC drives- Chopper fed DC drives-four quadrant chopper circuit-closed loop control-speed control-current control-cascade control –constant torque/power operation-comparison of chopper/converter fed drives- techniques-merits/demits

UNIT III ANALYSIS AND MODELLING OF INDUCTION MOTOR DRIVE 9
Basics of induction motor drive-classification – equivalent circuit- torque Vs slip characteristics-steady state performance- Dynamic modeling of induction motor, Three
phase to two phase transformation-stator, rotor, synchronously rotating reference frame model

UNIT IV  CONTROL OF INDUCTION MOTOR DRIVE  9
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  9
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

REFERENCES
   of India, 2002.
2. Thyristor control of Electric drives, Vedam Subrahmanyam, Tata McGraw Hill,
   1988
4. Simon Ang, Alejandro Oliva “POWER SWITCHING CONVERTERS”, CRC Press,
   2005
5. Buxbaum, A. Schierauf, and K.Staughen, “A design of control systems for DC

CO8003  MULTI SENSOR DATA FUSION  L T P C
3 0 0 3

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
sensors and sensor data, Use of multiple sensors, Fusion applications. The inference
hierarchy: output data. Data fusion model. Architectural concepts and issues. Benefits of
data fusion, Mathematical tools used: Algorithms, coordinate transformations, rigid body

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  9

UNIT V  HIGH PERFORMANCE DATA STRUCTURES:  9
Tessellated, trees, graphs and function. Representing ranges and uncertainty in data structures. Designing optimal sensor systems with in dependability bounds. Implementing data fusion system.

TOTAL : 45 PERIODS

REFERENCES:

CO8004  OPTIMAL CONTROL AND FILTERING  L T P C
3 0 0 3

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  9

UNIT II  LINEAR QUADRATIC TRACKING PROBLEMS  9
Linear tracking problem – LQG problem – Computational procedure for solving optimal control problems – Characteristics of dynamic programming solution – Dynamic
programming application to discrete and continuous systems – Hamilton Jacobi Bellman equation.

UNIT III NUMERICAL TECHNIQUES FOR OPTIMAL CONTROL 9
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 9

UNIT V KALMAN FILTER AND PROPERTIES 9

TOTAL : 45 PERIODS

REFERENCES:

CO8071 ROBOTICS AND CONTROL L T 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 9
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 9
Mechanism-matrix representation-homogenous transformation-DH representation-
Inverse kinematics-solution and programming-degeneracy and dexterity

UNIT III DIFFERENTIAL MOTION AND PATH PLANNING 9
Jacobian-differential motion of frames-Interpretation-calculation of Jacobian-Inverse
Jacobian- Robot Path planning

UNIT IV DYNAMIC MODELLING 9
Lagrangian mechanics- Two-DOF manipulator- Lagrange-Euler formulation – Newton-
Euler formulation – Inverse dynamics

UNIT V ROBOT CONTROL SYSTEM 9
- Linear control schemes- joint actuators- decentralized PID control- computed torque
control – force control- hybrid position force control- Impedance/ Torque control

TOTAL : 45 PERIODS

REFERENCES
3. Fu, Gonzalez and Lee Mcgrahill ,"Robotics ", international
4. R.D. Klafter, TA Chmielewski and Michael Negin, "Robotic Engineering, An Integrated

CO8072 ROBUST CONTROL L T P C 3 0 0 3

COURSE OBJECTIVES
- To introduce norms, random spaces and robustness measures
- To educate on H2 optimal control and estimation techniques
- To educate on Hinfinity optimal control techniques
- To educate on the LMI approach of Hinfinity 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 H2 OPTIMAL CONTROL 9
Linear Quadratic Controllers – Characterization of H2 optimal controllers – H2 optimal
estimation-Kalman Bucy Filter – LQG Controller

UNIT III  H-INFINITY OPTIMAL CONTROL-RICCATI APPROACH  9
Formulation – Characterization of H-infinity sub-optimal controllers by means of Riccati equations – H-infinity control with full information – Hinfinity estimation

