GOVERNMENT COLLEGE OF ENGINEERING, AURANGABAD

(An Autonomous Institute of Government of Maharashtra)

Department of Electrical Engineering

Teaching and Evaluation Scheme

ME ELECTRICAL (Electrical Power Systems) Full Time

(Implemented from 2014 admitted batch)

SEMESTER-I

THEORY COURSES													
Sr. No.	**Course Code**	**Subject**	**Scheme of Teaching (Hrs/Week)**			**Total Credits**	**Scheme of Evaluation (Marks)**					
							Theory			**Term Work**	**Practical/ Viva-voce**	**Total**
			L	**T**	**P**		**Test**	**TA**	**ESE**			
1	EE 541	Electrical Machine Modeling and Analysis	03			03	25	25				50
2	EE 542	Power System Planning, Operation & Control	03			03	20	20	60			100
3	EE 543	Computer Aided Power Systems Analysis	03			03	20	20	60			100
4	EE 544	H.V.D.C. Transmission Systems	03			03	20	20	60			100
5	EE 545 – EE 550	Elective-I	03			03	20	20	60			100
6	EE 551	Power Systems Components Modeling	02			02	25	25				50
7	EE 552	Optimization Technique	02			02	25	25				50
LABORATORY COURSES												
8	EE 553	Engineering Computation Laboratory			04	02				25	25	50
9	EE 554	Lab Power System Components Modeling			04	02				25		25
10	EE 555	Seminar-I			01	01				25		25
A]	**Total of Semester I**		**19**	**00**	**09**	**24**	**155**	**155**	**240**	**75**	**25**	**650**

SEMESTER-II

THEORY COURSES												
Sr. No.	**Course Code**	**Subject**	**Scheme of Teaching (Hrs/Week)**			**Total Credits**	**Scheme of Evaluation (Marks)**					
							Theory			**Term Work**	**Practical/ Viva-voce**	**Total**
			L	**T**	**P**		**Test**	**TA**	**ESE**			
1	EE 556	Power Systems Dynamics & Stability	03			03	20	20	60			100
2	EE 557	Advanced Switchgear Protection	03			03	20	20	60			100
3	EE 558	Flexible A.C. Transmission Systems	03			03	20	20	60			100
4	EE 559	High Voltage Engineering	03			03	20	20	60			100
5	EE 560	Digital Signal Processing	03			03	25	25				50
6	EE 561 - EE 566	Elective –II	03			03	20	20	60			100
LABORATORY COURSES												
7	EE 567	DSP Laboratory			04	02				25		25
8	EE 568	Switchgear Protection Laboratory			02	01				25		25
9	EE 569	High Voltage Engineering Laboratory			02	01				25		25
10	EE 570	Seminar-II			02	02				25		25
		Implant Training*										
B]	**Total of Semester II**		**18**	**00**	**10**	24	**125**	**125**	**300**	**100**	**00**	**650**
Total of Semester (A+B)			**37**	**00**	**19**	**48**	**280**	**280**	**540**	**175**	**25**	**1300**

*** Students will complete their in-plant training in industries for minimum one week to maximum one month during summer vacation (after 2nd semester) and accordingly submit the report and present the seminar in third semester.**

(Implemented from 2014 admitted batch)
SEMESTER III

THEORY COURSES												
Sr. No.	**Course Code**	**Subject**	**Scheme of Teaching (Hrs/Week)**			**Total Credits**	**Scheme of Evaluation (Marks)**					
							Theory			**Term Work**	**Practical & Viva-voce**	**Total**
			L	**T**	**P**		**Test**	**TA**	**ESE**			
1	EE 571	Dissertation Phase-I Seminar			20	10				50		50
2	EE 674	Renewable Energy Technology (Institute level open elective)	03	01		04	20	20	60			100
4	EE 675	Environmental Engineering	03			03	20	20	60			100
C] Total of Semester III			**06**	**01**	**20**	**17**	**40**	**40**	**120**	**50**	**00**	**250**
SEMESTER IV												
1	EE 572	Dissertation Phase-II			20	10				25	75	100
2	EE 573	Comprehensive viva-voce				01					50	50
D] Total of Semester IV			**00**	**00**	**20**	**11**	**00**	**00**	**00**	**25**	**125**	**150**
Total of all semester(A+B+C+D)			**43**	**01**	**59**	**76**	**320**	**320**	**660**	**250**	**150**	**1700**

L-Lectures, T-Tutorials, P-Practical, TA-Teacher Assessment, ESE-End-Semester Examination

	List of Electives Semester –I	
1	EE 545	Modern Electric Drives
2	EE 546	E.H.V. Transmission Systems
3	EE 547	Power System Design
4	EE 548	Power System Reliability
5	EE 549	Solar Energy Systems
6	EE 550	Fuzzy-Logic & Artificial Neural Networks
List of Electives Semester –II		
1	EE 561	Smart Grid Technologies & Application
2	EE 562	Life Estimation of Power Equipments
3	EE 563	Illumination Engineering
4	EE 564	Power Systems Transients
5	EE 565	Restructured Power Systems
6	EE 566	Wind Energy Systems

ME (Electrical Power Systems)

Semester-I

EE 541: ELECTRICAL MACHINES ANALYSIS AND MODELING

(Compulsory)

(Implemented from 2014)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	25 Marks
Total Credits	03	Teacher Assessment	25 Marks

UNIT-1 Basic concepts of Modeling:
Basic Principles of Electrical Machine Analysis, Need of modeling, Introduction to modeling of electrical machines, Kron's primitive Machine

UNIT-2 Concept of transformation:
Commonly Used Reference Frames, change of variables & m/c variables and transform variables for arbitrary reference frame. Stationary Circuit Variables Transformed to the Arbitrary Reference Frame, Transformation Between Reference Frames, and Transformation of a Balanced Set, Balanced Steady State Phasor Relationships, And Balanced Steady State Voltage Equations.

UNIT-3 Modelling of Direct-Current Machine,: Voltage and Torque Equations in Machine Variables, Mathematical model of separately excited D.C motor – Steady State analysis-Transient State analysis, Application to D.C. machine for steady state and transient analysis,

UNIT-4 Polyphase Induction Machines:
Modelling of 3 phase Induction Motor, Voltage, torque equations, Equivalent circuit, Steady state analysis, Dynamic performance during sudden changes in load torque and three phase fault at the machine terminals.

UNIT-5 Polyphase Synchronous Machine:
Modeling of synchronous machines, Voltage and Torque Equations in stator, rotor and air-gap field reference frames using Parks Transformations, Voltage and power equation for salient and non-salient alternator, Simplified equations of a synchronous machine with two damper coils, Dynamic Performance During Sudden Changes in Load Torque, Dynamic Performance During a Three-Phase Fault at the Machine Terminals, Approximate Transient Torque Versus Rotor Angle Characteristics , Comparison of Actual and Approximate Transient Torque-Angle Characteristics during a Sudden Change in Input Torque.

UNIT-6 Modeling Permanent Magnet Synchronous Machine:
Introduction, Types of Permanent Magnet Synchronous Machines, PMAC & PMDC(BLDC) ,Voltage and torque equations in machine variables, voltage and torque equations in rotor reference frame variables, Block diagram and transfer functions, and applications.

BOOKS

1. P.C. Krause, “Analysis of Electric Machinery, McGraw Hill”, NY, 1987
2. C.V. Jones, “The unified Theory of Electrical Machines”, Butterworth,-London, 1967
3. Stevenson, “Power System Analysis”, McGraw Hill, NY
4. Dhar R.N., “Computer Aided Power System Operation and Analysis”, Tata McGraw Hill
5. P.S. Bhimbra, “The Generalised Theory of Electrical Machines”, Tata McGraw Hill
6. B.Adkins&R.G.Harley, “The General theory of AC Machines”, Tata McGraw Hill
7. R. Krishnan, “Electric Motor Drives – Modelling, Analysis and Control”, PHI
8. Learning Private Limited, New Delhi, 2011.

Teacher Assessments:

Assessments should be based on -

1. Assignment 10 Marks
2. MCQ 10 Marks

Designed By: Mr. P. S. Swami

EE542: POWER SYSTEM PLANNING, OPERATION & CONTROL

(Compulsory)

(Implemented from 2014)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 Objectives of planning:
Long and short term planning, Load forecasting – characteristics of loads – methodology of forecasting – energy forecasting – peak demand forecasting – total forecasting – annual and monthly peak demand forecasting.

