FACULTY OF ENGINEERING

Syllabus for the

M.E. Electrical (Power Systems)

(w.e.f. 2008-2009)

UNIVERSITY OF PUNE

THE SYLLABUS IS PREPARED BY :

BOS- Electrical Engineering,

University of Pune.

PEER REVIEW BY :

- Prof. M.G. Unde, (Chairman)
- Dr.D.J.Doke,
  Ex-Dean FOE, University of Pune, Pune.
- Dr.J.G.Ghodekar,
  Ex-Dean FOE, Shivaji University, Kolhapur
- Shri Shantanu Dixit, (Expert from Industry)
  Prayas, Pune
- Shri. D.M.Tagare, (Expert from Industry)
  Madhav Capacitors Pvt. Ltd., Pune.

Note : This syllabus is subject to change without prior notice by the concerned BOS

Structure of M.E.(Electrical)- Power Systems (2008 Course)
ELECTRICAL ENGINEERING BOARD
University of Pune

Subject Code no.	Subject	Teaching Scheme		Examination Scheme			Total marks	Credits
		Lect	Pract	paper	Tw	Or		
Semester- I								
503201	Computer Applications in Power Systems	3	---	100	---	---	100	3
503202	Power Sector Economics, Management and Restructuring	3	---	100	---	---	100	3
503203	Power System Modeling	3	---	100	---	---	100	3
503204	Elective -I	3	---	100	_	---	100	3
503205	Elective -II	3	----	100	_	----	100	3
503206	Lab-Practice - I	----	6	---	50	----	50	3
503207	Seminar-I	----	4	---	50	---	50	2
	Total	**15**	**10**	**500**	**100**	**----**	**600**	**20**

Semester- II

Subject Code no.	Subject	Teaching Scheme		Examination Scheme			Total marks	Credits
		Lect	Pract	paper	Tw	Or		
503208	Power System Dynamics	3	---	100	---	---	100	3
503209	Power System Planning & Reliability	3	---	100	---	---	100	3
503210	High Voltage Power Transmission	3	---	100	---	---	100	3
503211	Elective - III	3	---	100	---	---	100	3
503212	Elective - IV	3	---	100	---	---	100	3
503213	Lab-Practice - II	---	6	---	50	---	50	3
503214	Seminar - II	---	4	---	50	---	50	2
	Total	**15**	**10**	**500**	**100**	**---**	**600**	**20**
Semester- III								

Subject Code no.	Subject	Teaching Scheme		Examination Scheme			Total marks	Credits
		Lect	Pract	paper	Tw	Or		
603201	Seminar III	---	4	---	50	---	50	2
603202	Project stage -I	---	18	--	50	---	50	6
	Total		**22**		**100**	**---**	**100**	**8**

Semester- IV

Subject Code no.	Subject	Teaching Scheme		Examination Scheme			Total marks	Credits
		Lect	Pract	paper	Tw	Or		
603202	Project stage-II	--	18	---	150	50	200	12
	Total		**18**	**----**	**150**	50	**200**	**12**

Note: The contact hours for the calculation of load of teacher Seminar - 01 Hr/Week/student

Project - 02 Hrs/Week/Student

Contd…2

Continue, Structure of M.E. (Electrical) - Power System (2008 Course)

- **Lab- Practice- I & Lab. Practice - II** will have minimum 10 experiments each.
- **Seminar III** will be based on the Project Work.
- The Term Work of Project stage II of semester IV should be assessed jointly by the pair of internal and external examiners, along with the oral examination of the same.

Elective - I

i) Digital Signal Processing and its Applications
ii) Advanced Power Electronics

Elective - II

i) Artificial Intelligence and its Applications in Power Systems .
ii) Renewable Energy Sources

Elective - III

i) Digital Power System Protection
ii) Power Electronics Applications in Power Systems

Elective - IV

i) Power Quality Assessment and Mitigation
ii) Partial Discharges in Electrical Power Apparatus
iii) Open *

* Candidate will have option for any one of the elective subject from the existing Pune University PG programmes, either from the same Board or from any other Board, with the consent of his guide.

PROF. M. G. UNDE

Date: 08-02-2008

CHAIRMAN
B.O.S.
ELECTRICAL ENGG.
UNIVERSITY OF PUNE

503201:COMPUTER APPLICATIONS IN POWER SYSTEMS

Teaching Scheme	Examination Scheme
3 Hours / Week	Paper : 100 Marks

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. [8hrs]

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. [8hrs]

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. [8hrs]

Unit 4

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, 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. [10 hrs]

Unit 5

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. [6hrs]

Unit 6

Fault Analysis

Revision of symmetrical and unsymmetrical faults, formulating the sequence impedance matrix, fault configurations and equations, General computer simulation of faults. [6hrs]

Text Books:

1. *Computer Aided Power System operation and Analysis-R.N.Dhar, Tata Mc-Graw 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 (TataMcGraw Hill)*
4. *Electrical Energy System Theory–an introduction- Olle Elgerd. TMH Publishing Company, New Delhi*
5. *Power System Optimisation- D. P. Kothari, J. S. Dhillon, PHI*
6. *Power Generation Operation and Control – Allen Wood, Wiley Publications*

503202: Power Sector Economics, Management and Restructuring

Teaching Scheme	Examination Scheme
3 Hours / Week	Paper : 100 Marks

Unit 1

Power Sector in India

Introduction to various institutions in Indian Power sector such as CEA, Planning Commissions, PGCIL, PFC, Ministry of Power, state and central governments, REC, utilities and their roles. Critical issues / challenges before the Indian power sector, Salient features of Electricity act 2003, Various national policies and guidelines under this act. [8hrs]

Unit 2

Power sector economics and regulation

Typical cost components and cost structure of the power sector, Different methods of comparing investment options, Concept of life cycle cost , annual rate of return , methods of calculations of Internal Rate of Return(IRR) and Net Present Value(NPV) of project, Short term and long term marginal costs, Different financing options for the power sector .

