SAVITRIBAI PHULE PUNE UNIVERSITY

FACULTY OF ENGINEERING

SYLLABUS FOR

M.E. ELECTRICAL (POWER SYSTEMS)

(2017 course)

WITH EFFECT FROM YEAR 2017-2018

Structure for M.E.(Electrical) - Power Systems (2017 Course)

Semester - I

Subject Code	Subject	Teaching Scheme	Examination Scheme				Total Marks	Credits
		Lect./Pr.	Paper		TW	Oral / Presentation		
			In Semester Assessment	End Semester Assessment				
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	Subject	Teaching Scheme	Examination Scheme				Total Marks	Credits
		Lect./Pr.	Paper		TW	Oral / Presentation		
			In Semester Assessment	End Semester Assessment				
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	**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**

Evaluation of Seminars and Project in different semesters would be carried out as per rules and regulations of ME programs under faculty of engineering effective from June 2017.

List of Elective Subjects

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

503205 Elective-I (5 credits)		**503210 Elective-II (5 credits)**		**603203 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) Artificial Neural Network and its applications in power system	1) Artificial Intelligent tools
2) Partial Discharges in Electrical Equipments	2) IPR and Patent Law	2) Digital Signal Processing and its applications	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) Energy Storage systems	4) Communication protocols in SCADA system	-	4) Green building design
			5) Electrical Power Distribution systems		

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/PPT/ 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/PPT	25 Marks

B.O.S.
Electrical Engineering

Semester I

503201: COMPUTER APPLICATIONS IN POWER SYSTEMS

Teaching Scheme
Lectures: 4 Hours / Week
Credits: 4

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

Course Objectives:-The student will be able to

1. Learn mathematical functions of various optimization techniques
2. Understand the necessity of load flow studies and various methods of load flow studies
3. Understand the applications of various methods for optimal power flow analysis

Course Outcome:- At the end of course, student will be able to
CO1:- Conversant with various optimization techniques.
CO2 :- Use methods of power flow analysis, optimal power flow analysis
CO3:- Elaborate optimal power system operation

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. [8 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

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.

[8Hrs]

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.
7. NPTEL online course on "Power System analysis"

503202: POWER SECTOR ECONOMICS AND MANAGEMENT

Teaching Scheme
Lectures: 4 Hours / Week
Credits: 4

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

Course Objectives:-The student will be able to

1. Learn the scenario of power sector in India
2. Understand the necessity of regulations and power sector economics
3. Understand tariff structure in detail.
4. Get knowledge of global power sector reforms
5. Understand the concept and types of power market and price of power.
6. Learn the transmission planning and pricing

Course Outcome: - At the end of course, student will be able to

CO1:- Analyze the effect of power sector reform in India as well as globally
CO2 :- Evaluate the economic aspects of power project.
CO3 :- Differentiate between types of power-markets.
CO4:- Workout methods of Transmission Pricing

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, Energy policy and guidelines under this act latest amendments in Indian Power Sector. 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 . Role of regulation and evolution of regulatory commission in India, Regulatory process in India, stages of tariff determination. Economic regulations – cost plus, performance based, incentive, Price and Revenue cap, Rate of return , sliding scale regulation. Key performance parameters. [8 Hrs.]

Unit 3 Power Tariff

Different tariff principles (marginal cost, cost to serve, average cost), objectives and components of tariff. Consumer tariff structures and considerations, different consumer categories, telescopic tariff, fixed and variable charges, time of day, interruptible tariff, power factor tariff, different tariff based penalties and incentives etc., tariff linked to quality of supply and service. Multi year tariff, levelised tariff. 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. Feed in tariff for renewable. Non price issues in electricity restructuring, environmental and social considerations. [6 Hrs.]

Unit 4 Power sector restructuring models and global reforms

Different industry structures (vertically integrated, regulated and deregulated), key market entities- ISO, Genco, Transco, Disco, Retailco. Competition in the electricity sector- conditions, barriers, different types, benefits and challenges. Different market trading models, single buyer model, Wholesale competition, retail completion model. Models based on contractual arrangement – pool model, bilateral/multilateral model, pool and bilateral contracts.ISO models- micro, mini and max ISO. Global experience with electricity reforms in different countries.

Open access, Introduction to Indian Energy Exchange and its operation time markets, market power and exercising it and its effect on market operations. [8 Hrs]

Unit 5 Electricity Markets and Pricing

Electricity price basics, Demand and price elasticity. Types of power and energy markets- spot market, day ahead, hour ahead market, forward contract future contract, option contract, contract for differences, ancillary market. Market operation market clearing price, market efficiency, effect gate closure, settlement process. Market Clearing price (MCP), Zonal and locational MCPs. Dynamic/ spot pricing, Market power and exercising market power. [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. 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 – InterScience
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, Hatimyamin, Zuyi Li, Wiley InterScience.
4. Deregulation in Power Industry, course hand outs 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

Course Objectives :

1. Introduce basic modeling concepts of various power system components.
2. Develop detail model of synchronous machine for dynamic studies.
3. Analyze synchronous machine model for steady state & transient state
4. Describe basics of excitation systems, voltage regulators and their parameters.
5. Develop models of different excitation systems.
6. Extend concept of mathematical modeling for transmission line, SVC and loads

Course Outcomes: Student will be able to

CO1:-Develop simple models for electrical power system components.

CO2:-Perform analysis of synchronous machine behavior for steady state & transient state

CO3:-Write models of different excitation systems.

