BHARTI UNIVERSITY DURG (C.G.)

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SCHEME OF EXAMINATION

&

SYLLABUS

Of

M.TECH

In

POWER SYSTEM ENGINEERING

UNDER

DEPARTMENT OF ELECTRICAL ENGINEERING

Session 2021-22

(Approved by Board of Studies)

Effective from NOV 2021

BHARTI UNIVERSITY, DURG

SCHEME OF EXAMINATION DEPARTMENT OF ELE. ENGG.

M.TECH. in Power Systems Engineering (EPS)

FIRST SEMESTER

S. No.	Board of Study	Subject Code	Subject	Periods per week			Scheme of exam			Total Marks
				L	T	P	Theory/Practical			
							ESE	CT	TA	
1.	Electrical Engg.	**MT03111**	Power System Dynamics	3	1	-	70	10	20	100
2.	Electrical Engg.	**MT03112**	Computer Aided PowerSystem Analysis	3	1	-	70	10	20	100
3.	Electrical Engg.	**MT03113**	Power System Protection	3	1	-	70	10	20	100
4.	Electrical Engg.	**MT03114**	Flexible AC Transmission System (FACTS)	3	1	-	70	10	20	100
5.	Refer Table-I		Elective-I	3	1	-	70	10	20	100
6.	Electrical Engg.	**MT03116**	Power System Lab - I	-	-	3	70	-	30	100
7.	Electrical Engg.	**MT03117**	Protection Simulation Lab	-	-	3	70	-	30	100
TOTAL				15	5	6	490	50	160	700

Table –I

Elective- I MT03115			
Sr. No.	**Board of Study**	**Subject Code**	**Subject**
1	Electrical Engg.	**MT03115(1)**	Power Electronics
2	Electrical Engg.	**MT03115(2)**	Digital Signal Processing
3	Electrical Engg.	**MT03115(3)**	Distributed Generation

L-Lecture T- Tutorial P- Practical ESE- End Semester Exam
CT- Class Test TA- Teachers Assessment

Note (1) – $1/4^{th}$ of total strength of students subject to minimum of twenty students is required to offer anelective in the college in a Particular academic session.

Note (2) – Choice of elective course once made for an examination cannot be changed in futureexaminations.

Semester: M.TECH. I **Specialization: Power Systems Engg.**

Subject: Power System Dynamics **Branch: Electrical Engineering**

Total Theory Periods: 40 **Code: MT03111**

Total Marks in End Semester Exam. : 70 **Total Tutorial Periods: 12**

Minimum number of class test to be conducted: 02

UNIT-I : Elementary Mathematical Model:

Swing Equation , Units , Mechanical Torque , Electrical Torque , Power - Angle Curve of a Synchronous Machine , Natural Frequencies of Oscillation of a Synchronous Machine , System of One Machine against an Infinite Bus-The Classical Model , Equal Area Criterion , Classical Model of a Multimachine System, Classical Stability Study of a Nine-Bus System, Shortcomings of the Classical Model, Block Diagram of One Machine.

UNIT-II: Synchronous Machine:

Park's Transformation , Flux Linkage Equations , Voltage Equations , Formulation of State - Space Equations , Current Formula tion , Per Unit Conversion , Normalizing the Voltage Equations, Normalizing the Torque Equations , Torque and Power , Equivalent Circuit of a Synchronous Machine , The Flux Linkage State-Space Model , Loaf Equations , Sub transient and Transient Inductances and Time Constants , Turbine Generator Dynamic Models

UNIT-III: Simulation of Synchronous Machine:

Steady-State Equations and Phasor Diagrams, Machine Connected to an Infinite Bus through a Transmission Line, Machine Connected to an Infinite Bus with Local Load at Machine Terminal, Determining Steady- State Conditions, Initial Conditions for a Multimachine System , Determination of Machine Parameters from Manufacturers' Data , Analog Computer Simulation of the Synchronous Machine, Digital Simulation of Syn chronous Machines **.**

Linear Model of Synchronous Machine: Linearization of the Generator State -Space Current Model, Linearization of the Load Equation for the One-Machine Problem, Linearization of the Flux Linkage Model, Simplified Linear Model, Block Diagrams, State-Space Representation of Simplified Model.

