STRUCTURE FOR

M.E. ELECTRICAL (POWER SYSTEMS) PROGRAMME

UNDER FACULTY OF ENGINEERING

EFFECTIVE FROM JUNE 2013
UNIVERSITY OF PUNE

THE SYLLABUS IS PREPARED BY:

BOS - Electrical Engineering,

University of Pune.

PEER REVIEW BY:

- Prof. Dr. Mrs. G.A. Vaidya, (Chairman)
- Dr. D.J. Doke,
  Ex-Dean FOE, University of Pune, Pune.
- Dr. N. Gopalakrishnan,
  (Academic Expert)
- Shri Sham Kanitkar, (Expert from Industry)
## Structure for M.E.(Electrical) - Power Systems (2013 Course)

### Semester - I

<table>
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<tr>
<th>Subject Code no.</th>
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List of Elective Subjects

Note: Select any one subject from module I and one subject from module II for each Elective.

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EXAMINATION SCHEME GUIDELINES

A) Compulsory subjects: Credits 4

Total marks: 100

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B) Elective subjects: Credits 5

Total marks: 100

**Module 1 (Credits – 4)**

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**Module 2 (Credit – 1)**

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Chairman
B.O.S.
Electrical Engineering
503201: COMPUTER APPLICATIONS IN POWER SYSTEMS

Teaching Scheme
Lectures: 4 Hours / Week
Credits: 4

Examination Scheme
In Semester Assessment: 50
End Semester Assessment: 50

Unit 1 Optimization Techniques

[8 Hrs.]

Unit 2 Optimization Techniques
Nonlinear Programming, Unconstrained optimization Techniques, Direct search methods, Indirect search methods, Descent methods, One dimensional minimization methods, unimodal function, elimination methods.

[8 Hrs.]

Unit 3 Load Flow Studies
Revision of Load flow studies by using Newton Raphson method (polar and rectangular). Contingency evaluation, concept of security monitoring, Techniques of contingency evaluation, Decoupled load flow and fast decoupled load flow.

[8 Hrs.]

Unit 4
Three Phase Load Flow: Three phase load flow problem notation, specified variables, derivation of equations.

[6 Hrs.]

Unit 5 Optimal Power Flow Analysis

[8 Hrs.]

Unit 6 Optimal Power System Operation and Fault Analysis
Optimal Power System Operation: Calculation of loss coefficients, loss coefficients using sensitivity factors, power loss in a line, Generation shift distribution factors, Transmission loss coefficients, transmission loss formula as a function of generation and loads, economic dispatch using loss formula which is function of real and reactive power, linear programming method.
Fault Analysis: Revision of symmetrical and unsymmetrical faults, formulating the sequence impedance matrix, fault configurations and equations, General computer simulation of faults.

[10 Hrs]
**Text Books:**

**Reference Books :**
5. Power System Optimisation- D. P. Kothari, J. S. Dhillon, PHI.
503202: POWER SECTOR ECONOMICS AND MANAGEMENT

Teaching Scheme
Lectures: 4 Hours / Week
Credits: 4

Examination Scheme
In Semester Assessment: 50
End Semester Assessment: 50

Unit 1 Power Sector in India
Introduction to various institutions in Indian Power sector such as CEA, Planning Commissions, PGCIL, PFC, Ministry of Power, state and central governments, REC, utilities and their roles. Critical issues / challenges before the Indian power sector, Salient features of Electricity act 2003, Various national policies and guidelines under this act. Need of regulation and deregulation of power industry. Conditions favouring deregulation in power sector.

[8 Hrs.]

Unit 2 Power sector economics and regulation
Typical cost components and cost structure of the power sector, Different methods of comparing investment options, Concept of life cycle cost, annual rate of return, methods of calculations of Internal Rate of Return (IRR) and Net Present Value (NPV) of project, Short term and long term marginal costs, Different financing options for the power sector. Different stakeholders in the power sector, Role of regulation and evolution of regulatory commission in India, types and methods of economic regulation, regulatory process in India.

[8 Hrs.]

Unit 3 Power Tariff
Different tariff principles (marginal cost, cost to serve, average cost), Consumer tariff structures and considerations, different consumer categories, telescopic tariff, fixed and variable charges, time of day, interruptible tariff, different tariff based penalties and incentives etc., Subsidy and cross subsidy, life line tariff, Comparison of different tariff structures for different load patterns. Government policies in force from time to time. Effect of renewable energy and captive power generation on tariff. Determination of tariff for renewable energy. Non price issues in electricity restructuring, quality of supply and service, standards of performance by utility, environmental and social considerations.

[6 Hrs.]

Unit 4 Power sector restructuring and market reform
Different industry structures and ownership and management models for generation, transmission and distribution. Competition in the electricity sector- conditions, barriers, different types, benefits and challenges Latest reforms and amendments. Different market and trading models / arrangements, open access, key market entities- ISO, Genco, Transco, Disco, Retailco, Power market types, Energy market, Ancillary service market, transmission market, Forward and real time markets, market power and exercising it and its effect on market operations.

[8 Hrs.]

Unit 5 Electricity Markets and Pricing
Electricity price basics, Market operation, Market efficiency, gate closure, settlement process. Market Clearing price (MCP), Zonal and locational MCPs. Dynamic, spot pricing and real time pricing, Dispatch based pricing, Power flows and prices. Optimal power flow, Spot prices for real
and reactive power. Unconstrained real spot prices, constraints and real spot prices. Global experience with electricity reforms in different countries.

[9Hrs.]

Unit 6 Transmission Planning and pricing
Transmission planning, Different methods of transmission pricing, Different transmission services, Congestion issues and management, Transmission cost allocation methods, Locational marginal price, firm transmission right. Transmission ownership and control, Transmission pricing model in India, Availability based tariff, role of load dispatch centers (LDCs), concept of arbitrage in Electricity markets, game theory methods in Power System, security constrained unit commitment. Ancillary services for restructuring, Forward ancillary service auction. Power purchase agreements.

[9 Hrs.]

Text Books:
2. Electricity Economics Regulation and Deregulation, by G. Rothwell and T Gómez, Wiley – Inter Science
4. Electric Utility Planning and Regulation, Edward Kahn, American Council for Energy Efficient Economy

Reference Books:

Other references:
1. Regulation in infrastructure Services: Progress and the way forward - TERI, 2001
3. Various publications, reports and presentations by Prayas, Energy Group, Pune www.prayaspune.org
503203: POWER SYSTEM MODELING

Teaching Scheme
Lectures: 4 Hours / Week
Credits: 4

Examination Scheme
In Semester Assessment: 50
End Semester Assessment: 50

Unit 1 Modeling of Power System Components:
The need for modeling of power system, different models for power system analysis. Simplified models of non-electrical components like boiler, steam, hydro-turbine & governor system. Transformer modeling, tap-changing & phase-shifting transformer modeling.