CO4:-Apply concept of modeling for transmission line, SVC and loads

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. Block Diagram of Excitation control scheme, effect of change in excitation on system parameters**,** Exciter with rheostat control, Definitions of voltage response ratio & exciter voltage ratings. Voltage regulators such as electro-mechanical and solid state. [8 Hrs.]

Unit 5 Excitation system modeling - II:
Excitation control systems using dc generator exciter, dc generator pilot excitation scheme, modelling of self and separately excited dc generator, AC excitation system: Field controlled alternator rectifier system (stationary diode type), Brushless excitation system (rotating diode type),static excitation system: Potential source controlled rectifier system, compound source controlled rectifier system. [8 Hrs.]

Unit 6 Transmission line, SVC and load modeling :
Transmission line modeling, Applications of Clark's & Kron's transformation, static VAR compensators, static load modeling, induction motor modeling using synchronous machine model. [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.
3. Power Systems Dynamics-Analysis and simulation –R. Ramanujam, PHI Learning Private limited New Delhi.

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

Course Objectives: The student will be able to

1. To give knowledge about basic concepts in research.
2. To train students for technical writing.
3. To cultivate quality research output.

Course outcome: At the end of the course, students will be able to

CO1 :- Carry out literature review and write it in proper format
CO2 :- Enlist different parts of thesis and research proposal.
CO3:- Find research metrics and information about patents from on line resources.

Unit 1: Basics of research

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.

Research Formulation, Defining and formulating the research problem, Selecting the problem Necessity of defining the problem, Importance of literature review in defining a problem.

Using web for literature review, Types of literature: books, papers, reviews, treatise, monographs, patents, process of identifying gap areas from literature review Development of working hypothesis. Different tools for literature survey. [8 Hrs]

Unit 2: Technical Writing:

Writing Thesis: 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.

Writing papers: types of technical papers, Journal papers, Conference papers, Survey papers, Poster papers, Comparison, Structure of a survey, conference and journal paper.

Writing Research Proposal: Importance of research funding in research, standard formats for different research schemes of AICTE, DST. Preparation for research proposal, how to write a research proposal. . [8 Hrs]

Unit 3: Assessment of research output:

Measure for quality of research, citation index Researcher metrics (i10-index, H-index etc.), Article metrics, Journal Metrics.

Ethical practices in research such as plagiarism, acknowledgment etc. Commercialization of research, Copy right, royalty, Intellectual property rights and patent law, Trade related aspects of Intellectual Property Rights, patent search, drafting and filing patent, legal procedure in granting patent.

` [8 Hrs]

Unit 4

Linear Programming : Standard form of a linear programming problem-geometry of linear programming problems-definitions and theorems, linear simultaneous equations: Elimination method, Jacobi's method, Relaxation method solution of the system of pivotal reduction of a general system of equations, simplex method. [8 Hrs]

Unit 5

Constrained Nonlinear Programming : Characteristics of a constrained problem, Classification, Basic approach of Penalty Function method, Introduction to Convex Programming Problem. Finite Difference approximations of partial derivatives. [8 Hrs]

Unit 6

Following methods with applications to particular problem of Electrical Engineering:
Genetic algorithm, Simulated Annealing method, PSO, GA, SAM, Ant Colony method, ARIMA, Linear regression, Multi regression. [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
6. Shail Jain, R.K. Jain, Patents: Procedures and Practices, Universal Law Publishing Co. , New Delhi, 2011.
7. K.V.Mittal and C. Mohan, "Optimization Methods in operation Research and System Analysis"- New Age International (p) Limited, 3rd edition 1996.
8. Moritz Diehl- Franc, ois Glinuer-Eliass Jarlebring, Wim Michiels, " Recent Advances in Optimization ans its Applications in Engineering", Springer.
9. James A. Momoh, Electric Power Systems Applications of Optimization.
10. Soliman Abdel- HadySoliman, Abdel-Aal Hassan Mantawy, " Modern Optimizatin Techniques with Applications in Electric Power Systems"

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. Satarkar, S.V., Intellectual Property Rights and Copy Right. ESS Publications.
7. Royston M. Roberts, Serendipity: Accidental Discoveries in Science, Wiley Publication, 1989
8. James A. Momoh, Electric Power Systems Applications of Optimization.
9. Soliman Abdel- Hady Soliman, Abdel-Aal Hassan Mantawy, " Modern Optimization Techniques with Applications in Electric Power Systems"

In semester assessment of the course must include following assignments (Any 2):

1. Write a literature survey for a given topic.
2. Write a research proposal for given research scheme.
3. Write an application for filing a patent.
4. Case study for famous inventions/discoveries and famous failures.
5. Write a paper using technical writing language such as Latex.

503205: (ELECTIVE- I)

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/week	Paper		TW	Oral / Presentation	Total	
503205		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
--	--	503205 M2(iv)	Smart Grid Technologies

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

Course Objectives :

1. To learn about various advancements in Power Electronics.
2. To know working of various types of Power Electronic converter configurations.
3. To understand use of different energy storage systems.
4. To know various advanced control techniques for Power flow control in converter configurations**.**

Course Outcome: after successful completion of this course, student will be able to

CO1 Select appropriate Power Electronic converter configuration for desired application.
CO2 Analyze working and control requirements of the Power Electronic converter configuration.
CO3 Choose and apply the suitable control technique for operation of Power Electronic converter configuration.
CO4 Select the required energy storage system correctly.
CO5 Compare and comment on performance of the chosen Power Electronic converter configuration with other converters for same application.