UNIT-IV: Excitation Systems:

Simplified View of Excitation Control, Control Configurations, Typical Excitation Configurations, Excitation Control System Definitions, Voltage Regulator, Exciter Buildup, Excitation System response, State – Space Description of the Excitation System, State Space Representation of the Excitation system, Computer Representation of Excitation Systems, Typical Systems Constants, The effect of Excitation on Generator Performance**.**

Effect of Excitation on Stability: Effect of Excitation on Generator Power limits, Effect of the Excitation System on Transient Stability, Effect of Excitation on Dynamic Stability, Root – Locus Analysis of a Regulated Machine Connected to an Infinite Bus , Approximate System Representation, Supplementary Stabilizing Signals, Linear Analysis of the Stabilized Generator. General Comments on the Effect of Excitation on Stability.

UNIT-V: Multimachine Systems with Constant Impedance Load:

Statement of the Problem, Matrix representation of a Passive Network, Converting Machine Coordinates to System Reference, Relation Between Machine Currents & Voltages, System Order, Machines Represented by Classical Methods, Linearized Model for the Network, Hybrid Formulation, Network Equation with Flux Linkage Model, Total System Equation, Multimachine System Study.

Text Books:

1. Power System Control and Stability Vol -I By P. M. Anderson & A. A. Fouad.
2. Power System Stability and Control by Prabha Kundur- EPRI. Mc Graw Hill Inc.

Reference Books:

1. Power System Dynamic Stability and Control, Padiyar Interline Publisher Bangalore.

Semester: M.TECH. I **Specialization: Power Systems Engg.**

Subject: Computer Aided Power System Analysis **Branch: Electrical Engineering**

Total Theory Periods: 40 **Code: MT03112**

Total Marks in End Semester Exam. : 70 **Total Tutorial Periods: 12**

Minimum number of class test to be conducted: 02

Unit-I

Network equations, graph theory, Bus admittance matrix by step by step method, primitive network, bus incidence matrix, formation of Ybus by singular transformation, bus impedance matrix by inversion of Ybus, algorithm for bus impedance matrix, addition of a branch, addition of link, modification of Zbus by changes in primitive network. Concept of using these matrices for load flow study and fault study.

Unit-II

Fault Analysis, [ZBUS] Building algorithm, sequence matrices, Symmetrical And Unsymmetrical Short-Circuit Analysis of Lar ge Power Systems, Phase Shift in sequence quantities due to transformers.

Unit-III

Load flow study, introduction, power system equations, solution technique ie Gauss Seidel, Newton Raphson and fast decoupled load flow, incorporation of voltage controlled busses, representation of transformer , introduction to optimal load flow technique..

Unit-IV

Transient stability studies, introduction, swing equation, machine equations, power system equations, solution techniques, example of transient stability calculations, exciter and governor control system, description of transient stability program.

Unit-V

Power System Security, Factors affecting Security, State Transition Diagram, Contingency Analysis Using Network Sensitivity Method and AC Power Flow Method, Correcting the

Generation Dispatch Using Sensitivity Methods, Introduction to State Estimation.

Text Books:-

1. George L.Kusic,.Computer Aided Power System Analysis., Prentice Hall of India (P) Ltd., New Delhi, 1989.
2. J. Arrilaga, C.P. Arnold, B.J. Harker, .Computer Modelling of Electric Power Systems..
3. G. W. Stagg and A. H. El- Abiad, Computer methods in Power System Analysis, Mc - Graw Hill Kogakusha Ltd 1968.