[8 Hrs.]

Unit 2 Synchronous machine modeling:
Model for steady-state analysis. The development of model for dynamic studies. The current & flux linkage models using Park’s transformation leading to simulation as linear model.

[8 Hrs.]

Unit 3 Analysis of synchronous machine modeling:
Synchronous machine connected to an infinite bus, its simulation for steady-state condition and transient conditions.

[8 Hrs.]

Unit 4 Excitation system modeling - I:
Simplified view of excitation control. Excitation configuration, primitive systems, Definitions of voltage response ratio & exciter voltage ratings.

[8 Hrs.]

Unit 5 Excitation system modeling - II:
Excitation control systems using dc generator exciter, alternator-rectifier, alternator-SCR, voltage regulators such as electro-mechanical and solid state.

[8 Hrs.]

Unit 6 Transmission line, SVC and load modeling:
Transmission line modeling, static VAR compensators, load modeling including induction motor modeling.

[8 Hrs.]

Text Books:

Reference Books:
503204: RESEARCH METHODOLOGY

Teaching Scheme
Lectures: 4 Hours / Week
Credits: 4

Examination Scheme
In Semester Assessment: 50
End Semester Assessment: 50

Unit 1:
Definition, Research Characteristics, Research Need, Objectives and types of research: Motivation and objectives – Research methods vs Methodology, Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical. [8 Hrs]

Unit 2:

Unit 3:
Research design, sampling design and scaling techniques – Research design – Basic Principles-Need of research design — Features of good design – Important concepts relating to research design, basic principles of experimental designs, implications of sample design, steps in sample design, criteria of selecting sampling procedure, characteristics of good sampling design, different types of sample design. Scaling techniques: measurement scales, sources of error, technique of developing measurement tool, important scaling techniques, scale construction techniques. [8 Hrs]

Unit 4:
Data Collection and analysis:- Observation and Collection of primary and secondary data - Methods of data collection, processing operations, types of analysis, statistics in research, measures of central tendency, measures of dispersion, measures of asymmetry, measures of relationships, simple regression analysis, multiple correlation and regression, partial correlation. [8 Hrs]

Unit 5:
Unit 6:

[8 Hrs]

Text Books :
1. Kothari, C.R., Research Methodology: Methods and Techniques. New Age International
3. Suresh Sinha, Anil K Dhiman, Research Methodology, ESS Publications, Volumes 2
5. Wadehra, B.L. Law relating to patents, Trade Marks, copyright designs and geographical indications. Universal Law Publishing

References:
5. Fink, A., Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
503205: (ELECTIVE- I)

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<td>Project Management</td>
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<td>503205 M2(ii)</td>
<td>IPR and Patent Law</td>
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<td>503205 M2(iv)</td>
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503205 M1 (i) : ADVANCED POWER ELECTRONICS

Teaching Scheme
Lectures: 4 Hrs./Week
Credits: 4

Examination Scheme
In-Semester Examination : 25 Marks
End Semester Examination: 50 Marks

Unit 1 Voltage Source Converters :

[8 Hrs ]

Unit 2 (i) Matrix Converter: 3×3 matrix converter, principal of working, mathematical treatment, comparison of matrix converter with multipulse converter.
(ii) Self and Line commutated current source converter: Basic concepts of CSC, converters with self commutating devices. Comparison with voltage source converter

[8Hrs.]

Unit 3 Multilevel Inverters:
Multilevel concept, Types of multilevel Inverters, diode clamped multilevel inverter, flying-capacitors multilevel inverters, cascaded multilevel inverter, switching device currents, d.c. link capacitor voltage balancing, features of multilevel inverters, comparison of multilevel converters

[8Hrs.]

Unit 4 (i) Fundamental and harmonic voltages for a 3 level converter, 3 level converter with parallel legs, generalized techniques of harmonic elimination and voltage control.
Applications of multilevel Inverter: Reactive power compensation Back to back intertie system, Utility compatible adjustable speed drives.

[8Hrs.]

Unit 5 Energy Storage Systems:
Flywheel energy storage system, superconducting magnetic energy storage system, other energy storage systems.

[6Hrs.]

Unit 6 Akagi’s p-q theory:
Conventional concepts of active and reactive power in single phase and three phase circuits- Equation of power with sinusoidal voltage source and non-linear loads - αβ0 transformation of three phase four wire system- Akagi’s instantaneous power (pq) theory- relationship between Akagi’s components and conventional active and reactive power application of pq theory to reactive and harmonic power compensation in simple circuits.

[10Hrs]
Text Books:

References:
503205 M1 (ii) : PARTIAL DISCHARGES IN ELECTRICAL EQUIPMENTS

Teaching Scheme
Lectures: 4 Hrs./Week
Credits :4

Examination Scheme
In-Semester Examination : 25 Marks
End Semester Examination:50 Marks

Unit 1 The Phenomenon of Partial Discharge (PD):
Introduction, Definition of terms, typical electrode configurations with PD, internal discharges and surface discharges, external discharges, equivalent circuits, PD characteristics of parameters, waveform and characteristics of an individual PD pulse, train of PD current pulses, train of PD pulses in relation to the temporarily assigned instantaneous value of the high voltage, non electrical PD characteristics parameters. [8 Hrs.]

Unit 2 Fundamentals of PD Measuring Techniques:
Wave form and spectrum of PD, PD charge measuring equipments, integration in the frequency domain, selectively wide band system, narrow band system, integration in the time domain with very large wide band systems, measuring impedance or coupling 4 terminal device, PD measuring circuits, calibration, calibration pulses, calibration of PD measuring setup, calibration of the complete test set up, uncertainty of measurements. [8 Hrs.]

Unit 3 Screening and Filtering Problems during Partial Discharge Measurements:
Need for screening, design of screens, completely enclosed screen, screen interruptions, effect of corners, cavity resonance, design of filters, measurement of screening efficiency, lead through bushings. [8 Hrs.]

Unit 4 Effects of PD on Electrical Insulating Materials:
Effects of PD on gaseous insulating materials, liquid insulating materials, solid insulating materials, surface discharges, internal discharges, mixed dielectrics. [8 Hrs.]

Unit 5 Evaluation of PD:
Relation between measured and actual charge, relation between the time-dependent occurrence of PD, and the extent of damage due to it. [8 Hrs.]

Unit 6 Measurement and Location of PD:
Need for PD measurement, Development of PD measurement technique in cables, problems during PD measurements on long cables, reflection and superposition effects. [8 Hrs.]