UNIT IV  H-INFINITY OPTIMAL CONTROL- LMI APPROACH  9

UNIT V  SYNTHESIS OF ROBUST CONTROLLERS & 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

REFERENCES

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

REFERENCES
3. Astrom and Wittenmark, "Adaptive Control ", PHI

CO8074  SYSTEM THEORY  L T P C
30 0 3

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  9
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-Controllable 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

REFERENCES:
UNIT I  INTRODUCTION TO SCADA  
Evolution of SCADA, SCADA definitions, SCADA Functional requirements and Components, SCADA Hierarchical concept, SCADA architecture, General features, SCADA Applications, Benefits

UNIT II  SCADA SYSTEM COMPONENTS  
Remote Terminal Unit (RTU), Interface units, 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 III  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, PLC etc. Interface provisions and communication extensions, synchronization with NCC, DCC.

UNIT IV  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.

UNIT V  SCADA APPLICATIONS IN POWER SYSTEM  
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,

TOTAL: 45 PERIODES

REFERENCES:
1. Stuart A. Boyer: SCADA-Supervisory Control and Data Acquisition, Instrument Society of America Publications, USA, 2004
4. David Bailey, Edwin Wright, Practical SCADA for industry, Newnes, 2003
5. Michael Wiebe, A guide to utility automation: AMR, SCADA, and IT systems for electric Power, PennWell 1999
Pre-requisites: Basics of Signal Processing, Mathematics of Transforms, Microcontroller

COURSE OBJECTIVES
- To expose the students to 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 compare Architectures & features of Programmable DSP processors
- To discuss on Application development with commercial family of DS Processors
- To design & develop logical functions of DSP processors with Re-Programmable logics & Devices

UNIT I INTRODUCTION TO DIGITAL SIGNAL PROCESSING 12

UNIT II WAVELET TRANSFORM 6
Introduction to continuous wavelet transform - discrete wavelet transform - orthogonal wavelet decomposition - Multiresolution Analysis - Wavelet function - DWT, bases, orthogonal Basis - Scaling function, Wavelet coefficients - ortho normal wavelets and their relationship to filter banks - Digital filtering interpolation (i) Decomposition filters, (ii) reconstruction, the signal - Example MRA - Haar & Daubechies wavelet.

UNIT III ARCHITECTURES OF COMMERCIAL DIGITAL SIGNAL PROCESSORS 12
Introduction, catogorisation of DSP Processors, Fixed Point (Blackfin), Floating Point (SHARC), TI TMS 320c6xxx & OMAP processors TMS320C54X & 54xx on Basic Architecture – comparison : of functional variations of Computational building blocks, MAC, Bus Architecture and memory, Data Addressing, Parallelism and pipelining, Parallel I/O interface, Memory Interface, Interrupt, DMA (one example Architecture in each of these case studies).

UNIT IV INTERFACING I/O PERIPHERALS FOR DSP BASED APPLICATIONS 6
UNIT V    VLSI IMPLEMENTATION
Low power Design-need for Low power VLSI chips-Basics of DSP system architecture
design using VHDL programming, Mapping of DSP algorithm onto hardware, Realisation
of MAC & Filter structure.

TOTAL:45 PERIODS

REFERENCES:
   Education 2002.
6. Raghuveer M.Rao and Ajit S. Bapardikar, Wavelet transforms- Introduction to
7. K.P. Soman and K.L. Ramchandran,Insight into WAVELETS from theory to
8. Ifeachor E. C., Jervis B. W ,”Digital Signal Processing: A practical approach, 
   Pearson-Education, PHI/  2002
    Learning,2010
    Press2009.