References Books:-

1. A.K. Mahaianabis, D.P. Kothari, S.I. Ahson, .Computer Aided Power
2. System Analysis & Control. Tata McGraw Hill, New Delhi, 1988.
3. O.I. Elgard, .Electric Energy System Theory : An Introduction., 2 nd Edition,
4. McGraw Hill, New York, 1982.
5. Sadat, .Power System Analysis., McGraw Hill Co. Ltd., India, 2000.
6. I.J. Nagarath, D.P. Kothari, .Modern Power System Analysis., Tata McGraw Hill PublishingCo. Ltd., New Delhi, 1994.

Semester: M.TECH. I **Specialization: Power Systems Engg.**

Subject: Power System Protection **Branch: Electrical Engineering**

Total Theory Periods: 40 **Code: MT03113**

Total Marks in End Semester Exam. : 70 **Total Tutorial Periods: 12**

Minimum number of class test to be conducted: 02

Unit I

Protective Relaying -

Qualities of relaying, Definitions, Codes, Standards, Characteristic Functions, Classification, analog-digital - numerical, schemes and design, factors affecting performance, zones and degree of protection, faults types and evaluation, Instrument transformers for protection**.**

Unit II

Basic static relay units, sequence networks, fault sensing data processing units, FFT and Wavelet based algorithms, Phase& Amplitude Comparators, Duality, Zero Crossing/Level Defectors, Relay Schematics and Analysis, OverCurrent Relay, Instantaneous/Inverse TimeIDMTCharacteristics;DirectionalRelays;DifferentialRelays,RestrainingCharacteristics;DistanceRelays:Types, Characteristics;

Unit III

Protection of Power System Equipment, Generator, Transformer, Generator, Transformer Units, Transmission Systems, Bus-bars, Motors; Pilot wire and Carrier Current Schemes;System grounding, ground faults and protection, Load shedding and frequency relaying, Out of step relaying, Re-closing and synchronizing.

Unit IV

Numerical relays, Characteristics, Functional Diagrams, architecture, algorithms, Microprocessor & DSP based relays, sampling, aliasing, filter principles, Integrated and multifunction protection schemes, SCADA based protection systems, FTA, Testing of Relays.

Unit V

AC Circuit Breakers : Current interruption, Transient Recovery Voltage (TRV) , Rate of rise of TRV, Resistance switching, Damping of TRV, Opening Resistors, Inductive & Capacitive current interruptions , Current chopping , Rated characteristics of Circuit breakers, Types of Circuit Breakers, Testing of High Voltage AC Circuit Breakers

Text Books:-

1. C.R. Mason, The art and science of protective relaying, John Wiley & Sons.
2. A.R.Warrington, Protective Relays, Vol .1&2, Chapman and Hall.

References Books:-

1. T.S.Madhav Rao, Power system protection static relays with microprocessor applications, Tata McGraw Hill Publication.
2. Power System Protection Vol. I, II , III&IV, The Institution Of Electrical Engineers, Electricity Association Services Ltd., 1995
3. Helmut Ungrad , Wilibald Winkler, Andrzej Wiszniewski, Protection techniques in electrical energy systems, Marcel Dekker, Inc.
4. Badri Ram , D.N. Vishwakarma, Power system protection and switch gear, Tata McGraw H ill.
5. Blackburn, J. Lewis ,Protective Relaying, Principles and Applications, Marcel Dekker, Inc., 1986.
6. Anderson, P.M, Power System Protection,. McGraw-Hill, 1999
7. Singh L.P ,Digital Protection, Protective Relaying from Electromechanical to Microprocessor, John Wiley & Sons, 1994
8. Wright, A. and Christopoulos, C, Electrical Power System Protection,. Chapman & Hall, 1993,
9. Walter A. Elmore, J. L. Blackburn, Protective Relaying Theory and Applications, ABB T&D Co. Marcel Dekker, Inc.
10. Arun G. Phadke, James S. Thorp, Computer Relaying for Power Systems, Marcel Dekker, Inc.