UNIT-2 System Interconnection and Integrated Operation:
Optimal Generation Scheduling, Representation of Transmission Loss by B-coefficients, Derivation of Transmission Loss formula. Representation of Transmission Loss by Power Flow equations, Optimal Load Flow solution. Inequality constraints

UNIT-3 Hydro-thermal co-ordination:
Hydroelectric plant models –short term hydrothermal scheduling problem - gradient approach – Hydro units in series - pumped storage hydro plants-hydro-scheduling using Dynamic programming and linear programming.

UNIT-4 Automatic Generation and Voltage Control:
Load Frequency Control (Single Area and Two Area Load Case) and Economic Dispatch Control, Basic Concepts of Load Dispatch Centres, Functions of Energy Management Centres, Emergency and Restoration of Power System, Automatic Voltage Control, Load Frequency Control with GRCS Digital L F Controllers, Decentralized Control. Reactive Power Control, Methods for Reactive Power Control

UNIT-5 Operation and Control of Interconnected Power System:
Functions of SCADA System, Common Features to All SCADA System, Alarm Function, Integration of Measurement, Control and Protection Functions by SCADA System, SCADA Configuration, Distribution Automation and Control

BOOKS

1. R.N. Sullivan, “Power System Planning” , Tata McGraw Hill
2. A.S. Pabla, “Electrical Power System Planning”, Mc Millan India Ltd.
3. L.K. Khirchmayer, “Economic operation of Power System”, Willey Eastern Ltd.
4. P.S.R. Murty, “Power System Operation & control”, Tata McGraw Hill
5. I. J. Nagrath, D.P.Kothari, “Modern Power System Analysis”, Tata McGraw Hill
6. S. Rao, “EHV-AC, HVDC Transmission & Distribution Engineering”, Khanna Publishers
7. Allen J. Wood, and Bruce F. Wollenberg, “Power Generation, Operation and Control”, John Wiley &Sons, Inc., New York.

Teacher Assessments:

Assessments should be based on -

1. Assignment 10 Marks
2. MCQ 10 Marks

Designed By: Mrs. A. A. Bhole

EE 543: COMPUTER AIDED POWER SYSTEMS ANALYSIS

(Compulsory)

(Implemented from 2014)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 Network Modelling:
System graph, loop, cut set and Incidence matrices, Primitive network and matrix, Formation of various network matrices by singular transformation. Bus Impedance Algorithm: Singular transformation, Direct inspection, Building Block algorithm for bus impedance matrix, Addition of links, addition of branches, (considering mutual coupling), modification of bus impedance matrix for network changes, Formation of bus admittance matrix and modification, Gauss elimination, Node elimination (Kron's reduction)

UNIT-2 Analysis of symmetrical & unsymmetrical Faults:
Shunt Faults, Shunt Fault Calculations, Series Faults, Sequence Impedances of Transmission Lines, Sequence Capacitance of Transmission Lines, Sequence Impedance of Synchronous and Induction Machines, Transformers, Three Winding Transformers

UNIT-3 Computer Solution of Power Flow Problem:
Solution using Admittance and Impedance Matrix, Comparison of Admittance and Impedance Matrix Techniques. Power-Flow Problem, Gauss-Seidal, Newton-Raphson Methods, Power Flow Studies in System Design and Operation, Decoupled Power Flow Method.

UNIT-4 State Estimation:
Method of least squares – statistics – errors – estimates – test for bad data – structure and formation of Hessian matrix – power system state estimation.

UNIT-5 Sparse Matrix techniques for large scale power systems:
Optimal ordering schemes for preserving sparsity, Flexible packed storage scheme for storing matrix as compact arrays – Factorization by Bi-factorization and Gauss elimination methods; Repeat solution using Left and Right factors and L and U matrices.

BOOKS

1. J. Grainger and W.D. Stevenson, *"Power System Analysis"*, McGraw Hill, 1994
2. G.W. Stagg and A. H. EI-Abiad, "*Computer methods in Power System Analysis"*, McGraw Hill 1968
3. I.J. Nagrath and D.P.Kothari, "*Modern Power System Analysis"*, Tata McGraw Hill, 1980
4. G.L.Kusic, "*Computer Aided Power Systems Analysis"*, Prentice Hall, 1986
5. Pai M.A., "*Computer Techniques in Power System Analysis"*, Tata McGraw hill, New Delhi, 2006.

6. Tinney W.F and Meyer W.S, "*Solution of Large Sparse System by Ordered Triangular Factorization",* IEEE Trans. on Automatic Control, Vol: AC-18, pp: 333-346, Aug 1973.

Teacher Assessments:

Assessments should be based on -

1. Assignment 10 Marks
2. MCQ 10 Marks

Designed By: Mrs. A. A. Bhole

EE 544: HVDC TRANSMISSION SYSTEMS

(Compulsory)

(Implemented from 2014)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 Principles of HVDC Transmission:
TerminalEquipment's and Their Controls, Reactive Power Control. Analysis of HVDC Converters, Choice of Converter Configuration, Analysis of Graetz Circuit, Converters Bridge Characteristics, Twelve Pulse Converters, Detailed Analysis of Converter

UNIT-2 HVDC System Control:
DC Link Control, Converter Control Characteristics, Control of Firing Angle, Current, Extinction Angle and Power

UNIT-3 Harmonics and Filters:
Generation of Harmonics, Design of AC and DC Filters, Carrier Frequency and Rl Noise. Multi-Terminal DC Systems, Potential Applications, Types, Control and Protection

UNIT-4 Analysis of AC/DC Systems:
Converter Model and Control, Modeling of AC and DC Networks, Modeling of DC Links, Solution of DC Load Flow, Per Unit System for DC Quantities, Solution of AC - DC Power Flow

UNIT-5 Protection:
Converter Faults, Protection Against Over Currents, Over Voltages, HVDC Circuit Breakers, Protection by DC Reactors, Insulation Coordination. Earth Return: Use of Earth and Sea Return, Advantages and Problems.
Simulation of HVDC Systems: Digital Dynamic Simulation of Converters and DC Systems, Some Case Study of HVDC Installation

BOOKS:

1. Adams and Hingorani, "HVDC transmission".
2. E.W.Kimbark, "DC transmission", Vol. I & II.
3. K.R.Padiyar, "HVDC power transmission systems - Technology and System Interactions", New Age International Ltd.
4. S. S. Rao, "EHV - AC & HVDC transmission Engg & Practice", khanna publishers

Teacher Assessments:

Assessments should be based on -

1. Assignment 10 Marks
2. MCQ 10 Marks

EE 551: POWER SYSTEM COMPONENTS MODELING

(Compulsory)

(Implemented from 2014)

Teaching Scheme		**Evaluation Scheme**	
Lectures	02Hrs/Week	Test	25 Marks
Total Credits	02	Teacher Assessment	25 Marks

UNIT-1 Power system Network matrices:
Graph Theory- Incident matrices, Formation of element –node, cut set, branch and loop incident matrices-Primitive matrix, singular and nonsingular transformations, for formation of network matrices.

UNIT-2 Representation of Power System Networks:
Single phase modelling of transformer on nominal ratio and off nominal transformer tap setting and phase shifting transformer.
Formation of Z Bus: Partial network- Z bus building algorithm- Addition and removal of branch and link, Modification of Z bus matrix for removal and addition of mutually coupled elements.
Formation of Y Bus: Y Bus formation by direct inspection – Y bus formation by singular transformation, problem.

UNIT-3 Three Phase Network Modelling:
Three Phase Element - Three phase balanced network elements – symmetrical components transformation matrices, three phase unbalanced network elements, incident and network matrices for three phase network, and algorithm for formation of 3 phase Z bus**.**

UNIT-4 Generator and Load Modelling:
Generator Modelling : Swing equation – Steady state and transient models
Load modelling: Representation and characteristic of basic types of loads, voltage dependent load modelling, Constant power and constant impedance loads, modelling of induction motor, electrodynamic equation.

UNIT-5 Generator automatic controller:
Governor Modelling: Mathematical modelling of speed governing system, Derivation of small signal transfer function.
Turbine modelling: Turbine model of first order, Block diagram representation of steam turbines and approximate linear models.
Excitation System modelling: Fundamental characteristics of an excitation system, transfer function, Block diagram representation of AVR models-IEEE type-1 model.