ET8072    MEMS TECHNOLOGY    L T P C
3 0 0 3
Pre-requisites: Basic Instrumentation, Material Science, Programming

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

TOTAL : 45 PERIODS

REFERENCES

ET8151 ADVANCED DIGITAL PRINCIPLES AND DESIGN LT P C
3104
Pre-requisites: Digital logic Devices, Circuits, Boolean Algebra

OBJECTIVES
• To expose the students to the fundamentals of sequential system design, modelling
• To teach the fundamentals of Asynchronous circuits, switching errors
• To study on Fault identification in digital switching circuits
• To introduce logics for design of Programmable Devices
• To comparatively study the classification of commercial family of Programmable Devices

UNIT I SEQUENTIAL CIRCUIT DESIGN 9

UNIT II ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN

UNIT III FAULT DIAGNOSIS AND TESTABILITY ALGORITHMS

UNIT IV SYNCHRONOUS DESIGN USING PROGRAMMABLE DEVICES
Programming Techniques - Re-Programmable Devices Architecture- Function blocks, I/Oblocks, Interconnects, Realize combinational, Arithmetic, Sequential Circuit with Programmable Array Logic; Architecture and application of Field Programmable Logic Sequence.

UNIT V ARCHITECTURES AND PROGRAMMING PROGRAMMABLE LOGIC DEVICES

LOGIC SYNTHESIS AND SIMULATION
Overview of digital design with VHDL, hierarchical modelling concepts, modules and port definitions, gate level modelling, data flow modelling, behavioural modelling, task & functions, logic synthesis-simulation-Design examples, Ripple carry Adders, Carry Look ahead adders, Design of Arithmetic circuits for Fast adder, Array Multiplier, ALU, Shift Registers, Multiplexer, Comparator/other examples on Test Bench.

L:45 + T: 15 TOTAL: 60 PERIODS

REFERENCES:
ET8152 MICROCONTROLLER BASED SYSTEM DESIGN

Pre-requisites: Basics of Processor Architecture & Programming in 8085/8051

COURSE OBJECTIVES
- To expose the students to the fundamentals of microcontroller based system design.
- To teach I/O and RTOS role on microcontroller.
- To impart knowledge on
- PIC Microcontroller based system design.
- To introduce Microchip PIC 8 bit peripheral system Design
- To give case study experiences for microcontroller based applications.

UNIT I 8051 ARCHITECTURE

UNIT II 8051 PROGRAMMING

UNIT III PIC MICROCONTROLLER

UNIT IV PERIPHERAL OF PIC MICROCONTROLLER

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

TOTAL : 45 PERIODS

REFERENCES:
OBJECTIVES

- To expose the students to the fundamentals of interaction of OS with a computer and User computation.
- To teach the fundamental concepts of how processes are created and controlled with OS.
- To study on programming logic of modeling Process based on range of OS features.
- To compare types and Functionalities in commercial OS.
- To discuss the application development using RTOS.

UNIT I REVIEW OF OPERATING SYSTEMS 15


UNIT II OVERVIEW OF RTOS 9


UNIT III REAL TIME MODELS AND LANGUAGES 6


UNIT IV REAL TIME KERNEL 6

Principles – Design issues – Polled Loop Systems – RTOS Porting to a Target – Comparison and Basic study of various RTOS like – VX works – Linux supportive RTOS – C Executive.

UNIT V RTOS APPLICATION DOMAINS 9


TOTAL: 45 PERIODS

REFERENCES:

ET8252 SOFTWARE FOR EMBEDDED SYSTEMS

Pre-requisites: Basics in Programming, Embedded System & operating systems

COURSE OBJECTIVES
- To expose the students to the fundamentals of embedded Programming.
- To Introduce the GNU C Programming Tool Chain in Linux.
- To study the basic concepts of embedded C and Embedded OS
- To introduce time driven architecture, Serial Interface with a case study.
- To introduce the concept of embedded Java for Web Enabling of systems.

UNIT I EMBEDDED PROGRAMMING

UNIT II C PROGRAMMING TOOLCHAIN IN LINUX
C preprocessor - Stages of Compilation - Introduction to GCC - Debugging with GDB - The Make utility - GNU Configure and Build System - GNU Binary utilities - Profiling - using gprof - Memory Leak Detection with valgrind - Introduction to GNU C Library

UNIT III EMBEDDED C AND EMBEDDED OS
Adding Structure to ‘C’ Code: Object oriented programming with C, Header files for Project and Port, Examples. Meeting Real-time constraints: Creating hardware delays - Need for timeout mechanism - Creating loop timeouts - Creating hardware timeouts. Creating embedded operating system: Basis of a simple embedded OS, Introduction to sEOS, Using Timer 0 and Timer 1, Portability issue, Alternative system architecture, Important design considerations when using sEOS.