Semester: M.TECH. I **Specialization: Power Systems Engg.**

Subject: Flexible AC transmission System (FACTS) **Branch: Electrical Engineering**

Total Theory Periods: 40 **Code: MT03114**

Total Marks in End Semester Exam. : 70 **Total Tutorial Periods: 12**

Minimum number of class test to be conducted: 02

Unit I

FACTS Concept and General System Considerations, Power Flow in AC System, Definitions on FACTS, Basic Types of FACTS Controllers. Converters for Static Compensation, Three Phase Converters and Standard Modulation Strategies (Programmed Harmonic Elimination and SPWM), GTO Inverters, Multi -Pulse Converters and Interface Magnetics,

Unit II

Transformer Connections for 12 , 24 and 48 pulse operation, Multi-Level Inverters of Diode Clamped Type and Flying Capacitor Type and suitable modulation strategies (includes SVM), Multi-level inverters of Cascade Type and their modulation, Current Control of Inverters

Unit III

Static Shunt Compensators, SVC and STATCOM, Operation and Control of TSC, TCR, STATCOM, Compensator Control, Comparison between SVC and STATCOM, STATCOM for transient and dynamic stability enhancement

Unit IV

Static Series Compensation, GCSC, TSSC, TCSC and SSSC, Operation and Control, External System Control for Series Compensators, SSR and its damping, Static Voltage and Phase Angle Regulators, TCVRand TCPAR, Operation and Control

Unit V

UPFC and IPFC, The Unified Power Flow Controller, Operation, Comparison with other FACTS devices, control of P and Q, Dynamic Performance, Special Purpose FACTS

Controllers, Interline Power Flow Controller, Operation and Control**.**

Text Books:

1. N.G. Hingorani & L. Gyugyi: Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems. IEEE Press, 2000.
2. T.J.E Miller, Reactive Power Control in Electric Systems John Wiley & Sons

References Books:-

1. Ned Mohan et.al: Power Electronics.John Wiley and Sons.
2. 'FACTS Controllers and applications" course book for STTP, 2003, Dr Ashok S & K S Suresh kumar

Semester: M.TECH. I **Specialization: Power Systems Engg.**

Subject: Power Electronics **Branch: Electrical Engineering**

Total Theory Periods: 40 **Code: MT03115(1)**

Total Marks in End Semester Exam. : 70 **Total Tutorial Periods: 12**

Minimum number of class test to be conducted: 02

Unit: - I

Overview of power semi conductor device, Ideal and Real switches Power diodes Structure and I-V characteristic, Switching characteristic, Breakdown voltage consideration. Schottky diodes. Power BJT, Basic structure and Switching characteristic, Safe operating area.

Power MOSEETS &IGBT'S: -Structure and I-V Characteristics, Switching characteristic, safe operating area G TO'S: - Baric Structure, V-I characteristic, Physics of Turn off operation, G TO'S Protection

Unit: -II

AC switching controllers, Single-phase resistive load, Integral half cycle control and phase control, Single phase R -L Load. Three-phase application of switching control for Star and Delta connected loads.

Unit: -III

Inverters: - Type of Inverters VSI, CSI and current regulated inverters Single phase half bridge Inverter - Circuit configuration and switching. Single phase full bridge configuration Control of AC frequency and voltage, PWM switching scheme, Implementation of SPWM in Half Bridge and Full Bridge Inverters.

Three phase inverters, circuit configuration and switching sequence, waveform of current for star and delta connected loads, Waveform shaping using SPWM.

Unit: -IV

Buck, Boost, Buck-Boost SMPS Topologies . Basic Operation- Waveforms - modes of Basic Operation- Waveforms - modes of operation –Continuous and discontinuous, Cuk dc-dc converters Output voltage ripple .

Unit: -V

Introduction to Resonant Converters. Classification of Resonant Converters. Basic Resonant CircuitConcepts. Load Resonant Converter. Resonant Switch Converter.