Unit 1 Voltage Source Converters:
Review of 3-ph- full wave bridge converter, operation and harmonics, 3 level voltage source converters. PWM converter. Generalized technique of harmonic elimination and voltage control. Advanced modulation techniques (space vector modulation, 3 harmonic PWM), Converter rating. [8 Hrs]

Unit 2 (i) Self and Line commutated current source converter: Basic concepts of CSC, converters with self commutating devices. Comparison with voltage source converter.
(ii) Matrix Converter: 3×3 matrix converter, principle of working, mathematical treatment, comparison of matrix converter with multipulse 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
Applications of multilevel Inverter:
Reactive power compensation Back to back intertie system, Utility compatible adjustable speed drives. [8Hrs.]

Unit 4 Energy Storage Systems:
Flywheel energy storage system, Superconducting magnetic energy storage system, other advance energy storage systems [6Hrs.]

Unit 5 Resonant Pulse Converters:
Types of Resonant pulse converters, Series resonant inverters with unidirectional & Bidirectional switches, Analysis of half bridge and full bridge configurations, Frequency response of series resonant inverters, Parallel resonant inverters, Voltage control of resonant inverters, Class E Resonant inverter and rectifier , zero current and zero V switching resonant Converters, comparison. [8 Hrs]

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

Course Objectives: - At the end of course, student will be able to

1. Understand the phenomenon of Partial discharge and techniques for its measurement
2. Learn various problems associated with partial discharge measurement
3. Know the effects of partial discharge on insulating material
4. Evaluate and locate the partial discharge

Course Outcome: - At the end of course, student will be able to

CO1:- Identify the occurrence of partial discharge
CO2:- Measure and evaluate partial discharge
CO3:- Know the effects of partial discharge

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 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 :

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

Course Objectives: - At the end of course, student will be able to

1. Understand the phenomenon of industrial automation
2. Learn various industrial measurement characteristics
3. Know the various techniques of automatic control
4. Understand various hardware required for industry- automation

Course Outcome: - At the end of course, student will be able to

CO1:- Know the automation in Industry
CO2:- Select appropriate technique for control and automation
CO3:- Select appropriate industrial drives

Unit 1 : Introduction
Architecture of 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

Course Outcome:
At the end of this course student will be able to
CO1: Prepare the project scheduling using different techniques and able to plan, manage and control the project quality.
CO2: Measure, assess and manage the project risk with the help of different techniques.

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. **[5**Hrs**]**

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

Course Outcome:
At the end of this course student will be able to
CO1: Define intellectual property and distinguish between different types of IPR with legal requirements.
CO2: Describe laws of IPR in different countries and international.

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 nonobviousness, 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)

503205 M2 (iii): TECHNICAL COMMUNICATION

Teaching Scheme
Lectures: 1 Hr/Week
Credit: 1

Examination Scheme
In-Semester Examination: 25 Marks

Course Outcome:
At the end of this course student is able to
CO1: Design effective technical presentation and communicate it in verbal and written form.
CO2: Write technical report and paper in typesetting software LATEX.

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

Course Outcome:
At the end of this course student will be able to
CO1: Draw and describe detail block diagram of phasor measurement unit and its applications
CO2: Apply wide area measurement system with the help of different standards in power system.

Unit 1
Need of Synchronous 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, Use of phasor data 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 Damping 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
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 and Analysis using SIMULINK.

503205 M1 (i) (Elective – I): ADVANCED POWER ELECTRONICS

1. Three phase convertor supplying 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.

Semester II

503207: POWER SYSTEM DYNAMICS

Teaching Scheme
Lectures: 4 Hours / Week
Credits : 4

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

Course Objectives:

1. Understand fundamental concepts & their classification in power system stability.
2. Explore voltage stability and islanding concepts in power stability studies
3. Impart knowledge on the design and application of Power system Stabilizer.
4. Extend basic stability analysis for multi machine system.
5. Analyze dynamics of synchronous generator connected to infinite bus.

Course Outcomes: Students will be able to

CO1 Solve basic power system stability problems.

CO2 Interpret the design and working and of Power system Stabilizer.

CO3 Develop a model of synchronous generator connected to infinite bus for dynamic analysis

CO4 Apply and solve dynamic stability problems of synchronous generator connected to infinite bus.

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
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.]

Unit 3 Power System Stabilizers:
Basic concepts of control signals in PSS, structure and tuning, field implementation, PSS design and application, future trends. [8 Hrs.]

Unit 4 Multi-machine System- Fundamentals:
Development of swing equation for coherent & non coherent group of multi machines, power flow in multi machine system, simplified multi machine model, Improved model of the system for linear load. [8 Hrs.]

Unit 5 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 6 Detail 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.]

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 & Reliability

Teaching Scheme
Lectures: 4 Hours / Week
Credits: 4

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

Prerequisites: Students should have gone through mathematics, power system, power system operation and control.

Course Objective:

1. To be familiar with load characteristics and its forecasting.
2. To acquire the mathematical knowledge based on probability analysis.
3. To give the student familiarities with the reliability indices based on IEEE standard 493 and 1366.
4. To give knowledge about generation planning with economic model design.
5. To give knowledge about transmission planning and understanding of Interregional transmission system in India.
6. To develop the ability to analyze and design the distribution system planning.