UNIT IV TIME-DRIVEN MULTI-STATE ARCHITECTURE AND HARDWARE

UNIT V EMBEDDED JAVA

TUTORIAL:
Program Development and practice in C, C++ and Java

TOTAL : 60 PERIODS

REFERENCES

ET8253 VLSI BASED DESIGN METHODOLOGIES
L T P C
3 1 0 4

Pre-requisites: Logic design, programmable devices, programming

OBJECTIVES
• To give an insight to the students about the significance of CMOS technology and fabrication process.
• To teach the importance and architectural features of programmable logic devices.
• To introduce the ASIC construction and design algorithms
• To teach the basic analog VLSI design techniques.
• To study the Logic synthesis and simulation of digital system with Verilog HDL.

UNIT I CMOS DESIGN
Overview of I VLSI design Methodologies- Logic design with CMOS-transmission gate circuits-Clocked CMOS-dynamic CMOS circuits, Bi-CMOS circuits- Layout diagram, Stick diagram-IC fabrications – Low Power VLSI techniques-Trends in IC technology.

UNIT II PROGRAMMABLE LOGIC DEVICES
UNIT III BASIC CONSTRUCTION, FLOOR PLANNING, PLACEMENT AND ROUTING 6
System partition – FPGA partitioning – Partitioning methods- floor planning – placement-
physical design flow – global routing – detailed routing – special routing- circuit
extraction – DRC.

UNIT IV ANALOG VLSI DESIGN 6
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 LOGIC SYNTHESIS AND SIMULATION 12
Overview of digital design with Verilog HDL, hierarchical modelling concepts, modules
and port definitions, gate level modelling, data flow modelling, behavioural modelling,
task & functions, Verilog and logic synthesis-simulation-Design examples,Ripple carry
Adders, Carry Look ahead adders, Multiplier, ALU, Shift Registers, Multiplexer,
Comparator, Test Bench.

TUTORIALS:
Digital design with Verilog HDL, gate level modelling, -simulation-Design
examples,Ripple carry Adders, Carry Look ahead adders, Multiplier, ALU, Shift
Registers, Multiplexer, Comparator, on Xilinx Platform/Processor Supported Test Bench

L: 45+T:15 = 60 PERIODS
REFERENCES:
1. M.J.S Smith, “Application Specific integrated circuits”,Addition Wesley
2. Kamran Eshraghian,Douglas A.pucknell and Sholeh Eshraghian,”Essentials of
VLSI circuits and system”, Prentice Hall India,2005.
4. Mohamed Ismail ,Terri Fiez, “Analog VLSI Signal and information Processing”,
5. Samir Palnitkar, “Veri Log HDL, A Design guide to Digital and Synthesis” 2nd
OBJECTIVES:
To impart knowledge on,
• different HV applications in industry and food preservation.
• different HV applications in cancer treatments and microbial inactivation.
• the awareness on safety and hazard issues.

UNIT I APPLICATION IN INDUSTRY

UNIT II APPLICATION IN MICROBIAL INACTIVATION
Introduction – definitions, descriptions and applications – mechanisms of microbial inactivations - electrical breakdown - electroporation - inactivation models - Critical factors - analysis of process, product and microbial factors - pulse generators and treatment chamber design - Research needs.

UNIT III APPLICATION IN FOOD PRESERVATION
Processing of juices, milk, egg, meat and fish products - Processing of water and waste – Industrial feasibility, cost and efficiency analysis.