Text Books:

1. Ned Mohan et.al : Power Electronics, John Wiley and Sons
2. Mohammed Rashid: Power Electronics, Tata McGrawHill Publication .

References Books:-

1. G.K.Dubey et.al : Thyristorised Power Controllers Wiley Eastern Ltd.
2. Dewan & Straughen : Power Semiconductor Circuits John Wiley & Sons
3. G.K. Dubey & C.R. Kasaravada, Power Electronics & Drives Tata McGraw Hill
4. IETE Press Book :Power Electronics
5. Joseph Vithaythil : Power Electronics, McGraw Hill Publication

Semester: M.TECH. I **Specialization: Power Systems Engg.**

Subject: Digital Signal Processing **Branch: Electrical Engineering**

Total Theory Periods: 40 **Code: MT03115(2)**

Total Marks in End Semester Exam. : 70 **Total Tutorial Periods: 12**

Minimum number of class test to be conducted: 02

Unit I

Discrete time signals, systems and their representations:

Discrete time signals, Linear shift invariant systems, Stability and causality, Sampling of continuous time signals, Discrete time Fourier transform, Discrete Fourier series, Discrete Fourier transform, Z, transform, Properties of different transforms, Linear convolution using DFT, Computation of DFT

Unit II

Digital filter design and realization structures

Design of IIR digital filters from analog filters, Impulse invariance method and Bilinear transformation method, FIR filter design using window functions, Comparison of IIR and FIR digital filters, Basic IIR and FIR filter realization structures, Signal flow graph representations

Unit III

Analysis of finite word-length effects

Quantization process and errors, Coefficient quantisation effects in IIR and FIR filters, A/D conversion noise, Arithmetic round, off errors, Dynamic range scaling, Overflow oscillations and zero input limit cycles in IIRfilters

Unit IV

Statistical signal processing

Linear Signal Models, All pole, All zero and Pole, zero models, Power spectrum estimation, Spectral analysis of deterministic signals, Estimation of power spectrum of stationary random signals, Optimum linear filters, Optimum signal estimation, Mean square error estimation,

Optimum FIR and IIR filters.

Unit V

Discrete Hilbert Transform

Real and imaginary part sufficiency of the fourier transform for causal sequences, sufficiency theorems for finite length sequences, relationship between magnitude and phase, Hilbert transform relation for complex sequences.

Text Books:-

1. Alan V. Oppenheim, Ronald W. Schafer, Discrete -Time Signal Processing, Prentice-Hall of India Pvt. Ltd., New Delhi, 1997
2. John G. Proakis, Dimitris G. Manolakis, Digital Signal Processing(third edition), Prentice-Hall of India Pvt. Ltd, New Delhi, 1997

References Books:

1. Sanjit K Mitra, Digital Signal Processing: A computer-based approach ,Tata Mc Grow-Hill edition .1998
2. Dimitris G .Manolakis, Vinay K. Ingle and Stephen M. Kogon, Statistical and Adaptive Signal Processing, Mc Grow Hill international editions .-2000
3. Emmanuel C. Ifeachor, Barrie W. Jervis , Digital Signal Processing-A practical Approach, Addison . Wesley,1993
4. Abraham Peled and Bede Liu, Digital Signal Processing, John Wiley and Sons, 1976

Semester: M.TECH. I **Specialization: Power Systems Engg.**

Subject: Distributed Generation **Branch: Electrical Engineering**

Total Theory Periods: 40 **Code: MT03115 (3)**

Total Marks in End Semester Exam. : 70 **Total Tutorial Periods: 12**

Minimum number of class test to be conducted: 02

Unit I

Concepts of Distributed Generation:

Centralised Generation : Main features, Economics, Advantages & Disadvantages De-centralised/ Distributed / Embeded/Dispersed Generation, Operation of Distributed Generation Systems, Consideration of Reliability & Economics Advantages & Disadvantages, Introduction to energy conversion, Principles of renewable energy systems-technical and social implication.