BOOKS

1. Computer Method in Power System Analysis by Stagg G. W. and A. H. EI Abaid , McGraw-Hill Companies.
2. Computer Technique in Power System Analysis by M. A. Pai , Tata McGraw-Hill

Companies.
3. Power System Dynamics: Stability and Control by K. R. Padiyar , Interline Publishing Pvt. Ltd.
4. Modern Power System Analysis by I. J. Nagarath & D. P. Kothari, Tata McGraw-Hill, 2nd Edition.

Teacher Assessments:

Assessments should be based on -

1. Assignment	10 Marks
2. MCQ	10 Marks
3. Quiz	05 Marks

Designed By: Mr.S.S.Mopari

EE 552: OPTIMIZATION TECHNIQUES

(Compulsory)

(Implemented from 2014)

Teaching Scheme		**Evaluation Scheme**	
Lectures	02Hrs/Week	Test	25 Marks
Total Credits	02	Teacher Assessment	25 Marks

UNIT-1 Introduction:
Concept of optimization and classification of optimization techniques
Linear Programming : Standard form of LPP Simplex Method of solving LPP, duality, decomposition principle, transportation problem and application of LPP to Electrical Engineering

UNIT-2 Non-Linear Problem (NLP) **:**
One dimensional methods, Elimination methods,
Interpolation methods, Unconstrained optimization techniques-Direct search and Descent methods, constrained optimization techniques, direct and indirect methods

UNIT-3 Dynamic Programming**:**
Multistage decision processes, concept of sub-optimization and principle of optimality, conversion of final value problem into an initial value problem.

UNIT-4 Genetic Algorithm:
Introduction to genetic Algorithm, working principle, coding of
Variables, fitness function. GA operators; Similarities and differences between Gas and traditional methods; Unconstrained and constrained optimization using Genetic Algorithm, global optimization using GA.

UNIT-5 Applications to Power system:
Economic Load Dispatch in thermal and Hydro-thermal system using GA and classical optimization techniques, Unit commitment problem, reactive power optimization. Optimal power flow, LPP and NLP techniques to Optimal flow problems.

BOOKS

1. S.S.Rao, "Optimization - Theory and Applications", Wiley-Eastern Limited.
2. David G. Luenberger, "Introduction of Linear and Non-Linear Programming ", Wesley Publishing Company
3. Polak, "Computational methods in Optimization", Academic Press.
4. Pierre D.A, "Optimization Theory with Applications", Wiley Publications.
5. Kalyanmoy deb, "Optimization for Engineering Design: Algorithms and Examples", Kalyanmoy deb, PHI Publication.

6. D.E. Goldberg &Addision, "Genetic Algorithm in Search Optimization and Machine Learning ", Wesley Publication, 1989
7. L.P. Singh, "Advanced Power System Analysis and Dynamics", Wiley Eastern Limited.
8. HadiSaadat "Power System Analysis ", TMH Publication.
9. OlleI.Elewgerd " Electrical Energy System : An Introduction", TMH Publication, New Delhi.

Teacher Assessments:

Assessments should be based on -

1. Assignment 10 Marks
2. MCQ 10 Marks

Designed By:Mr. P. S. Swami

EE 553:ENGINEERING COMPUTATION LABORATORY

(Compulsory)

(Implemented from 2014)

Teaching Scheme		**Evaluation Scheme**	
Practical	04Hrs/Week	Term work	25 Marks
Total Credits	02	Viva voce	25 Marks

Term Work

Term work shall consist of record of minimum eight experiments/assignments using engineering computation software such as MATLAB, PSCAD, and ETAP with moderate to high complexity.

EE 554:POWER SYSTEM COMPONENTS MODELING LABORATORY

(Compulsory)

(Implemented from 2014)

Teaching Scheme		**Evaluation Scheme**	
Practical	04Hrs/Week	Term work	25 Marks
Total Credits	02		

EE 555:SEMINAR-I

(Compulsory)

(Implemented from 2014)

Teaching Scheme		**Evaluation Scheme**	
Practical	01Hrs/Week	Term work	25 Marks
Total Credits	01		

Student will present seminar on work done by them on any topic relevant to syllabus. The seminar should include some simulations carried out by students.

ME (Electrical Power Systems)

Semester-II

EE 556: POWER SYSTEM DYNAMICS AND STABILITY

(Compulsory)

(Implemented from 2014)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 Power System stability considerations:
definitions- classification of stability – rotor angle and voltage stability- synchronous machine representation- classical model – load modelling- concepts- modelling of excitation systems – modelling of prime movers.

UNIT-2 Transient stability:
Swing equation-equal area criterion-solution of swing equation-Numerical methods-Euler method-Runge-Kutte method-critical clearing time and angle-effect of excitation system and governors-Multi-machine stability –extended equal area criterion- transient energy function approach.

UNIT-3 Small signal stability:
State space representation – Eigen values- modal matrices-small signal stability of single machine infinite bus system – synchronous machine classical model representation-effect of field circuit dynamics-effect of excitation system-small signal stability of multi machine system.

UNIT-4 Voltage stability:
Basic concepts related to voltage stability, voltage collapse, voltage stability analysis, prevention of voltage collapse

UNIT-5 Methods of improving stability:
Transient stability enhancement – high speed fault clearing – steam turbine fast valuing -high speed excitation systems- Fundamentals and performance of Power System Stabilizer – Multi band PSS – Three dimensional PSS – Location & dispatch of reactive power by VAR sources.

BOOKS

1. P. M. Anderson and A.A. Fouad, “Power System Control and Stability”, IOWA state university press, USA
2. P.Kunder, “Power System Stability and Control”, McGraw Hill, New York
3. P. Sauer and M.A. PAI, “Power System Dynamics and Stability”, Prentice Hall, 1997
4. K.R.Padiyar, “Power System Dynamics, Stability and Control”, Edition II Interline Publishers, Bangalore, 1996
5. Van Cutsem, T. and Vournas, C”. Voltage “Stability of Electric Power Systems”, Kluwer Academic Publishers, 1998.
6. Taylor.C.W, “Power System Voltage Stability”, McGraw-Hill, 1994.

Teacher Assessments:

Assessments should be based on -

1. Assignment 10 Marks
2. MCQ 10 Marks

Designed By: Mrs. A. A. Bhole

EE557: ADVANCED SWITCHGEAR AND PROTECTION

(Compulsory)

(Implemented from 2014)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 Arc Interruption Theories:

The details study of – Slepian's theory, Prince's theory's, Cassies theory's, Mayr's theory, Browne's combined theory

Switching Transients: Closing of a line, Reclosing of a line, Interruption of small capacitive currents, Interruption of Inductive load currents, Current chopping, Interruption of short line fault, Traveling waves : Velocity and characteristic impedance, Energy contents of Traveling waves, Reflection and Refraction of Traveling waves

UNIT-2 Design of circuit Breakers:

Standards of Circuit Breakers, Design aspect of Vacuum Interrupters, contact shape and size, contact material, contact travel. Time-travel characteristics of moving contact of Vacuum circuit breaker, Contact Pressure, Contact Erosion

Testing of Circuit Breakers :Introduction, Classification, Description of a simple testing station, Equipment used in the station, Testing procedure, Direct testing, Test report, Indirect testing

UNIT-3 Static Relays:

Introduction, Basic components, classification Comparators, amplitude and phase comparator, duality between amplitude and phase comparators.

(i) Static Over Current Relays: Instantaneous over current relay, definite time over current relay, inverse-time over current relay, directional over current relay.

(ii) Static Differential Relays: Differential relay scheme, single phase static comparator, poly phase differential protection. Differential protection for generator and transformer.