Course Outcome: After successful completion of this course, the student will be able to:

CO1 :- Evaluate load forecasting
CO2 :- Calculate reliability indices for utility, transmission and distribution system
CO3 :- Apply the knowledge of generation and transmission planning
CO4 :- Apply the knowledge of distribution planning

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; Objectives and Factors affecting system planning; Short Term Planning; Medium Term Planning; Long Term Planning. [8 Hrs]

Unit 2: Mathematical Basics for Reliability Calculations:

Random variables; frequently occurring distribution functions (Binomial; Normal; Exponential; Gaussian); Markov Process; Regression analysis; Mathematical expectation probability concept. [6 Hrs]

Unit 3: Reliability:

Concept of Reliability; Failure analysis; Definitions of distribution system reliability and its indices (SAIDI, SAIFI, CAIDI, ASAI, ASUI); Definition of generation system reliability and its indices (LOLP; LOLE, EENS); Causes of interruption; Customer composite damage function (CCDF); Reliability cost. [8 Hrs]

Unit 4: Generation Planning:

Generation model; Functional economic analysis; Economic assessment method (Net Present Value method; Internal profit rate method; minimum cost method; annual equivalent value method); Capacity Expansion; Generation Optimization model; mathematical model of generation investment decisions & algorithms (Ranking algorithm; Steepest Descend method) Evaluation of Reliability for Generation Planning. [10 Hrs]

Unit 5: Transmission Planning:

Interregional transmission system in India; Analysis of causes of failure of transmission line; tower and substation equipment's; Role of construction monitoring of transmission projects; Long term transmission planning studies; Short term transmission planning studies; Evaluation of system & load point indices in a transmission network. [8 Hrs]

Unit 6: Distribution Planning:

Concept and Types of Distribution systems; Evaluation techniques; Causes of interrupts in distribution network & its equipment; Monitoring of distribution system through reconfiguration algorithm; Role of protective devices such as dis-connector, circuit breakers and isolators; Concept of partial load transfer; Effect of weather in distribution system planning; Evaluation of distribution system reliability indices. [8 Hrs]

Text Books:

1. Reliability Evaluation of Power System - Roy Billinton & Ronald N. Allan, Springer Publication.
2. Probability and Statistic for Engineers, Miler & Freund's, Pearson Education, Richard Johnson.
3. Electricity Economics & Planning – T.W.Berrie, Peter Peregrinus Ltd., London

Reference Books:

1. Modern Power System Planning – X. Wang & J.R. McDonald, McGraw Hill
2. Electrical Power Distribution Engineering - T. Gönen, McGraw Hill Book Company
3. Electrical Power Distribution A.S. Pabla, Tata McGraw Hill Publishing Company Ltd.

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

Course Objectives: - At the end of course, student will be able to

1. Understand the necessity of HVDC transmission
2. Learn all important aspects of multi-terminal HVDC and HVDC Light
3. Learn various FACTS controllers
4. Understand configuration and operation of devices for shunt and series compensation
5. Understand configuration and operation of UPFC

Course Outcome: - At the end of course, student will be able to

CO1:- Compare EHVAC and HVDC transmission
CO2:- Apply the knowledge of multi-terminal HVDC and HVDC Light
CO3:- Compare different types of FACTS Controllers
CO3:- Select appropriate compensation device

Part I HVDC Transmission

Unit 1: 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 2: Multi terminal HVDC system

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

Unit 3: 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.]

Part II : FACTS

Unit 4: 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 5 :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 6: 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.]

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.
6. HVDC Transmission- S Kamakshaiah and V Kamraju, McGraw Hills Publications

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. Electric Power Transmission, B. W. Weedy and Cory, Wiley, 4th Edition.
4. Flexible ac transmission systems(FACTS), Yong Hua Song & Allan T Johns
5. HVDC Power Transmission Systems- K.R.Padiyar, New Age Publications, New Delhi, (2nd Edition)
6. High Voltage DC Transmission and FACTS- Sood Vijay K, CRC Press (USA), 2004
7. HVDC Transmission Power Conversion Applications in Power Systems, Chan-Ki Kim, Vijay K. Sood, Gil-Soo Jang, Seong-Joo Lim and Seok-Jin Lee.

503210: (ELECTIVE- II)

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/week	Paper		TW	Oral / Presentation	Total	
503210		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 and its applications	503210 M2(ii)	Fundamentals of Cyber Security
503210 M1(iii)	Advanced Control Theory	503210 M2(iii)	Disaster Management
503210 M1(iv)	Energy Storage systems	503210 M2(iv)	Communication protocols in SCADA System
		503210 M2(v)	Electrical Power Distribution Systems

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

Course Objectives: - At the end of course, student will be able to

1. Understand the necessity of EHV AC transmission
2. Learn all important aspects of voltage gradient
3. Learn various concepts associated with Corona and electric field
4. Understand design aspects of EHV AC transmission system
5. Understand reasons and remedies for over voltages in EHV systems

Course Outcome: - At the end of course, student will be able to

CO1:- Evaluate the corona and voltage gradient
CO2:- Apply design aspects of EHV systems
CO3:- Apply the knowledge of overvoltage and their remedies

Unit 1 Overview of Electrical power transmission at high voltages [8 Hrs.]
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

Unit 2 Voltage gradients of conductors: [8 Hrs.]
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.

Unit 3 Corona [8Hrs.]

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.

Unit 4 Electric Field under transmission lines and its computation [8Hrs.]

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.

