VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY
BURLA, SAMBALPUR, ODISHA-768018
DEPARTMENT OF ELECTRICAL ENGINEERING

MISSON OF THE DEPARTMENT

To produce Electrical Engineers with dynamic well rounded personalities adaptable to ever increasing demands of emerging technologies involving analytical and practical skills.

VISION OF THE DEPARTMENT

- To develop the department as a renowned academic center of learning in the discipline of Electrical Engineering.
- To establish research and development center of repute so as to encourage active participation with industry by staff and students to take on practical problems of industry and to provide feasible solutions.
- To establish tie-ups with institutions of national and international repute and to foster building up of a wide knowledge base to keep in tune with ever increasing demands of technologies.
- Developing simple, appropriate technologies, which will be instrumental in the up-liftment of rural society.

VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY

BURLA, SAMBALPUR, ODISHA-768018

DEPARTMENT OF ELECTRICAL ENGINEERING

MASTER OF TECHNOLOGY IN POWER SYSTEM ENGINEERING

PROGRAMME EDUCATIONAL OBJECTIVES

1. To develop specialized manpower for electrical power and energy industry.
2. To enhance analytical skills so as to enable to solve complex industrial problems.
3. To augment the students' capacity in pursuing research in emerging areas of power system.
4. To improve students' perspective towards environmental issues by sensitizing and building the awareness of green technologies.
5. To inculcate the culture of research oriented projects with state-of-art facility laboratories in power system.

VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY
BURLA, SAMBALPUR, ODISHA-768018
DEPARTMENT OF ELECTRICAL ENGINEERING

MASTER OF TECHNOLOGY IN POWER SYSTEM ENGINEERING

PROGRAMME OUTCOMES

a. Work in power industry which is involved with the aspects of generation, transmission, and distribution.
b. Shoulder responsibilities in planning and utilization of electrical energy.
c. Design of electrical systems.
d. Analyze and model the complex electrical systems.
e. Expose to the recent state-of-art in electrical engineering.
f. Contribute in academics.
g. Undertake research in emerging areas of power systems.
h. Use recent soft tools in analysis of power system problems.
i. Deploy knowledge and skills in inter-disciplinary areas.
j. Understand the importance of financial aspects in power system infrastructure development.
k. Appreciate the impact of industrial activities on global warming and finding the sustainable technical solutions.

Master of Technology in Power System Engineering (Two Years Regular Course) 2016

First (Autumn) Semester:

Sub.Code	Subjects	L	T	P	C
MEE2101	Power System Management	3	1	0	4
MEE2102	Power System Analysis	3	1	0	4
MEE2103	Operation & Control of Restructured Power System	3	1	0	4
	Elective – I(Any two)	3+3	1+1	0	4+4
MEE2191	Power System Lab-I	0	0	6	4
MEE2192	Seminar – I	0	0	3	2
MEE2193	Comprehensive Viva Voce-I				2
	Total	15	5	9	28

Second (Spring) Semester:

Sub Code	Subjects	L	T	P	C
	Power System Dynamics	3	1	0	4
	Reliability of Power System	3	1	0	4
	FACTS Modelling, Control & Applications	3	1	0	4
	Elective-II (Any two)	3+3	1+1	0	4+4
	Power System Lab-II	0	0	6	4
	Seminar – II	0	0	3	2
	Comprehensive Viva Voce-II				2
	Total	15	5	9	28

Third (Project) Semester:

Sub Code	Subjects	L	T	P	C
	Dissertation interim evaluation	0	0	0	10
	Seminar on Dissertation	0	0	0	3
	Comprehensive Viva Voce-III				2
	Total				15

Fourth (Project) Semester:

Sub Code	Subjects	L	T	P	C
	Dissertation Open Defence	0	0	0	5
	Dissertation Evaluation	0	0	0	20
	Total				25

Elective -I in First Semester

Distribution System Engineering
Power Electronics Control of Drives
Power System Transients
Advanced Control Systems
Dynamics of Electrical Machines

Elective -II in Second Semester

Power System Optimization
Computer Aided Power System Protection
Power Quality
Non Linear System Theory
Non-Conventional Electrical Energy Systems

CORRELATION OF COURSE OUTCOMES WITH THE POs

Year & Semester : M. Tech 1st Year (1st semester)

Name of the Subject : Power System Management (3-1-0)

Course Objectives:

The objectives of this subject are:

1. To provide knowledge of load density calculation in an area and forecasting of load in advance using different methods.
2. To provide the information of power system economics and factors effecting the economic load dispatch.
3. To train the students to analyze various types of electricity market operation and control issues under congestion management.
4. To understand the procedure of power system financing.

Syllabus:

Module-I: (10 Hours)

Load characteristics and load forecast Basic definitions- load definitions, load factor definitions, diversity principle in distribution systems, Load Forecast- factors affecting load forecasting methods, small areas load forecasting, spatial load forecasting methods, simulation, trending and mixed load forecasting methods.

Module-II: (10 Hours)

Basics of Power System Economics & Short-term Operation Planning of Power System, Load curves and load duration curves, Economic load dispatch- concept of marginal cost and Kuhn-

Tucker's condition of optimum in power dispatch, participation factors Classical method to calculate loss coefficients, Loss coefficient calculation using Y-Bus, Loss coefficients using sensitivity factors, Transmission loss coefficients, Transmission loss formula.

Module-III: (10 Hours)

Power Pools & Electricity Markets Inter-area transactions, multi-area power interchanges, Energy brokerage systems, Market design and auction mechanism, Pool versus bilateral markets and price formation, Role of independent generators and system operator.

Module-IV: (10 Hours)

Power Sector Financing Time value of money, utility economic evaluation, Capacity planning issues and methods- Levelizing and levelized bus-bar analysis, Screening curve analysis, Horizon-year generation additions analysis, Capacity planning in competitive environment.

Text Books:

[1]. A. J. Wood and B. F. Wallenberg, “Power generation, operation and control”, Wiley-Interscience, 2nd Edition, 1996.

[2]. H. G. Stoll, Least-cost electric utility planning, Wiley-Interscience, 1989.

[3]. K. Bhattacharya, M. H. J. Bollen and J. E. Daalder, Operation of restructured power systems, Kluwer Academic Publishers, USA, 2001.

Reference Books:

[1].D.P. Kothari, J.S. Dillon,” Power System Optimization”, PHI Learning Private limited, 2ndEdition, 2011.

After completion of this course

Course Outcomes:

CO1: Students will understand the calculation of load density.

CO2: Students will know, how the loss coefficients effect the economic load dispatch

CO3: Students will also learn different pricing mechanism of electric energy and trading of power under deregulated environment.