(i) Static Distance Relays: Impedance relay, reactance relay and mho relay using amplitude and phase comparators. Protection of EHV lines against short circuit and over voltages. Distance and carrier aided schemes. Stability of protection on power swing. Out of step blocking and tripping schemes. (With emphasis on implementation using static relays)

UNIT-4 Digital Protection Introduction to digital protection:

Block diagram of digital relay, sampling theorem, correlation with a reference wave, Fourier analysis of analogue and discrete signals, least error squared technique, digital filtering – low pass, high pass, finite impulse response and infinite impulse response fillers. Introduction to digital over-current, transformer differential and transmission line distance protection

UNIT-5 Philosophy of Numerical relaying:

Characteristics - Functional Diagrams - Architecture and algorithms -Anti –aliasing Filters, sampling, Measurements principles using Fourier and other algorithms and

its application for implementation of various numerical relays. SCADA based protection systems

UNIT-6 Embedded protection systems:
General architecture & Essential requirements of an embedded protection system – metering, protection, automation and control modules; model/component based approach in designing an embedded system

BOOKS

1. B. Ravindranath , M. Chander, "Power system protection and switchgear", New Age International Ltd.
2. Y.G.Paithankar& Marcel Dekker, "Transmission Network Protection"
3. Y.G. Paithankar& S. R. BhidePrentis, "Fundamentals of Power System Protection" PHI
4. T.S.Madhav Rao, "Power System Protection Static Relays with Microprocessor Applications" TMH 2nd Edition
5. C. Russell, "Switchgear : The art and science of Protective Relaying", Mason Wiley Eastern Ltd.
6. L. P. Sing, "Digital Protection".
7. Handbook of Switchgears, Bharath Heavy Electricals.
8. DR. Khedkar M K, DR. Dhole G M, "A Textbook of Electric Power Distribution Automation", University Science Press, Delhi, Laxmi Publications, 2010.
9. Arun G. Phadke, James S. Thorp, "Computer Relaying for Power Systems", Marcel Dekker, Inc.
10. Wright. A. and Christopoulos.C, "Electrical Power System Protection", Chapman & Hall, 1993.

Teacher Assessments:

Assessments should be based on -

1. Assignment 10 Marks
2. MCQ 10 Marks

Designed By: Mr. P. S. Swami

EE 558: FLEXIBLE AC TRANSMISSION SYSTEM (FACTS)

(Compulsory)

(Implemented from 2014)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 FACTS Concepts:
Flow of Powers in AC System, Dynamic Stability Consideration of Transmission Interconnection, Relative Importance of Controllable Parameters, FACTS Controllers

UNIT-2 Static Shunt Compensator:
Methods of Controllable VAR Generation, Static VAR Compensators, Static VAR Systems

UNIT-3 Static Series Compensator:
Variable Impedance Type Series Compensators, Switching Converter Type Series Compensators, External Control for Series Reactive Compensators.

UNIT-4 Combined Compensators:
Unified Power Flow Controller, Interline Power Flow Controller, Generalized and Multifunctional FACTS Controllers

Static Voltage and Phase Angle Regulators:

UNIT-5 TCVR and TCPAR, Objectives of voltage and phase angle regulators, Approaches to Thyristor-controlled voltage and phase angle regulators (TCVRs and TCPARs), switching converter based voltage and phase angle regulators, Hybrid phase angle regulators.
Special Purpose FACTs controllers: NGH-SSR damping scheme and thyristor-controlled braking resistor, sub synchronous resonance, NGH-SSR damping scheme, Thyristor-controlled braking resistor (TCBR), Application Examples.

BOOKS

1. A. E. Fitzgerald & C. Kingsley & S. D. Umans, “Electric Machinery”, Tata McGraw Hill, New Delhi, 5th Edition.
2. A.E. Clayton & N.N. Nancock, “The Performance & Design of DC Machines”, CBS Publications & Distributors, Delhi, 3rd Edition.
3. I. J. Nagrath& D. P. Kothari, “Electric Machines”, Tata McGraw Hill, New Delhi, 2nd Edition.
4. Syed A. Nasar, “Electric Machines & Power Systems”, Volume I, Tata McGraw Hill, New Delhi.
5. Dr P. S. Bhimbra, Electric Machinery, 5th edition, Khanna Publishers, Delhi.

Teacher Assessments:

Assessments should be based on -

1. Assignment 10 Marks
2. MCQ 10 Marks

Designed By :Dr. A. G. Thosar

EE 559: High Voltage Engineering

(Compulsory)

(Implemented from 2014)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 Conduction & Break Down in Gases:
Ionization Process & Current Growth, Townsends Criterion for Break Down, Determination of Alpha & Gamma, Streamer Theory of Break Down in Gases, Paschen's Law, Breakdown in Non-Uniform Field & Corona Discharge. Conduction & Break Down in Pure Liquid & Commercial Liquid--cavitation mechanism, suspended particle mechanism etc.; Breakdown in Solid Dielectrics-intrinsic, electromechanical, thermal breakdown etc.

UNIT-2 Generation of High Voltage & Currents:
Generation of High D. C. Voltages: voltage doubler, voltage multiplier, electrostatic machines etc.; Generation of High Alternating Voltages: cascade circuits, resonating circuits etc.
Generation of transient voltages: Single stage and multistage impulse generator circuits, tripping and synchronization of impulse generator; Generation of switching surge voltages; Generation of Impulse Currents

UNIT-3 Measurement of High Voltages & Currents:
Measurement of High Direct Current Voltages, High Alternating Voltages & Impulse Voltages- use of potential dividers, gaps and other methods of measurement; Measurement of High Direct Currents, High Alternating Currents & High Impulse Currents

UNIT-4 Over Voltage Phenomenon & Insulation Coordination:
Natural Causes for Over Voltages, Lightning Phenomenon, Over Voltages Due to Switching Surges, System Faults & Other Abnormal Conditions, Principles of Insulation Coordination on High Voltage & Extra High Voltage Power Systems, concept of statistical factor of safety, risk of failure

UNIT-5 High Voltage Testing of Power Apparatus:
High voltage testing of bushings, transformers, cables etc.
Non-destructive insulation test techniques: High voltage dielectric loss measurements, discharge measurements

BOOKS

1. M. S. Naidu , V. Kamaraju, “High Voltage Engineering” , Tata McGraw –Hill publications
2. E. kuffel, W.S. Zaengl, J. Kuffel, “High Voltage Engineering fundamentals”, Butterworth – Heinemann publishers
3. D. kind, K. Feser, “High Voltage Test Techniques”, Vieweg/ SBA publications
4. M. Khalifa, “High Voltage Engineering- Theory & Practices”, Dekker publications

Teacher Assessments:

Assessments should be based on -

1. Assignment 10 Marks
2. MCQ 10 Marks

Designed By: Dr. V. A. Kulkarni

EE 560: DIGITAL SIGNAL PROCESSING

(Compulsory)

(Implemented from 2014)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	25 Marks
Total Credits	03	Teacher Assessment	25 Marks

UNIT-1 Signals and Signal Processing:

Characterization and Classification of Signals, Typical Signal Processing Operations, Examples of Typical Signals, Typical Signal Processing Applications, Why Digital Signal Processing?

Discrete-Time Signals and Systems in the Time-Domain: Discrete-Time Signals, Typical Sequences and Sequence Representation, the Sampling Process, Discrete-Time Systems, Time-Domain Characterization of LTI Discrete-Time Systems, Finite-Dimensional LTI Discrete-Time Systems, Correlation of Signals, Random Signals

UNIT-2 Transform-Domain Representations of Discrete-Time Signals:

The Discrete-Time Fourier Transform, Discrete Fourier Transform, Relation Between the DTFT and the DFT, and Their Inverses, Discrete Fourier Transform Properties, Computation of the DFT of Real, Sequences, Linear Convolution Using the DFT, The z-Transform, Region of Convergence of a Rational z-Transform, The Inverse z-Transform, z-Transform Properties, Transform-Domain Representations of Random Signals

LTI Discrete-Time Systems in the Transform-Domain:

Finite-Dimensional LTI Discrete-Time Systems, The Frequency Response, The Transfer Function, Types of Transfer Functions, Simple Digital Filters, All-pass Transfer Function, Minimum-Phase and Maximum-Phase Transfer Functions, Complementary Transfer Functions, Inverse Systems, System Identification, Digital Two-Pairs, Algebraic Stability Test, Discrete-Time Processing of Random Signals, Matched Filter

UNIT-3 Digital Processing of Continuous-Time Signals**:**

Introduction, Sampling of Continuous-Time Signals, Sampling of Bandpass Signals, Analog Lowpass Filter Design, Design of Analog Highpass, Bandpass, and Bandstop Filters, Anti-Aliasing Filter, Design of Sample-and-Hold Circuit, Analog-to-Digital Converter, Digital-to-Analog Converter, Reconstruction Filter Design, Effect of Sample-and-Hold Operation.