Different stakeholders in the power sector, Role of regulation and evolution of regulatory commission in India, types and methods of economic regulation, regulatory process in India. [8hrs]

Unit 3

Power Tariff

Different tariff principles (marginal cost, cost to serve, average cost),

Consumer tariff structures and considerations, different consumer categories, telescopic tariff, fixed and variable charges, time of day, interruptible tariff, different tariff based penalties and incentives etc., Subsidy and cross subsidy, life line tariff, Comparison of different tariff structures for different load patterns. Government policies in force from time to time. Effect of renewable energy and captive power generation on tariff. Determination of tariff for renewable energy.

[6hrs]

Unit 4

Power sector restructuring and market reform

Different industry structures and ownership and management models for generation, transmission and distribution. Competition in the electricity sector- conditions, barriers, different types, benefits and challenges Latest reforms and amendments.

Different market and trading models / arrangements, open access, key market entities- ISO, Genco, Transco, Disco, Retailco, Power market types, Energy market, Ancillary service market, transmission market, Forward and real time markets, market power.

[8hrs]

Unit 5

Electricity Markets Pricing and Non-price issues

Electricity price basics, Market Clearing price (MCP), Zonal and locational MCPs.

Dynamic, spot pricing and real time pricing, Dispatch based pricing, Power flows and prices. Optimal power flow Spot prices for real and reactive power. Unconstrained real spot prices, constrains and real spot prices.

Non price issues in electricity restructuring (quality of supply and service, standards of performance by utility, environmental and social considerations)

Global experience with electricity reforms in different countries.

[9hrs]

Unit 6

Transmission Planning and pricing

Transmission planning, Different methods of transmission pricing, Different transmission services, Congestion issues and management, Transmission cost allocation methods, Locational marginal price, firm transmission right.

Transmission ownership and control, Transco and ISO, Transmission pricing Model in India, Availability based tariff, role of load dispatch centers (LDCs) Salient features of Electricity act 2003, Price based Unit commitment, concept of arbitrage in Electricity markets, game theory methods in Power System, security constrained unit commitment. Ancillary services for restructuring, Forward ancillary service auction. Power purchase agreements [9hrs]

References:

Text Books:

1. *"Know Your Power", A citizens Primer On the Electricity Sector, Prayas Energy Group, Pune*
2. *Sally Hunt, "Making Competition Work in Electricity", 2002, John Wiley Inc*
3. *Electric Utility Planning and Regulation, Edward Kahn, American Council for Energy Efficient Economy*

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.in*
6. *Market Operations in Electric Power Systems Forecasting, Scheduling and Risk Management –Mohammad Shadepur, Hatim Yatim, Zuyi Li.*
7. *Bhanu Bhushan, "ABC of ABT - A primer on Availability Tariff" - www.cercind.org*

Website:

1. *www.mercindia.com*
2. *www.cercind.org*
3. *www.prayaspune.org*

503203 :Power System Modeling

Teaching Scheme	Examination Scheme
3 Hours / Week	Paper : 100 Marks

Unit 1

Modelling of Power System Components:

The need for modelling of power system, different areas of power system analysis. Simplified models of non-electrical components like boiler, steam & hydro-turbine & governor system.

Transformer modelling such as auto-transformer, tap-changing & phase-shifting transformer.

[8 Hrs]

Unit 2

Synchronous machine modelling :

Model required for steady-state analysis. The development of model required 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 modelling:

Synchronous machine connected to an infinite bus, its simulation for steady-state condition [8 Hrs]

Unit 4

Excitation system modelling - I:

Simplified view of excitation control. Excitation configuration, primitive systems, Definitions of voltage response ratio & exciter voltage ratings.

[8 Hrs]

Excitation system modelling - II:

Excitation control systems using dc generator exciter, alternator-rectifier, alternator-SCR, voltage regulators such as electro-mechanical and solid state. [8 Hrs]

Unit 6

Transmission line, SVC and load modelling :

Transmission line, d-q transformation using $\propto$-β variables, static VAR compensators, load modeling. [8 Hrs]

Text Book:

1. Power Systems Dynamics – K.R.Padiyar, B.S. Publications
2. Power System Control and Stability – Vol. – I – Anderson & Foud, IEEE Press, New York.