CO4: Students will learn, financing methods in power sector

Mapping on to Course Outcomes & POs:

Course Outcomes	**Programme Outcomes**										
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
CO1	√	√		√		√	√	√			
CO2	√	√	√	√	√	√	√	√		√	
CO3		√		√	√	√	√	√		√	√
CO4	√	√	√	√	√	√	√	√	√	√	

Year & Semester : M.Tech 1st Year (1st semester)

Name of the Subject : Power System Analysis (3-1-0)

Course Objectives:

1. To understand the concepts of per-unit system and modeling of power system
2. To learn the concepts of power flow analysis
3. To learn the concepts of unit commitment and hydro-thermal coordination
4. To understand the concepts of state estimation and contingency analysis

Syllabus:

Module-I (10 Hours)

Power Systems Review: Review of basic concepts- per unit systems, ac circuits, phasors, power system structure and topology; System Modeling: From Detailed to Approximate Including Their Controls: Automatic Voltage Regulator (AVR): Exciter types, Exciter Modeling, Generator Modeling, Static and Dynamic analysis of the AVR Loop, AVR Root Loci, Stability Compensation, Effect of Generator Loading. Automatic Load Frequency Control (ALFC): Steady state and dynamic analysis in frequency domain for multi-area power system. Transmission systems: transformers and lines, including distributed parameter models Loads: RL, motor drives and aggregated models.

Module-II (10 Hours)

Power flow analysis, Optimal power flow, Solution of OPF by Gradient method, Newton’s method, LP method, Security constrained OPF, Continuation power flow, Sparse matrix techniques for large scale system problems.

Module-III (10 Hours)

Unit commitment of generators, Hydro-thermal coordination- hydrological coupling between hydro power stations, power balance and discharge equations, formulation of the operational planning problem, pumped storage units and their scheduling, Generation with limited energy supply, Probabilistic production simulation.

Module-IV (10 Hours)

Power System Security, Contingency analysis, sensitivity factors, preventive & corrective measures, State Estimation in Power Systems, Weighted lest square estimation, Estimation in AC network, Orthogonal decomposition.

Books:

[1]. P. Kundur, *Power system stability and control*, McGraw-Hill, 1994
[2]. Olle I. Elgerd, *Electric Energy Systems Theory AN Introduction*, McGraw Hill E Pvt Ltd, New Delhi.
[3]. Stagg G.W., EL Abiad A.H., *Computer methods in power system analysis,* McGraw Hill, 1968.
[4]. A. J. Wood and B. F. Wallenberg, *"Power generation, operation and control",* WileyInterscience, 2nd Edition, 1996.

Course Outcomes:

CO1: Students are able tounderstand modeling of power system

CO2: Able to calculate steady state voltages and bus angles given the load and generation using load flow calculation methods i.e. GSLF, NRLF, FDLF

CO3: Able to analyze hydro-thermal coordination problems

CO4: Able to carryout contingency analysis and ranking

Mapping on to Course Outcomes & POs:

Course Outcomes	**Programme Outcomes**										
	a	**B**	**c**	**D**	**e**	**f**	**G**	**h**	**i**	**j**	**k**
CO1	√	√	√	√	√	√	√	√	√	√	√
CO2			√	√	√	√	√	√	√	√	
CO3		√		√	√	√	√	√	√	√	
CO4		√	√	√	√	√	√	√	√	√	

Year & Semester : M.Tech 1st Year (1st semester)

Name of the Subject : Operation and Control of Restructured Power Systems

Course Objectives:

The objectives of this subject are:

1. To provide in-depth understanding of operation of deregulated electricity market systems.
2. To examine topical issues in electricity markets and how these are handled world-wide in various markets.
3. To train the students to analyze various types of electricity market operational and control issues under congestion management.
4. To understand the operation of ancillary
5. To learn different pricing mechanism and power trading in restructured power system.

Syllabus:

Module-I (10 Hours)

Fundamentals of Electricity Markets and Energy Auctions, Review of Concepts- marginal cost of generation, least-cost operation, incremental cost of generation; Kuhn-Tucker's conditions of optimum, inter-utility interchanges, Supply and demand functions, equilibrium, types of electricity markets, imperfect markets, Bilateral and pool markets, LMP based markets, auction models and price formation, price based unit commitment, country practices, Market power and imperfect competition

Module-II (10 Hours)

Transmission Open Access, Power wheeling transactions and marginal costing, transmission costing, Transmission pricing paradigms- embedded cost based, incremental cost based methods, country practices

Module-III (10 Hours)

Transmission Congestion Management and Transmission Rights, Congestion management methods- market splitting, counter-trading; Effect of congestion on LMPs- country practices, Firm Transmission Rights, FTRs as benefits and liability, FTR auction models, country practices

Module-IV (10 Hours)

Ancillary Services and System Security in Deregulation, Classifications and definitions, AS management in various markets- country practices, Frequency regulation, reserves & AGC services, Reactive power ancillary services in electricity markets- country practices, System security in deregulation

Books:

[1]. S. Stoft, Power System Economics: Designing markets for electricity, Wiley-Interscience, 2002.
[2]. K. Bhattacharya, M.H.J. Bollen and J.E. Daalder, Operation of restructured power system Kluwer Academic Publishers, 2001
[3]. M. Shahidehpour, H. Yamin and Z. Li, Market operations in electric power systems, Wiley Interscience, 2002
[4]. D. S. Kirschen and G. Strbac, Fundamentals of power system economics, John Wiley & Sons, 2004

Course Outcome:

After completion of this course

CO1: Students will understand the operation of power system under deregulated environment.

CO2: Students will know, how the control strategy is affected in a restructured power system.

CO3: Students will get the knowledge of worldwide scenario of restructured power system.

CO4: Students will learn, how the power system ancillary shall be used under deregulated environment.