UNIT-4 Digital Filter Structures:

Block Diagram Representation, Equivalent Structures, Basic FIR Digital Filter Structures, Basic IIR Filter Structures, Realization of Basic Structures using MATLAB, All pass Filters, Tunable IIR Digital Filters, IIR Tapped Cascaded Lattice Structures, FIR Cascaded Lattice Structures, Parallel All pass Realization of IIR Transfer Functions, Digital Sine-Cosine Generator.

UNIT-5 Digital Filter Design**:**

Preliminary Considerations, Bilinear Transform Method of IIR Filter Design, Design

of Low pass IIR Digital Filters, Design of Highpass, Bandpass, and Bandstop IIR Digital Filters, Spectral Transformations of IIR Filters, FIR Filter Design Based on Windowed Fourier Series, Computer-Aided Design of Digital Filters, Design of FIR Filters with Least-Mean-Square Error, Digital Filter Design Using MATLAB
Applications of Digital Signal Processing:
Position and Speed Control of Stepper Motor, DC Motor Speed Control, Serial Communications and Data Transfer, Sine Modulated PWM Signal Generation

BOOKS

10. Proakis," Digital Signal Processing", Pearson Education Limited
11. Oppenheim and Schafer, "Discrete-Time Signal Processing",, Prentice-Hall, 1989.
12. Ambardar Ashok, "Digital Signal Processing: A Modern Introduction", Penram International Publishing (India) Pvt. Ltd.
13. Rabiner, Lawrence R., "Theory and Application of Digital Signal Processing", Gold, Bernard, PrenticeHall
14. H.A. Toliyat& S.G. Campbell, "DSP-Based Electromechanical Motion Control", CRC Press 2003

Teacher Assessments:

Assessments should be based on -

1. Assignment 10 Marks
2. MCQ 10 Marks

Designed By:Mr V.P.Dhote

EE 567:LAB DIGITAL SIGNAL PROCESSING

(Compulsory)

(Implemented from 2014)

Teaching Scheme		**Evaluation Scheme**	
Practical	04Hrs/Week	Term work	25 Marks
Total Credits	02		

Term Work

The term work shall consist of record of minimum six experiments from the list given below.

1. Architecture of DSP chips-TMS 320C 6713 DSP Processor
2. Linear convolution
3. Circular convolution
4. FIR Filter (LP/HP) Using Windowing technique
5. Rectangular window
6. Triangular window Kaiser window
7. IIR Filter(LP/HP) on DSP processors
8. N-point FFT algorithm
9. Power Spectral Density of a sinusoidal signals
10. FFT of 1-D signal plot
11. MATLAB program to generate sum of sinusoidal signals
12. MATLAB program to find frequency response of analog filters (LP/HP)
13. Simulation of Position and Speed Control of Stepper Motor,
14. Simulation of DC Motor Speed Control

EE 568: LAB SWITHGEAR AND PROTECTION

(Compulsory)

(Implemented from 2014)

Teaching Scheme		**Evaluation Scheme**	
Practical	02Hrs/Week	Term Work	25 Marks
Total Credits	01		

Term work shall consist of eight experiment from the list below:

1. Biased and Unbiased differential protection of transformer
2. Distance Protection of transmission line
3. Differential protection of an alternator
4. Study of digital over current protection relay
5. Study of Numerical relay
6. Study of static relay
7. Study of digital relay
8. Study of Embedded protection schemes
9. Visit report on protection scheme in substation
10. Any other relevant experiment faculty may add

EE 569: LAB HIGH VOLTAGE ENGINEERING

(Compulsory)

(Implemented from 2014)

Teaching Scheme		**Evaluation Scheme**	
Practical2	02Hrs/Week	Term work	25 marks
Total Credits	01		

Term Work:

The term work shall consist of record of minimum six experiments from the list given below.

1. Measurement of dielectric strength of transformer oil
2. Measurement of High A.C. Voltage using sphere gap
3. Measurement of breakdown strength of solid insulating material
4. Impulse voltage test on insulator
5. Power frequency test on insulator
6. Tan δ measurement of insulator
7. Study of Impulse Generator

EE 570:SEMINAR-II

(Compulsory)

(Implemented from 2014)

Teaching Scheme		**Evaluation Scheme**	
Practical	02Hrs/Week	Term work	25 Marks
Total Credits	02		

Student will present seminar on work done by them on any topic relevant to syllabus. The seminar should include some simulations carried out by students

ME (Electrical Power Systems)

Semester-III & IV

EE 571:DISSERTATION PHASE I

(Compulsory)
(Implemented from 2014)

Teaching Scheme		**Evaluation Scheme**	
Lectures	20Hrs/Week	Term work	50 Marks
Total Credits	10		

Students will present a seminar on the dissertation work carried out as a part of term work. The department will constitute a committee of three members to evaluate the presentation. The committee will have following structure.

1. Head of the department - chairman
2. Guide - member
3. Subject expert from institute/industry – member

The committee will monitor the quality of the dissertation work.

EE 572: RENEWABLE ELECTRIC TECHNOLOGY

(Institute level open elective)

(Implemented from 2014)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Tutorial	01Hrs/Week	Teacher Assessment	20 Marks
		End Semester Exam	60 Marks
Total Credits	04		

UNIT-1 Distributed Generation**:**
Distributed Generation with Fossil Fuels, Concentrating Solar Power (CSP) Technologies, Biomass for Electricity, Micro-Hydropower Systems, Fuel Cells, Electrical Characteristics of Real Fuel Cells, Types of Fuel Cells, Hydrogen Production

UNIT-2 Wind Power Systems**:**
Historical Development of Wind Power, Types of Wind Turbines, Power in the Wind, Impact of Tower Height, Maximum Rotor Efficiency, Wind Turbine Generators, Speed Control for Maximum Power, Average Power in the Wind, Simple Estimates of Wind Turbine Energy, Specific Wind Turbine Performance Calculations, Wind Turbine Economics

UNIT-3 The Solar Resource**:**
The Solar Spectrum, The Earth's Orbit, Altitude Angle of the Sun at Solar Noon, Solar Position at any time of Day, Sun Path Diagrams for Shading Analysis, Solar Time and Civil (Clock) Time, on a Collecting Surface, Monthly Clear-Sky Insolation, Solar Radiation Measurements, Average Monthly Insolation

UNIT-4 Photovoltaic Materials and Electrical Characteristics**:**
The PV I–V Curve Under Standard Test Conditions (STC), Impacts of Temperature and Isolation on I –V Curves, Shading Impacts on I–V Curves, Crystalline Silicon Technologies, Thin-Film Photovoltaic Systems, Current–Voltage Curves for Loads, Grid-Connected Systems, Grid-Connected PV System Economics, Stand-Alone PV Systems, PV-Powered Water Pumping

BOOKS

1. Gilbert M. Masters, "Renewable and Efficient Electric Power Systems", Wiley-IEEE Press August 2004
2. Siegfried Heier, "Rachel Waddington Grid Integration of Wind Energy Conversion Systems",Wiley Publications
3. "Power Generation Renewables" by PEP (Professional Engineering Publishers) Wiley publications
4. Thomas Ackermann, "Wind Power in Power Systems", Wiley publication

Teacher Assessment:

Assessment will be based on following:

1. Assignments 10 Marks
2. MCQ 10 Marks

Designed By: Mr. S. M. Shinde

EE 573: DISSERTATION PHASE II

(Compulsory)

(Implemented from 2014)

Teaching Scheme		**Evaluation Scheme**	
Practical	28Hrs/Week	Term work	25 Marks
Total Credits	14	Practical / Viva-voce	75 Marks

Student will present a seminar on the dissertation work carried out as a part of term work. The department will constitute a committee of three members to evaluate the presentation. The committee will have following structure.

1. Head of the department- chairman
2. Guide - member
3. Subject Expert from Institute/Industry – member

The committee will monitor the quality of the dissertation work.