Reference Books:

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

503204 : (Elective – I) DIGITAL SIGNAL PROCESSING & ITS APPLICATIONS

Teaching Scheme	Examination Scheme
3 Hours / Week	Paper : 100 Marks

Unit I : Analysis of Signals :
Fourier Series (Trigonometric and exponential, Fourier Transform (Full Details), Convolution concept, Sampling theorem, Analog to digital Conversion, Discrete time signals, Analysis of Discrete time systems, Z transform, inverse Z transform with properties. 6 hrs

.

Unit II : Analysis of signals in digital domain:
Discrete Fourier Transform(DFT) and inverse DFT, FFT algorithm, frequency analysis of discrete time signal, power density, energy density. Application : Harmonic Analysis 6 hrs

Unit III : FIR Filter:
Symmetric, Anti-symmetric Filter design using windows, frequency sampling techniques, brief idea about alternation theorem and equi-ripple filter, design structure-direct form and cascade form , structure realization. Application : Detection of fault in bearings 8 hrs

Unit IV: IIR Filter:
Basic concepts of analog filter design using Bufferwortz and chebysheb applications
IIR filter design methods such as impulse invariance, bilinear transform filter structures, A)Direct Form B) Parallel form C) Cascade form
Application : Detection of filters to remove the noise for detecting commands on power transmission lines. 6 hrs

Unit V: Basics of DSP architecture:
Desirable features and architecture of DSP processors, multiplex and multiplier accumulator, modified bus structures and memory access schemes, multiple access memory, multi-ported memory, piping, special addressing modes in DSP, ON-chip peripherals ,Effect of finite word length. 6 hrs

Unit VI: DSP Processors and applications:
Study of DSP processors such as TMS320C5X, and others and their applications to power systems. 8 hrs

Text Books:

1. Digital Signal Processing – John Proakis and Manolakis (Prentice Hall of India Pvt. Ltd.) (Refer chapter 1 to 5)
2. Digital Signal Processing- A Computer based approach – S.K.Mitra (Tata McGraw Hill Publication)

Reference Books :

1. Digital Signal Processors- B. Venkat Ramani and Bhasker (Refer chapter 2 to 5) (Tata McGraw Hill Publishing Co., New Delhi)
2. Discrete – time signal processing – A.V. Oppenheim, Schafer, Buck (Pearson Prentice Hall)
3. Signals and Systems – A.V.Oppenheim, Willisky (Prentice Hall of India Pvt. Ltd.)

503204: (Elective- I) ADVANCED POWER ELECTRONICS

Teaching scheme : 3Hrs/Week Examination Scheme
Paper :100 Marks

Note : Mathematical treatment is necessary, as applicable

Unit 1: Review of Modern Power Devices :

Constructional features, characteristics and specifications of following power devices-SCR, GTO, MOSFET,IGBT, MCT. Comparison of devices. (4Hrs.)

Unit 2: Voltage Source Converters :

3-ph- full wave bridge converter, operation and harmonics, Transformer connection for 12 pulse operation, 24 and 48 pulse operation. Operation of 12-pulse converter. 3 level voltage source converter. PWM converter. Generalised technique of harmonic elimination and voltage control. Advanced modulation techniques (SPWM, space vector modulation, 3^{rd} harmonic PWM) Comparison of PWM techniques. Converter rating. (10 Hrs.)

Unit 3: Self and Line commutated current source converter:

Basic concepts of CSC, converters with self commutating devices. Comparison with voltage source converter (6Hrs.)

Unit 4 : Multilevel Inverters :

Multilevel concept, Types of multilevel Inverters, diode clamped multilevel inverter, flying-capacitors multilevel inverters, cascaded multilevel inverter, applications switching device currents, d.c. link capacitor voltage balancing, features of multilevel inverters, comparison of multilevel converters (8 Hrs.)

Unit 5 : Energy Storage Systems :

Flywheel energy storage system, superconducting magnetic energy storage system, other energy storage systems, active filters, shunt, series and hybrid filters (6Hrs.)

Unit 6: Akagi's p-q theory:

Conventional concepts of active and reactive power in single phase and three phase circuits- Equation of power with sinusoidal voltage source and non-linear loads- $\alpha\beta o$ 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

Active filters- series, shunt, and their comparison (6Hrs)

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.

Reference Books :

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

503205: Elective – II: Artificial Intelligence & its Applications in Power System

Teaching Scheme	**Examination Scheme**
3 Hrs/Week	**Paper: 100 Marks**

Unit I) Introduction to Artificial Intelligence :

Introduction , Fuzzy systems, Artificial Neural Network (ANN), Expert Systems, Genetic Algorithm, Evolutionary Programming.

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, [6 Hrs]

Unit II) 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) [6 Hrs]

Unit III) Single Layer Network and Multi-layer Network :

Single Layer Perceptron: architecture – training algorithm, Least – Mean square algorithm, learning curves, Learning Rate, Annealing techniques.

Feed forward Neural Network(MLP) , Back propagation algorithm. Limitation of Back-propagation algorithm.

Concept of learning rate, momentum coefficient, Generalization capacity,

[8 Hrs]

Unit IV) Fuzzy Mathematics :

Basic concept of Fuzzy Logic, Fuzzy set – Basic definition – Mambership function, Operations of fuzzy sets. [6 Hrs]

Unit V) Fuzzy Theory :

Fuzzy relations - Fuzzy graphs - Fuzzy analysis – Propositional logic , predictive logic, Fuzzy set theory. [8 Hrs]

Unit VI) AI Applications in Power Systems :

Application of ANN and Fuzzy logic in Power System Planning , Operation and control – load forecasting, Unit Commitment, Load Dispatch and Protection.

