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,
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Structure for M.E.(Electrical) - Power Systems (2013 Course)

Semester - I

Subject Code no.	Subject	Teaching Scheme	Examination Scheme				Total Marks	Credits
			Paper					
		Lect./Pr.	In Semester Assessment	End Semester Assessment	TW	Oral / Presentation		
503201	Computer Applications in Power Systems	4	50	50	--	--	100	4
503202	Power Sector Economics and Management	4	50	50	--	--	100	4
503203	Power System Modeling	4	50	50	--	--	100	4
503204	Research Methodology	4	50	50	--	--	100	4
503205	Elective-I	5	50	50	--	--	100	5
503206	Lab Practice-I	4	--	--	50	50	100	4
Total		**25**	**250**	**250**	**50**	**50**	**600**	**25**

Semester - II

Subject Code no.	Subject	Teaching Scheme	Examination Scheme				Total Marks	Credits
			Paper					
		Lect./Pr.	In Semester Assessment	End Semester Assessment	TW	Oral / Presentation		
503207	Power System Dynamics	4	50	50	-	-	100	4
503208	Power System Planning & Reliability	4	50	50	--	--	100	4
503209	HVDC and Flexible AC Transmission	4	50	50	-	-	100	4
503210	Elective-II	5	50	50	--	--	100	5
503211	Lab Practice-II	4	--	--	50	50	100	4
503212	Seminar-I	4	--	--	50	50	100	4
Total		**25**	**200**	**200**	**100**	**100**	**600**	**25**

Semester - III								
Subject Code no.	**Subject**	**Teaching Scheme**	**Examination Scheme**				**Total Marks**	**Credits**
		Lect./Pr.	**Paper**		**TW**	**Oral / Presentation**		
			In Semester Assessment	End Semester Assessment				
603201	Advanced Power System Protection	4	50	50	--	--	100	4
603202	Power Quality Assessment and Mitigation	4	50	50	--	--	100	4
603203	Elective III	5	50	50	--	--	100	5
603204	Seminar II	4	--	--	50	50	100	4
603205	Project Stage - I	08	--	--	50	50	100	8
Total		**25**	**150**	**150**	**100**	**100**	**500**	**25**

Semester - IV							
Subject Code no.	**Subject**	**Teaching Scheme**	**Examination Scheme**			**Total Marks**	**Credits**
		Lect./Pr.	**Paper**	**TW**	**Oral / Presentation**		
603206	Seminar-III	5	--	50	50	100	5
603207	Project work Stage II	20	--	150	50	200	20
Total		**25**	**--**	**200**	**100**	**300**	**25**

List of Elective Subjects

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

Elective-I (5 credits)		**Elective-II (5 credits)**		**Elective-III (5 credits)**	
Module I (credits=4)	Module II (credit=1)	Module I (credits=4)	Module II (credit=1)	Module I (credits=4)	Module II (credit=1)
1) Advanced Power Electronics	1) Project Management	1) EHV AC Transmission	1) Electric Vehicles	1) ANN and Its application in power system	1) Artificial Intelligent tools
2) Partial Discharges in Electrical Equipments	2) IPR and Patent Law	2) Digital Signal Processing	2) Fundamentals of Cyber Security	2) Renewable Energy	2) Intelligent Sensors and instrumentation
3) Industrial Automation and Control	3) Technical communication	3) Advanced Control Theory	3) Disaster management	3) Advance Processors and Applications	3) Human Rights
-	4) Smart Grid Technologies	-	4) Communication protocols in SCADA system	-	4) Green building design

EXAMINATION SCHEME GUIDELINES

A) Compulsory subjects: Credits 4

Total marks: 100

To be done at Institute Level		**University Exam**	
In semester assessment Units 1 - 4		**End semester assessment**	
Class tests	30 Marks	Units 1- 4	18 Marks
Assignments / Mini Project	20 Marks	Unit 5	16 Marks
		Unit 6	16 Marks
Total	50 Marks	Total	50 Marks

B) Elective subjects: Credits 5

Total marks: 100

Module 1 (Credits – 4)			
In semester assessment Units 1-4		**End semester assessment**	
Class tests	15 Marks	Units 1 & 2	12 Marks
Assignments/PPT presentation	10 Marks	Units 3 & 4	14 Marks
		Unit 5	12 Marks
		Unit 6	12 Marks
Total	25 Marks	Total	50 Marks

Module 2 (Credit – 1)	
In semester assessment	Units 1-2
Class tests / Assignments	25 Marks

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

Introduction, Statement of an optimization problem, design vector, design constraints, constraint surface, objective function, classification of optimization problem. Classical optimization Techniques, single variable optimization, multivariable optimization with equality constraints, Direct substitution method, constrained variation method, Lagrange Multiplier method, formulation of multivariable optimization, Kunh Tucker conditions.

[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.

AC-DC load flow: Introduction, formulation of problem, D.C. System model, converter variables, Derivation of equations, Inverter operation, generalized flow chart for equation solution. [6 Hrs.]

Unit 5 Optimal Power Flow Analysis

Optimal power flow analysis considering equality and inequality constraints. Economic dispatch with and without limits (Classical method) Gradient method, Newton's method, Newton Raphson method. [8Hrs.]