CO5: Students will also learn different pricing mechanism of electric energy and trading of power under deregulated environment

Mapping on to Course Outcomes & POs:

Course Outcomes	**Programme Outcomes**										
	a	**b**	**c**	**d**	**e**	**f**	**G**	**h**	**i**	**j**	**k**
CO1	√	√	√	√	√	√	√	√	√	√	√
CO2	√	√	√	√	√	√	√	√	√	√	√
CO3	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√	√	√	√	√	√	√	√	√	√
CO5	√	√	√	√	√	√	√	√	√	√	√

Year & Semester : 1st Year, (1st Semester)

Name of the Subject : Distribution system Engineering (3-1-0)

Course objectives:

1. Provide general concept of distribution generation system. As renewable energy system.
2. Planning for the distribution system and to understand the need of automation and control of distribution system.
3. Design of sub-transmission and distribution substation also design of primary and secondary system
4. Voltage drop, voltage regulation power loss calculation**.**

Syllabus:

Module-I (10 Hours)

Distribution system planning Short term planning, Long term planning, Dynamic planning, Sub-transmission and substation design, Sub-transmission networks configurations, Substation bus schemes, Distribution substations ratings, Service areas calculations, Substation application curves

Module-II (10 Hours)

Distributed Generation Standards, DG potential, Definitions and terminologies; current status and future trends, Technical and economic impacts, Definitions and terminologies; current status and future trends, Technical and economic impacts DG Technologies, DG from renewable energy sources, DG from non-renewable energy sources, distributed generation applications, Operating Modes, Base load; peaking; peak shaving and emergency power, Isolated, momentary parallel and grid connection

Module-III (10 Hours)

Primary and secondary system design considerations Primary circuit configurations, Primary feeder loading, secondary networks design Economic design of secondaries, Unbalance loads and voltage considerations

Module-IV (10 Hours)

Distribution system performance and operation Distribution automation and control, Voltage drop calculation for distribution networks, Power loss Calculation, Application of capacitors to distribution systems, Application of voltage regulators to distribution systems

Books:

[1]. Anthony J. Pansini "Electrical Distribution Engineering", CRC Press.
[2]. H Lee Willis, "Distributed Power Generation Planning and Evaluation", CRC Press.
[3]. James A Momoh, "Electric Power Distribution Automation Protection And Control" CRC Press
[4]. James J. Burke "Power distribution engineering: fundamentals and applications", CRC Press.
[5]. T. Gonen, "Electric Power Distribution System Engineering", McGraw-Hill, 1986, ISBN 0-07-023707-7

Course Outcomes:

CO1: Plan for the distribution system and apply the automation and control techniques in the field.

CO2: Tariff calculation can be utilized in field.

CO3: Design of distribution system can be achieved.

CO4: Concepts of DGs can be used for further improvement in distribution power operation.

CO5: Voltage regulation loss calculation can help the student to analyze the distribution system.

Mapping on to Course Outcomes & POs:

Course Outcomes	**Programme Outcomes**										
	a	**b**	**c**	**D**	**e**	**f**	**G**	**h**	**i**	**j**	**K**
CO1	√	√	√	√	√	√	√	√	√	√	√
CO2	√	√		√	√		√	√	√	√	
CO3	√	√	√	√	√	√	√	√	√	√	
CO4	√	√	√	√	√	√	√	√	√	√	√
CO5	√	√	√	√	√		√	√	√	√	√

Year & Semester : 1st Year, (1st Semester)

Name of the Subject : Power Electronics Control Of Drives (3-1-0)

Course Objectives:

1. To understand the concepts of modeling of power system and power electronics
2. To learn the concepts of drives
3. To learn the concepts of converter and chopper controlled dc drive
4. To understand the details of induction motor and synchronous motor AC drive.

Syllabus:

Module-I (10 Hours)

DC Drives: Evaluation of a dc drive performance, Chopper-fed dc motor drives, Features of a Chopper-fed separately-excited dc motor, Current limit control, Steady-state performance of a dc motor fed from chopper and phase-controlled rectifiers, Dual converters, Three-phase dc motor drives Principles of adjustable-speed ac drives: Selecting an adjustable-speed drive, Constant volts/hertz operation, Generation of adjustable-frequency ac power, Adjustable frequency operation of ac motors.

Module-II (10 Hours)

Speed control of wound-rotor induction motor drives: Theoretical principles of slip-energy recovery, Sub synchronous static converter cascade, Static control of rotor resistance.

Module-III (10 Hours)

Adjustable-frequency Induction motor drives: Constant terminal volt/hertz operation and control, constant air-gap flux operation and control, controlled current slip operation, Constant horse power operation, Terminal V/f control, Air-gap flux control Field-oriented control, Implementation of Field-Oriented Control(FOC)

Module-IV (10 Hours)

Adjustable-frequency Synchronous Motor Drives: Types of synchronous machine and their steady-state theory of operation, Adjustable frequency operation.

Books :

[1] V.Subramanyam, "*Thyristorised control of Electric Drives*", TMH Publishing Company

[2] J.M.D. Murphy and F.G. Turnbull , "*Power Electronic control of AC Motors*", Pregman press, Great Britain,1989

[3]. B.K. Bose, "*Modern Power Electronics and AC Drives*", Pearson Education, Asia 2002

Course Outcomes:

CO1: Students are able to understand modeling of power system

CO2: Able to know the various types of DC drive

CO3: Able to analyze and implementation of power electronics to different drives

CO4: Able to analyze operation and control of induction motor and synchronous motor drives

Mapping on to Course Outcomes& POs:

Course outcomes	Programme Outcomes										
	a	b	C	d	e	f	g	h	i	j	k
CO1	√		√	√							
CO2				√			√	√		√	
CO3				√			√			√	
CO4			√		√			√			

Year & Semester : M.Tech 1st Year (1st semester)
Name of the Subject : Power System Transients (3-1-0)

Course Objectives:

1. To understand the concepts of switching transients and damping, transients in DC and three phase circuits.
2. To learn the origin and nature and type of power system transients.
3. To learn about the travelling surges, lighting phenomena and fast transientsin transmission lines.
4. To understand the insulation coordination procedures for high voltages systems.

Syllabus:

Module-I (10 Hours)

Simple switching transient: - Circuit closing transients, Recovery transients initiated by removal of short circuits, double frequency transients, Damping: - Generalized damping curves, series R-L-C circuits resistance switching, load switching, and other forms of damping, Abnormal switching transients: - Normal and abnormal switching, current suppression, capacitance switching, other restriking phenomena, Ferro resonance.

Module-II (10 Hours)

Transients in 3phase circuits: Importance of the type of neutral connection, switching a 3-phase reactor with an isolated neutral, 3-phase capacitance switching, the symmetrical component method of solving 3-phase switching transients in star connected transformers, circuit reduction. Transients in D.C. Circuits and conversion equipment: - Interruption of direct currents, delayed and periodic functions characteristics of thyristor and commutation transients. The current limiting static circuit breaker, Topics on electromagnetic phenomena: - A review of electromagnetic induction with respect to transients, Penetration of magnetic field into conductors under steady state and transient condition, Electromagnetic shielding, Importance of electromagnetic effects for cryogenic systems.