[6 Hrs]

Text Books:

1. Simon Haykin, “Neural Networks: A Comprehensive Foundation”, 2nd Edition, Pearson Education.
2. Zimmermann, H. J., 'Fuzzy Set Theory and Its Applications', 2nd Edition, Kluwer Academic Publishers.
3. El Hawaray “Electrical Power Applications with Fuzzy systems”, IEEE Press.
4. Power System Optimisation- D. P. Kothari, J. S. Dhillon, PHI
5. M.Ganesh,”Introduction to fuzzy sets and fuzzy logic” Prentice Hall India.
6. Kelvin Waruicke, Arthur Ekwlle, Raj Agarwal, “AI Techniques in Power System”, IEE London U.K.

Reference Books:

1. S. Rajsekaram, G. A. Vijayalaxmi Pai, “Neural Networks, Fuzzy Logic & Genetic Algorithms Synthesis & Applications”, Practice Hall India
2. S. N. Sivanandam, S. Sumathi, S. N. Deepa, “Introduction to Neural Network Using MATLAB 6.0”, Tata McGraw Hill
3. George Klir & Tina. A. Folger, 'Fuzzy Sets, Uncertainty and Information', Prentice Hall of India Pvt. Ltd
4. G. F. Luger and W. A. Stubblefield, *Artificial Intelligence*. Redwood City, CA: Benjamin Cummings, 1993.
5. Mohamed H. Hassoun, “Fundamentals of Artificial Neural Network”, Practice Hall India.
6. Eugene Charniat, Drew McDermott, ”Introduction to Artificial Intelligence” Pearson Education.
7. James A. Anderson, “An Introduction to Neural Networks”, Practice Hall India Publication.
8. Jacek Zurada, “Introduction to Artificial Neural Network”, Jaico Publishing House India.
9. A. J. Wood and B. F. Wollenberg, Power Generation, Operation and Control. New York: Wiley, 1996.

Reference Papers :

[1] C.-C. Su and Y.-Y. Hsu, “Fuzzy dynamic programming: an application to unit commitment,” *IEEE Trans. Power Syst.*, vol. 6, pp. 1231–1237, Aug. 1991. no. 6, pp. 339–346, Feb. 1996.

[2] H. Sasaki, M. Watanabe, and R. Yokoyama, “A solution method of unit commitment by artificial neural networks,” *IEEE Trans. Power Syst.*, vol. 7, pp. 974–981, Aug. 1992.

[3] H. Sasaki, M. Watanabe, J. Kubokawa, N. Yorina, and R. Yokoyama, “A solution method of unit commitment by artificial neural network,” in *Proc. IEEE Power Eng. Soc. Summer Meeting*, 1991.

[4] M. P.Walsh and M. J. O. Malley, “Augmented Hopfield network for unit commitment and economic dispatch,” *IEEE Trans. Power Syst.*, vol. 12, pp. 1765–1774, Nov. 1997.

[5] N. P. Padhy, “A new fuzzy expert decision making approach for unit commitment with reliable risk reserve and emission constraints,” *J. Energy Environment*, vol. 1, pp. 25–36, Nov. 1999.

[6]“Unit commitment using hybrid models: a comparative study for dynamic programming, expert system, fuzzy system and genetic algorithms,” *Elect. Power Energy Syst.*, vol. 23, pp. 827–836, 2000.

[7] S. Li, S. M. Shahidehpour, and C. Wang, “Promoting the application of expert systems in short-term unit commitment,” *IEEE Trans. Power Syst.*, vol. 3, pp. 286–292, Mar. 1993.

[8] S. Mukhtari, J. Singh, and B. Wollenberg, “A unit commitment expert system,” *IEEE Trans. Power Syst.*, vol. 3, pp. 272–277, Feb. 1988.

[9] S. Saneifard, N. R. Prasad, and H. A. Smolleck, “A fuzzy logic approach to unit commitment,” *IEEE Trans. Power Syst.*, vol. 12, pp. 988–995, May 1997.

[10] S.-J. Huang and C.-L. Huang, “Application of genetic-based neural network to thermal unit commitment,” *IEEE Trans. Power Syst.*, vol. 12, pp. 654–660, May 1997.

503205: (Elective-II) Renewable Energy Sources

Teaching Scheme
3Hours/Week

Examination Scheme
Paper : 100 Marks

Unit - 1) Energy Scenario :

Classification of Energy Sources, Energy resources (Conventional and non-conventional), Energy needs of India, and energy consumption patterns. World-wide Potentials of these sources. Energy efficiency and energy security. Energy and its environmental impacts. Global environmental concern, Kyoto Protocol, Concept of Clean Development Mechanism (CDM) and Prototype Carbon Funds (PCF). Factors favoring and against renewable energy sources,IRP

[6 Hrs]

Unit – 2) Solar Energy :

Solar thermal Systems: Types of collectors, Collection systems, efficiency calculations, applications.