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:

1. Computer Aided Power System Operation and Analysis-R.N.Dhar, Tata McGraw Hill New Delhi.
2. Computer Techniques in Power System Analysis- M.A. Pai, Tata Mc-Graw Hill New Delhi.
3. Computer Methods in Power System Analysis- Stagg and El.Abiad, Mc-Graw Hill (International Student Edition.)

Reference Books :

1. Computer Analysis of Power Systems-J.Arrilinga, C.P.Arnold. Wiely Eastern Ltd.
2. Optimisation Techniques-S.S.Rao, Wiely Eastern Ltd, New Delhi.
3. Modern Power System Engineering, Nagrath and Kothari (Tata McGraw Hill)
4. Electrical Energy System Theory–an introduction- Olle Elgerd. TMH Publishing Company, New Delhi.
5. Power System Optimisation- D. P. Kothari, J. S. Dhillon, PHI.
6. Power Generation Operation and Control – Allen Wood, Wiley Publications.

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:

1. Fundamentals of Power System Economics by D.S. Kirschen and G. Strbac, John Wiley & sons.
2. Electricity Economics Regulation and Deregulation, by G. Rothwell and T Gómez, Wiley – Inter Science
3. Sally Hunt, "Making Competition Work in Electricity", 2002, John Wiley Inc
4. Electric Utility Planning and Regulation, Edward Kahn, American Council for Energy Efficient Economy

Reference Books:

1. "Know Your Power", A citizens Primer On the Electricity Sector, Prayas Energy Group, Pune.
2. Power System Economics Designing markets for Electricity by Steven Stoft , Wiley- inter Science.
3. Market Operations in Electric Power Systems, Forecasting, Scheduling and Risk Management, by M. Shahidepour, Hatim yamin, Zuyi Li, Wiley Inter Science.
4. Deregulation in Power Industry, hand outs of CEP conducted by S.A. Khaparde.

Other references:

1. Regulation in infrastructure Services: Progress and the way forward - TERI, 2001
2. Maharashtra Electricity Regulatory Commission Regulations and Orders - www.mercindia.com
3. Various publications, reports and presentations by Prayas, Energy Group, Pune www.prayaspune.org
4. Central Electricity Regulatory Commission, Regulations and Orders - www.cercind.org
5. Electricity Act 2003 and National Policies – www.powermin.nic.
6. Bhanu Bhushan, "ABC of ABT - A primer on Availability Tariff" - www.cercind.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:
1. Power Systems Dynamics – K.R.Padiyar, B.S. Publications
2. Power System Control and Stability – Vol. – I – Anderson & Foud, IEEE Press, New York.

Reference Books:
1. Power System Dynamics & Control – Kundur, IEEE Press , New York
2. Power System Operation & Control – P.S.R. Murthy
3."Electrical Energy System Theory – an introduction" by Olle Elgerd. TMH Publishing Company 2nd Edition, New Delhi
4."Power System Analysis" – John J. Granier and W.D. Stevenson Jr, 4th Edition, McGraw Hill International student edition.

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:
Research Formulation – Defining and formulating the research problem -Selecting the problem - Necessity of defining the problem - Importance of literature review in defining a problem – Literature review – Primary and secondary sources – reviews, treatise, monographs-patents – web as a source – searching the web - Critical literature review – Identifying gap areas from literature review - Development of working hypothesis. Summarizing a Technical Paper - summary template Online tools - Google, CiteSeer, ACM Digital Library, IEEE, The on-line Computer Science bibliography, Searching patents [8 Hrs]

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:
Reporting and thesis writing – Structure and components of scientific reports - Types of report – Technical reports and thesis – Significance – Different steps in the preparation – Layout, structure and Language of typical reports – Illustrations and tables - Bibliography, referencing and footnotes - Oral presentation – Planning – Preparation –Practice – Making presentation – Use of visual aids - Importance of effective communication - Documentation and presentation tools: LATEX

[8 Hrs]

Unit 6:

Types of technical papers - Journal papers, Conference papers, Survey papers, Poster papers, Review papers Comparison, Structure of a survey, conference and journal paper, Organization and flow of thesis/ Project report, Research proposal: preparation, budgeting, presentation, funding agencies for engineering research, Intellectual property rights and patent law – Trade Related aspects of Intellectual Property Rights [8 Hrs]

Text Books :

1. Kothari, C.R., Research Methodology: Methods and Techniques. New Age International
2. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., An introduction to Research Methodology, RBSA Publishers
3. Suresh Sinha, Anil K Dhiman,Research Methodology, ESS Publications,Volumes 2
4. Day R.A., How to Write and Publish a Scientific Paper, Cambridge University Press
5. Wadehra, B.L. Law relating to patents, Trade Marks, copyright designs and geographical indications. Universal Law Publishing

References:

1. Louis Cohen, Lawrence Manion and Keith Morrison, Research Methods in Education, 7th Edition, Cambridge University Press, ISBN – 978-0415-58336-7
2. Anthony, M., Graziano, A.M. and Raulin, M.L., Research Methods: A Process of Inquiry, Allyn and Bacon
3. Ranjit Kumar, Research Methodology: A Step by Step Guide for Beginners, 2nd Edition, APH Publishing Corporation
4. Leedy, P.D. and Ormrod, J.E., Practical Research: Planning and Design, Prentice Hall
5. Fink, A., Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
6. Leslie Lamport, ' Latex: A document preparation system' Addison Wesley, Reading, Massachusetts, second edition, 1994, ISBN 0-201-52983-1.