EE 574:COMPREHENSIVE VIVA-VOCE

(Compulsory)
(Implemented from 2015)

Teaching Scheme		**Evaluation Scheme**	
		Practical/viva-voce	50 Marks
Total credit	01		

ME (Electrical Power Systems)

Electives

EE 545: MODERN ELECTRIC DRIVES

(Elective)

(Implemented from 2014)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 Concepts of electric drives:
classification of electric drives, classification of control schemes, classification of methods of speed control, components of electric drives

UNIT-2 Speed torque characteristics of motors:
types of loads, types of braking, speed torque characteristic of DC shunt and series motor, compound motor, speed control of Dc motor, stepper motor, speed control of AC motor

UNIT-3 Heating and power rating of drive motors:
transient and dynamics of DC and AC motors

UNIT-4 Motor starters and controllers for DC and AC motor

UNIT-5 Industrial application of drives

Books:

1. G.K. Dubey, “Fundamentals of Electrical Drives”, Narosa Publication
2. N.K. De and P.K.Sen “Electric Drives”, Prentice Hall India
3. B.K. Bose, “Power Electronics and Variable Frequency Drive”, IEEE Press, 2000
4. VedamSubramanyam, “Electric Drives Concepts and Applications”, Tata McGrawhill

Teacher Assessment:

Assessment will be based on the following:

1. Assignment 10 Marks
2. MCQ 10 Marks

Designed by Dr. N. R. Bhasme

EE 546: EHV TRANSMISSION SYSTEM

(Elective)

(Implemented from 2014)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 Basic Aspects of A.C. Power Transmission:
Power-Handling Capacity and Line Loss, Surface Voltage Gradient on Conductors, Electrostatic Field of EHV Lines. Measurement of Electrostatic Fields. Electromagnetic Interference.

UNIT-2 Traveling Waves and Standing Waves:
Line Energization with Trapped - Charge Voltage. Reflection and Refraction of Traveling Waves. Transient Response of Systems with Series and Shunt Lumped Parameters. Principles of Traveling-Wave Protection Lightning & Lightning Protection, Insulation Coordination Based on Lightning

UNIT-3 Over Voltages in EHV Systems:
Caused by Switching Operations, Origin of Over Voltages and their Types, Over Voltages Caused by Interruption of Inductive and Capacitive Currents, Ferro-Resonance Over Voltages, Calculation of Switching Surges, Power Frequency Voltage Control and Over Voltages, Power Circle Diagram.

UNIT-4 Reactive Power Flow and Voltage Stability in Power Systems:
Steady - State Static Real Power and Reactive Power Stability, Transient Stability, Dynamic Stability. Basic Principles of System Voltage Control. Effect of Transformer Tap Changing in the Post- Disturbance Period, Effect of Generator Excitation Adjustment, Voltage Collapse in EHV Lines, Reactive Power Requirement for Control of Voltage in Long Lines. Voltage Stability

UNIT-5 Power Transfer at Voltage Stability Limit of EHV Lines:
Magnitude of Receiving End Voltage at Voltage Stability Limit. Magnitude of Receiving End Voltage During Maximum Power Transfer. Magnitude of Maximum Power Angle at Voltage Stability Limit. Optimal Reactive Power at Voltage Stability Limit

BOOKS

1. A. Chakrabarti, D.P.Kothari, A.K. Mukhopdadhyay ,"Performance, operation & control of EHV power transmission system " , wheeler publications
2. Rakosh Das Begamudre,"Extra high-voltage A.C. transmission Engineering" New Age International Pvt. Ltd.
3. S. Rao, "EHVAC & HVDC Transmission Engineering & Practice" , Khanna Publications

Teacher Assessment:

Assessment will be based on the following:

3. Assignment 10 Marks
4. MCQ 10 Marks

EE 547: POWER SYSTEM DESIGN

(Elective)

(Implemented from 2014)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 Power System Components:
Location of Main Generating Stations and Substations, Interconnections, Load Dispatch Centers

UNIT-2 Design of Transmission Lines:
Selection of Voltage, Conductor Size, Span, Number of Circuits, Conductor Configurations, Insulation Design, Mechanical Design of Transmission Line, Towers, Sag- Tension Calculations

UNIT-3 Design of EHV Transmission Line:
Based Upon Steady State Limits and Transient Over Voltage, Design Factors Under Steady States, Design of 400kV, 1000mW Medium and Long Transmission Line Without and with Series Capacitance Compensation and Shunt Reactors at Both Ends, 750kVLong Transmission Line with Only Shunt Reactors. Extra High Voltage Cable Transmission, Design Basis of Cable Insulation, Search Performance of Cable Systems, Laying of Power Cables

UNIT-4 Vigorous Solution of Long Transmission Line:
Interpretation of Long Line Equations, Ferranti Effect, Tuned Power Lines, Equivalent Circuit of Long Line, Power Flow Thorough Transmission Line and Methods of Voltage Control

UNIT-5 Power System Earthing:
Earth Resistance, Tolerable and Actual Step and Touch Voltages, Design of Earthing Grid, Concrete Encased Electrodes, Tower Footing Resistance, Impulse Behavior Earthing System

BOOKS

1. M.V. Deshpande, “Electrical Power System Design”, Tata McGraw Hill
2. B.R.Gupta, “Power System Analysis and Design”, Wheeler Publishing co.
3. I.J.Nagrath& D. P. Kothari, “Power System Engineering”, Tata McGraw Hill
4. Rakosh Das Begamudre, “Extra high-voltage A.C. transmission engineering”, New Age International Pvt. Ltd.
5. S.S.Rao, “EHV AC & HVDC Transmission Engineering & Protection”, Khanna Publishers

Teacher Assessment:

Assessment will be based on the following:

1. Assignment 10 Marks
2. MCQ 10 Marks

EE 548: POWER SYSTEM RELIABILITY

(Elective)

(Implemented from 2014)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 Generating system reliability analysis – I**:**
Generation system model, capacity outage probability tables, Recursive relation for capacitive model building, sequential addition method, unit removal, Evaluation of loss of load and energy indices

UNIT-2 Generating system reliability analysis – ii:
Frequency and Duration methods, Evaluation of equivalent transitional rates of identical and non-identical units, Evaluation of cumulative probability and cumulative frequency of non- identical generating units – 2, level daily load representation, merging generation and load models

UNIT-3 Basic concepts of risk indices:
PJM methods, security function approach, rapid start and hot reserve units, Modelling using STPM approach. Bulk Power System Reliability Evaluation: Basic configuration, conditional probability approach, system and load point reliability indices, weather effects on transmission lines, Weighted average rate and Markov model, Common mode failures.

UNIT-4 ANALYSIS Probability array method:
Two inter connected systems with independent loads, effects of limited and unlimited tie capacity, imperfect tie, Two connected Systems with correlated loads, Expression for cumulative probability and cumulative frequency. Distribution System Reliability Analysis – I (Radial configuration): Basic Techniques, Radial networks, Evaluation of Basic reliability indices, performance indices, load point and system reliability indices, customer oriented, loss and energy oriented indices

UNIT-5 Basic techniques:
Inclusion of bus bar failures, scheduled maintenance, temporary and transient failures, weather effects, common mode failures, Evaluation of various indices.
Substations and Switching Stations: Effects of short-circuits, breaker operation, Open and Short-circuit failures, Active and Passive failures, switching after faults, circuit breaker model, preventive maintenance, exponential maintenance times.

BOOKS

1. Reliability Evaluation of Power Systems by Roy Billinton and Ronald N. Allan, Plenum press, New York and London (Second Edition), 1996. 2. Reliability Modeling in Electric Power Systems by J. Endrenyi, John Wiley and Sons, 1978. (First Edition

Teacher Assessments:

Assessment will be based on the following:

1. Assignment 10 Marks
2. MCQ 10 Marks

EE 549: SOLAR ENERGY SYSTEMS

(Elective)

(Implemented from 2014)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

Prerequisites:

CourseObjectives:

To familiarize students with the characteristics of solar radiation, its global distribution, and conversion methods of solar energy to heat and power

Course Outcomes:

Upon successful completion of the course the students will be able to understand and apply

1. The characteristics and world distribution of solar radiation.
2. The solar radiation and measurement techniques.
3. The methods of calculation of solar radiation availability at a given location.
4. The fundamentals of thermal and direct conversion of solar energy to power.