Photo voltaic (PV) technology: Present status, - solar cells , cell technologies, characteristics of PV systems, equivalent circuit, array design , building integrated PV system, its components , sizing and economics. Peak power operation. Standalone and grid interactive systems. [8 Hrs]

Unit – 3) 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 Choice of generators, turbine rating, electrical load matching, Variable speed operation, maximum power operation, control systems, system design features, stand alone and grid connected operation. [8 Hrs]

Unit – 4) 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, Cofiring, 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. [8 Hrs]

Unit – 5) Energy storage and hybrid system configurations :

Energy storage: Battery – types, equivalent circuit, performance characteristics, battery design, charging and charge regulators. Battery management. Fly wheel-energy relations, components, benefits over battery. Fuel Cell energy storage systems. Ultra Capacitors. [6 Hrs]

Unit – 6) Grid Integration :

Stand alone systems, Hybrid systems – hybrid with diesel, with fuel cell, solar-wind, wind –hydro systems, mode controller, load sharing, system sizing. Hybrid system economics.

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. [10 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.

Reference Books :

4. Wind and solar systems by Mukund Patel, CRC Press.
5. Solar Photovoltaics for terrestrials , Tapan Bhattacharya.
6. Wind Energy Technology – Njenkins, John Wiley & Sons,
7. Solar & Wind energy Technologies – McNeils, Frenkel, Desai, Wiley Eastern.
8. Solar Energy – S.P. Sukhatme, Tata McGraw Hill.
9. Solar Energy – S. Bandopadhay, Universal Publishing.
10. Guide book for National Certification Examination for EM/EA – Book 1

503206 : Lab Practice- I

A minimum of eight experiments should be performed under Lab Practice – I. Out of which minimum five experiments should be from the list. At least one experiment should be from each subject. 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's method on digital computer.
2. Optimal Power flow analysis by Newton's method.
3. AC-DC load flow analysis on digital computer.
4. Analysis of various types of faults on digital computer

503203 : POWER SYSTEM MODELING

1. Steady state analysis of synchronous machine using SIMULINK as a linear model.
2. Steady state Analysis of synchronous machine connected to infinite bus using SIMULINK.
3. Steady state analysis of excitation control systems using SIMULINK.

503204(Elective – I) : DIGITAL SIGNAL PROCESSING AND ITS APPLICATIONS

1. a) Generation of various signals such as sine, cos, square, exponential.
   b) Generation of various sequences such as unit impulse, unit step, unit ramp, sine, cos.
2. Linear Convolution of two input sequences.
3. FIR low pass filter design using Kaiser window.
4. Bufferworth band pass IIR filter design.
5. To find FFT/DFT of a sequence.

503204(Elective – I) : ADVANCED POWER ELECTRONICS

1. Operation of three phase voltage source converter.
2. Measurement of harmonics in output voltage of 3 phase VSI.

503205 (Elective – II) AI APPLICATIONS IN POWER SYSTEMS

1. To study of Perceptron learning law
2. To develop feed forward neural network and error back propagation algorithm.

503207 Seminar – I

Working Load: 4 Hrs / week

Term work : 50 marks
Credits: 02

Each student is required to deliver a seminar in first semester on state of art of the topic of his/her own choice. The topic of the seminar should be out of the syllabus and relevant to the latest trends in Electrical Power Systems. The student is expected to submit the seminar report in standard format approved by the University of Pune.

503208: Power System Dynamics

Teaching Scheme
3 Hours / Week

Examination Scheme
Paper : 100 Marks

Unit 1: Review of Classical Methods :

System model, states of operation and system security, steady state stability, transient stability, simple representation of excitation control . [6 Hrs]

Unit 2:Dynamics of Synchronous Generator Connected to Infinite Bus:

System model, simplified synchronous machine model, calculation of Initial conditions, system simulation, improved model of synchronous machine, inclusion of SVC model. [8 Hrs]

Unit 3 :Analysis of Single Machine :

Small signal analysis, applications of Routh-Hurwitz criterion, analysis of synchronizing and damping torque, state equation for small signal model [8 Hrs]

Unit 4 :Power System Stabilizers:

Basic concepts of control signals in PSS, structure and tuning, field implementation, PSS design and application, future trends. [8 Hrs]

Unit 5 :Multi-machine System :

Simplified model, Improved model of the system for linear load, Inclusion of dynamics of load and SVC, introduction to analysis of large power system. [8 Hrs]

Unit 6 :a) Voltage Stability :

Definition, factors affecting voltage instability and collapse, analysis and comparison of angle and voltage stability, analysis and comparison voltage instability and collapse, control of voltage instability.

b) Islanding :

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

Text Book:

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

Reference Books :

1. Power System Stability – E.W. Kimbark, IEEE press, N.Y, Vol. 3.
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, 25th July 2002,Vol. I,PP 92-96

503209: Power System Planning and Reliability

Teaching Scheme **Examination Scheme**
3 Hrs/week **Paper - 100marks**

Unit 1: Load Forecasting :

Introduction, Factors affecting Load Forecasting, Load Research, Load Growth Characteristics, Classification of Load and Its Characteristics, Load Forecasting Methods - (i) Extrapolation (ii) Co-Relation Techniques, Energy Forecasting, Peak Load Forecasting, Reactive Load Forecasting, Non-Weather sensitive load Forecasting, Weather sensitive load Forecasting, Annual Forecasting, Monthly Forecasting, Total Forecasting.