Unit II

Solar energy:

Overview of solar energy conversion methods, Solar radiation components-collector measureme nts-estimation, Solar water heating –Calculation- Types analysis economics-Applications, Solar thermal power generation.

Unit III

Direct energy conversion (DEC)

DEC devices-photo voltaic system-solar cells-cell efficiency-Limitations-PV modules-Battery ba ck up-Systems design -Lighting and water pumping applications:

Unit IV

Wind energy:

Wind power characteristics-power extraction-types of wind machines, Dynamics matching-performance of wind generators, Wind mills-application-economics of wind power.

Unit V

Other Energy Sources:

Fuel cells, types-losses in fuel cell, Application: MHD generators- application of MHD generation, Biofuels-classification -biomass conversion process-application,ocean thermal energy conversion systems, Tidal and wave power-applications, Micro and mini hydel power, Hybrid Energy System- implementation –case study, Geo Thermal Energy.

Text Books:-

1. J.N.Twidell & A.D.Weir-Renewable Energy Sources, University press, Cambridge
2. S.L.Soo,Direct Energy Conversion, Prentice Hall Publication.

Reference Books:

1. Sukhatme, S.P., Solar Energy -Principles of Thermal Collection and Storage, Tata McGraw - Hill ,New Delhi.
2. Kreith, F.,and Kreider,J.F.Principles of Solar Engineering ,Mc-Graw -Hill Book Co.
3. James Larminie , Andrew Dicks,Fuel Cell Systems,John Weily & Sons Ltd.
4. J.F. Manwell, J.G. McGowan, A.L. Rogers, Wind Energy Explained John Willy & Sons Ltd.
5. E.J. Womack MHD Power Generation Engineering aspects, Chapman and Hall Publication.
6. G.D. Rai, Non Conventional energy Sources, Khanna Publications, New Delhi.

Semester: M.TECH. I **Specialization: Power Systems Engg.**

Subject: Power System Lab - I **Branch: Electrical Engineering Total**

Practical Periods: 40 **Code: MT03116**

Total Marks in End Semester Exam. :70

List of Experiments:

Development of algorithms & flowcharts and digital simulation of the following using MATLAB/PSCAD Software package:

- Introduction to MATLAB and other Simulation software
- Z-bus and Y-bus formulation and their inversion.
- Load flow studies (Gauss-Siedle method, Newton Raphson method)
- Flow study with Fast Decoupled Method.
- Fault analysis (balanced and unbalanced)
- Solution of Swing equations by modified Euler's method.
- Simulating Power Systems with Simulink
- Solution of Power System equations using Modified Euler's Method.
- Solution of Swing equations using Runge – Kutta method (RK4).
- Power system simulation by MATLAB using the Sim Power Systems Toolbox

Semester: M.TECH. I **Specialization: Power Systems Engg.**

Subject: Protection Simulation Lab **Branch: Electrical Engineering**

Total Practical Periods: 40 **Code: MT03117**

Total Marks in End Semester Exam. : 70

List of Experiments:

- Ratio Test of a C.T and determination of error.
- Determination of knee point voltage of a CT.
- Summation Transformer characteristics.
- Study of CT Connection for E/F protection.
- Study of Open delta PT Connection for earth fault indication.
- Protection of 3 ph. Alternater (simulation study).
- Protection of 3 ph. Induction Motor (simulation study).
- Over current / under voltage / Negative seq Relay Characteristics(simulation study).
- Simulation of Transmission line protection.
- Study of differential protection of transformer (simulation study).

BHARTI UNIVERSITY, DURG

SCHEME OF EXAMINATION DEPARTMENT OF ELE. ENGG.