UNIT-1 Introduction to Solar Energy Historical Perspective:

Energy Use in the India, Solar Energy; Obstacles and Outlook The Solar Spectrum, The Earth's Orbit, Altitude Angle of the Sun at Solar Noon, Solar Position at Any Time of Day, Sun Path Diagrams for Shading Analysis, Solar Time and Civil (Clock) Time, Sunrise and Sunset, Clear Sky Direct-Beam Radiation, Solar Radiation Measurements, Average Monthly Insolation

UNIT-2 PN junction solar cell generation of photo voltage:

Light generated current, I-V equation of solar cell Solar cell characteristics, cell parameters short circuit current, open circuit voltage, fill factor, efficiency. The PV I–V Curve under Standard Test Conditions (STC), Impacts of Temperature and Insolation on I –V Curves, Shading Impacts on I–V Curves

UNIT-3 Crystalline Silicon Technologies:

Thin-Film Photovoltaic Generic advantages of thin film technologies, materials for thin film technologies, common features of thin film technologies, amorphous Si solar cell, Cadmium Telluried solar cellCurrent–Voltage Curves for Loads,

UNIT-4 Concentrator PV Cell systems:

optics for concentrator,V-trough concentrator modules, compound parabolic trough concentrator,parabolid reflector, Fresnell'slense concentrator, tracking requirments of CPV Grid-Connected Systems, Grid-Connected PV System Economics, Stand-Alone PV Systems, PV-Powered Water Pumping

UNIT-5 Devices for thermal collection and storage:
Liquid flat plate collectors, Solar air heaters, central receiver collector,solar pond, Solar distillation

BOOKS

1. Renewable and Efficient Electric Power Systems, Gilbert M. Masters, Wiley Interscience publication
2. Solar Photovoltaics' Fundamentals, Technologies and Applications, Chetan Singh Solanki, Second edition, PHI Publication
3. "Principle of Solar Engineering" by D. Yogi Goswami, Frank Kreith and Jan F. Kreider, 2nd ed. Taylor & Francis, 2000, ISBN-10: 1-56032-714-6, ISBN -13:978-156032-714-1
4. Power Generation Renewables by PEP (Professional Engineering Publishers) Wiley publications
5. "Modeling Daylight Availability and Irradiance Components from Direct and Global Irradiance" by R. Perez, P. Ineichen, R. Seals, J. Michalsky and R. Stewart, Solar Energy 44 (5) pp. 271-289
6. Solar Energy principles of thermal collection and storage, S.P.SUKHATME & J.K.Nayak Third edition Tata McGraw Hill publication

Teacher Assessments:

Assessments based on the following topics,

Policy initiatives regarding solar, Concerns about Global Warming, visits to installed sites, working Models of tracking system, Numerical from exercise

Designed By :Mr. S. M. Shinde

EE 550: FUZZY LOGIC AND ARTIFICIAL NEURAL NETWORKS

(Compulsory)

(Implemented from 2014)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End semester exam	60 Marks

UNIT-1 Artificial neural network:
Introduction, Neuron Physiology, Artificial Neurons, and Artificial Neural Networks supervised Learning, Early Learning Models, and Features of Artificial Neural Networks.

UNIT-2 Feed-forward Neural Network:
Vector and Matrix Notation, Recurrent Neural Network, Elman Back propagation Neural Network.

UNIT-3 Fuzzy Logic Systems:
Introduction, Foundation of Fuzzy Systems, Representing Fuzzy Elements, Basic Terms and Operations, Properties of Fuzzy Sets, Fuzzification, Arithmetic Operations of Fuzzy Numbers, The alpha cut method, The extension method , Linguistic Descriptions and their Analytical Forms, Fuzzy Linguistic Descriptions, Fuzzy Relation Inferences, Fuzzy Implication and Algorithms, Defuzzification Methods, Centre of Area Defuzzification, Centre of Sums Defuzzification

UNIT-4 Application of neural network and fuzzy logic:
Application of neural network and fuzzy logic to various drives in power system, power semiconductor devices etc.

UNIT-5 Application of fuzzy logic to power system

BOOKS

1. N. P. Padhy, “Artificial Intelligence and Intelligent Systems”, OXFORD University Press, New Delhi, 2005
2. Stamations V. Kartalopoulos, “Understanding Neural Networks and Fuzzy Logic: Basic concepts and Applications”, PHI, New Delhi, 2002.
3. Kevin Warwick, Arthur Ekwue and Raj Aggarwal, “Artificial Intelligence Techniques in Power Systems”, IEE Power Engineering Series, UK, 1997.
4. Springer Berlin Heidelberg, “Intelligent Systems and Signal Processing in Power Engineering”, New York

Teacher Assessments:

Assessment will be based on following:

1. Assignment 10 Marks
2. MCQ 10 Marks

Designed By: Dr. A. G. Thosar

EE 561: SMART GRID TECHNOLOGIES & APPLICATIONS

(Elective)

(Implemented from 2014)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 Introduction to Smart Grid**:**

Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient & Self-Healing Grid, Present development & International policies in Smart Grid. Case study of Smart Grid. CDM opportunities in Smart Grid

UNIT-2 Smart Grid Technologies:

Part 1:Introduction to Smart Meters, Real Time Pricing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Phase Shifting Transformers.

Part 2: Smart Substations, Substation Automation, Feeder Automation. Geographic Information System(GIS), Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System(WAMS), Phase Measurement Unit

UNIT-3 Micro grids and Distributed Energy Resources:

Concept of micro grid, need & applications of micro grid, formation of micro grid, Issues of interconnection, protection & control of micro grid. Plastic & Organic solar cells, Thin film solarCells, Variable speed wind generators, fuel cells, micro turbines, Captive power plants, Integration of renewable energy sources.

UNIT-4 Power Quality Management in Smart Grid:

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring,Power Quality Audit.

UNIT-5 Information and Communication Technology for Smart Grid:

Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN). Bluetooth, Zig-Bee, 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.

BOOKS

1. Ali Keyhani, Mohammad N. Marwali, Min Dai “Integration of Green and Renewable Energy in Electric Power Systems”, Wiley
2. Clark W. Gellings, “The Smart Grid: Enabling Energy Efficiency and Demand Response”, CRC Press
3. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”, Wiley
4. Jean Claude Sabonnadiere, NouredineHadjsaid, “Smart Grids”, Wiley Blackwell
5. Tony Flick and Justin Morehouse, “Securing the Smart Grid”, Elsevier Inc. (ISBN: 978-1-59749-570-7)

Teacher Assessments:

Assessment will be based on following:

1. Assignment 10 Marks
2. MCQ 10 Marks

Designed By : Mrs. A. A. Bhole

EE 562: LIFE ESTIMATION OF POWER EQUIPMENT

(Elective)

(Implemented from 2014)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 Dielectric behavior in electric and thermal fields:
Introduction, Mechanism of electrical conduction in matter, Charge storage in dielectric, Non-ideal dielectrics, Behavior of dielectric in time varying fields, Conduction in dielectrics, breakdown in dielectrics
Measurement of dielectric parameter:
General, Permittivity and Tan δ, Volume and surface conductivity, Partial discharge measurements, Calibration of PD Measuring circuit and detector, Measurement of dielectric strength

UNIT-2 Models for electrical insulation failure:
General, Physical models for insulation failure, single stress modelling, Multifactor models.
Stochastic nature of electrical insulation failure:General, Statistical aspects of thermal ageing.

UNIT-3 Concepts in life testing of insulation:
General, Life testing strategies, Miner's theory of cumulative damage, Accelerated stress testing, Censored life testing (CLT).

UNIT-4 Diagnostic testing of insulation in high voltage equipment**:**
General, Concepts in diagnostic testing, End point criteria, Relevance of diagnostic tests and evaluation of test results.

UNIT-5 Equipment specific diagnostic and reliability assessment**:**
General, Types of insulation systems in power equipment, Equipment specific condition monitoring and diagnostic testing, Dry type systems, Gas insulated substations, Liquid impregnated and liquid filled systems.

BOOKS:

1. Reliability and life estimation of power equipment by T.S. Ramu &Chakradhar Reddy "new age international publishers"

Teacher Assessments:

Assessment will be based on following:

1. Assignment 10 Marks
2. MCQ 10 Marks

Designed by Dr. A. G. Thosar

EE 563: ILLUMINATION ENGINEERING

(Elective)

(Implemented from 2014)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 Importance of Lighting in Human Life:

Optical systems of human eye ,Dependence of human activities on light, performance characteristics of human visual system, Artificial lighting as substitute to natural light, Ability to control natural light,

Construction and working principles of spectro-radiometer, spectrophotometer and colorimeter. Retro reflection & its application.