503205: (ELECTIVE- I)

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
		Paper		TW	Oral / Presentation	Total	
503205	Lect/week	In semester Assessment	End Semester Assessment				
	5	50	50	-	-	100	5

Code No.	Modules of 4 credit (Select any one)	Code No.	Modules of 1 credit (Select any one)
503205 M1(i)	Advanced Power Electronics	503205 M2(i)	Project Management
503205 M1(ii)	Partial Discharges in Electrical Equipments	503205 M2(ii)	IPR and Patent Law
503205 M1(iii)	Industrial Automation and Control	503205 M2(iii)	Technical communication
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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 :
Review of 3-ph- full wave bridge converter, operation and harmonics, 3 level voltage source converters. PWM converter. Generalised technique of harmonic elimination and voltage control. Advanced modulation techniques (space vector modulation, 3 harmonic PWM) Comparison of PWM techniques. Converter rating.

[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 - αβo 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:

1. Power Electronic Control in Electrical Systems by E.Acha, Miller & Others (Newnes, Oxford publication) – first Edition

2. Power Electronics by M. H. Rashid Prentice Hall of India Pvt. Ltd. New Delhi, (3rd Edition)

References *:*

1) Understanding FACTS by N.G. Hingorani & L.Gyugyi (IEEE Press, Indian Edition)

2) E.H.Watanube, R.M. Stephen and Maurico Ardes "New Concepts of instantaneous active and reactive powers in Electrical systems with Generic loads" (IEEE transaction on Power Delivery Vol.8, no.2 April 1993, PP-697-703.

3) L.Benchaita, S. Sadaate and A.Salemnia – " A comparison of voltage source and current source shunt Active filter by simulation and Experimentation" (IEEE Transaction on Power Systems , Vol 14, No.2, May 99, PP 642-647.

4) H. Akagi, E.H. Watanabe and M.Aredes "Instantaneous Power Theory and Applications to Power Conditioning, IEEE Press , New York.

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, wave-form 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 ongaseous 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 :

1. Kreuger F. H. Partial Discharge Measurements.
2. Dieter Konig & Y Narayan Rao, PD in Electrical Apparatus. Vde-Veriag gmph – Berlin.

Reference e-journals and course material:

1. High Voltage Engineering, O. Kuffel E, Zaengl W. S, Oxford, Pergamon.
2. IEC – Publication 270 (1981) Partial Discharge Measurements.

503205 M1(iii) : INDUSTRIAL AUTOMATION AND CONTROL

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

guidelines of AC drive. Energy Savings with Variable Speed Drives, DC Motor Drives, DC and BLDC Servo Drives. [8Hrs]

References:

1. Lingefeng Wang, Kay Chen Tan, "Modern Industrial Automation and Software Design" John Wiley & Sons Inc.
2. K. L.S. Sharma, " Overview of Industrial Process Automation" Elsevier
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:

1. K. Nagarajan, "Project Management", 5th Edition, New Age International Publishers, 2010.
2. Prasanna Chandra, "Projects: planning, analysis, selection, implementation and review", 4th Edition, Tata McGraw Hill Publishing Co. Ltd, New Delhi, 1995.
3. Rosy Burke, "Project Management: planning and control technique", Wiley India, 2003
4. S. Chaudhary, "Project Management", Tata McGraw Hill, 1988.

Reference Books:

1. J. R. Meredith, S. J. Mantel, "Project Management: A managerial approach", Wiley India, 2010
2. John M. Nicholas, Herman Steyn, "Project Management", 3rd Edition, Elsevier Inc., 2008
3. Samuel Mantel, Jr. J. R. Meredith, S. M. Scafer, M. M. Sutton, M. R. Copalan, "Project Management" 1st Edition, 2011

503205 M2 (ii) : IPR AND PATENT LAW

Teaching Scheme
Lectures: 1 Hr/Week
Credit: 1

Examination Scheme
In-Semester Examination : 25 Marks

Unit1:
Intellectual property, History, Types(Seven types of Intellectual Property Rights) viz. Patent, Industrial Designs, Trademark, Copyright, Geographical Indication, Integrated Circuit Layout, Trade Secrets.
Patents and standards: History of patent law, History of Indian Patent System, Utility model
Procedures: Patent application, Patent infringement and enforcement, Patent licensing, Patent prosecution. Criteria of patentability, Rights granted for IP owners.
Legal requirements: Patentable subject matter, Novelty, Utility (patent), Inventive step and non-obviousness, Industrial applicability, Person skilled in the art, Prior art, Inventor ship, Sufficiency of disclosure, Unity of invention, Intellectual property brokering, Intellectual property education, Intellectual property infringement, Intellectual property valuation. [7 Hrs]

Unit:2
CEN and CENELEC Patent Policy, CEN-CENELEC Guidelines for Implementation of the Common IPR Policy on Patents, Declaration of patents.
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:

1) Intellectual Property Rights - Prabuddha Ganguli, Tata McGraw Hill publishing Company Ltd.
2) Satarkar S.V., Intellectual Property Rights and Copy Right. ESS Publications.