M.TECH. in Power Systems Engineering

SECOND SEMESTER

S.No	Board of Study	Subject Code	Subject	Periods per week			Scheme of exam			Total Marks
				L	T	P	Theory/Practical			
							ESE	CT	TA	
1.	Electrical Engg.	MT03121	EHV-AC & DC	3	1	-	70	10	20	100
2.	Electrical Engg.	MT03122	Power Quality	3	1	-	70	10	20	100
3.	Electrical Engg.	MT03123	Power System Stability and Control	3	1	-	70	10	20	100
4.	Electrical Engg.	MT03124	Power System Generation Operation & Control	3	1	-	70	10	20	100
5.	Refer Table- II		Elective-II	3	1	-	70	10	20	100
6.	Electrical Engg.	MT03126	Power System Lab-II	-	-	3	70	-	30	100
7.	Electrical Engg.	MT03127	Power Quality Lab	-	-	3	70	-	30	100
TOTAL				**15**	**5**	**6**	**490**	**50**	**160**	**700**

Table - II

Elective II (MT03125)			
Sr. No.	**Board of Study**	**Subject Code**	**Subject**
1	Electrical Engg.	MT03125(1)	Transients in Power System
2	Electrical Engg.	MT03125(2)	Restructuring Power System
3	Electrical Engg.	MT03125(3)	Distribution System Automation

L- Lecture T- Tutorial P- Practical

ESE- End Semester Exam CT- Class Test TA - Teachers Assessment

Note (1) – 1/4th of total strength of students subject to minimum of twenty students is required to offer an elective in the college in a Particular academic session .

Note (2) – Choice of elective course once made for an examination cannot be changed in future examinations.

Semester: M.TECH. II **Specialization: Power Systems Engg.**

Subject: EHV-AC & DC **Branch: Electrical Engineering**

Total Theory Periods: 40 **Code: MT03121**

Total Marks in End Semester Exam. : 70 **Total Tutorial Periods: 12**

Minimum number of class test to be conducted: 02

UNIT-I

Sequential impedances of AC systems EHVAC transmission over voltages, insulation design of lightning and switching over voltages, High voltage testing of AC equipments, Reactive Power compensation of EHV AC lines.

UNIT-II

DC Power Transmission Technology: Application of DC Transmission, Description of DC Transmission System, Planning for HVDC Transmission, Modern Trends in DC Transmission, Thyristor Device, Thyristor Valve, Valve Tests, Recent Trends in valves. Comparison of EHV AC & DC transmission.

UNIT-III

HVDC Converters: Pulse Number, Choice of Converter Configuration, Simplified Analysis of Graetz Circuit, Converter Bridge Characteristics. Characteristics of a Twelve Pulse Converter, Detailed Analysis of Converters

HVDC System Control: Principal of DC Link Control, Converter Control Characteristics, System Control Hierarchy, Firing Angle Control, Current and Extinction Angle Control, Starting and Stopping of DC Link, Power Control, Higher Level Controllers, Telecommunication Requirements

UNIT-IV

Converter Faults and Protection: Converter Faults , Protection Against Overcurrents, Over voltages in a Converter Station , Surge Arresters, Protection Against Over voltages.

Smoothing Reactor and DC Line: Smoothing Reactors, DC Line, Transient over Voltages In DC Line, Protection of DC Line, DC Breakers, Monopolar Operation, Effects of Proximity of AC and DC Transmission Lines

UNIT-V

Reactive Power Control: Reactive Power Requirements in Steady State, Sources of Reactive Power, Static Var Systems, Reactive Power Control during Transients

Harmonics and Filters: Generation of Harmonics, Design of AC Filters, DC Filters, Carrier Frequency and RI Noise

Textbook:

1. HVDC Power Transmission System: K.R. Padiyar , Wiley Eastern Limited.

Reference:

1. Power System Stability and Control by Prabha Kundur- EPRI. Mc Graw Hill Inc.

Semester: M.TECH. II **Specialization: Power Systems Engg.**

Subject: Power Quality **Branch: Electrical Engineering**

Total Theory Periods: 40 **Code: MT03122**

Total Marks in End Semester Exam. : 70 **Total Tutorial Periods: 12**

Minimum number of class test to be conducted: 02

Unit-I

Introduction - power quality, voltage quality, overview of power quality phenomena, classification of power quality issues, power quality measures and standards, THD -TIF-DIN- C-message weights-flicker factor-transient phenomena, occurrence of power quality problems, power acceptability curves, IEEE guides, standards and recommended practices.