Colorimetric-Different colour specification systems and their limitations. Measurement of CRI, CRI of radiation due to multiple sources. Pigment colour and mixing of pigments in paint industries

UNIT-2 Light Source:

Lamp materials: Filament, glass, ceramics, gases, phosphors and other metals and non-metals. Solid Sodium Argon Neon lamps, SOX lamps, Electro luminescent lamps, LEDs characteristics, features and applications, LASERS, characteristics, features and applications, non-lighting lamps, Induction lamps. Optical fibre, its construction as a light guide, features and application

UNIT-3 Photometric Control of Light Sources and their Quantification:

Luminaries design considerations, optical control schemes, design procedure of reflecting and refracting type of luminaries. Lighting Fixture types, use of reflectors and refractors, physical protection of lighting fixtures, types of lighting fixtures according to installation type, types of lighting fixtures according to photometric usages, ingress protection code, luminaries standard. Indian standard recommendations.

UNIT-4 Factors of Good Lighting Design:

Indoor Lighting Design: Zonal cavity method for general lighting design, coefficient of Utilization determination for zonal cavities and different shaped ceilings. Using COU (coefficient of utilization), using beam angles and polar diagrams, glare calculations. Typical applications: office, educational facility, theatre, residential, hospital. Indian Standard recommendation for indoor lighting, selection criteria for selection of lamps and luminaries, design consideration and design procedure. (Problems on COV, beam angles and polar diagrams).

Designing problem and solution and designing documentation. Exterior lighting system- Road lighting system and highway lighting system.

UNIT-5 Outdoor Lighting Design:

Road classifications according to BIS, pole arrangement,

terminology, lamp and luminaries selection, different design procedures, beam lumen method, point by point method, isolux diagram, problems on point by point method. Energy Efficient Lighting: Comparison between different light sources, comparison between different control gears, overcoming problems in energy efficient lighting, payback calculation, life cycle costing, (problems on payback calculations, life cycle costing). Solar Lighting: Day Lighting, Photovoltaic Lighting

Emergency Lighting: Central Systems, Standalone systems Cold Lighting: Concept, Method of generation – Optical Fiber cable (OFC), filters, Application

BOOKS

1. H. S. Mamak, “Book on Lighting”, Publisher International lighting Academy
2. Joseph B. Murdoch, “Illumination Engineering from Edison’s Lamp to Lasers”
3. M. A. Cayless, A. M. Marsden, “Lamps and Lighting”.
4. “BIS, IEC Standards for Lamps, Lighting Fixtures and Lighting”, Manak Bhavan, New Delhi
5. D. C. Pritchard, “Lighting”, 4th Edition, Longman Scientific and Technical, ISBN 0-582-23422-0 Elmer, “Design of Reflectors”
6. “IES Lighting Handbook”, (Reference Volume 1984), Illuminating Engineering Society of North America
7. “IES Lighting Handbook”, (Application Volume 1987), Illuminating Engineering Society of North America

Teacher Assessments:

Assessment will be based on following:

1. Assignment 10 Marks
2. MCQ 10 Marks

Designed By: Mr. P. S.Swami

EE 564:POWERSYSTEM TRANSIENT

(Elective)

(Implemented from 2014)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 Introduction :
Travelling waves on transmission lines – Wave Equation – surge impedance and wave velocity – Specification of Travelling waves - Reflection and Refraction of waves – Typical cases of line terminations – Equivalent circuit for Travelling wave studies – Forked line – Reactive termination – Analysis of trapezoidal wave - Analysis of complicated waves

UNIT-2 Travelling waves on transmission line:
Successive reflections – Bewley Lattice Diagrams – Attenuation and Distortion – Multi- conductor system – Self and mutual surge impedance – Voltage and currents for two conductor systems

UNIT-3 Lightning, switching and temporary overvoltages**:**
Lightning: Physical phenomena of lightning – Interaction between lightning and power system – Factors contributing to line design – Switching: Short line or kilometric fault – Energizing transients - closing and re-closing of lines - line dropping, load rejection - Voltage induced by fault – Very Fast Transient Overvoltage (VFTO)

UNIT-4 Protection of systems against surges:
Transmission line insulation and performance – Ground wires – Protective angle – Tower footing resistance – Driven rods – Counterpoise – Protector tube – Substation protection – surge diverters – Selection of arrester rating – Location of arresters – Influence of additional lines – Effect of short length of cable – Surge capacitor, surge reactor and surge absorber – Shielding substation with ground wires – Protection of rotating machines

UNIT-5 Insulation co-ordination:
Principle of insulation co-ordination in Air Insulated substation (AIS) and Gas Insulated Substation (GIS), insulation level, statistical approach, co-ordination between insulation and protection level –overvoltage protective devices – lightning arresters, substation ear thing.

BOOKS:

1. Gupta.B.R, “Power System Analysis and Design”, S.Chand Publications 2004
2. Thapar.B, Gupta.B.R and Khera.L.K, “Power System Transients and High Voltage Principles”, Mohindra Capital Publishers
3. Allan Greenwood, “Electrical Transients in Power System”, Wiley & Sons Inc. New York, 1991.
4. Klaus Ragaller, “Surges in High Voltage Networks”, Plenum Press, New York, 1980.

5. Rakosh Das Begamudre, “Extra High Voltage AC Transmission Engineering”, (Second edition) New age International (P) Ltd., New Delhi, 1990.

6. Naidu M S and Kamaraju V, “High Voltage Engineering”, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.

Teacher Assessments:

Assessment will be based on following:

1. Assignment 10 Marks
2. MCQ 10 Marks

EE 565: RESTRUCTURED POWER SYSTEMS

(Elective)

(Implemented from 2014)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 Introduction:
Basic concept and definitions, privatization, restructuring, transmission open access, wheeling, deregulation, components of deregulated system, advantages of competitive system.

UNIT-2 Deregulation of Power Sector:
Separation of ownership and operation, Deregulated models, pool model, pool and bilateral trades model, multilateral trade model. Competitive electricity market: Independent System Operator activities in pool market, Wholesale electricity market characteristics, central auction, single auction power pool, double auction power pool, market clearing and pricing, Market Power and its Mitigation Techniques, Bilateral trading, Ancillary services.

UNIT-3 Transmission Pricing:
Marginal pricing of Electricity, nodal pricing, zonal pricing, embedded cost, Postage stamp method, Contract Path method, Boundary flow method, MW-mile method, MVA-mile method, Comparison of different methods.

UNIT-4 Congestion Management:
Congestion management in normal operation, explanation with suitable example, total transfer capability (TTC), Available transfer capability (ATC), Different Experiences in deregulation: England and Wales, Norway, China, California, New Zealand and Indian power system.

UNIT-5 Ancillary Services and System Security in Deregulation:
Classifications and definitions, AS management in various markets- country practices. Technical, economic, & regulatory issues involved in the deregulation of the power industry.

BOOKS

1. Loi Lei Lai, “Power System Restructuring and Deregulation”, John Wiley & Sons Ltd.
2. Restructured power systems, operation, trading and volatility, ”Mohammad shahidehpour, M.alomoush”, CRC Press

Teacher Assessments:

Assessment will be based on following:

1. Assignment 10 Marks
2. MCQ 10 Marks

Designed By: Mrs. A. A. Bhole

EE 566: WIND ENERGY SYSTEMS

(Elective)

(Implemented from 2014)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 Historical development of wind power:
types of wind turbines , aerodynamic construction of blade, power in the wind and Betz's limit, Impact of tower height, maximum rotor efficiency, Altitude and temperature correction for air density , Multiple gear box

UNIT-2 Wind turbine generators:
synchronous generator, The asynchronous Induction generator, Speed control for maximum power, importance of variable rotor speeds, pole changing induction generator, variable slip induction generator, indirect grid connection system

UNIT-3 Discrete wind histogram:
wind power probability density function, waybill and Rayleigh statics, Estimates of wind turbine energy, Annual energy calculations, specific wind turbine performance calculations

UNIT-4 Idealized wind turbine power curve:
optimizing rotor diameter and generator rated power, wind speed cumulative distribution function using real power curves with weibull characteristics

UNIT-5 Capacity factor to estimate energy produced:
capital cost and annual cost, Annualized cost of electricity from wind turbines, environmental impacts of wind turbine, wind farms

TEXT AND REFERENCE BOOKS

1) Renewable and Efficient Electric Power Systems, Gilbert M. Masters, Wiley Interscience publication

Teacher Assessments:

Assessments based on the following topics,

Policy initiatives regarding Use of renewable energy sources, Concerns about Global Warming, visits to installed sites, working Models, Numerical from exercise

Designed By: Mr. S. M. Shinde