Text Books:

Reference e-journals and course material:
Teaching Scheme
Lectures: 4 Hrs./Week
Credits: 4

Examination Scheme
In-Semester Examination: 25 Marks
End Semester Examination: 50 Marks

Unit 1: Introduction
Architecture industrial automation system, development trends in industrial automation, classification of existing systems, and functionality of industrial automation system. Relay and contactor logic, AC and DC relays and their role for load control. Power and Auxiliary contactors and their usage for load control. [8Hrs]

Unit 2: Industrial Measurement System Characteristics
Sensors and control logic, control using potential free output sensors, Control using PO, PC, NO, NC type output sensor, 2W (2 wire), 3W (3 wire), 4W (4 wire) and 4WC sensors, Linear potentiometer Timer hardware architecture, Controlling industrial system using timers, Controlling industrial system using counters. Temperature measurement, Pressure, Force and Torque Sensors, Motion Sensing, Flow measurement, Signal Conditioning, Data Acquisition Systems. [8Hrs]

Unit 3: Automatic Control
Introduction, P-I-D Control, manual and auto PID Control Tuning, Feed forward Control Ratio Control, Time Delay Systems and Inverse Response Systems, Special Control Structures. Temperature controller hardware architecture. [8Hrs]

Unit 4: PLC
Introduction to Sequence Control, PLC, RLL (Relay Ladder Logic), Sequence Control. Scan Cycle, Simple RLL Programs, Sequence Control. More RLL Elements, RLL Syntax, A Structured Design Approach to Sequence, PLC Hardware Environment, Introduction To CNC Machines, Contour generation and Motion Control, Allen Bradley PLC and SIEMEN PLC. [8Hrs]

Unit 5: Industrial Control
Basics of hydraulics, Hydraulic components their functions and symbols Hydraulic actuators, Pumps and its operation, pump control, Hydraulic valves (Direction control, pressure and flow control), special valves, pressure gauges and switches, hydraulic logic circuits, Hydraulic Control System, Multiple pressure and speed operations, Industrial Hydraulic Circuit, Pneumatic systems and components Pneumatic Control Systems, compressor operation and control, air treatment. [8Hrs]

Unit 6: Industrial Drives
AC Drive basics, Electrical specifications and hardware architecture. AC drive and AC motor specification matching. AC drive power wiring and interfacing input and output signals. Operation and control of AC motor in scalar mode. Operation and control of AC drive in vector control mode. Performance verifications of special features of AC drive. Requirement and specifications of input and output chokes, braking applications, methodology and specifications of braking resistors. Selection of power, motor and signal cables for AC drive application. Wiring and lay outing

References:
3. Kok Kiong “Drives and Control for Industrial Automation” Springer
503205 M2 (i) : PROJECT MANAGEMENT

Teaching Scheme
Lectures: 1 Hr/Week
Credit: 1

Examination Scheme
In-Semester Examination: 25 Marks

Unit 1
Project Scheduling: Gantt chart and its application, AOA (Activity on Arrow diagram), AON (Activity on Node) Diagram, Precedence diagramming methods (PDM), Critical Path Method (CPM), Programme Evaluation and Review Technique (PERT), GERT (Graphical Evaluation and Review Technique), Resource allocation, Line of Balancing and crashing the network.

Project Quality Management: The processes of project quality management, Quality planning, assurance and control, Quality of procured items, Techniques of quality assurance and control, project execution and control, International Project Management. [9Hrs]

Unit 2
Project Risk Management: Introduction, Managing risks in projects, Measurement and assessment of risk, Sources of risks. Risk: - Adjusted discount rate method, certainly equivalent method, correlation coefficient, portfolio risks, diversible & non-diversible risks, CAPM (Capital Asset pricing model) case studies of project management, computer aided project management. [5Hrs]

Text Books:
3. Rosy Burke, “Project Management: planning and control technique”, Wiley India, 2003

Reference Books:
503205 M2 (ii) : IPR AND PATENT LAW

Teaching Scheme
Lectures: 1 Hr/Week
Credit: 1

Examination Scheme
In-Semester Examination : 25 Marks

Unit 1:

Patents and standards: History of patent law, History of Indian Patent System, Utility model

Unit 2
Copyright: CEN-CENELEC copyright policy, piracy. Industrial design rights
Trademarks: Geographical indication, Protected designation of origin, Trade dress.
Other types: Database right, Fashion law, Indigenous intellectual property, Industrial design rights (or registered designs), Intellectual rights to magic methods, Internet domain name, Know how, Mask work (or Integrated circuit layout design protection), Open-source software, Orphan drug rights, Personality rights, Plant breeders' rights Patent law by region or country: Indian patent law, Australian patent law, Canadian patent law, Patent law of the People's Republic of China, European patent law, Japanese patent law, United States patent law. [7 Hrs]

Text Books:

References:
www.cen.eu
www.cenelec.eu
www.cencenelec.eu
http://ipindia.nic.in/
http://ipindia.nic.in/ipr/patent/patents.htm
http://www.cipo.ic.gc.ca (Canadian patent office)
http://www.epo.org(Europian patent office)


503205 M2 (iii) : TECHNICAL COMMUNICATION

Teaching Scheme
Lectures: 1 Hr/Week
Credit: 1

Examination Scheme
In-Semester Examination : 25 Marks

Unit 1
Effective Presentation Strategies
Define the purpose of presentation, Analyzing audience and locale, organizing contents, Preparing an Outline, Visual Aids, Understanding the nuance of delivery, sample speech and practice the presentation. [3Hrs]

Listening techniques
Types of listening, listening with a purpose, barriers to listening, listening comprehension, effective listening strategies, listening in conversational interaction, team listening. [2Hrs]

Speech techniques
Conversation and oral skills, strategies for good conversation, techniques to develop effective word accent, word stress, primary and secondary stress, use of correct stress pattern, developing voice quality, developing correct tone. [2Hrs]

Unit 2:
Writing technical reports, research papers, dissertation, thesis and research proposals. Important parts of reports like abstract, results, conclusion. Supplementary parts like list of symbols, list of tables, annexure, references etc. Making title page, writing mathematical equations, including graphics, making tables and writing references using LaTex/ MiKTeX.
Assignment for one technical proposal, one research paper and one technical report should be submitted using LaTex/MiKTeX for in semester assessment. [7 Hrs]

Reference books:
1) Technical Communication-Principals and Practice, Meenakshi Raman, Sangeeta Sharma, OXFORD university Press.
2) Effective Technical Communication, M Ashraf Rizvi, TATA McGRAW HILL
UNIT 1
Need of Synchrophasor Measurements, Phasor Measurement Unit: Architecture, Functions, Optimal Placement of PMUs, phasor data concentrators and associated communication system. Visualization tools to enhance visibility and control within transmission system, PMU measurements and sampling rates State Estimation & observability by using PMU, phasor data use for real-time operation, frequency stability monitoring and trending, power oscillation, voltage monitoring and trending. Alarming and setting system operating limits. Dynamic line rating and congestion management, outage restoration. Application of PMU for wide area monitoring and control. [9Hrs]

UNIT 2

Text Books:

Reference Books
1. “Power System State Estimation”, Mukhtar Ahmad
3. “SMART GRID Infrastructure & Networking”, KRZYSZTOF INIEWSKI, TATA McGRAW-HILL EDITION.
503206 : LAB PRACTICE- I

Teaching Scheme
4 Hrs / Week
Credits : 4

Examination Scheme
Term Work : 50 Marks
Oral Exam.: 50 Marks

A minimum of eight experiments should be performed under Lab Practice – I. Out of which minimum six experiments should be from the list below. Minimum six experiments should be based on compulsory subjects. A list of experiments that may be performed under various subjects of semester - I is given below as a guideline.