Module-III (10 Hours)

Fast transients: Origin and nature of power system Transients, traveling waves on transmission system, the line equation, the shape attenuation and distortion of waves, reflection of traveling waves ,successive reflections, traveling waves on multi conductor systems, transition points on multi conductor circuits, Travelling waves in transmission lines: Circuit with distributed parameters, wave equation, reflection and refraction of travelling waves, behavior of travelling waves at the line terminations Lattice diagram, Attenuation and distortion of travelling waves. Multi conductor systems and multi velocity waves, Lighting phenomena: Scope of lightning problems, the physical phenomena of lightning, interaction of lightning with power systems Factors contributing to good line design, Switching surges: Normal frequency effects, high charging currents, cancellation waves, recovery voltage, restricting phenomena, Protection of transmission systems against surge. High Frequency Oscillations and terminal transients of Transformer

Module-IV (10 Hours)

INSULATION COORDINATION: Insulation coordination procedures (IEC) for high voltage systems: Design criteria, classification of overvoltage, insulation design for switching, lightning and temporary overvoltage, pollution, application of arresters for protection of lines and stations, statistical methods of insulation coordination, risk of failure, test prescriptions. Insulation coordination procedures (IEC) for low voltage systems: representative overvoltage, selection of clearance and creepage distances, macro and micro environments, testing techniques, transient(switching and lightning) voltage surge suppression in industrial and commercial electrical installations, protection of electronic devices.

Text Books/References:

[1] Allan Greenwood , "*Electrical Transients in power Systems*", Wiley Iterscience, 1991

[2]. Lou Van Der Sluis, "*Transients in power Systems"*, John Wiley & Sons Ltd, 2001

[3]. R Rudenberg, "*Transient Performance of Electric power systems, Phenomenon in Lumped Networks*", MGH, 1950

[4]. R Rudenterg, "*Electric Stroke waves in power systems, Harvard University press, Cambridge*", Massachusetts, 1968

[5]. Transmission Line Reference Book, EPRI, USA, 1982

Course Outcomes:

CO1: Students are able tounderstand normal and abnormal switching transients and damping.

CO2: Able to know the concept of power system transients in dc and ac three phase circuits.

CO3: Able to analyze the lighting phenomenon, fast switching surges in transmission lines.

CO4: Able to design the insulation coordination in high voltage systems

Mapping on to Course Outcomes& POs:

Course outcomes	Programme Outcomes										
	a	b	C	d	e	f	g	h	i	j	k
CO1	√	√		√		√					
CO2	√	√	√	√	√	√	√	√			
CO3	√	√		√		√	√	√			
CO4	√	√	√	√	√	√	√	√			

Year & Semester : M.Tech 1st Year (1st semester)

Name of the Subject : Advanced Control System (3-1-0)

Course objectives

1. The purpose of this course is to introduce the key concepts in advanced control systems for SISO as well as MIMO systems.
2. Digital control techniques are to be described
3. The students should be able to characterize and tune different adaptive controllers
4. The purpose is to give up-to-date knowledge for designing controllers for non-linear systems.

MODULE-I(10 Hours)

SISO Control Analysis and Design Analysis of SISO Control Loops, Classical PID Control, Synthesis of SISO Controllers, Fundamental Limitations in SISO Control, Model error Limitations, Structural Limitations, Frequency Domain design limitations, Architectural Issues in SISO Control, Internal Model Principle, Feed forward and Cascade Control, Anti-wind-up scheme, Introduction to Model Predictive Control

MODULE-II(10 Hours)

Digital Computer Control, Models for sampled Data Systems, Sample Data Design, Internal Model Principle for Digital Control, Models for hybrid Control, Systems, Analysis of Inters ample behaviour.

MODULE-III(10 Hours)

Advanced SISO Control. SISO controller Parameterizations, Control Design Based on Optimisation, Synthesis via state space methods, Introduction to Nonlinear Control.

MODULE-IV(10 Hours)

MIMO Control Essentials, Analysis of MIMO Control Loops, Exploiting SISO Techniques in MIMO Control, MIMO Control Design: Design via Optimal control techniques, Model Predictive Control MIMO Controller Parameterizations, Decoupling

TEXT BOOKS:

l. Graham C. Goodwin, Stefan F.Graebe, Mario E.Salgado, "*Control System Design*", PHI-2002.
m. M. Athans and P. Falb, "*Optimal control*", MGH
n. K. Astrom, and B.wittenmark, "*Computer Control Systems: Theory and design*", Prentice Hall

Course Outcomes:

1. At the end of the course students will be able to apply the modeling concepts.
2. The students will learn issues of sensitivity, stability, and loop synthesis as well as feedforward and cascade structures

3. The students will learn designs for digital control and how the constraint of the trade-off web be circumvented by optimization.
4. The students will learn techniques specifically aimed at MIMO Control Problems
5. Students can apply Matlab Real Time programming/ LabVIEW to the model

Mapping of Course Outcomes to Programme Outcomes

Course Outcom	Programme Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
CO1					√			√			√
CO2					√			√			√
CO3					√			√			√
CO4											√
CO5								√	√		√

Year & Semester : M.Tech 1st Year (1st semester)

Name of the Subject : Dynamics of Electrical Machines (3-1-0)

Course Objectives:

1. To provide knowledge about the fundamentals of electrical machines by using transformation theory based mathematical modelling.
2. To impart knowledge about principle of operation and performance of DC, Synchronous, Induction machines and transformers.
3. To analyze the steady state and dynamic state operation of DC, Synchronous, Induction machines and transformers.

SYLLABUS

MODULE-I (10 HOURS)

Singly excited circuits, Coupled circuits, Solution of Electro-dynamical Equations by Euler's method and Runge-Kutta method. Linearization of the Dynamic Equations and Small Signal Stability.

Elementary DC Machine, Voltage and torque equations, Basic types of DC machines, Dynamic characteristics of DC motors, time-domain block diagrams and state equations, solution of dynamic characteristics by Laplace transformation.

MODULE-II (10 HOURS)

The basis of General Theory and Generalized Equation of A.C machines, Equation in terms of phases variable park's transformation, Various reference frames, Derivation of two-axis equation, Torque equation, Field and damper windings, Equivalent circuits, Operational impedances and frequency response loci, Modified equation with more accurate coupling between field and damper windings.

MODULE-III (10 HOURS)

Synchronous Generator short circuit and system faults: Symmetrical short circuit of unloaded generator, Analysis of short circuit oscillograms, short circuit of loaded synchronous generator, Unsymmetrical short of synchronous generator, system fault calculation, Sudden load changes, Equivalent circuit under transient condition, Constant flux linkage theorem, Simplified phasor diagram for transient changes.

MODULE-IV (10 HOURS)

Induction machines: General equation of the induction motor (equation), Application of equation in primary and secondary reference frames and complex form of equation, Short circuit and fault current due to the induction motor, fault calculation.

Transformers: Transient phenomena in transformer, General characteristics of over voltage and current inrush, Transient over voltage characteristics.