[10 Hrs]

Unit 2: System Planning :

Introduction, Objectives & Factors affecting to System Planning , Short Term Planning, Medium Term Planning, Long Term Planning, Reactive Power Planning.

[6 Hrs]

Unit 3: Reliability :

Reliability, Failure, Concepts of Probability, Evaluation Techniques (i) Markov Process (ii) Recursive Technique, Stochastic Prediction of Frequency and Duration of Long & Short Interruption, Adequacy of Reliability, Reliability Cost. [8 Hrs]

Unit 4: Generation Planning and Reliability :

Objectives & Factors affecting Generation Planning, Generation Sources, Integrated Resource Planning, Generation System Model, Loss of Load (Calculation and Approaches), Outage Rate, Capacity Expansion, Scheduled Outage, Loss of Energy, Evaluation Methods.
Interconnected System, Factors Affecting Interconnection under Emergency Assistance. [10 Hrs]

Unit 5: Transmission Planning and Reliability :

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

Unit 6: Distribution Planning and Reliability :

Radial Networks – Introduction, Network Reconfiguration, Evaluation Techniques, Interruption Indices, Effects of Lateral Distribution Protection, Effects of Disconnects, Effects of Protection Failure, Effects of Transferring Loads, Distribution Reliability Indices.
Parallel & Meshed Networks - Introduction, Basic Evaluation Techniques, Bus Bar Failure, Scheduled Maintenance, Temporary and Transient Failure, Weather Effects, Breaker Failure [8 Hrs]

Text Books:

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

Reference Books :

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

503210: HIGH VOLTAGE POWER TRANSMISSION

Teaching Scheme
3 Hrs/Week

Examination Scheme
Paper: **100 Marks**

Part 1 : HIGH VOLTAGE AC TRANSMISSION

UNIT 1: Engineering Aspects of EHV AC Transmission System.

Principles, configuration, special features of high voltage AC lines, power transfer ability, reactive power compensation, audible noise, corona bundle conductors, electric field, right of way, clearances in a tower, phase to phase, phase to ground, phase to tower, factors to be considered, location of ground wire, angle of protection, clearances, tower configuration.
Principles of radio interference, origin of radio interference, method of propagation, factors to be considered in line design. [8 Hrs]

UNIT 2: Power System Transients:

Introduction, circuit closing transients, sudden symmetrical short circuit of alternator, recovery transients due to removal of short circuit, traveling waves on transmission lines, wave equation, surge impedance and wave velocity, specifications of traveling waves, reflection and refraction of waves, typical cases of line terminations , equivalent circuit for traveling wave studies, forked lines, reactive termination, successive reflections, Bewley lattice diagram, attenuation and distortion, arcing grounds, capacitance switching, current chopping, lightning phenomenon, over voltages due to lightning, line design based on direct strokes, protection of systems against surges, statistical aspects of insulation co-ordination.

[8 Hrs]

UNIT 3: Other Issues:

Biological effects of electric field, safe values of electric field, requirements of transmission line, live line maintenance, basic principle, special tools and procedure, methods of voltage control, tap changing, shunt compensation, shunt rectors and shunt capacitors. [8 Hrs]

Part 2: HIGH VOLTAGE DC TRANSMISSION

UNIT 4 : General Background :

EHV AC versus HVDC Transmission, power flow through HVDC link, equation for HVDC power flow, effect of delay angle and angle of advance, bridge connections, waveform of six pulse and twelve pulse bridge converter, commutation, phase control, angle of extinction, control of DC voltage, connections of three phase six pulse and twelve pulse converter bridges, voltage and current waveforms.

[8 Hrs]

UNIT 5:

Bipolar HVDC terminal, converter transformer connections, switching arrangements in DC yard for earth return to metallic return, HVDC switching system, switching arrangements in a bipolar HVDC terminal, sequence of switching operations, HVDC circuit breakers, DC current interruption, commutation principle, probable types and

applications of HVDC circuit breakers, multi-terminal HVDC systems, parallel tapping, reversal of power, configurations and types of multi-terminal HVDC systems, commercial multi terminal systems.

[8 Hrs]

UNIT 6 :

Faults and abnormal condition in bipolar, two terminal HVDC system, pole-wise segregation, protective zones, clearing of DC line faults and reenergizing, protection .of converters, transformer, converter valves, DC yards, integration of protection and controls, hierarchical levels of control, block diagram, schematic diagram, current control, power control, DC voltage control, commutation channel, master control, station control, lead station, trail station, pole control, equidistant firing control, synchronous HVDC link, asynchronous HVDC Link.