Unit 5 Over voltages in EHV Systems [8 Hrs]

[A] **Over voltages in EHV Systems by Lightning and Lightning Protection**
General Principles of the Lightning-Protection Problem, Tower-Footing Resistance, Insulator Flashover and Withstand Voltage
Probability of Occurrence of Lightning-Stroke Currents, Lightning Arresters and Protective Characteristics, Dynamic Voltage Rise and Arrester Rating, Operating Characteristics of Lightning Arresters

[B] Over voltages in EHV Systems Caused by Switching Operations
Origin of Over voltages and Their Types, Short-Circuit Current and the Circuit Breaker, Recovery Voltage and the Circuit Breaker ,Over voltages Caused by Interruption of Low Inductive Current , Interruption of Capacitive Currents ,Ferro-Resonance Over voltages , Calculation of Switching Surges—Single Phase Equivalents ,Distributed-Parameter Line Energized by Source , Reduction of Switching Surges on EHV Systems

Unit 6 Design Aspects in EHV Transmission systems [8 Hrs]
[A] **Theory of Travelling Waves and Standing Waves**
Travelling Waves and Standing Waves at Power Frequency, Differential Equations and Solutions for General Case, Standing Waves and Natural Frequencies, Open-Ended Line: Double-Exponential Response, Open-Ended Line: Response to Sinusoidal Excitation, Reflection and Refraction of Travelling Waves, Transient Response of Systems with Series and Shunt Lumped Parameters and Distributed Lines, Principles of Travelling-Wave Protection of E.H.V. Lines

[B] Design of EHV Lines Based upon Steady-State Limits and Transient Over voltages
Introduction Design Factors Under Steady State, Design Examples: Steady-State Limits, Design Examples, Line Insulation Design Based Upon Transient Over voltages, Extra High Voltage Cable Transmission, Design Basis of Cable Insulation, Examples of Cable Designs, Tests on Cable Characteristics, Surge Performance of Cable Systems, Gas Insulated EHV Lines.

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
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

Course Objectives:

At the end of the course, a student will be able to –

1. Understand basics of digital signals and systems and understand the basic mathematical tools needed for the analysis of discrete systems.
2. Analyze discrete signals as well as discrete systems in frequency domain and apply related numerical analysis for the same.
3. Understand the basics of filter design with clear understanding of the notion of digital filtering which includes FIR and IIR filters.
4. Know the practical applications of frequency analysis and digital filtering.

Course Outcome:
At the end of course student is able to
CO1: Classify discrete time signal and system and determine Z and inverse Z-transform of DTS.
CO2: Determine frequency response of first and second order LTI system with phase and group delay.
CO3: Derive frequency response of DTS using DTFT and DFT.
CO4: Design and realize IIR filter using different techniques.
CO5: Design and realize IIR filter using different window techniques.
CO6: Apply basics of DSP in different applications of electrical engineering.

Unit 1
A) 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, Discrete-time systems described by difference equations. [4Hrs]
B) Z transform: Definition, basics, properties, inverse Z-transform using power series and partial fraction Solution of difference equation, Analysis of LTI system. [4Hrs]

Unit 2
Frequency analysis of discrete time signals:
A) Discrete Time Fourier Transform: Frequency response of DTS, Discrete frequency spectrum and range, DTFT Definition and its properties, Numericals. [3 Hrs]
B) Discrete Fourier Transform: Definition and Properties of DFT, Circular convolution, Linear convolution using circular convolution, Fast Fourier Transform: Radix 2 DIT and DIF algorithms. [5 Hrs]

Unit 3

Time and Frequency response of discrete time systems:

A) Time Response: Natural response, forced response and total response, impulse response and step response. [3Hrs]

B) Frequency response: 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. [5 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. [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 (rectangular, Hanning and Kaiser),
Realization of IIR filters: direct form I, direct form II, cascade and parallel.
Realization of FIR filters by direct form, cascade form and parallel form. [8 Hrs]

Unit 6

Applications of DSP to power system:

1) Measurement of power
2) Measurement of frequency
3) PWM generation
4) Condition monitoring and speed control of Electrical Machines
5) Power transformer protection
6) Synchronized phasor measurement
7) Harmonic Analysis
8) Design of Discrete PID controller. [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
3. P.Ramesh Babu "Digital Signal Processing" 4th Edition, Scitech Publication, Chennai

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

References:

1]. C. Gherasim, J. Van den Keybus, J. Driesen and R. Belmans, "DSP implementation of power measurements according to the IEEE trial-use standard 1459," in *IEEE Transactions on Instrumentation and Measurement*, vol. 53, no. 4, pp. 1086-1092, Aug. 2004.

2]. Q. Shang and C. Du, "A Novel Measurement System of Electric Power Parameters Based on DSP and ARM," *2009 International Conference on Measuring Technology and Mechatronics Automation*, Zhangjiajie, Hunan, 2009, pp. 353-356.

3]. D. Liu and G. Liao, "Multi-functional Power Parameter Harmonic Detection System," *2010 WASE International Conference on Information Engineering*, Beidaihe, Hebei, 2010, pp. 173-176.

4]. H. Ukai, K. Nakamura, S. Nishigaki, Y. Ohta and N. Matsui, "Advanced synchronized measurement system of harmonics using DSP and GPS," *2000 26th Annual Conference of the IEEE Industrial Electronics Society. IECON 2000. 2000 IEEE International Conference on Industrial Electronics, Control and Instrumentation. 21st Century Technologies*, Nagoya, 2000, pp. 748-753 vol.2.