BOOKS

[3]. B.Adkins and R.H. Hiiley, *The Generalized Theory of Electrical Machines*, Chapman and Hall,. London, UK

[4]. P.C. Kraus, O. Wasynczuk, S.D. Sudhof, *Analysis of Electrical Machinery and Drives Systems*, IEEE Press, John Wiely and Sons, Piscataway, New Jersey, USA

[5]. P. Kundur, *Power System Stability and Control*, McGraw-Hill, 1994

Course Outcomes:

1. An ability to develop dynamic model of electrical machines.
2. An ability to develop equivalent circuit of machines and perform steady state analysis.
3. Ability to perform fault analysis by using dynamic machine models.
4. Ability to develop and test new control approaches in electrical machines.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
CO1		√							√		
CO2				√	√						
CO3	√						√	√			
CO4					√	√					

Year & Semester : M.Tech 1st Year (1st semester)
Name of the Subject : Power System Lab-I (0-0-6)

COURSE OBJECTIVE

1. To do analysis for the power system network using load flow solutions methods.
2. To familiar with different electrical software by solving different power system problems.

Syllabus:

1. Power flow solution using Newton-Raphson Method & Fast Decoupled Load Flow
2. Optimal Power Flow
3. Fault Analysis-1
4. Stability Analysis-1
5. Simulation of a power plant
6. Study of single machine infinite bus system
7. Two Problems using PSCAD/EMTDC software
8. Two Problems using ETAP software
9. Two Problems using SIMPOWER

Course Outcomes:

CO1: Students can solve the practical problems which are associated with the power system.

CO2: Students are able to develop different models using different software available in power system.

CO3: Students are able to solve different power system problems in conventional as well as soft computing methods.

Mapping on to Course Outcomes& POs:

Course outcomes	Programme Outcomes										
	a	b	C	d	e	f	g	h	i	j	k
CO1	√	√	√	√							
CO2		√		√			√	√			
CO3	√	√		√			√	√			

Year & Semester : M.Tech 1st Year (2nd semester)

Name of the Subject : Power System Dynamics (3-1-0)

Course Objectives:

1. To learn the dynamics, the control and the stability of electric power systems.
2. To study stability analysis and improvement for Voltage stability, Short-term voltage stability, Long-term voltage stability, Angle stability, Small-signal angle stability, Transient (large disturbances)angle stability
3. To establish the dynamic models of various power system components such as synchronous machine, turbine, speed governors, excitation systems, voltage regulators, power system stabilizers which are combined into a general differential-algebraic model under the phasor approximation.
4. To understand and run numerical methods for time-domain simulation.
5. To study and analyze the dynamic problems such as sub-synchronous resonance and torsional oscillation.

Syllabus:

Module-I (10 Hours)

Power System Stability Problems: Basic concepts and definitions, Rotor angle stability, Synchronous machine characteristics, Power versus angle relationship, Stability phenomena, Voltage stability and voltage collapse, Mid-term and long-term stability, Classification of stability.

Module-II (10 Hours)

Small Signal Stability: State space concepts, Basic linearization technique, Participation factors, Eigen properties of state matrix, small signal stability of a single machine infinite bus system, Studies of parametric effect: effect of loading, effect of KA, effect of type of load, Hopf bifurcation, Electromechanical oscillating modes, Stability improvement by power system stabilizers. Design of power system stabilizers.

Module-III (10 Hours)

Large Perturbation Stability: Transient stability: Time domain simulations and direct stability analysis techniques (extended equal area criterion) Energy function methods: Physical and mathematical aspects of the problem, Lyapunov's method, Modeling issues, Energy function formulation, Potential Energy Boundary Surface (PEBS): Energy function of a single machine infinite bus system, equal area criterion and the energy function, Multi-machine PEBS.

Module-IV (10 Hours)

Sub Synchronous Oscillations: Turbine generator torsional characteristics, Shaft system model,

Torsional natural frequencies and mode shapes, Torsional interaction with power system controls: interaction with generator excitation controls, interaction with speed governors, interaction with nearby DC converters, Sub Synchronous Resonance (SSR): characteristics of series capacitor -compensated transmission systems, self – excitation due to induction generator effect, torsional interaction resulting in SSR, Analytical methods, Counter measures to SSR problems. Voltage stability, System oscillations

BOOKS:

[1]. P. Kundur, "Power system stability and control", McGraw-Hill, 1994

[2]. P. Sauer and M. Pai, "Power system dynamics and stability", Prentice Hall, 1998

Course Outcomes:

CO1. At the end of the course, the student will have acquired a deeper understanding of how power systems operate, more particularly the dynamic phenomena that can restrict their range of admissible operation.

CO2. The course gives an opportunity to study in some more detail the dynamics of a practical, relatively complex nonlinear system.

CO3. It improves the ability to interpret results coming from the simulation of differential-algebraic models.

CO4. It is also an opportunity to outline some of the controllers commonly used by industry. Hence, the course may prove useful in other disciplines than power system engineering.

CO5. Finally, the course offers an opportunity to present results of research works in the area of concern

Mapping on to Course Outcomes & POs:

Course Outcomes	Programme Outcomes										
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
CO1	√	√	√	√	√	√	√		√		√
CO2	√				√		√		√	√	
CO3		√		√		√		√		√	√
CO4			√			√	√				
CO5		√	√	√			√	√	√	√	√

Year & Semester : M.Tech 1st Year, (2nd Semester)

Subject Name : Reliability In Power System (3-1-0)

Course Objectives

The objective of this subject are:

1. To understand the importance of maintaining reliability of power system components.
2. To apply the probabilistic and other methods for evaluating the reliability of generation, transmission and distribution systems.
3. To evaluate the reliability of composite system.
4. To assess the different models of system components in reliability studies.
5. To estimate the reliability of various other components such as sub-station, breakers etc.

Syllabus:

Module-I (10 Hours)

Generating Capacity Basic Probability Methods: The generation system model, Loss of load indices, Equivalent forced outage rate, Capacity expansion analysis, scheduled outages, Evaluation methods on period basis, Load forecast uncertainty, Forced outage rate uncertainty, Loss of energy indices. Generating Capacity Frequency & Duration Method*:* The generation model, System risk indices.

Module-II (10 Hours)

Interconnected Systems*:* Probability error method in two interconnected systems, Equivalent assisting unit approach to two interconnected systems, Factors affecting the emergency assistance available through the interconnections, Variable reserve versus maximum peak load reserve, Reliability evaluation in three interconnected systems, multi connected system, Frequency & duration approach. Operating Reserve: General concepts, PJM method, Extension to PJM method, Modified PJM method, Postponable outages, Security function approach, Response risk, Interconnected systems.

Module-III (10 Hours)

Composite Generation & Transmission Systems: Radial configurations, Conditional probability approach, Network configurations, State selection, System & load point indices, Application to practical systems, Data requirements for composite system reliability.