UNIT IV APPLICATION IN CANCER TREATMENT

UNIT V SAFETY AND ELECTROSTATIC HAZARDS

TOTAL: 45 PERIODS

REFERENCES

HV8072 ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY

OBJECTIVES:
- To provide fundamental knowledge on electromagnetic interference and electromagnetic compatibility.
- To study the important techniques to control EMI and EMC.
- To expose the knowledge on testing techniques as per different Indian and international standards in EMI measurement.

UNIT I INTRODUCTION
Definitions of EMI/EMC - Sources of EMI - Intersystems and Intrasytem - Conducted and radiated interference - Characteristics - Designing for electromagnetic compatibility (EMC) - EMC regulation - typical noise path - EMI predictions and modeling, Cross talk - Methods of eliminating interferences.

UNIT II GROUNDING AND CABLING
Cabling - types of cables, mechanism of EMI emission / coupling in cables - capacitive coupling - inductive coupling - shielding to prevent magnetic radiation - shield transfer impedance, Grounding - safety grounds - signal grounds - single point and multipoint ground systems - hybrid grounds - functional ground layout - grounding of cable shields - guard shields - isolation, neutralizing transformers, shield grounding at high frequencies, digital grounding - Earth measurement Methods.

UNIT III BALANCING, FILTERING AND SHIELDING
Power supply decoupling - decoupling filters - amplifier filtering - high frequency filtering - EMI filters characteristics of LPF, HPF, BPF, BEF and power line filter design - Choice of capacitors, inductors, transformers and resistors, EMC design components - shielding - near and far fields shielding effectiveness - absorption and reflection loss - magnetic materials as a shield, shield discontinuities, slots and holes, seams and joints, conductive gaskets, windows and coatings - grounding of shields.

UNIT IV EMI IN ELEMENTS AND CIRCUITS
Electromagnetic emissions, noise from relays and switches, non-linearities in circuits, passive inter modulation, transients in power supply lines, EMI from power electronic equipment, EMI as combination of radiation and conduction.

UNIT V ELECTROSTATIC DISCHARGE, STANDARDS AND TESTING TECHNIQUES
Static Generation - human body model- static discharges - ESD versus EMC, ESD protection in equipments - standards – FCC requirements – EMI measurements – Open
area test site measurements and precautions- Radiated and conducted interference measurements, Control requirements and testing methods.

TOTAL : 45 PERIODS

REFERENCES

IN8251    APPLIED INDUSTRIAL INSTRUMENTATION    L T P C
                      3 0 0 3

OURSE OBJECTIVES
To enable students
- To acquire knowledge about the various techniques used for the measurement of primary industrial parameters like flow, level, temperature and pressure.
- understand the important parameters to be monitored and analyzed in Thermal power Plant
- To get an exposure on the important parameters to be monitored and analyzed in Petrochemical Industry
- To learn about the hazardous zone classification and intrinsic safety techniques to the adapted in industries.
- Learn about other special purpose instruments like Nuclear radiation detection techniques, fibre optic sensors, Instrumentation for NDT applications etc

COURSE OUTCOMES
On completion of this course, students will be able to
- understand the instrumentation behind flow, level, temperature and pressure measurement
- Acquire basic knowledge on the important measurement parameters and required analyzers with respect to Boilers in Thermal power plant,
- know about the working principle of instruments used in different operations in petrochemical industry
- explain about the necessary safety techniques to be adopted in a typical Process industry
- Understand about the Instrumentation used in Nuclear Radiation Detection, corrosion monitoring and to have an exposure on NDT analysis.
UNIT I REVIEW OF INDUSTRIAL INSTRUMENTATION
Overview of Measurement of Flow, level, Temperature and Pressure

UNIT II MEASUREMENT IN THERMAL POWER PLANT (BOILERS)
Selection and Installation of instruments used for the Measurement of fuel flow, Air flow, Drum level, Steam pressure, Steam temperature – Feed water quality measurement- Flue gas Oxygen Analyzers- Coal Analyzer.

UNIT III MEASUREMENT IN PETROLEUM REFINERY
Parameters to be measured in petroleum industry:-Flow, Level, Temperature and Pressure measurement in Distillation, Pyrolysis, catalytic cracking and reforming process- Hydrocarbon analyzers-oil in or on water-sulphur in oil Analyzer.