503201 : COMPUTER APPLICATIONS IN POWER SYSTEMS
1. Load flow analysis by using Newton Raphson method on digital computer.
2. Optimal Power flow analysis.
3. AC-DC load flow analysis on digital computer.
4. Analysis of various types of faults on digital computer.
5. Short circuit analysis.

503203 : POWER SYSTEM MODELING
1. Steady state analysis of synchronous machine using SIMULINK as a linear model.
2. Steady state Analysis of synchronous machine connected to infinite bus using SIMULINK.
3. Steady state analysis of excitation control systems using SIMULINK.
4. Induction Motor Modeling.

503205 M1 (i) (Elective – I): ADVANCED POWER ELECTRONICS
1. Three phase convertor for R (resistive) and R-L load (simulation / hardware).
2. Three phase voltage source Inverter (simulation / hardware).

503205 M1 (ii) (Elective – I): PARTIAL DISCHARGES IN ELECTRICAL EQUIPMENTS
1. Measurement of audible corona inception voltage and development of glow discharge using corona cage.
2. Effect of uniform and non uniform field on break down strength of air/solid dielectric medium

503205 M1 (iii) (Elective – I): INDUSTRIAL AUTOMATION AND CONTROL
1. PLC program using combination of timer and counter.
2. PLC based temperature monitoring and control using sensors such as RTD.
Teaching Scheme
Lectures: 4 Hours / Week
Credits : 4

Examination Scheme
In Semester Assessment: 50
End Semester Assessment : 50

Unit 1 Review of Classical Methods:
System model, states of operation and system security, steady state stability, transient stability, simple representation of excitation control. [8 Hrs.]

Unit 2 Dynamics of Synchronous Generator Connected to Infinite Bus:
System model, simplified synchronous machine model, calculation of Initial conditions, system simulation, improved model of synchronous machine, inclusion of SVC model. [8 Hrs.]

Unit 3 Analysis of Single Machine:
Small signal analysis, applications of Routh-Hurwitz criterion, analysis of synchronizing and damping torque, state equation for small signal model [8 Hrs.]

Unit 4 Power System Stabilizers:
Basic concepts of control signals in PSS, structure and tuning, field implementation, PSS design and application, future trends. [8 Hrs.]

Unit 5 Multi-machine System:
Simplified model, Improved model of the system for linear load, Inclusion of dynamics of load and SVC, introduction to analysis of large power system. [8 Hrs.]

Unit 6
a) Voltage Stability:
Definition, factors affecting voltage instability and collapse, analysis and comparison of angle and voltage stability, analysis and comparison voltage instability and collapse, control of voltage instability.

b) Islanding: Necessity for islanding, methods, use, advantages and disadvantages, implication on power system dynamic performance. [8 Hrs]

Text Books:

Reference Books:
Teaching Scheme
Lectures: 4 Hours / Week
Credits : 4

Examination Scheme
In Semester Assessment: 50
End Semester Assessment : 50


Unit 5: Transmission Planning and Reliability: Introduction, Objectives of Transmission Planning, Network Reconfiguration, System and Load Point Indices, Data required for Composite System Reliability. [6 Hrs]


Text Books:

**Reference Books:**

503209: HVDC AND FLEXIBLE A.C. TRANSMISSION

Teaching Scheme
Lectures: 4 Hours / Week
Credits : 4

Examination Scheme
In Semester Assessment: 50
End Semester Assessment : 50

Part I : FACTS
Unit 1 Power Electronic Controllers
Basics, Challenges and needs, static Power converter structures, AC controller based structures, DC link converter topologies, converter output and harmonic control, power converter control issues. [8 Hrs.]

Unit 2 Shunt and series compensation
Operation and control of SVC, STATCOM configuration and control, applications of SVC and STATCOM. TCSC operation, layout and protection, applications of TCSC, static Synchronous series compensator (SSSC). [8 Hrs.]

Unit 3 Unified Power Flow Controller
UPFC configuration, steady state operation control and characteristics, introduction to transient performance, operational constraints of UPFC, Power flow studies in UPFC embedded systems. [8 Hrs.]

Part II HVDC Transmission
Unit 4 General background
EHVAC versus HVDC transmission, power flow through HVDC link, equation for HVDC power flow bridge connection, control of DC voltage and power flow, effects of angle of delay and angle of advance commutation, CIA, CC and CEA control, twelve pulse converter operation Harmonics in HVDC systems. [8 Hrs.]

Unit 5 Multi terminal HVDC system
HVDC system layout and placement of components, HVDC protection, grounding, multi terminal HVDC systems, configurations and types. [8 Hrs.]

Unit 6 HVDC Light
Introduction to VSC transmission, power transfer characteristics, structure of VSC link, VSC DC system control, HVDC light technology, potential for multiterminal sub transmission systems. [8 Hrs.]

Text Books:

**Reference books:**

2. Power Electronics Handbook, M.H.Rashid
### Code No. 503210: (ELECTIVE- II)

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<td>503210 M2(i)</td>
<td>Electric Vehicles</td>
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<tr>
<td>503210 M1(ii)</td>
<td>Digital Signal Processing</td>
<td>503210 M2(ii)</td>
<td>Fundamentals of Cyber Security</td>
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<td>Advanced Control Theory</td>
<td>503210 M2(iii)</td>
<td>Disaster Management</td>
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### Teaching Scheme

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### Examination Scheme

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503210 M1 (i) : EHV AC TRANSMISSION

Teaching Scheme
Lectures: 4 Hrs./Week
Credits: 4

Examination Scheme
In-Semester Examination : 25 Marks
End Semester Examination: 50 Marks

Unit 1 Overview of Electrical power transmission at high voltages

[8 Hrs.]

Unit 2 Voltage gradients of conductors:

[8 Hrs.]

Unit 3 Corona

[8 Hrs.]