Plant & Station Availability: Generating plant availability, Derated states & auxiliary systems, Allocation & effect of spares, Protection systems, HVDC systems.

Module-IV (10 Hours)

Distribution Systems Basic Techniques & Radial Networks: Evaluation techniques, additional interruption indices, Application to radial systems, effect of lateral distributor protection, Effect of disconnects, Effect of protection failures, effect of transferring loads, Probability distributions of reliability indices. Distribution Systems-Parallel & Meshed Networks: Basic evaluation techniques, Inclusion of busbar failures, Inclusion of scheduled maintenance, Temporary & transient failures, Inclusion of weather effects, Common modes failures, Common mode failures & weather effects, Inclusion of breaker failures.

Books:

[1]. . Billiton Roy& Allan Ronald "*Reliability of Power system*", Pitman Pub. 1984

[2]. Richard Elect. Brown, "*Electric Power Distribution Reliability*", CRC Press.

Course Outcome:

After completion of this course

CO1: Students will be able to use the basic probability methods to evaluate the reliability of power system.

CO2: Students will learn frequency and duration method for reliability evaluation.

CO3: Students shall understand the methodology for distribution system reliability evaluation.

CO4: Students will learn about reliability test system and various models for reliability evaluation of power system.

CO5: Students will determine the plant and station availability.

Mapping on to Course Outcomes& POs

Course Outcomes	**Programme Outcomes**										
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
CO1					√	√	√	√	√	√	
CO2				√	√	√			√	√	
CO3			√	√		√	√		√	√	√
CO4		√	√			√	√	√	√	√	√
CO5	√	√	√	√	√	√		√	√	√	

Year & Semester : M.Tech 1st Year, (2nd Semester)

Subject Name : FACTS Modelling Control and Applications (3-1-0)

Course Objectives:

1. Understand the importance of controllable parameters and benefits of FACTS controllers in power system operation.
2. Know the significance of different types of FACTS controller and their modelling for power system control.
3. Understand the application of various FACTS controller for improvement of power system performance.

Syllabus:

Module-I (10 Hours)

FACTS concepts and general system considerations: Power flow in AC system, transient stability and dynamic stability, basic description of FACTS controllers, brief review of voltage sourced converter and current sourced converter, modeling philosophy

Static var compensator (SVC and STATCOM): objectives of shunt compensation, methods of controllable Var Generation, regulation slope, transfer function, V-I and V-Q characteristics, transient stability enhancement, var reserve control, conventional power flow models, shunt variable susceptance model, firing angle model, transient stability model, voltage magnitude control using SVC & STACOM, Application example

Module-II (10 Hours)

Static Series compensators (TCSC and SSSC): objectives of series compensation, improvements of voltage and transient stability, power oscillation damping, sub-synchronous damping, transmittable power and transmittable angle characteristics, control range, conventional power flow models, variable series impedance model, firing angle model, transient stability model, active power flow control using TCSC & SSSC, Application example

Module-III (10 Hours)

Static voltage and phase angle regulator (TCVR and TCPAR): objectives of voltage and phase angle regulators, approaches to TCVR and TCPAR, switching converter based voltage and phase angle regulators, Unified power flow controller: Basic operating principles, transmission control, independent real and reactive power flow control, power flow models, transient stability model, control structure, basic control system for P and Q control, dynamic performance, Application example

Module-IV (10 Hours)

Brief control studies such as Steady state analysis and control, EMTP studies, power oscillation stability analysis and control, transient stability control

BOOKS

[1]. Y. H. Songs, A. T. Johns, *“Flexible AC Transmission Systems”,* IEE Press, 1999

[2]. N. G. Hingorani, L. Gyugyi, *“Understanding FACTS”,* IEEE Press, Indian Edition, 2001.

[3]. E. Acha, *“FACTS: modelling and simulation in power networks”,* John Wiley & Sons, 2004.

[4]. K. R. Padiyar , “ *FACTS Controllers in Power Transmission & Distribution* ” , New Age International Publishers , 2014

[5]. Vijay K. Sood , “ HVDC and FACTS Controller: Applications of Static Converters in Power Systems” , Kluwer Power Electronics & Power System Series , 2006

Course Outcome:

CO1: An ability to apply knowledge of FACTS Controllers.

CO2: An ability to design a Compensators within realistic constraints.

CO3: An ability to identify, model, and solve real network problems with FACTS controllers

CO4: The broad education necessary to understand the impact of engineering solutions in a global perspective

CO5: A knowledge of recent trend in FACTS controllers and application of FACTS controllers.

Mapping on to Course Outcomes& POs:

Course Outcomes	**Programme Outcomes**										
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
CO1	√	√		√	√	√	√	√	√	√	√
CO2			√	√	√		√			√	√
CO3		√				√	√	√	√		
CO4	√		√	√				√	√		√
CO5		√	√		√	√		√		√	

Year & Semester : M.Tech 1st Year, (2nd Semester)

Subject Name : Power System Optimization (3-1-0)

Course Objectives:

1. To understand the concepts of economic load dispatch, emission load dispatch and optimal hydrothermal scheduling of power system.
2. To learn the different classical and intelligent optimization methods to solve power system problems.
3. To learn the efficient methods of problem solving for load dispatch and hydro thermal scheduling and active and reactive power balance.
4. To understand the multi-objective optimization methods in power system problem solving.

Syllabus:
Module-I (10 Hours)

Economic Load Dispatch of thermal Generating Units: Introduction, Generator operating cost, Economic Dispatch problem on a bus bar, Optimal generation scheduling, Economic dispatch using Newton-Raphson method, Economic dispatch using the approximate Newton-Raphson method, Economic dispatch using efficient method, Function of generation & loads.

MODULE-II (10 Hours)

Optimal Hydro thermal Scheduling: Introduction, Hydro plant performance Models, Short-Range Fixed-Head Hydro thermal Scheduling, Newton-Raphson for short-range fixed –head hydro thermal scheduling, Approximate Newton-Raphson method for short –range fixed-head hydro thermal Scheduling, Short-Range variable-head hydro thermal scheduling-Classical Method, Approximate Newton-Raphson method for short -range variable-head hydro thermal scheduling, Hydro plant modeling for long term operation, Long-Range generation scheduling of hydro thermal systems.

MODULE-III (10 Hours)

Multi-Objective Generation Scheduling: Introduction, Multi objective optimization- State of the art, Fuzzy set theory in power system, the surrogate worth trade of approach for multi objective thermal power dispatch problem, multi objective thermal power dispatch- weighing method, multi objective dispatch for active & reactive power balance.