UNIT IV INSTRUMENTATION FOR INDUSTRIAL SAFETY
Electrical and Intrinsic Safety - Explosion Suppression and Deluge systems -Conservation and emergency vents - Flame, fire and smoke detectors - Leak Detectors - Metal Detectors.

UNIT V SPECIAL PURPOSE INSTRUMENTATION
Detection of Nuclear Radiation – Corrosion monitoring – Fibre optic sensors- Instrumentation in weather stations -Instrumentation for NDT applications-Image processing Technique for measurements.

TOTAL : 45 PERIODS

REFERENCE BOOKS
4 Håvard Devold, “Oil and Gas Production Handbook - An Introduction to Oil and Gas Production”, ABB ATPA oil and gas, 2006
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 9
Magnetic circuits, permanent magnet, stored magnetic energy, co-energy - force and torque in singly and doubly excited systems – machine windings and air gap mmf - winding inductances and voltage equations.

UNIT II DC MACHINES 9
Elementary DC machine and analysis of steady state operation - Voltage and torque equations – dynamic characteristics of permanent magnet and shunt d.c. motors – Time domain block diagrams - solution of dynamic characteristic by Laplace transformation – digital computer simulation of permanent magnet and shunt d.c. machines.

UNIT III REFERENCE FRAME THEORY 9
Historical background – 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 9

UNIT V SYNCHRONOUS MACHINES 9
Three phase synchronous machine and analysis of steady state operation - voltage and torque equations in machine variables and rotor reference frame variables (Park’s equations) – analysis of dynamic performance for load torque variations – digital computer simulation.

TOTAL : 45 PERIODS

TEXT BOOKS
REFERENCES

PE8153  ANALYSIS OF POWER CONVERTERS  L T P C  3 0 0 3

OBJECTIVES :
- To provide the electrical circuit concepts behind the different working modes of power converters so as to enable deep understanding of their operation.
- To equip with required skills to derive the criteria for the design of power converters starting from basic fundamentals.
- To analyze and comprehend the various operating modes of different configurations of power converters.
- To design different power converters namely AC to DC, DC to DC and AC to AC converters.

UNIT I  SINGLE PHASE AC-DC CONVERTER  9

UNIT II  THREE PHASE AC-DC CONVERTER  9

UNIT III  DC-DC CONVERTERS  9

UNIT IV  AC VOLTAGE CONTROLLERS  9

UNIT V  CYCLOCONVERTERS  9

TOTAL : 45 PERIODS
TEXT BOOKS

REFERENCES

PE8251 SOLID STATE DC DRIVES L T P C 3 0 0 3

OBJECTIVES:
- To understand steady state operation and transient dynamics of a motor load system
- To study and analyze the operation of the converter / chopper fed DC drive, both qualitatively and quantitatively.
- To analyze and design the current and speed controllers for a closed loop solid state DC motor drive.
- To understand the implementation of control algorithms using microcontrollers and phase locked loop.

UNIT I DC MOTORS FUNDAMENTALS AND MECHANICAL SYSTEMS 9
DC motor- Types, induced emf, speed-torque relations; Speed control – Armature and field speed control; Ward Leonard control – Constant torque and constant horse power operation - Introduction to high speed drives and modern drives.
Characteristics of mechanical system – dynamic equations, components of torque, types of load; Requirements of drives characteristics - stability of drives – multi-quadrant operation; Drive elements, types of motor duty and selection of motor rating.

UNIT II CONVERTER CONTROL 9
Principle of phase control – Fundamental relations; Analysis of series and separately excited DC motor with single-phase and three-phase converters – waveforms, performance parameters, performance characteristics.
Continuous and discontinuous armature current operations; Current ripple and its effect on performance; Operation with free wheeling diode; Implementation of braking schemes; Drive employing dual converter.
UNIT III  
CHOPPER CONTROL  
9
Introduction to time ratio control and frequency modulation; Class A, B, C, D and E chopper controlled DC motor – performance analysis, multi-quadrant control - Chopper based implementation of braking schemes; Multi-phase chopper; Related problems.