References:

www.cen.eu
www.cenelec.eu
www.cencenelec.eu
http://ipindia.nic.in/
http://ipindia.nic.in/ipr/patent/patents.htm
http://www.ipaustralia.gov.au/ (Australian Intellectual property)
http://guides.slv.vic.gov.au/
http://www.cipo.ic.gc.ca (Canadian patent office)
http://www.epo.org(Europian patent office)
http://www.academicleadership.org/emprical_research/The_State_of_Intellectual_Property_Education_Worldwide.shtml (Intellectual property education)

http://www.epo.org/law-practice/legal-texts/html/epc/2010/e/ar69.html
http://www.epo.org/law-practice/legal-texts/html/epc/2010/e/ar64.html
http://www.cas.go.jp/jp/seisaku/hourei/data/PA.pdf
http://nopr.niscair.res.in/bitstream/123456789/12687/1/JIPR%2016%285%29%20377-384.pdf

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
3) Leslie Lamport, ' Latex: A document preparation system' Addison Wesley, Reading, Massachusetts, second edition, 1994, ISBN 0-201-52983-1.

503205 M2 (iv) : SMART GRID TECHNOLOGIES

Teaching Scheme
Lectures: 1 Hr/Week
Credit: 1

Examination Scheme
In-Semester Examination : 25 Marks

Unit 1

Need of Synchro phasor 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

WAMS (Wide Area Measurement system): Architecture, Components of WAMS, GUI (Graphical User Interface), Applications: Voltage Stability Assessment, Frequency stability Assessment, Power Oscillation Assessment, Communication needs of WAMS, WAMPAC (Wide Area Monitoring Protection & Control), RAS (Remedial Action Scheme). Standards: IEEE 1344, IEEE C37.118 (2005), IEEE Standard C37.111-1999 (COMTRADE), IEC61850 GOOSE.

[5Hrs]

Text Books:

1. "Synchronized Phasor Measurements and Their Applications", Arun G. Phadke, J.S. Thorp, Springer Publication.
2. "Event detection and visualization based on phasor measurement units for improved situational awareness", Joseph Euzebe Tate, UMI Dissertation Publishing.
3. "Wide Area Monitoring, Protection and Control: The Gateway to Smart Grids", Fahd Hashiesh, M. M. Mansour , Hossam E. Mostafa Fahd Hashiesh , M. M. Mansour , Hossam E. Mostafa.

Reference Books

1. "Power System State Estimation", Mukhtar Ahmad
2. "Computer Relaying for Power Systems", Dr. Arun G. Phadke, Dr. James S. Thorp, Wiley Publication, Second Edition.
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.

503207: POWER SYSTEM DYNAMICS

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:

1. Power System Dynamics- K.R. Padiyar, B.S. Publications
2. Power System Dynamics Control – Prabha S. Kundur, IEEE Press, New York

Reference Books:

1. Power System Stability – E.W. Kimbark, IEEE press, N.Y, Vol.
2. Power System Control and Stability – Vol. – I – Anderson & Foud, IEEE Press, New York.
3. Power System Voltage Stability – C. W. Taylor., McGraw Hill International student edition.
4. Distributed Generation Islanding – implication on power system dynamics performance. – R.A. Walling, N. W. Miller, Power Engineering Society, Summer Meeting, 2002, IEEE Publication, 25 July 2002, Vol. I, PP 92-96.

503208: POWER SYSTEM PLANNING AND RELIABILITY

Teaching Scheme
Lectures: 4 Hours / Week
Credits : 4

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

Unit 1: Load Forecasting : Introduction, Factors affecting Load Forecasting, Load Research, Load Growth Characteristics, Classification of Load and Its Characteristics, Load Forecasting Methods - (i) Extrapolation (ii) Co-Relation Techniques, Energy Forecasting, Peak Load Forecasting, Reactive Load Forecasting, Non-Weather sensitive load Forecasting, Weather sensitive load Forecasting, Annual Forecasting, Monthly Forecasting, Total Forecasting, Objectives & Factors affecting to System Planning , Short Term Planning, Medium Term Planning, Long Term Planning. [10 hrs]

Unit 2: Probability theory : Introduction to probability, Probability distributions : Random variables, density and distribution functions. Mathematical expectation. Binominal distribution, Poisson distribution, normal distribution, exponential distribution, Weibull distribution. Normal Gaussian, Gamma and Beta distribution. Correlation and regression

[6 Hrs]

Unit 3: Reliability : Reliability, Failure, Concepts of Probability, Evaluation Techniques (i) Markov Process (ii) Recursive Technique, Stochastic Prediction of Frequency and Duration of Long & Short Interruption, Adequacy of Reliability, Reliability Cost.

[8 Hrs]

Unit 4: Generation Planning and Reliability : Objectives & Factors affecting Generation Planning, Generation Sources, Integrated Resource Planning, Generation System Model, Loss of Load (Calculation and Approaches), Outage Rate, Capacity Expansion, Scheduled Outage, Loss of Energy, Evaluation Methods. Interconnected System, Factors affecting interconnection under Emergency Assistance.