[8 Hrs]

Text Books:

1. *EHV AC Transmission Rakosh Das Begamudre, New Age Publishers*
2. *Direct Current Transmission Vol-I, Kimbark E.W. , Wiley Interscience*

Reference Books:

1. *An Introduction to High Voltage Engineering by Subir Ray, Prentice Hall of India Private Limited, New Delhi – 110 001.*
2. *HVDC Transmission- Adamson C. Hingorani N.G.*
3. *Power Transmission by DC Uhimann E.*
4. *HVAC and HVDC Transmission, Engineering and practice : S. Rao, Khanna Publisher, Delhi.*
5. *Electric Power Systems : B.M. Weddy and B.J.Cory, John Wiely and Sons, Fourth edition (2002)*
6. *Power System Analysis and Design : J.Duncan Glover, Mulukutla S.Sarma, Thomson Brooks/cole /Third Edition (2003)*
7. *Power System Analysis and Design, B.R. Gupta, S.Chand and Company (2004)*

-- xox --

503211: (Elective – III) DIGITAL POWER SYSTEM PROTECTION

Teaching Scheme
3 Hours / Week

Examination Scheme
Paper : 100 Marks

Unit I: Numerical Protection:
Introduction , block diagram of numerical relay, sampling theorem, correlation with a reference wave, least error squared (LES) technique, digital filtering, numerical over-current protection. [6 Hrs]

.

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

Unit III Digital protection of Synchronous generator:
Introduction, faults in synchronous generator, protection schemes for synchronous generator, digital protection of synchronous generator. [6 Hrs]

Unit IV: Digital Protection of Power Transformer:
Introduction, faults in a transformer, schemes used for transformer protection, digital protection of transformer [5 Hrs]

Unit V:. **Distance and overcurrent relay setting and co-ordination:** Directional instantaneous IDMT overcurrent relay, directional multizone distance realy, 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. [7 Hrs]

Unit VI: PC applications in short circuit studies for designing relaying scheme :
Types of faults, assumptions, development of algorithm for S.C. studies, PC based integrated software for S.C. studies, transformation to component quantities, S.C. studies of multiphase systems.
Ultra high speed protective relays for high voltage long transmission line. [8Hrs]

Text Books:

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

Reference Books :

1. Fundamentals of Power System Protection
   Paithankar & Bhide (Prentice Hall of India Pvt Ltd., New Delhi)
2. Protective Relaying for Power System II
   Stanley Horowitz (IEEE press , New York)
3. Digital Relay / Numerical relays – T.S.M. Rao, Tata Mc Graw Hill, New Delhi

503211: (Elective- III) POWER ELECTRONICS APPLICATIONS IN POWER SYSTEMS

Teaching Scheme
3 Hours / Week

Examination Scheme
Paper : 100 Marks

Unit 1: Power Electronic Controllers:

Basics, challenges and needs, static power converter structures, AC controller based structures, D.C. link converter topologies, converter output and harmonic control, power converter control issues. [6 Hrs]

Unit 2: Shunt Compensation:

SVC and STATCOM: Operation and control of SVC, STATCOM configuration, control & applications. [6 Hrs]

Unit 3:Series Compensation:

Principle of operation, application of TCSC for damping of electromechanical oscillations, application of TCSC for mitigation of sub-synchronous resonance, TCSC layout and protection, static synchronous series compensator (SSSC). [8 Hrs]

Unit 4: Unified Power Flow Controller:

Steady state operation, control and characteristics, introduction to transient performance, power flow studies in UPFC embedded systems, Operational constraints on UPFC. [7 Hrs]

Unit 5: Other FACTS Controllers:

Circuit, model and operating features of Dynamic Voltage Regulator(DVR), Thyristor Controlled Braking Resistors (TCBR), Thyristor Controlled Phase Angle Regulator(TCPAR), comparison of all FACTS controllers. [7 Hrs]

Unit 6: Control Strategies and co-ordination :

Conventional control, Hysterisis control, Artificial Neural Network, fuzzy logic controls, comparison between different control schemes, co-ordination between different FACTS controllers. [6 Hrs]

Text Books:

1. Power Electronic Control in Electrical Systems
   - E. Acha, Agelidis, Anaya-Lara, Miller
   (Newnes Power Engg. Series, London)
   (International Student Edition)
2. Understanding FACTS
   - Hingorani and Gyugui
   (IEEE Press, New York, Indian Edition)

References :

1. Flexible A.C. Transmission Systems (FACTS)
   - Yong Hua Song and Johns (IEE Power and Energy Series 30)
2. Thyristor based FACTS controllers
   - Mathur & Verma (IEEE Press, New York)
3. Sub-synchronous Resonance – K.R. Padiyar, B.S. Publications, Hyderabad.

4.FACT's Controllers in Transmission & Distribution by K.R. Padiyar New Age Publishers ,Delhi, May 2007

503212: (Elective – IV) Power Quality Assessment and Mitigation

Teaching Scheme
3 Hrs/Week

Examination Scheme
Paper: 100 Marks

Unit I: Introduction:
Importance of power quality, terms and definitions of power quality as per IEEE std. 1159. such as transients, short and long duration voltage variations, interruptions, short and long voltage fluctuations, imbalance, flickers and transients. Symptoms of poor power quality. Definitions and terminology of grounding. Purpose of groundings. Good grounding practices and problems due to poor grounding. [6 Hrs]

Unit II: 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. [10 Hrs]

Unit III: Voltage sag, swells and interruptions:
Definitions of voltage sag and interruptions. Voltage sags versus interruptions. Economic impact of voltage sag. Major causes and consequences of voltage sags. Voltage sag characteristics. Voltage sag assessment. Influence of fault location and fault level on voltage sag. Areas of vulnerability. Assessment of equipment sensitivity to voltage sags. Voltage sag *limits for computer equipment, CBEMA, ITIC, SEMI F 42 curves. Representation of the results of voltage sags analysis. Voltage sag indices. Mitigation measures for voltage sags, such as UPS, DVR, SMEs, CVT etc., utility solutions and end user solutions. [8 Hrs]