Unit 4 Electric Field under transmission lines and its computation
Calculation of electrostatic field of EHV AC lines – effect on humans, animals and plants – electrostatic induction in un-energized circuit of double-circuit line – electromagnetic interference- Traveling wave expression and solution- source of excitation- terminal conditions-open circuited and short-circuited end- reflection and refraction coefficients-Lumped parameters of distributed lines-generalized constants-No load voltage conditions and charging current.

[8 Hrs.]

Unit 5 Design of EHV Transmission systems
Mechanical vibration of bundled conductors, Overhead line insulators: Ceramic and non-ceramic types, Insulator performance in polluted environments, mitigation of pollution induced flashover, HV cable transmission - Underground cables and Gas insulated transmission lines, HV substations - AIS and GIS, Over voltages in power systems, Temporary, lightning and Switching over voltages, over voltage computation, Design of line insulation for power frequency voltage, lightning and switching over voltages, Insulation characteristics of long air gaps, Protection of station apparatus and transmission lines against over voltages, Surge arresters, Shielding of transmission lines
against lightning using ground wires, Insulation Co-ordination, Grounding of transmission towers and substations.

[8 Hrs.]

**Unit 6 Voltage Control:**
Different sources of reactive power: Generators, Synchronous condensers, Capacitors and inductors, SVCs, STATCOMs. Comparison between different sources of reactive power, Issues in reactive power management: cascade connection of shunt and series compensation – sub synchronous resonance in series capacitor – compensated lines.

[8 Hrs.]

**Text Book:**

1. EHVAC Transmission Engineering by R. D. Begamudre, New Age International (p) Ltd.

**Reference Books:**

1. EHVAC and HVDC Transmission by S. Rao, Khanna Publications.
Teaching Scheme
Lectures: 4 Hrs./Week
Credits: 4

Examination Scheme
In-Semester Examination : 25 Marks
End Semester Examination:50 Marks

Prerequisite: Fourier series, Fourier transform, Z transform

Unit 1
Discrete Signals and systems:
Sampling of continuous time signals, quantization, aliasing, Sampling Theorem, Elementary discrete-time signals, classification, sequence operations, Discrete-time systems and Classification, impulse response, linear convolution and its properties, Z transform: basics, properties, inverse Z transform using power series and partial fraction [8 Hrs]

Unit 2
Frequency response of discrete time systems:
Discrete-time systems described by difference equations, Analysis of LTI discrete systems using z transform, frequency response of first order and second order systems, transfer function, steady state and transient response, phase and group delays, ideal filters and their pole zero locations, zero phase and linear phase transfer functions. [8 Hrs]

Unit 3
Frequency analysis of discrete time signals:
Exponential representation of Fourier series and Fourier transform of continuous time signals, The Fourier series for discrete-Time periodic signals (only concept), The Fourier transform of discrete-time aperiodic signals (only concept), Discrete Fourier Transform, Properties: periodicity, linearity, and symmetry properties, Circular convolution, Linear convolution using circular convolution, Fast Fourier Transform: Radix 2 DIT and DIF algorithms [8 Hrs]

Unit 4
IIR filters:
Advantages and disadvantages of digital filter over analog filters, classification of digital filters: FIR and IIR, design of analog low pass Butterworth filter, Chebyshev filter, design of IIR filters from analog filters using bilinear transformation, impulse invariance. Realization of IIR filters: direct form I, direct form II, cascade and parallel. [8 Hrs]

Unit 5
FIR filters:
Comparison between FIR and IIR filters, symmetric and antisymmetric FIR filters, design of linear phase FIR filters using windows method and frequency sampling method, Realization of FIR filters by direct form, cascade form and parallel form. [8 Hrs]

Unit 6
Applications to power system:
Measurement of power, measurement of frequency, Condition monitoring of Electrical Machines, Power transformer protection, Synchronized phasor measurement, Harmonic Analysis. [8 Hrs]
Text Books:

Reference Books:
503210 M1(iii) : ADVANCED CONTROL THEORY

Teaching Scheme
Lectures: 4 Hrs./Week
Credits: 4

Examination Scheme
In-Semester Examination : 25 Marks
End Semester Examination:50 Marks

Unit 1
Review of classical and modern control concepts: PID control and tuning approaches, State space method, analysis and design of control system in state space, pole placement, state observer, design of control system with Luenberger observer. (6 Hrs)

Unit 2
Optimal control:
Parameter optimization and optimal control problems, quadratic performance index, analysis and design of finite and infinite time Linear Quadratic Regulators, Introduction to Linear Quadratic Gaussian approach. (8 Hrs)

Unit 3
Robust Control:
Concept of robust control, description and categorization of system uncertainties. System and signal norms, small gain theorem, robust stability, design of robust control, Introduction to H-∞ control. (8 Hrs)

Unit 4
Nonlinear Control:

Unit 5
Sliding mode control
Notion of variable structure system and variable structure control, Introduction to sliding mode control, features of sliding mode control, sliding mode control design, concept of sliding surface, control design using reaching laws, stability analysis. (8 Hrs)

Unit 6
Applications to power system/power electronics:
Transfer functions of various power electronic devices like converters (switching model, averaging model), Applications of control theory for control of converters, renewable systems, distribution generation, power quality devices. (10 Hrs)
Text Books:

Reference Books:
503210 M2(i) : ELECTRIC VEHICLES

Teaching Scheme
Lectures: 1 Hr/Week
Credit: 1

Examination Scheme
In-Semester Examination : 25 Marks

Unit 1

History and development of on-road Electric Vehicles (EV). Different configurations of hybrid EVs with block diagram representation, merits & demerits of different configurations in view of vehicle efficiency and energy storage system. [7 Hrs]

Unit 2

Energy storage systems – Basics of EV batteries, specifications, power density, Energy density, Charging & Discharging cycle and recommended methodologies for charging. Recommended drives for EV and converter topology used in EVs. [7 Hrs]

Reference books :
1. Ron Hodkinson & John Fenton, Light Weight Electric/ Hybrid Vehicle design, Butterworth Publications, Heinemann
2. H. A. Kiehne, Battery Technology Handbook, MARCEDLE KKEIRN,C
3. Sandeep Dhameja , Electric vehicle battery systems , Butterworth–Heinemann
503210 M2(ii) : FUNDAMENTALS OF CYBER SECURITY

Teaching Scheme
Lectures: 1 Hr/Week
Credit : 1

Examination Scheme
In-Semester Examination : 25 Marks

Unit 1:
Introduction cyber security
[4 Hrs]
[2 Hrs]
Authentication and access control: Identification, Authentication, Authentication by passwords, Protecting passwords, Access control structures, Types of access control
[2 Hrs]

Unit 2:
Lattice and reference monitors: Security levels and categories, Lattice diagram, Reference monitors, Security kernel, Hardware security features, protecting memory
[2 Hrs]
Security models: Bell-LaPadula, Biba, Non-deducibility, Non-interference, Other models
[2 Hrs]
Cryptography: Cryptographic mechanisms, Digital signatures, Encryption, Certificates
[2 Hrs]