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

Course Objectives: The students will be able to understand

1. the design of different controllers
2. nonlinear control method: Sliding Mode Control and design a controller
3. Widely used observers like Sliding Mode observer and Nonlinear Extended state observer
4. application of SMC to converters
5. different stability concepts in the context of linear and nonlinear systems
6. nonlinear controller design

Course Outcome: The students will be able to

CO1 :- Design controllers like PID, Pole placement, LQR, Feedback Linearization, Sliding mode control
CO2 :- Design and implement observer based control laws
CO3:- Apply sliding mode control to power converters

Unit I:Classiscal and Modern Control :

A) PID Control, Tuning methods (Ziegler Nichols, Cohen Coon)
State space method, analysis and design of control systems in state space, pole placement (3 methods) [04 Hrs]
B) Luenberger observer, Design of control system with Luenberger observer [02 Hrs]
C) Introduction to optimal control problems, design of control system with LQR controller [02 Hrs]

Unit II: Sliding Mode Control **[**08 Hrs]

Concept of Sliding mode Control, chattering, chattering attenuation, concept of equivalent control, sliding mode equation, sliding surface design, regular form

Unit III: State and Disturbance Observers [08 Hrs]

Evolution of state and disturbance observers a brief history

1. Sliding Mode Observers: mathematical model of observer, procedure for gain selection, error analysis, application to real life system and stability, advantages and limitations

2. Nonlinear Extended State Observer: mathematical model of observer, nonlinear gain selection, Linear ESO, error analysis, application to real life system and stability, advantages and limitations

Unit IV- Application of Sliding Mode Control to Power Converters **[**08 Hrs]

DC/DC Converters, Direct sliding mode control, Buck-type DC/DC converter, Boost type DC/DC converter, Observer-based control: Observer based control of Buck converters, Observer-based control of boost converters

Unit V: Non-linear Control: [08Hrs]

Nonlinear systems and equilibrium points, Linearization and local stability, Lyapunov stability criterion, Methods of constructing Lyapunov's functions for Nonlinear systems: Krasovskis, Variable gradient Method

Unit VI: Nonlinear Control System Design: [08 Hrs]

Feedback linearization, I-O Linearization: Generating a linear IP- OP relation, Normal Forms, Zero dynamics, I-S Linearization

Text Books:

1**.** 'Modern Control Engineering'- Katsuhiko Ogata, Prentice Hall India, 5th edition 2010.

2. 'Control Systems Engineeing' by IJ Nagrath and M Gopal ,Sixth edition , New Age International Publishers

3. 'Applied Non Linear Control', Jean-Jacques E. Slotine, Prentice Hall Englewood Cliffs, New Jersey.

4. Sliding Mode Control and Observation
Shtessel, Y., Edwards, C.,Fridman,L,levant, A, Publisher-Springer

5. Sliding Mode Control-Utkin

Reference Books:

1.'Sliding-mode Control: Theory and applications' by Sarah K. Spurgeon, Taylor & Francis, 1998

2. IEEE Papers for observers

503210 M1(iv) :ENERGY STORAGE SYSTEMS

Teaching Scheme
4 Hours / Week
Credits: 4

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

Course Objectives: Student will be able to

1. Get knowledge of different principles of energy storage and conversion.
2. Learn about feasibility of different energy storage devices and their integration for complete control system.
3. Get knowledge of Electrical energy storage systems namely battery and Ultra-capacitor.
4. Design different converter topologies for Energy storage system and tie integration with power system.

Course Outcomes, Students will be

CO1. Able to explain the fundamental principles of energy storage and conversion
CO2. Analyze, model and simulate a Energy system to know its performance characteristics.
CO3. Select a battery storage system based on load requirement in a electric vehicle.
CO4. Design a converter topology for hybrid energy storage system and realize the same as a hardware system.
CO5. Select, design and implement a energy storage device based on load delivery pattern.

Unit I. Conventional energy storage systems

Compressed gas storage system: bulk energy storage. System cost, capacity, conversion efficiency, Flywheel: Models for flywheel capacity, availability, efficiency, and self-discharge, applications in transportation, uninterruptible power supply (UPS). (06 Hrs)

Unit II. Battery energy storage system

Battery specifications and performance characteristics, emerging battery technologies. Comprehensive analysis of design considerations and application specific needs. Impacts on system cost in terms of life cycle, environmental, and reliability of the end solutions. Batteries for Automobiles and Electric Vehicles: Specifications and performance characteristics of Lead-Acid, Nickel-Cadmium, Nickel-Metal, Hydride and, Lithium-Ion Batteries. (08 Hrs)

Unit III. Fuel Cells

Introduction to fuel cells. Proton exchange membrane (PEM) including direct methanol, phosphoric acid, alkali, solid oxide, and molten carbonate. Topics include understanding of operation, benefits, economics, lifetimes and failure mechanisms. Application of fuel cells in the bulk power and energy system. (08 Hrs)

Unit IV. Capacitors

Introduction to ultra-capacitors including operation, applications, and emerging technologies. Topics include the usage in mobile applications and close proximity to renewable energy sources. Discussion of primary target market usage in today's energy and power sectors.

(10 Hrs)

Unit V. Hybrid energy storage systems

Battery-Ultra capacitor hybrid storage systems: Matching characteristics both energy devices supplying a common load.

Energy and power management of Hybrid energy storage system, control strategies for applications like Electric vehicle and grid connected renewable. (08Hrs)

Unit VI. Converter topology for Electric energy storage and utility

Design of converters for battery storage, standalone PV system and grid integration with renewables. (08 Hrs)

Text Books

1. Sukhatme,S.P., "Solar Energy", TataMcGrawHill,1984
2. Kishore V V "Renewable Energy Engineering and Technology" ,Teri Press,NewDelhi,2012

Reference Books:

1. Thaler, Alexander, Watzenig, Daniel, "Automotive Battery Technology" Springer
2. A.TerGazarian, "Energy storage for Power Systems", Peter Peregrinus Ltd on behalf of Institution of Electrical Engineers
3. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2002
4. Fuel cell systems Explained, James Larminie and Andrew Dicks, Wiley publications, 2003.
5. Electrochemical technologies for energy storage and conversion, Ru-shiliu, Leizhang, Xueliang sun, Wiley publications, 2012
6. Robert Huggins, "Energy storage –Fundamentals,Materials And Applications ",Springer
7. National Academy Press ,Washington, "A comparison of Alternative Storage Systems for automobiles"
8. Patrick T. Moseley, Jürgen Garche , "Electrochemical Energy Storage for Renewable Sources and Grid balancing" , Elsevier Publication

503210 M2(i) : ELECTRIC VEHICLES

Teaching Scheme
Lectures: 1 Hr/Week
Credit: 1

Examination Scheme
In-Semester Examination : 25 Marks

Course Outcome:
At the end of this course student will be able to
CO1: Distinguish between different configuration of electric vehicles with merits and demerits.
CO2: Recommend drive for EV applications with suitable energy storage technology.