UNIT IV  
CLOSED LOOP CONTROL  
9
Modeling of drive elements – Equivalent circuit, transfer function of self, separately excited DC motors; Linear Transfer function model of power converters; Sensing and feeds back elements - Closed loop speed control – current and speed loops, P, PI and PID controllers – response comparison. Simulation of converter and chopper fed d.c drive.

UNIT V  
DIGITAL CONTROL OF D.C DRIVE  
9
Phase Locked Loop and micro-computer control of DC drives – Program flow chart for constant horse power and load disturbed operations; Speed detection and current sensing circuits.

TOTAL : 45 PERIODS

TEXT BOOKS

REFERENCES
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  9
Fundamentals of Permanent Magnets- Types- Principle of operation- Magnetic circuit analysis- EMF and Torque equations- Characteristics and control

UNIT II  PERMANENT MAGNET SYNCHRONOUS MOTORS  9

UNIT III  SWITCHED RELUCTANCE MOTORS  9
Constructional features –Principle of operation– Torque prediction–Characteristics Power controllers – Control of SRM drive- Sensorless operation of SRM – Applications.

UNIT IV  STEPPER MOTORS  9

UNIT V  OTHER SPECIAL MACHINES  9
Principle of operation and characteristics of Hysteresis motor – AC series motors – Linear motor – Applications.

TEXT BOOKS:

REFERENCES:
OBJECTIVES:

- To provide knowledge about the stand alone and grid connected renewable energy systems.
- To equip with required skills to derive the criteria for the design of power converters for renewable energy applications.
- To analyse and comprehend the various operating modes of wind electrical generators and solar energy systems.
- To design different power converters namely AC to DC, DC to DC and AC to AC converters for renewable energy systems.
- To develop maximum power point tracking algorithms.

UNIT I  INTRODUCTION
Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) - Qualitative study of different renewable energy resources ocean, Biomass, Hydrogen energy systems: operating principles and characteristics of: Solar PV, Fuel cells, wind electrical systems-control strategy, operating area.

UNIT II ELECTRICAL MACHINES FOR RENEWABLE ENERGY CONVERSION
Review of reference theory fundamentals-principle of operation and analysis: IG, PMSG, SCIG and DFIG.

UNIT III  POWER CONVERTERS
Solar: Block diagram of solar photo voltaic system: line commutated converters (inversion-mode) - Boost and buck-boost converters- selection Of inverter, battery sizing, array sizing.

Wind: three phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters-matrix converters.

UNIT IV  ANALYSIS OF WIND AND PV SYSTEMS
Stand alone operation of fixed and variable speed wind energy conversion systems and solar system-Grid connection Issues -Grid integrated PMSG and SCIG Based WECS-Grid integrated solar system

UNIT V  HYBRID RENEWABLE ENERGY SYSTEMS
Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Wind-PV-Maximum Power Point Tracking (MPPT).

TOTAL : 45 PERIODS

TEXT BOOK

REFERENCES:
HV8073 DESIGN OF SUBSTATIONS L T P C 3 0 0 3

OBJECTIVES:

- To provide in-depth knowledge on design criteria of Air Insulated Substation (AIS) and Gas Insulated Substation (GIS).
- To study the substation insulation co-ordination and protection scheme.
- To study the source and effect of fast transients in AIS and GIS.

UNIT I INTRODUCTION TO AIS AND GIS 9
Introduction – characteristics – comparison of Air Insulated Substation (AIS) and Gas Insulated Substation (GIS) – main features of substations, Environmental considerations, Planning and installation.

UNIT II MAJOR EQUIPMENT AND LAYOUT OF AIS AND GIS 9
Major equipment – design features – equipment specification, types of electrical stresses, mechanical aspects of substation design.