[10 Hrs]

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]

Unit 6: Distribution Planning and Reliability : Radial Networks – Introduction, Network Reconfiguration, Evaluation Techniques, Interruption Indices, Effects of Lateral Distribution Protection, Effects of Disconnects, Effects of Protection Failure, Effects of Transferring Loads, Distribution Reliability Indices. Parallel & Meshed Networks - Introduction, Basic Evaluation Techniques, Bus Bar Failure, Scheduled Maintenance, Temporary and Transient Failure, Weather Effects, Breaker Failure.

[8 Hrs]

Text Books:

1. Reliability Evaluation of Power System - Roy Billinton & Ronald N. Allan, Springer Publication.
2. Power System Planning - R.L. Sullivan, Tata McGraw Hill Publishing Company Ltd.

3. Probability and Statistic for Engineers, Miler & Freund's, Pearson Education, Richard Johnson.

Reference Books:

1. Modern Power System Planning – X. Wang & J.R. McDonald, McGraw Hill Book Company
2. Electrical Power Distribution Engineering - T. Gönen, McGraw Hill Book Company
3. Generation of Electrical Energy – B.R. Gupta, S. Chand Publications
4. Electrical Power Distribution A.S. Pabla, Tata McGraw Hill Publishing Company Ltd.
5. Electricity Economics & Planning – T.W.Berrie, Peter Peregrinus Ltd., London

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 back ground

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:

1. Power Electronic control in Electrical Systems – E.Acha, V.A.Agelidis, O.Anaya-lara and TJE Miller , Newnes, Oxford.
2. Understanding FACTS- N.G. Hingorani and L.Gyugi, IEEE Press, New York.
3. Flexible Power Transmission- The HVDC Options, J. Arrilaga, Y.H.Liu and N.R.Watson, John Wiley and sons Ltd., New York.

4. High Voltage Direct Current Transmission – J. Arrillaga, Peter Peregrinus Ltd., London, UK.
5. Power Transmission by Direct Current – Erich Uhlmann, Springer International.

Reference books:

1. FACTS controllers in transmission and Distribution – K.R.Padiyar, New Age Publications, New Delhi.
2. Power Electronics Handbook, M.H.Rashid
3. HVDC Power Transmission Systems- K.R.Padiyar, New Age Publications, New Delhi, (2nd Edition)

503210: (ELECTIVE- II)

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
		Paper		TW	Oral / Presentation	Total	
503210	Lect/week	In semester Assessment	End Semester Assessment				
	5	50	50	-	-	100	5

Code No.	Modules of 4 credit (Select any one)	Code No.	Modules of 1 credit (Select any one)
503210 M1(i)	EHV AC Transmission	503210 M2(i)	Electric Vehicles
503210 M1(ii)	Digital Signal Processing	503210 M2(ii)	Fundamentals of Cyber Security
503210 M1(iii)	Advanced Control Theory	503210 M2(iii)	Disaster Management
-	-	503210 M2(iv)	Communication protocols in SCADA System

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
Necessity of EHV AC transmission – advantages and problems–power handling capacity and line losses,– resistance of conductors – properties of bundled conductors – bundle spacing and bundle radius- Line and ground reactive parameters-Line inductance and capacitances – sequence inductances and capacitances – modes of propagation –ground return

[8 Hrs.]

Unit 2 Voltage gradients of conductors:
Bundled conductors, Resistance, Inductance and capacitance calculations of EHV line configurations, Computation of surface voltage gradient on conductors. Electrostatics – field of sphere gap – field of line changes and properties – charge – potential relations for multi-conductors – surface voltage gradient on conductors – distribution of voltage gradient on sub-conductors of bundled system.

[8 Hrs.]

Unit 3 Corona
Power loss due to corona, Radio noise and Audible noise and their measurement as well as computation. Power loss and audible noise (AN) – corona loss formulae – charge voltage diagram – generation, characteristics - limits and measurements of AN – relation between 1-phase and 3-phase AN levels – Radio interference (RI) - corona pulses generation, properties, limits – frequency spectrum – modes of propagation – excitation function – measurement of RI, RIV and excitation functions. [8Hrs.]

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.
2. Performance Operation & control of EHV Power transmission System by A Chakrabarti, D.P.Kothari, Mukhopadhyay, Wheelers Publisher.