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
Semester Examination : 25 Marks

Course Outcome:
At the end of this course student is able to
CO1: Be familiar with information security awareness, a clear understanding of its importance, network security threats and countermeasures
CO2: Master fundamentals of secret and public cryptography using different security models.

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

Course Objectives:

At the end of this course student will be able to
CO1: Get knowledge about various disasters
CO2: Make plan for relief and strategies of disaster management

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

Course outcome
At the end of this course student will be able to
CO1: Familiar basic structure of SCADA system architecture.
CO2: Describe communication and protocols in SCADA system.

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.

503210 M2 (v) : Electrical Power Distribution Systems

Teaching Scheme
Lectures: 1 Hr/ Week

Examination Scheme
In-Semester Examination : 25 Marks

Course outcome
At the end of this course student will be able to

CO1: Design the distribution system for given application.

CO2 : Be familiar with the protection and reliability issues in distribution systems

CO3: Describe primary and secondary distribution systems

Unit 1:

Distribution network planning, distribution transformers, grounding and protection Distribution losses distribution substation, transformers for distribution systems, substation bus schemes, description and comparison of switching schemes, substation location and rating, Capacitors in distribution systems and distribution system protection. [07 Hrs]

Unit 2:

Design considerations on primary systems: Introduction, types of feeders, voltage levels, radial type feeders, design considerations of secondary systems: secondary voltage levels, existing systems improvement. Distribution system automation: Reforms in power sector, methods of improvement, reconfiguration, reinforcement, automation, communication systems. [07 Hrs]

Text Books:

1. Electrical Power Distribution Engineering by Turan Gonen, McGraw Hill.

Reference Books:

1. Electrical Power Distribution by A. S. Pabla, TMH, 5th Ed., 2004
2. Electrical distribution Systems by Dale R. Patrick, Stephen W. Fardo, CRC Press

503211: LAB PRACTICE- II

Teaching Scheme
4 Hrs / Week
Credits : 04

Examination Scheme
Term Work: 50 Marks
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. Butterworth 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
4 Hrs/Week
Credits: 4

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

Seminar I **s**hall be on the state of the art topic of student's own choice based on relevant specialization approved by an authority. Topic should cover the advancement on the technology under specialization. The content of seminar report may include basic theory, concept, schematics, models, methods, economics, merits, demerits etc. relevant to the selected topic of seminar. A student should study sufficient number of papers from referred journals related to the topic in consultation with the guide. A guide should maintain weekly record of discussion related to the topic. The student shall submit the seminar report in standard format, duly certified by the concerned Guide and Head of the department/institute for satisfactory completion of the work.

Semester III

603201: ADVANCED POWER SYSTEM PROTECTION

Teaching Scheme
Lectures: 4 Hours / Week
Credits: 4

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

Course Objectives:

1. To understand effects of different short circuit faults on power system.
2. To analyse steady state and transient performance of current and potential transformer.
3. To study two point and three point Least Error Squared (LES) technique.
4. To understand digital protection of synchronous generator and transformer.
5. To understand different protection schemes of transmission line.
6. To comprehend different aspects of setting and coordination of distance and overcurrent relay.

Course Outcomes: At the end of course, the student will be able to

CO1:- Develop an algorithm for short circuit studies in power system.

CO2:- Differentiate between measuring and protective devices and use CTs and PTs suitably.

CO3:- Do phasor calculation using two point and three point Least Error Squared technique and differentiate between the two.

CO4:- Apply different digital protection schemes for synchronous generator and transformer.

CO5:- Differentiate between different protection schemes of transmission line.

CO6:- Differentiate between relay setting and coordination in case of distance relays and overcurrent relays.

Unit I: 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. [8 Hrs]

Unit II: Current and voltage transformers:
A) Current Transformer: Polarity and dot marks, difference between measuring and protective devices, equivalent circuit, steady state and transient performance, accuracy class.
B) Potential Transformer: Steady state and transient performance.
C) CCVT: Equivalent circuit, applications, transient response, classification and design. [8 Hrs]

Unit III: Numerical Protection
Introduction, block diagram of numerical relay, sampling theorem, correlation with a reference

wave, digital filtering, and numerical over- current protection, phasor calculation using two point and three point LES techniques, Fourier analysis, Half and full DFT. [8 Hrs]

Unit IV A) Digital protection of Synchronous generator:
Introduction, faults in synchronous generator, protection schemes for synchronous generator, digital protection of synchronous generator.

B) Digital Protection of Power Transformer:
Introduction, faults in a transformer, schemes used for transformer protection, digital protection of transformer [8Hrs]

Unit V: Digital Protection of Transmission Line:
Introduction, Protection scheme of transmission line, distance relays, travelling 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 VI: Distance and overcurrent relay setting and co-ordination: Directional instantaneous IDMT overcurrent relay, directional multizone distance relay, distance relay setting, co-ordination of distance relays, co-ordination of overcurrent relays, computer graphics display, man-machine interface subsystem, integrated operation of national power system, application of computer graphics. [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 Y. G. (Marcel & Dekker, New York)

Reference Books :

1. Fundamentals of Power System Protection- Paithankar Y. G. & Bhide (PHI 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. NPTEL course on power system protection by S. A. Soman.