UNIT III INSULATION COORDINATION OF AIS AND GIS 9

UNIT IV GROUNDING AND SHIELDING 9
Definitions – soil resistivity measurement – ground fault currents – ground conductor – design of substation grounding system – shielding of substations – Shielding by wires and masts.

UNIT V FAST TRANSIENTS PHENOMENON IN AIS AND GIS 9

TOTAL : 45 PERIODS

REFERENCES

   “Power Engineer’s handbook”, TNEB Association.

PS8075 OPTIMISATION TECHNIQUES L T P C 3 0 0 3

COURSE OBJECTIVES
- To introduce the different optimization problems and techniques
- To study the fundamentals of the linear and non-linear programming problem.
- To understand the concept of dynamic programming and genetic algorithm technique

UNIT I INTRODUCTION 9
Definition, Classification of optimization problems, Classical Optimization Techniques, Single and Multiple Optimization with and without inequality constraints.

UNIT II LINEAR PROGRAMMING (LP) 9
Simplex method of solving LPP, revised simplex method, duality, Constrained optimization, Theorems and procedure, Linear programming, mathematical model, solution technique, duality.

UNIT III NON LINEAR PROGRAMMING 9

UNIT IV DYNAMIC PROGRAMMING (DP) 9
Multistage decision processes, concept of sub-optimization and principle of optimality, Recursive relations, Integer Linear programming, Branch and bound algorithm

UNIT V GENETIC ALGORITHM 9
Introduction to genetic Algorithm, working principle, coding of variables, fitness function, GA operators; Similarities and differences between Gas and traditional methods; Unconstrained and constrained optimization using genetic Algorithm, real coded gas, Advanced Gas, global optimization using GA, Applications to power system.

TOTAL : 45 PERIODS

44
TEXT BOOKS:

REFERENCES:

PS8076 SOLAR AND ENERGY STORAGE SYSTEM L T P C 3 0 0 3

COURSE OBJECTIVES
- To Study about solar modules and PV system design and their applications
- To Deal with grid connected PV systems
- To Discuss about different energy storage systems

UNIT I INTRODUCTION 9
Characteristics of sunlight – semiconductors and P-N junctions – behavior of solar cells – cell properties – PV cell interconnection

UNIT II STAND ALONE PV SYSTEM 9
Solar modules – storage systems – power conditioning and regulation – protection – stand alone PV systems design – sizing

UNIT III GRID CONNECTED PV SYSTEMS 9
PV systems in buildings – design issues for central power stations – safety – Economic aspect – Efficiency and performance - International PV programs

UNIT IV ENERGY STORAGE SYSTEMS 9
Impact of intermittent generation – Battery energy storage – solar thermal energy storage – pumped hydroelectric energy storage

UNIT V APPLICATIONS 9

TOTAL : 45 PERIODS

TEXT BOOKS:
REFERENCES:

PS8255 SMART GRIDS L T P C
3 0 0 3

COURSE OBJECTIVES
- To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure.
- To familiarize the power quality management issues in Smart Grid.
- To familiarize the high performance computing for Smart Grid applications

UNIT I INTRODUCTION TO SMART GRID
9
Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Concept of Resilient & Self Healing Grid, Present development & International policies in Smart Grid, Diverse perspectives from experts and global Smart Grid initiatives.

UNIT II SMART GRID TECHNOLOGIES
9
Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation ,Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/VAr control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV).

UNIT III SMART METERS AND ADVANCED METERING INFRASTRUCTURE
9
Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit (PMU), Intelligent Electronic Devices (IED) & their application for monitoring & protection.
UNIT IV  POWER QUALITY MANAGEMENT IN SMART GRID  9

UNIT V  HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS  9
Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), IP based Protocols, Basics of Web Service and CLOUD Computing to make Smart Grids smarter, Cyber Security for Smart Grid.

TOTAL : 45 PERIODS

TEXT BOOKS :

REFERENCES:
2. Xi Fang, Satyajayant Misra, Guoliang Xue, and Dejun Yang “Smart Grid – The New and Improved Power Grid: A Survey”, IEEE Transaction on Smart Grids,