503210 M1(ii) : DIGITAL SIGNAL PROCESSING AND ITS APPLICATIONS

Teaching Scheme	**Examination Scheme**
Lectures: 4 Hrs./Week	In-Semester Examination : 25 Marks
Credits: 4	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:

1. Mitra S., "Digital Signal Processing: A Computer Based Approach", Tata McGraw-Hill, 1998, ISBN 0-07-044705-5

2. Proakis J., Manolakis D., "Digital signal processing", 3rd Edition, Prentice Hall, ISBN 81-203-0720-8

Reference Books:

1. Oppenheim A., Schafer R., Buck J., "Discrete time signal processing", 2nd Edition, Prentice Hall, 2003, ISBN-81-7808-244-6

2. Rebizant**,** Waldemar, Szafran, Janusz, Wiszniewski, Andrzej, "Digital Signal Processing in Power System Protection and Control", 1st Edition. Springer, 2011, ISBN 0857298011, 9780857298010

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 uncertainities. System and signal norms, small gain theorem, robust stability, design of robust control, Introduction to H-∞ control. (8Hrs)

Unit 4

Nonlinear Control:

Nonlinear Systems and Equilibrium Points , Concepts of Stability, Linearization, Stability analysis of nonlinear systems, Feedback Linearization, Input-output linearization, Input-State Linearization. (8 Hrs)

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:

1. 'Modern Control Engineering'- Katsuhiko Ogata, Prentice Hall India, 5th edition 2010.
2. 'Applied Non Linear Control', Jean-Jacques E. Slotine, Prentice Hall Englewood Cliffs, New Jersey.
3. 'Non-linear Systems', by Hassan Khalil, Prentice Hall.

Reference Books:

1. 'Control of Power Inverters in Renewable Energy and Smart Grid Integration', Qing-Chang Zhong, Tomas Hornik, Wiley Publication, 2013
2. 'Sliding-mode Control: Theory and applications' by Sarah K. Spurgeon, Taylor & Francis, 1998
3. 'Digital Control and State Variable Methods' by M. Gopal, Tata-McGraw-Hill Publishing Company Limited
4. 'Optimal Control: Linear Quadratic Methods' Brian D. O. Anderson, John Barratt Moore, Dover Publications, 2007

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

Ethics and Law, What is a Cyber Crime / Social Theories, Computer Security: Then and Now, Computer System Security / Access Controls, Intrusion Detection: An Overview, Malicious Software Use and Detection [4 Hrs]

Security principles, threats and attack techniques: Introduction to security, Information security, Security triad: Confidential, Integrity, Availability, Focus of control, Security threats and attacks, Security management **[**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:

1. Dieter Gollmann, "Computer Security", 2nd ed., John Wiley & Sons, 2006 ISBN: 0-470-86293-9
2. Rick Lehtinen and G.T. Gangemi, "Computer Security Basics", O'Reilly Media, Inc., 2nd 2006 ISBN: 10: 0596006691

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. [7Hrs]

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

Text books:

1. Alexander, D. Natural Disasters, ULC press Ltd, London, 1993.
2. Carter. W. N., Disaster Management: A Disaster Management Handbook, Asian Development Bank, Bangkok, 1991.
3. Chakrabarty U. K., Industrial Disaster Management and Emergency Response, Asian Books Pvt. Ltd., New Delhi 2007.
4. Disaster Management, Lotus Publications Pvt. Ltd.

Reference Books:

1. Manual on Natural Disaster Management in India, NCDM, New Delhi, 2001.
2. Disaster Management in India, Ministry of Home Affairs, Government of India, New Delhi, 2011.
3. National Policy on Disaster Management, NDMA, New Delhi, 2009.
4. Disaster Management Act. (2005), Ministry of Home Affairs, Government of India, New Delhi, 2005.
5. http://nidm.gov.in/ - National Institute of Disaster Management (NIDM) (Ministry of Home Affairs, Govt. of India) website

503210 M2 (iv) : COMMUNICATION PROTOCOLS IN SCADA SYSTEM

Teaching Scheme
Lectures: 1 Hr/Week
Credit: 1

Examination Scheme
In-Semester Examination : 25 Marks

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.

The Evolution of SCADA Protocols: Overview of Open systems interconnection (OSI) Model, Functions of OSI Model Layers, OSI Protocols, Functions of Transmission control protocol / Internet protocol (TCP/IP) Layers, TCP/IP protocol, MODBUS model, DNP3 protocol, IEC61850 layered architecture, Control area network, Control and Information Protocol (CIP), DeviceNet, Control Net, EtherNet/IP, Flexible Function Block process (FFB), Process Field bus (Profibus), The Security Implications of the SCADA protocols.

[7 Hrs]

Text Books:

1. Ronald L. Krutz, “Securing SCADA System”, Wiley Publication.
2. Sunil S. Rao, “Switchgear and Protections”, Khanna Publication.
3. Robert Miller, James Malinowski “Power System Operation”, Mc Graw-Hill, Inc.

Reference Books:

1. Gordan Clark, Deem Reynders, “Practical Modem SCADA Protocols”
2. Stuart A Boyer, “SCADA supervisory control and data acquisition” International Society of Automation, North Carolina, 4th Edition.

503211: LAB PRACTICE- II

Teaching Scheme
4 Hrs / Week
Credits : 04

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

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.
4. Small signal analysis of single machine.
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.
3. Bufferworth IIR filter design.
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.
3. Design and simulation of H-∞ controller.
4. Analysis of closed loop control of converter based system.

503212 : SEMINAR – I

Teaching Scheme	**Examination Scheme**
4 Hrs/Week	Term Work: 50 Marks
Credits: 4	Oral/Presentation : 50Marks

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

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

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.

[8 Hrs]

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.

[8 Hrs]

Unit 3 Digital protection of Synchronous generator

Introduction, faults in synchronous generator, protection schemes for synchronous generator, digital protection of synchronous generator.