MODULE-IV (10 Hours)

Stochastic Multi Objective Generation Scheduling: Introduction, multi-objective stochastic optimal thermal power dispatch- $\in$ -constant method, multi-objective stochastic optimal thermal power dispatch- The surrogate worth trade-off method, multi-objective stochastic optimal thermal power dispatch- weighing method, stochastic economic-emission load dispatch, multi-objective optimal thermal dispatch- risk/dispersion method, stochastic multi-objective short term hydro thermal scheduling, stochastic multi -objective long-term hydro thermal scheduling.

Books:

[1] Kothari D.P, Dhillon J.S, “Power System Optimization” – PHI Private Limited.

[2]. JJames A Momoh, *“Electric Power System Application of Optimization”,* CRC Press

[3]. S.S. Rao, “Engineering Optimization-Theory and Practice Power”, 2009 John Willey & Sons, New York, USA.

[4]. A.D. Belegundu, T.R. Chandrupatla, “Optimization Concepts and Applications in Engineering”, Cambridge, University press

Course Outcomes:

CO1: Students are able to understand modeling of hydro, thermal or hybrid power system.

CO2: Able to know the concept of load dispatch, hydrothermal scheduling problems and classical and intelligent solution.

CO3: Able to solve single or multi optimization of power systems like cost and emission or both in a thermal or hydro thermal power system.

CO4: Able to analyze operation and control of hydro thermal power systems

Mapping on to Course Outcomes & POs:

Course outcomes	Programme Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
CO1	√	√	√	√							
CO2		√		√			√	√			
CO3				√			√	√			√
CO4			√		√			√			

Year & Semester : M.Tech 1st Year, (2nd Semester)

Name of the Subject : Computer Aided Power System Protection(3-1-0)

Course Objective:

1. To understand the concept of using digital computers for power system relaying.
2. To understand new development in the role of a potential user or manufacturer of computer relays.
3. To give a brief idea about wide area measurement systems

Syllabus:

Module-I (10 Hours)

Introduction to Computer Relaying: Development of computer relaying, Historical background, Expected benefits of computer relaying, Computer relay architecture, Analog to digital converter, Anti-aliasing filter, Substation computer hierarchy, Relaying Practices: Introduction to protection systems, Functions of a protection system, Protection of transmission lines, Transformer, reactor & generator protection, Bus protection, Performance of current & voltage transformers.

Module-II (10 Hours)

Mathematical Basis for Protective Relaying Algorithms: Introduction, Fourier series, Other orthogonal expansion, Fourier transform, Use of Fourier transform, Discrete Fourier transform, Introduction to probability & random processes, Random processes, Kalman filtering. Transmission Line Relaying: Introduction, Sources of error, relaying as parameter estimation, Beyond parameter estimation, Symmetrical component distance relay, protection of series compensated lines.

Module-III (10 Hours)

Protection of Transformers, Machines & Buses: Introduction, Power transformer algorithms, Generator protection, Motor protection, Digital bus protection. Hardware Organization in Integrated Systems: The nature of hardware issues, Computers for relaying, The substation environment, Industry environmental standards, Countermeasures against EMI, Supplementary equipment, Redundancy & backup, Servicing, training & maintenance.

Module-IV (10 Hours)

System Relaying & Control: Introduction, Measurement of frequency & phase, Sampling clock synchronization, Application of phasor measurements to state estimation, Phasor measurement in dynamic state estimation, Monitoring. Developments In New Relaying Principles: Introduction, Traveling waves on single-phase lines, Traveling waves on three-phase lines, Traveling waves due to faults, Directional wave relays, Traveling wave distance relay, Differential relaying with phasors, Traveling ` wave differential relays, Adaptive relaying, Examples of adaptive relaying, fault location algorithms, Other recent developments.

Books:

[1]. A.G. Phadke and J.S. Thorp, "Computer Relaying for Power Systems", John Wiley and Sons, 1994.

[2]. Stanley H. Horowitz and Arun G. Phadke, "Power System Relaying", Research Studies Press Ltd., England. J.L. Blackburn, “Protective, Relaying”, Marcel Dekker, Inc., 1987.

[3]. "Computer Relaying", IEEE Tutorial Course (79EH0148-7-PWR), IEEE Power Engineering Society, NJ, 1979

Course Outcome:

CO1: Students will be able to understand important operating principle, design and planning of the protective system in a power system.

CO2: The students will be exposed to traditional electro-mechanical relaying principle as well as to modern numerical relaying basics.

CO3: Students will be able to know about wide area measurement systems

Mapping on to Course Outcomes& POs:

Course Outcomes	Programme Outcomes										
	a	**b**	**c**	**d**	**e**	**f**	**g**	**H**	**i**	**j**	**k**
CO1	√	√	√		√		√	√		√	√
CO2	√		√	√	√			√	√	√	
CO3	√	√	√	√	√	√	√	√	√	√	

Year & Semester : M.Tech 1st Year, (2nd Semester)

Subject Name : Non-Linear System Theory (3-1-0)

Course Objectives:

1. To understand the fundamentals of nonlinear systems.
2. Ability to apply mathematical analysis of nonlinear systems.
3. To understand stability of nonlinear system.

Syllabus:

Module-I (10 **Hours**)

Non Linear Systems: Ordinary differential equation (ODE) systems, Differential & algebraic equation (DAE) systems, Equilibrium points, Limit cycles, point care maps, monodrama matrices, dynamic manifolds, region of attraction, Lyapunov stability,

Module -II (10 **Hours**)

Numerical Methods: Newton Raphson, Eigen value computation, initial value problems (IVP) and boundary value problems (BVP), Definitions of local and global bifurcations saddle node bifurcations, trans critical bifurcations, pitchforks and Hopf bifurcations, Limit induced bifurcations, center manifolds, Normal forms: Lyapunov Schmidt reduction DAE systems: bifurcations transversally conditions and singularity induced bifurcations

Module-III (10 **Hours**)

Singular bifurcations computations: continuation methods and direct methods, optimization techniques, Hoft bifurcations computations: continuation methods and direct methods, Bifurcations of limit cycle: definition and computation

Module –IV (10 **Hours**)

Chaotic Behavior: Definition and examples of continuous and discrete (fractal) strange attractors. Mechanisms that lead to chaos: Torus bifurcations period doubling, intermittency, instant chaos, fractal, dimensions, Lyapunov exponents, power spectra.

Books:

[1]. R Seydel, “Practical Bifurcation and Stability Analysis”, Springer Verlag

[2]. M Vidyasagar, “Nonlinear Systems Analysis”, Prentice Hall

Course Outcomes:

CO1: Get knowledge on nonlinear systems.

CO2: Able to apply mathematical analysis for control of nonlinear systems.

CO3: Gain knowledge on nonlinear systems stability and apply selectively.