Unit IV: Waveform Distortion:
Definition of harmonics, inter-harmonics, sub-harmonics. Causes and effect of harmonics. Voltage versus current distortion. Overview of fourier analysis. Harmonic indices. A.C. quantities under non-sinusoidal conditions. Triplen harmonics, characteristics and non characteristics harmonics. Harmonics 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. Harmonic filtering, passive and active filters. Modifying the system frequency response. IEEE Harmonic standard 519-1992. [10 Hrs]

Unit V: Power quality monitoring
Need of power quality monitoring and approaches followed in power quality monitoring. Power quality monitoring objectives and requirements. Initial site survey. Power quality Instrumentation. Selection of power quality monitors, selection of monitoring location and period. System wide and discrete power quality monitoring. Setting thresholds on monitors, data collection and analysis. Selection of transducers. Harmonic monitoring , Transient monitoring, event recording and flicker monitoring. [6Hrs]

UNIT VI: Power Quality Assessment & Mitigation

Power Quality assessment, Power quality indices and standards for assessment disturbances, waveform distortion, voltage and current unbalances. Power assessment under waveform distortion conditions. Power quality state estimation, State variable model, observability analysis, capabilities of harmonic state estimation. Test systems. Mitigation techniques at different environments. [8 Hrs]

Text Books :

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

Reference Books:

1. *Power system quality assessment - J. Arrillaga, M.R. Watson, S. Chan, John Wiley and sons.*
2. *Electric power quality - G. J. Heydt.*
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*
5. *IEEE std 519-1992/ IEEE std 1159 IEEE recommended practices and requirements for harmonics control in electrical power system.*

503212 :Elective IV : Partial Discharges in Electrical Power Apparatus

Teaching Scheme
3 Hours / Week

Examination Scheme
Paper : 100 Marks

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

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

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

Unit – 4 : Effects of PD on Electrical Insulating Materials :

Effects of PD 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. [6 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, damping, National and International specifications, Specifications for test methods, permissible PD magnitudes, Location of PD, methods of locating PD, PD location according to pulse spacing method. [10 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 Books :

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

503213 : Lab Practice- II

A minimum of eight experiments should be performed under Lab Practice – II. Out of which minimum five experiments should be from the list. At least one experiment should be from each subject. A list of experiments that may be performed under various subjects of semester -II is given below as a guideline.

503208: 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.

503210: HIGH VOLTAGE POWER TRANSMISSION

1. Digital Simulation of HVDC system
2. Simulation of Series and Shunt compensation of EHV Transmission line.
3. Harmonic Analysis and Simulation.

503211 (Elective III) : DIGITAL POWER SYSTEM PROTECTION

1. Digital protection of Transmission line.
2. Digital over current relay setting.
3. PC based integrated software for S.C. studies.

503211 (Elective III) POWER ELECTRONICS APPLICATIONS IN POWER SYSTEMS

1. Static power converter.
2. Operation of Unified Power flow controller.

503212 (Elective – IV) POWER QUALITY ASSESSMENT AND MITIGATION

1. Harmonic Measurement and Analysis for various electronic devices.
2. Voltage sag and swell analysis.

503212 (Elective – IV) PARTIAL DISCHARGES IN ELECTRICAL POWER APPARATUS

1. Measurement of audible corona inception voltage and development of glow discharge using corona cage.
2. Breakdown of air gap under uniform and non-uniform field.
3. Measurement of Electric Strength of composite insulation materials

503214 Seminar– II

Working Load: 4 Hrs / week

Term work: 50 marks
Credits: 02

The student is required to deliver a seminar in second semester on the topic relevant to latest trends in Electrical Power System preferably on the topic of his/her dissertation. The student is expected to submit the seminar report in standard format approved by the University of Pune.

603201 Seminar– III

Working Load: 4 Hrs / week Term work: 50 marks

Credits: 02

The Term Work will consist of a **report prepared by every student on a seminar topic on Advancement in Technology related to the selected dissertation topic or closely related to dissertation and oral presentation.** The student is expected to submit the seminar report in standard format approved by the University.

603202 Project Stage - I

Working Load: 18 Hrs / week

Term work: 50 marks
Credits: 06

Project Stage – I is the integral part of the dissertation project. The project should be based on the knowledge acquired by the student during the coursework and should contribute to the needs of the society. The project aims to provide an opportunity of designing and building complete system or subsystems in an area where the student like to acquire specialized skills.

The student should present the progress of the project. It will consist of problem statement, literature survey; project overview and scheme of implementation (block diagram, PERT chart, etc.)

603202 Project Stage - II

Working Load: 18 Hrs / week

Term work: 150 marks
Oral: 50 marks
Credits: 12

The Project Stage-II will be evaluated on the basis of –

1. Understanding of the problem statement.
2. Physical inspection of the project in case of hardware project.
3. Project Report
4. Oral examination

Term-work will be assessed jointly by a pair of internal and external examiners along with the oral examination of the same.