Reference Books:

WEBSITES:
1) www.cert.org
2) www.microsoft.com/security/
3) www.sans.org
4) www.us.cert.gov
503210 M2 (iii) : DISASTER MANAGEMENT

Teaching Scheme
Lectures: 1 Hr/Week
Credit: 1

Examination Scheme
In-Semester Examination : 25 Marks

Unit 1 Disaster, Hazards and Vulnerability
Concept of disaster, different approaches, concept of risk, levels of disasters Disaster phenomena and events, Natural and man-made hazards; response time, frequency and forewarning levels of different hazards, Characteristics and damage potential of natural hazards; hazard assessment, dimensions of vulnerability factors; vulnerability assessment, Vulnerability and disaster risk, Vulnerabilities to flood and earthquake hazards. [7 Hrs]

Unit 2 Disaster management mechanism and Planning
Concepts of risk management and crisis management, Disaster management cycle Response and Recovery, Development, Prevention, Mitigation and Preparedness Planning for relief, Strategies for disaster management planning, Steps for formulating a disaster risk reduction plan, Disaster management Act and Policy in India, Organizational structure for disaster management in India, Preparation of state and district disaster management plans. [7 Hrs]

- Students shall submit a detailed case study report on any disaster, prevention and preparedness.

Text books:

Reference Books:
2. Disaster Management in India, Ministry of Home Affairs, Government of India, New Delhi, 2011.
5. http://nidm.gov.in/ - National Institute of Disaster Management (NIDM) (Ministry of Home Affairs, Govt. of India) website
Unit 1
**SCADA Systems:** Introduction and definitions of SCADA
**Basic SCADA system Architecture:** Human Machine Interface, Master Terminal Unit, Remote Terminal Unit Communications for SCADA systems, Configuration of SCADA systems, SCADA system applications, SCADA systems in operation and control of interconnected power systems, Functions of SCADA systems, Common features of SCADA systems Automatic substation control, SCADA configuration, Energy management system, system operating states, system security, State estimation.

[7 Hrs]

Unit 2
**Communication in power systems:** Inductive coordination, Voice communication, carrier systems, Power line carrier systems, Microwave systems, co axial cable and optical fiber system, two way mobile radio systems.

[7 Hrs]

**Text Books:**

**Reference Books:**
1. Gordan Clark, Deem Reynders, “Practical Modem SCADA Protocols”
A minimum of eight experiments should be performed under Lab Practice – II. Out of which minimum six experiments should be from the list below. Minimum six experiments should be based on compulsory subjects. A list of experiments that may be performed under various subjects of semester -II is given below as a guideline:

**503207: POWER SYSTEM DYNAMICS**
1. Analysis of steady state stability for single machine system.
2. Analysis of transient stability using point by point method.
3. Analysis of dynamics of synchronous machine connected to infinite bus using swing curve.
5. Analysis of Power System stabilizer.

**503209: HVDC AND FLEXIBLE AC TRANSMISSION**
1. Simulation of HVDC system by using hardware /software.
2. Simulation of SVC
3. Hardware / software Simulation of TCR.
4. Simulation of STATCOM
5. Study of operation of Unified Power Flow Controller.

**503210 M1 (i) (Elective II): EHV AC TRANSMISSION**
1. Simulation of Series and Shunt compensation of EHV Transmission line.

**503210 M1 (ii) (Elective – II): DIGITAL SIGNAL PROCESSING**
1. Frequency response of a discrete system.
2. FIR filter design using windows technique.
4. Chebyshev IIR filter design.

**503210 M1 (iii) (Elective – II): ADVANCED CONTROL THEORY**
1. Design and simulation of finite time Linear Quadratic Regulator (LQR).
2. Design and simulation of sliding mode control for double integrating system.
4. Analysis of closed loop control of converter based system.
503212 : SEMINAR – I

Teaching Scheme
4 Hrs/Week
Credits: 4

Examination Scheme
Term Work: 50 Marks
Oral/Presentation : 50 Marks

Seminar I Shall be on state of the art topic of student’s own choice based on relevant specialization approved by an authority. The student shall submit the duly certified seminar report in standard format, for satisfactory completion of the work by the concerned Guide and head of the department/institute.
603201: ADVANCED POWER SYSTEM PROTECTION

Teaching Scheme
Lectures: 4 Hours / Week  
Credits: 4

Unit 1 Numerical Protection
Introduction, block diagram of numerical relay, sampling theorem, correlation with a reference wave, least error squared (LES) technique, digital filtering, and numerical over-current protection. Vector surge and df/dt digital relays.  

Unit 2 Digital Protection of Transmission line
Introduction, Protection scheme of transmission line, distance relays, traveling wave relays, digital protection scheme based upon fundamental signal, hardware design, software design, digital protection of EHV/UHV transmission line based upon traveling wave phenomenon, new relaying scheme using amplitude comparison.  

Unit 3 Digital protection of Synchronous generator
Introduction, faults in synchronous generator, protection schemes for synchronous generator, digital protection of synchronous generator.  

Unit 4 Digital Protection of Power Transformer
Introduction, faults in a transformer, schemes used for transformer protection, digital protection of transformer  

Unit 5 Distance and over current relay setting and co-ordination
Directional instantaneous IDMT over current relay, directional multi-zone instantaneous relay, distance relay setting, co-ordination of distance relays, co-ordination of over current relays, computer graphics display, man-machine interface subsystem, integrated operation of national power system, application of computer graphics.  

Unit 6 Short circuit studies in designing relaying scheme
Types of faults, assumptions, development of algorithm for S.C. studies, PC based integrated software for S.C. studies, transformation to component quantities, S.C. studies of multiphase systems. Ultra high speed protective relays for high voltage long transmission line.  

Text Books:
2. Transmission Network Protection - Paithankar (Marcel & Dekker, New York)
Reference Books:
603202: POWER QUALITY ASSESSMENT AND MITIGATION

Teaching Scheme
Lectures: 4 Hours / Week
Credits : 4

Examination Scheme
In Semester Assessment: 50
End Semester Assessment : 50

Unit 1 : Introduction
Importance of power quality, terms and definitions of power quality as per IEEE std. 1159. such as transients, short and long duration voltage variations, interruptions, short and long voltage fluctuations, imbalance, flickers and transients. Symptoms of poor power quality. Definitions and terminology of grounding. Purpose of groundings. Good grounding practices and problems due to poor grounding.