Mapping on to Course Outcomes & POs:

Course outcomes	Programme Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
CO1	√	√	√	√							
CO2		√		√			√	√			
CO3				√			√	√			√

Year & Semester : M.Tech 1st Year, (2nd Semester)

Subject Name : Non-Conventional Electrical Energy Systems (3-1-0)

COURSE OBJECTIVES

1. To prepare students to succeed in industry, technical profession, and to excel in post Students program.
2. The students shall understand Energy needs of India, and energy consumption patterns, energy security and environmental impacts and distributed generation.
3. The students shall able to understand maximum power tracking from different renewable energy sources, control systems and system design features.
4. To make the students understand stand alone and grid connected operation, energy storage and hybrid system configurations.
5. To make students familiar with Economics Operation of power system.
6. To understand the Steady State Stability and Transient Stability problems and able to design to prevent the above problems

Syllabus

MODULE-I (10 Hours)

INTRODUCTION TO RENEWABLE ENERGY SOURCES: Introduction to Non-conventional/Renewable Energy Sources & Technologies, Their Importance for Sustainable Development and Environmental Protection. SOLAR RADIATIONS: Measurement and Prediction of Solar Radiations; Instruments for Solar Radiation; Characteristics of Solar Spectra including Wavelength Distribution; Radiation Properties and Spectral Characteristics of Materials; Selective Surfaces & Basics of Solar Collectors. SOLAR THERMAL SYSTEM: Solar Collection Devices; their analysis; Solar Collector Characteristics; Solar Pond; application of solar energy to space heating etc.

MODULE-II(10 Hours)

BIOMASS: Biomass as an Energy Source; Energy Plantations; Conversion Technologies – Thermal, Chemical and Biological; Photosynthesis, Biogas generation, Classification of Biogas plants. BIOGAS: Principles of Bioconversion: Types of Bioreactors – Batch, Continuous, Plug-flow, Stirred Tank & Film, Reaction Kinetics, Reactor Design and Analysis, Materials-Municipal Refuse, Sewerage, Industrial Wastes, Agricultural Wastes, Animal and Human Wastes; Landfill systems; Properties and Uses of Biogas, BIOFUELS: Bioconversion Techniques – Direct Combustion, Pyrolysis, Flash Pyrolysis Fermentation and Gasification; Utilization of Industrial Wastes such as Bagasse; Household and Community Combustion Systems – Improved Cook-stoves; Industrial Biomass Combustion Systems; Gasification; Sizing; Beneficiation of Fuels, Thermodynamics & Kinetics of Gasification; Types of Gasifiers–Downdraft, Updraft, Cross flow, Fluidized, Combustion Characteristics of Biofuels; Utilization in Conventional Engines and or Power Generation including Cogeneration.

MODULE-III(10 Hours)

OTHERRENEWABLE SOURCESOF ENERGY: Waves Nature and availability of Energy from waves Onshore &Off-shores: Principles of Wave Converters– Raft, Duck, Oscillating Water Columns, Tapered Channels & Buoys; Energy Conversion &Transmission; Secondary Applications of Waves such as Harbour Wall, Seawater Pumping, WIND ENERGY: Basic Principle; Basic components of a WECS, Classification of W.E.C., Their types, Applications of Wind Energy, Environmental aspects, Wind Energy Developments in India.

MODULE-IV(10 Hours)

Tides: Origin & nature of Tides, Tidal Heads & Duration; Principles of Tidal Energy Conversion, Site Selection– Single and Multiple Bay System; Cycles & Load Factors; Regulation and Control of Tidal Power Generator (Ocean Thermal Energy Conversion): Temperate &Tropical Oceans; Principles of OTEC Systems; Site Selection; Power Cycles; Selection of Working Fluids; Pumps & Turbines; Heat Exchanger Criteria; Bio-fueling; Secondary Applications such as Fresh Water Production, Maniculture,etc.,Power Transmission & System Efficiency

GEOTHERMALENERGY:

NameofGeothermalResources,LocationandPotentialAssessment,Classification& Characteristics of Geothermal Resources– Hot Rock, Hot Water & Steam, Chemical & Physical Properties of Geothermal Brines: Control of Scale Deposition, Drilling, Logging & Cementing Operations for Geothermal Wells; Principles of Power Production System& Cycles: Refrigeration, Two-Phase Flow Turbines; Thermal Phase Flow Turbines; Thermal Utilization & Mineral Recovery; Ecological and Safety Considerations.

BOOKS

[1]. S.P.Sukhatme,“*SolarEnergy:PrinciplesofthermalCollectionandStorage*”,TataMcGrawHill,

[2]. H.P. GargandJaiPrakash,*“SolarEnergy:Fundamentals andApplications*”, TataMcGrawHill

[3]. Chang,“*EnergyConversion*”,PrenticeHall

[4]. Soo,“*DirectEnergyConversion*”,PrenticeHall

[5].BockrisandSrinivasan,“*FuelCells*”,McGrawHill

[6].DufficandBeckman,“SolarEngineeringofThermalProcesses”,Johnwiley

Course Outcomes

CO1: It gives knowledge about different Non-conventional energy sources.

CO2: It gives the idea about power generation from renewable sources.

CO3: Describe the nature and principle of different biomass energy extraction systems and know how to choose the suitable biomass fuels for different bio-energy applications.

CO4: Describe the challenges and problems associated with the use of various energy sources, including fossil fuels, with regard to non-conventional energy sources.

CO5: Collect and organize information on renewable energy technologies as a basis for further analysis and evaluation.

Mapping on to Course Outcomes& POs:

Course outcomes	Programme Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
CO1	√	√	√	√							
CO2		√		√			√	√			
CO3				√			√	√			√
CO4	√	√		√			√	√			√
CO5		√	√	√			√	√			

Year & Semester : M. Tech 1st Year (1st semester)
Name of the Subject : Power System Lab-II (0-0-6)

Course objective

1. To know different programming methods
2. To know analysis of power system problems

Syllabus:

1. Economic load dispatch using traditional optimization methods
2. Load forecasting using conventional and soft computing method
3. Fault Analysis-2
4. Stability Analysis-2
5. Fuzzy Inference System
6. Study of single machine infinite bus system
7. Two Problems using PSCAD/EMTDC software
8. Two Problems using ETAP software
9. Two Problems using SIMPOWER

Course Outcomes:

CO1: Students get knowledge of different software available to solve problems in power system

CO2: Students are able to develop models of completed power system network

CO3: Students are able to solve different power system problems in conventional as well as soft computing methods.

Mapping on to Course Outcomes& POs:

Course outcomes	Programme Outcomes										
	a	b	C	d	e	f	g	h	i	j	k
CO1	√	√	√	√							
CO2		√		√			√	√			
CO3	√	√		√			√	√			