[8 Hrs]

Unit 4 Digital Protection of Power Transformer

Introduction, faults in a transformer, schemes used for transformer protection, digital protection of transformer

[8 Hrs]

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.

[8 Hrs]

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.

[8 Hrs]

Text Books:

1. Digital Protection - L. P. Singh, (New Age International (P) Limited Publishers, New Delhi, 2nd Edition)
2. Transmission Network Protection - Paithankar (Marcel & Dekker, New York)

Reference Books:

1. Fundamentals of Power System Protection Paithankar & Bhide (Prentice Hall of India Pvt. Ltd., New Delhi)
2. Protective Relaying for Power System II Stanley Horowitz (IEEE press, New York)
3. Digital Relay / Numerical relays – T.S.M. Rao, Tata Mc Graw Hill, New Delhi
4. Anderson- Power System Protection IEEE Press
5. Digital Protection IEE Monograph, John and Salman, Peter Teregruins Publishers, London

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
Definition of harmonics, inter-harmonics, sub-harmonics. Causes and effect of harmonics. Voltage versus current distortion. Overview of fourier analysis. Harmonic indices and other indices for assessing impacts of harmonics. A.C. quantities under non-sinusoidal conditions. Triplen harmonics, characteristics and non characteristics harmonics. Harmonics resonances - series and parallel resonances. Consequences of harmonic resonance. Principles for controlling harmonics. Reducing harmonic currents in loads. K-rated transformer. Harmonic study procedure. Computer tools for harmonic analysis. Locating sources of harmonics. Modifying the system frequency response. Harmonic filtering, passive and active filters. IEEE Harmonic standard 519-1992.

[10 Hrs]

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

quality monitoring objectives and requirements. Initial site survey. Power quality instrumentation. Selection of power quality monitors, selection of monitoring location and period. System wide and discrete power quality monitoring. Setting thresholds on monitors, data collection and analysis. Selection of transducers. Harmonic monitoring , Transient monitoring, event recording and flicker monitoring.

[8 Hrs]

Unit 6 : Power Quality Assessment & Mitigation

Power Quality assessment, Power quality indices and standards for assessment disturbances, waveform distortion, voltage and current unbalances. Power assessment under waveform distortion conditions. Power quality state estimation, State variable model, observability analysis, capabilities of harmonic state estimation. Test systems. Mitigation techniques at different environments.

[8 Hrs]

Text Books :

1. Understanding power quality problems, voltage sag and interruptions - M. H. J. Bollen IEEE press, 2000, series on power engineering.
2. Electrical power system quality - Pogei C. Dugan, Mark F. McGranghan, Surya santoso, H. Wayne Beaty, second edition, McGraw Hill Pub.

Reference Books:

1. Power system quality assessment - J. Arrillaga, M.R. Watson, S. Chan, John Wiley and sons.
2. Electric Power Quality - G. T. Heydt. Stars in a circle Publications.
3. Power system harmonics: Computer modeling and analysis- Enriques Acha, Manuel Madrigal, John Wiley and sons Ltd.
4. Power System Harmonics – J. Arrillaga & N. Watson, John Wiley and sons.
5. IEEE STD 519-1992/ IEEE std 1159 IEEE recommended practices and requirements for harmonics control in electrical power system.

603203: (ELECTIVE - III)

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
		Paper		TW	Oral / Presentation	Total	
603203	Lect/week	In semester Assessment	End Semester Assessment				
	5	50	50	-	-	100	5

Code No.	Modules of 4 credit (Select any one)	Code No.	Modules of 1 credit (Select any one)
603203 M1(i)	ANN and its applications in power system	603203 M2(i)	Artificial Intelligent tools
603203 M1(ii)	Renewable Energy	603203 M2(ii)	Intelligent Sensors and instrumentation
603203 M1(iii)	Advance Processors and Applications	603203 M3(iii)	Human Rights
-	-	603203 M3(iv)	Green building design

603203 M1(i) : ARTIFICIAL NEURAL NETWORK AND ITS APPLICATIONS IN POWER SYSTEMS

Teaching Scheme	**Examination Scheme**
Lectures: 4 Hrs./Week	In-Semester Examination : 25 Marks
Credits : 4	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:

1. Simon Haykin, "Neural Networks: A Comprehensive Foundation", 2nd Edition, Pearson Education.
2. Kelvin Waruicke, Arthur Ekwlle, Raj Agarwal, "AI Techniques in Power System", IEE London U.K.

Reference Books:

1. Mohamed H. Hassoun, "Fundamentals of Artificial Neural Network", Practice Hall India.
2. S. N. Sivanandam, S. Sumathi, S. N. Deepa, "Introduction to Neural Network Using MATLAB 6.0", Tata McGraw Hill
3. S. Rajsekaram, G. A. Vijayalaxmi Pai, "Neural Networks, Fuzzy Logic & Genetic Algorithms Synthesis & Applications", Practice Hall India

603203 M1(ii) : RENEWABLE ENERGY

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

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

Unit 1

Solar Energy :.