[ 6 Hrs ]

Unit 2 : Flickers & transient voltages
RMS voltage variations in power system and voltage regulation per unit system, complex power. Principles of voltage regulation. Basic power flow and voltage drop. Various devices used for voltage regulation and impact of reactive power management. Various causes of voltage flicker and their effects. Short term and long term flickers. Various means to reduce flickers. Transient over voltages, sources, impulsive transients, switching transients, Effect of surge impedance and line termination, control of transient voltages.

[8 Hrs]

Unit 3 : Voltage sag, swells and interruptions
Definitions of voltage sag and interruptions. Voltage sags versus interruptions. Economic impact of voltage sag. Major causes and consequences of voltage sags. Voltage sag characteristics. Voltage sag assessment. Influence of fault location and fault level on voltage sag. Areas of vulnerability. Assessment of equipment sensitivity to voltage sags. Voltage sag limits for computer equipment, CBEMA, ITIC, SEMI F 42 curves. Representation of the results of voltage sags analysis. Voltage sag indices. Mitigation measures for voltage sags, such as UPS, DVR, SMEs, CVT etc., utility solutions and end user solutions.

[8 Hrs]

Unit 4 : Waveform Distortion

[10 Hrs]

Unit 5 : Power quality monitoring
Need of power quality monitoring and approaches followed in power quality monitoring. Power

[8 Hrs]

Unit 6 : Power Quality Assessment & Mitigation

[8 Hrs]

Text Books :

Reference Books:
5. IEEE STD 519-1992/ IEEE std 1159 IEEE recommended practices and requirements for harmonics control in electrical power system.
### 603203: (ELECTIVE - III)

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<td>603203 M2(i)</td>
<td>Artificial Intelligent tools</td>
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<td>603203 M2(ii)</td>
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<td>603203 M3(iv)</td>
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603203 M1(i) : ARTIFICIAL NEURAL NETWORK AND ITS APPLICATIONS IN POWER SYSTEMS

Teaching Scheme
Lectures: 4 Hrs./Week
Credits: 4

Examination Scheme
In-Semester Examination: 25 Marks
End Semester Examination: 50 Marks

Unit 1:
Basics of Artificial Neural Network:
Biological neurons: Function of single biological neuron, function of artificial neuron, Basic terminology related to artificial neuron. Characteristics of ANN, Typical applications of ANN such as classification, pattern recognition, forecasting Properties, strength of NN [8Hrs]

Unit 2:
Different Architectures of ANN and Learning Processes:
Different architectures of Neural Network, types of activation function, concept of Learning with a Teacher, Learning without a Teacher, Learning Tasks (Any two learning methods and applications) [8 Hrs]

Unit 3:
Single Layer Network and Multi-layer Network:
Single Layer Perceptron: architecture – training algorithm, Least – Mean square algorithm, learning curves, Learning Rate, [8Hrs ]

Unit 4:
Feed forward Neural Network: Fundamentals, Algorithms
Architecture, Back propagation algorithm, Concept of learning rate, momentum coefficient, sequential and batch mode of training, Generalization capacity, cross validation, Limitation of Back-propagation algorithm, accelerated convergence of back-propagation learning. [8 Hrs]

Unit 5:
Self Organizing Maps and Radial Basis Function Networks: Fundamentals, Algorithms
Two basis feature-mapping model, competitive process, cooperative process, adaptive process self organizing map algorithm, properties Cover’s theorem, Regularization theory, Regularization network, generalized Radial Basis Function Networks, properties of RBF network, learning strategies. [12 Hrs]

Unit 6:
Applications of ANN in Power System
Understanding of various applications of ANN in power system areas such as planning, operation, control and protection. [4 Hrs]
Text Books:

Reference Books:
Teaching Scheme
Lectures: 4 Hrs./Week
Credits : 4

Examination Scheme
In-Semester Examination : 25 Marks
End Semester Examination:50 Marks

Unit 1
Solar Energy :

Unit 2

Unit 3
Other Energy Sources:
Biomass – various resources, energy contents, technological advancements, conversion of biomass in other form of energy – solid, liquid and gases. Gasifiers, Biomass fired boilers, Co-firing, Generation from municipal solid waste, Issues in harnessing these sources. Hydro energy – feasibility of small, mini and micro hydel plants scheme layout economics. Tidal and wave energy,Geothermal and Ocean-thermal energy conversion (OTEC) systems – schemes, feasibility and viability. Fuel cell- types and operating characteristics, efficiency , energy output of fuel cell [8 Hrs.]

Unit 4
Grid Integration :
Stand alone systems, interconnection of distributor resources, concept of micro gird, formation of micro grid and economics hybrid with diesel, with fuel cell, solar-wind, wind –hydro systems, mode controller, load sharing, system sizing. Grid integration with the system: Interface requirements, Stable operation, Transient-safety, Operating limits of voltage, frequency, stability margin, energy storage, and load scheduling. Effect on power quality - harmonic distortion, voltage transients and sags, voltage flickers. Dynamic reactive power support. Systems stiffness. Energy storage, battery design, charging and charge regulators. Battery management, pumped storage, compressed air storages and ultra capacitors [8 Hrs.]
Unit 5

Smart Grid:
Introduction to Smart Grid: Concept of Smart Grid, Definitions, Need and Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Concept of Resilient & Self Healing Grid, Present development & International policies in Smart Grid.

Smart Grid Technologies: Introduction to Smart Meters, Real Time Pricing, Smart Appliances, Outage Management System (OMS), Plug in Hybrid Electric Vehicles (PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation.

[8 Hrs.]

Unit 6

Communication Technology for Smart Grid:
Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN), Phase Measurement Unit (PMU), Bluetooth, ZigBee, GPS, Wi-Fi, Wi-Max based communication, Wireless Mesh Network, Basics of CLOUD Computing & Cyber Security for Smart Grid, Broadband over Power line (BPL), IP based protocols. Smart Substations, Substation Automation, Feeder Automation. Geographic Information System (GIS), Intelligent Electronic Devices (IED) & their application for monitoring & protection.

[8 Hrs.]

Text Books:
2. Energy Technology – S. Rao, Parulkar
5. Renewable Energy Technologies – Chetan Singh Solanki, PHI Learning Pvt. Ltd.