603202: POWER QUALITY ASSESSMENT AND MITIGATION

Teaching Scheme
Lectures: 4 Hours / Week
Credits : 4

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

Course Objectives: - At the end of course, student will be able to

1. Understand important power quality attributes, various devices and methods of power quality measurements
2. Understand and learn to identify harmonics in systems
3. Learn various equipment of monitoring and assessment

Course Outcome: - At the end of course, student will be able to

CO1:- Identify the presence of power quality attributes
CO2:- Evaluate and measure various power quality attributes
CO3 :- Identify the sources of waveform distortion
CO4 :- Monitor and assess various types of power quality issues.

Unit1: 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.

[8Hrs]

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.

[8Hrs]

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. Measurement of voltage sag half cycle RMS, one cycle rms methods. 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 I

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. Power assessment under waveform distortion conditions.

[8Hrs]

Unit 5 : Waveform Distortion II

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.

[8 Hrs]

Unit 6 : Power Quality monitoring and assessment

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. Selection of transducers. Harmonic monitoring , Transient monitoring, event recording and flicker monitoring. Power Quality assessment, Power quality indices and standards for assessment disturbances, waveform distortion.

[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)	Artificial Neural Network 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
Lectures: 4 Hrs./Week
Credits : 4

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

Course Objectives: - At the end of course, student will be able

1. To introduce to the fundamentals of artificial neural network along with its original source of development.
2. To inform about various architecture and learning rules of ANN
3. To inform about the single layer and multilayer perceptron models
4. To explore learning rules of feed forward network, self organizing map and radial basis function.
5. To study various applications of ANN

Course Outcome:- At the end of course, student will be able to

CO1: Understand the basics of ANN along with all properties
CO2: Understand, compare and select architectures of ANN
CO3: Understand, compare and select learning rules of ANN
CO4: Apply the knowledge of ANN for various applications

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 forecasting, classification, 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

Course Objectives: - At the end of course, student will be able to

1. Learn various renewable sources of power/energy such as solar , wind and others
2. Understand and learn important issues associated with grid integration of renewable energy sources.
3. Learn smart grid, technologies and communication network in smart grid

Course Outcome: - At the end of course, student will be able to

CO1:- Evaluate the potential of solar, wind and other sources of energy.
CO2 :- Apply smart grid concepts and technologies of smart grid

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

Course Objectives:
After the completion of the course students will be able to
1. Understand the special features and architecture of Digital Signal Controller/processor.
2. Understand the memory mapping and data memory access.
3. Understand digital I/O operation.
4. Understand advance features like QEP, interrupt structure, ADC and PWM.

Course Outcomes:
CO1:Write an embedded C language programs for TMS 320F2812.
CO2: Use Code Composer Studio for programing TMS 320F2812.
CO3: Write programs for Digital Input output, Interrupts and ADC.
CO4: Connect trainer kit of TMS320F2812 to external devices.
CO5: Use advance features like PWM, QEP, inverter control for engineering applications

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

Course outcome
At the end of this course student is able to
CO1: Model and design control scheme using fuzzy logic.
CO2: Apply genetic algorithm in power system optimization problem.

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. Selforganizing 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

Course outcome
At the end of this course student is able to
CO1: Design sensors and transducer for measurement of electrical and non electrical quantities and convert signals into analog or digital form.
CO2: Distinguish between primary sensors, IC technologies, micro and nano sensors.

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

Course outcome
At the end of this course student is able to
CO1:Learn about policies, schemes and Constitution about Human rights
CO2: Learn roles of various entities about human rights

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

Course outcome
At the end of this course student is able to
CO1: Learn green and sustainable design techniques for both commercial and residential buildings.
CO2: Design water, lighting, energy efficiency plan using renewable energy source.

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 and based on broader area of interest to facilitate to proceed for dissertation work, selected by him/her approved by the guide and authority. He/she should study basic theory related to the topic from standard references. A student is expected to perform the exhaustive literature review of the topic. The student should focus on understanding the state of art – concept, literature published at standard platforms to enable the finalization of objective of his/her ME dissertation. A guide should maintain weekly record of discussion related to the topic. 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.

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.) simulation model, Layout & Design of the Set-up and results if obtained. As a part of the progress report of Project Stage-I, the student shall deliver a presentation on the advancement in Technology pertaining to the selected dissertation topic. The project stage I is the progress presentation of dissertation work. The student should clearly present different stages in which dissertation work is to be completed, giving planning of the remaining part to be completed in Project Stage-II. Publication based on the work is desirable in the reputed national or international journal or in the proceedings of reputed and reviewed conferences. A guide should maintain record of discussion related to the topic, work carried out by the student. 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.

Semester IV

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 content of report of seminar III will include development of the work till date along with relevant theory. A guide should maintain record of discussion related to the topic, work carried out by the student, action taken etc. 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. A student must publish minimum one paper based on the dissertation work in the reputed national or international journal or in the proceedings of reputed and reviewed conferences. Details of this publication should be mentioned in the final report. The dissertation work of candidate would be evaluated by the guide as well as panel of internal/external experts, before submitting it to the university so as to ensure basic minimum quality standard. A proper record of this evaluation is needed to be maintained. A guide should maintain record of discussion related to the topic, work carried out by the student, action taken etc. 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, head of the Department and head of the Institute.