Photovoltaic Systems: Introduction to the Major Photovoltaic System Types, Current–Voltage Curves for Loads, Grid-Connected Systems: Interfacing with the Utility, DC and AC Rated Power, The "Peak-Hours" Approach to Estimating PV Performance, Capacity Factors for PV Grid-Connected Systems, Grid-Connected System Sizing, Grid-Connected PV System Economics: System Trade-offs, Dollar-per-Watt Ambiguities, Amortizing Costs, Stand-Alone PV Systems, PV-Powered Water Pumping, PV systems – off grid systems and scope for inclusive growth of rural India. Grid autonomy. Calculation of system details [8 Hrs.]

Unit 2

Wind Energy : Wind Energy : wind speed and power relation, power extracted from wind, wind distribution and wind speed predictions. Wind power systems: system components, Types of Turbine, Turbine rating blade design, turbine rating turbine design aspects, Choice of generators, electrical load matching, power control, Effect of wind speed variations, tower height and its effect, Variable speed operation, maximum power operation, control systems, system design features, stand alone and grid connected operation. Design consideration of wind farms and control [8 Hrs.]

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 :

1. Renewable energy technologies - R. Ramesh, Narosa Publication.
2. Energy Technology – S. Rao, Parulkar
3. Non-conventional Energy Systems – Mittal, Wheelers Publication.
4. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response",CRC Press
5. Renewable Energy Technologies – Chetan Singh Solanki, PHI Learning Pvt. Ltd.

Reference Books :

1. Wind and solar systems by Mukund Patel, CRC Press.
2. Solar Photovoltaics for terrestrials , Tapan Bhattacharya.
3. Wind Energy Technology – Njenkins, John Wiley & Sons,
4. Solar & Wind energy Technologies – McNeils, Frenkel, Desai, Wiley Eastern.
5. Solar Energy – S.P. Sukhatme, Tata McGraw Hill.
6. Solar Energy – S. Bandopadhyay, Universal Publishing.
7. Ali Keyhani, Mohammad N. Marwali, Min Dai "Integration of Green and Renewable Energy in Electric Power Systems", Wiley
8. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama,"Smart Grid: Technology and Applications", Wiley
9. Jean Claude Sabonnadière, Nouredine Hadjsaïd, "Smart Grids", Wiley Blackwell
10. Peter S. Fox Penner, "Smart Power: Climate Changes, the Smart Grid, and the Future of Electric Utilities", Island Press; 1 edition 8 Jun 2010
11. Stuart Borlase, "Smart Grids (Power Engineering)", CRC Press.
12. Mladen Kezunovic, Mark G. Adamiak, Alexander P. Apostolov, Jeffrey George Gilbert "Substation Automation (Power Electronics and Power Systems)", Springer
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:

1. 'Programming and Use of TMS320F2812 DSP to Control and Regulate Power Electronic Converters'by Baris Bagci, Grin Verlag, 2007.
2. 'Digital Signal Processing' by Avatar Singh, S. Srinivassan, Cengage Learning, 2004.

References:

1. 'TMS320F2812 Digital Signal Processor: Implementation Tutorial' by Texas Instruments.
2. 'TMS320x281x DSP Event Manager (EV) Reference Guide' by Texas Instruments.

603203 M2(i) : ARTIFICIAL INTELLIGENT TOOLS

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.
2) Zimmerman H.J. "Fuzzy set theory-and its Applications"-Kluwer Academic Publishers, 1994.

Reference Books:

1) KOSKO B. "Neural Networks And Fuzzy Systems", Prentice-Hall of India Pvt. Ltd., 1994.
2) KLIR G.J. & FOLGER T.A. "Fuzzy sets, uncertainty and Information", Prentice-Hall of India Pvt. Ltd., 1993.
3) Driankov, Hellendroon, "Introduction to Fuzzy Control", Narosa Publishers.

603203 M2(ii) : INTELLIGENT SENSORS AND INSTRUMENTATION

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:

1) Barney, G. C., "Intelligent Instrumentation", Prentice Hall, 1995.
2) D. Patranabis, "Sensors and Transducers", PHI, 2003.

Reference Book:

1. Alan S. Morris, "Principles of Measurement & Instrumentation", PHI Pvt. Ltd., 1999.

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 [7Hrs]

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
3) Introduction to International Humanitarian Law by Curtis F. J. Doebbler - CD Publishing , 2005.
4) Freedom of Information by Toby Mendel - UNESCO, 2008

603203 M2 (iv) : GREEN BUILDING DESIGN

Teaching Scheme
Lectures: 1 Hr/Week
Credit : 1

Examination Scheme
In-Semester Examination : 25 Marks

Unit1 : 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 :

1. Sustainable Building Design Manual, Volume 2, TERI, New Delhi

2. Energy Efficient Buildings in India, TERI, New Delhi

3. Sustainable Building Design Manual, Volume 1 TERI, New Delhi

603204 : SEMINAR– II

Teaching Scheme
4 Hrs / week
Credits: 04

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

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	**Examination Scheme**
8 Hrs / week	Term work : 50 marks
Credits: 08	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.

603206 : SEMINAR- III

Teaching Scheme
5 Hrs / week
Credits: 05

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

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.

603207 : PROJECT WORK STAGE - II

Teaching Scheme
20Hrs / week
Credits: 20

Examination Scheme
Term work : 150 marks
Oral: 50 Marks

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.