Reference Books:
1. Wind and solar systems by Mukund Patel, CRC Press.
3. Wind Energy Technology – Njenkins, John Wiley & Sons,
13. “SMART GRID Infrastructure & Networking”, KRZYSZTOF INIEWSKI, TATA McGRAW-HILL EDITION
603203 M1(iii) : ADVANCE PROCESSORS AND APPLICATIONS

Teaching Scheme
Lectures: 4 Hrs./Week
Credits : 4

Examination Scheme
In-Semester Examination : 25 Marks
End Semester Examination:50 Marks

Unit 1
Introduction to the concept of digital signal processor, digital signal controller, basic architectures, essential features of digital signal processor/controller, Texas families of processors C2000, C5000, C6000, their features and applications. (6 Hrs)

Unit 2
Evolution of C2000 family, TMS 320F2812 block diagram, math units, data memory access, internal bus structure, ALU, instruction pipeline, memory map, code security module, interrupt response. (8 Hrs)

Unit 3
Digital input/output interface: GPIO register structure, digital I/O registers, clock module, watchdog timer, system control and status register. (8 Hrs)

Unit 4
Interrupt system: Interrupt lines, reset boot-loader, interrupt sources, maskable interrupt processing, peripheral interrupt expansion, C28x CPU timers, applications. (8 Hrs)

Unit 5
Event manager: Block diagram, timer operating modes, interrupt sources, GP timer registers, GP timer interrupts, event manager compare units, capture units, QEP unit, applications. (10 Hrs)

Unit 6
Analog Digital Converter: ADC module overview, ADC in cascaded mode, ADC in dual sequencer mode, ADC conversion time, ADC register block, applications. (8 Hrs)

Text Books:

References:
2. ‘TMS320x281x DSP Event Manager (EV) Reference Guide’ by Texas Instruments.
Teaching Scheme
Lectures: 1 Hr/Week
Credit: 1

Examination Scheme
In-Semester Examination: 25 Marks

Unit 1: Fuzzy Logic System
Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modeling and control. Fuzzification, inferencing and defuzzification. Fuzzy knowledge and rule bases. Fuzzy modeling and control schemes for nonlinear systems. Self-organizing fuzzy logic control. Case studies and assignment based on applications of fuzzy logic.

[7Hrs]

Unit 2: Genetic Algorithm
Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters. Concept on some other search techniques like tabu search and and-colony search techniques for solving optimization problems. GA application to power system optimization problem. Case studies: based on use of GA for optimization.

[7Hrs]

Text Books:
1) M. Ganesh “Introduction to Fuzzy Sets and Fuzzy Logic”, Prentice Hall, India.

Reference Books:
Teaching Scheme
Lectures: 1 Hr/Week
Credit: 1

Examination Scheme
In-Semester Examination : 25 Marks

Unit 1: Introduction
Sensors: primary sensing principles and measurement variables, sensor performance characteristics and terminology. Instrumentation: transducer measurement circuit, signal conditioning circuit, Data conversion: DAC, ADC, virtual instrumentation with Lab View.

[7 Hrs]

Unit 2: Smart Sensors
Primary sensors; excitation; compensation; information coding/processing; data communication; standards for smart sensor interface. Recent trends in sensor technologies: Introduction; film sensors (thick film sensors, thin film sensors); semiconductor IC technology standard methods; Micro Electro-Mechanical Systems (micro-machining, some application examples); nanosensors.

[7 Hrs]

Text books:

Reference Book:
603203 M2 (iii) : HUMAN RIGHTS

Teaching Scheme
Lectures: 1 Hr/Week
Credit: 1

Examination Scheme
In-Semester Examination: 25 Marks

Unit 1:
Human Rights – Concept, Development, Evolution
- Philosophical, Sociological and Political debates
- Benchmarks of Human Rights Movement.

Human Rights and the Indian Constitution
- Constitutional framework
- Fundamental Rights & Duties
- Directive Principles of State Policy
- Welfare State & Welfare Schemes

Human Rights & State Mechanisms
- Police & Human Rights
- Judiciary & Human Rights
- Prisons & Human Rights
- National and State Human Rights Commissions

[7 Hrs]

Unit 2:
Human Rights of the Different Sections and contemporary issues
- Unorganized Sector
- Right to Environment,
- Globalization and Human Rights
- Right to Development,

Citizens’ Role and Civil Society
- Social Movements and Non-Governmental Organizations
- Public Interest Litigation
- Role of Non Government organizations in implementation of Human rights.
- Right to Information

Human Rights and the international scene – Primary Information with reference to Engineering Industry
- UN Documents
- International Mechanisms (UN & Regional)
- International Criminal Court

[7 Hrs]

References:
1) Study material on UNESCO, UNICEF web site
2) HUMAN RIGHTS IN INDIA A MAPPING, Usha Ramanathan
   Available at:  http://www.ielrc.org/content/w0103.pdf
Unit 1: Sustainability and Building design

Sustainability, objectives of sustainable development, Sustainable aspects of habitat design, sustainable buildings, principles, approaches and characteristics, climate data, climate parameters and zones, comparative analysis of various climatic zones, site planning recommended check list for identifying site characteristics, site development and layout. Efficient water management and waste water treatment, solid waste management. [7 Hrs]

Unit 2: Energy efficiency

Solar passive techniques in building design to minimize load on conventional system i.e. heating, cooling, ventilation and lighting. Designing Energy efficient lighting and HVAC systems. Use of renewable energy system to meet part of building load. Green building certification. Overview various green building in India. Policy and regulatory mechanism. [7 Hrs]

Text Book:

Seven wonders of Green Building Technology- Karen Sirvaitis, Twenty first century books.

References:

2. Energy Efficient Buildings in India, TERI, New Delhi
Seminar II shall be on the topic relevant to latest trends in the field of concerned branch, preferably on the topic of specialization based on the electives selected by him/her approved by authority. The student shall submit the seminar report in standard format, duly certified for satisfactory completion of the work by the concerned guide and head of the Department/Institute.
603205 : PROJECT STAGE - I

Teaching Scheme
8 Hrs / week
Credits: 08

Examination Scheme
Term work : 50 marks
Oral: 50 Marks

Project work Stage – I is an integral part of the project work. In this, the student shall complete the partial work of the project which will consist of problem statement, literature review, project overview, scheme of implementation (Mathematical Model/block diagram/PERT chart, etc.) and Layout & Design of the Set-up. As a part of the progress report of Project work Stage-I, the candidate shall deliver a presentation on the advancement in Technology pertaining to the selected dissertation topic.

The student shall submit the duly certified progress report of Project work Stage-I in standard format for satisfactory completion of the work by the concerned guide and head of the Department / Institute.
<table>
<thead>
<tr>
<th>Teaching Scheme</th>
<th>Examination Scheme</th>
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<tr>
<td>5 Hrs / week</td>
<td>Term work : 50 Marks</td>
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<tr>
<td>Credits: 05</td>
<td>Oral/ Presentation: 50 Marks</td>
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Seminar III shall preferably be an extension of seminar II. The student shall submit the duly certified seminar report in standard format, for satisfactory completion of the work by the concerned guide and head of the Department/Institute.
In Project Work Stage – II, the student shall complete the remaining part of the project which will consist of simulation, fabrication of set up required for the project, work station, conducting experiments and taking results, analysis & validation of results and conclusions.

The student shall prepare the duly certified final report of project work in standard format for satisfactory completion of the work by the concerned guide and head of the Department/Institute.