Unit-II

Harmonics, individual and total harmonic distortion, RMS value of a harmonic waveform, triplex harmonics, important harmonic introducing devices, SMPS, Three phase power converters, arcing devices, saturable devices, harmonic distortion of fluorescent lamps, effect of power system harmonics on power system equipment and loads.

Modeling of networks and components under non-sinusoidal conditions, transmission and distribution systems, shunt capacitors, transformers, electric machines, ground systems, loads that cause power quality problems, power quality problems created by drives and its impact on drives

Unit-III

Power factor improvement, Passive Compensation, Passive Filtering, Harmonic Resonance, Impedance Scan Analysis, Active Power Factor Corrected Single Phase Front End, Control Methods for Single Phase APFC, Three Phase APFC and Control Techniques, PFC Based on Bilateral Single Phase and Three Phase Converter. Static VAR compensators, SVC and STATCOM.

Unit-IV

Active Harmonic Filtering, Shunt Injection Filter for single phase, three -phase three -wire and

three-phase four-wire systems, d-q domain control of three phase shunt active filters uninterruptible power supplies-constant voltage transformers, series active power filtering techniques for harmonic cancellation and isolation . Dynamic Voltage Restorers for sag , swell and flicker problems.

Unit-V

Grounding and wiring, introduction, NEC grounding requirements, reasons for grounding, typical grounding and wiring problems, solutions to grounding, and wiring problems.

Text books:-

1. Electric power quality by g.t.heydt Understanding Power Quality Problems
   by Math H. Bollen

References:

1. 1. J. Arrillaga, .Power System Quality Assessment., John wiley, 2000
2. 2 J. Arrillaga, B.C. Smith, N.R. Watson & A. R.Wood ,.Power system Harmonic .Analysis, Wiley, 1997 ‘Selected Topics in Power Quality and Custom Power’, Course book for STTP, 2004, Ashok S.
3. Surya Santoso, H. Wayne Beaty, Roger C. Dugan, Mark F. McGranaghan, Electrical Power System Quality , MC Graw
4. Hill, 2002

Semester: M.TECH. II **Specialization: Power Systems Engg.**

Subject: Power System Stability & Control **Branch: Electrical Engineering**

Total Theory Periods: 40 **Code: MT03123**

Total Marks in End Semester Exam. : 70 **Total Tutorial Periods: 12**

Minimum number of class test to be conducted: 02

Unit I

Power System Structure: Operating states, control problem, control loops. Power System Stability – classification, terms and definitions.

Power system components: H ydraulic and steam turbine, Effect of exciter and governor. Excitation system – requirements, functions, types and modeling of excitation systems, IEEE standards and models.

Unit II

Control of Power and Frequency: Power, Frequency characteristics, Division of load, Load frequency control, Generator, load and Prime mover models, Governor models, AGC in a two area system, AGC in a multi area system parameter setting constants, Tie- line bias control, AGC with optimal dispatch of Generation, AGC including Excitation system, Conventional PI and PID controllersfor AGC, AI applications automatic generation control.

Unit III

Control of voltage and Reactive Power: Relation between voltage, power and reactive power, Generation and absorption of reactive power, voltage control and voltage stability analysis, V-Q curves and sensitivity analysis, Voltage stability indices, Factors affecting voltage instability and voltage collapse.

Unit IV

Stability Studies: Concepts, steady state and transient stability, small signal stability analysis, excitation system, Dynamic and transient stability analysis of single machine and multi - machine systems, power system stabilizer design and analysis for stability problem. Transient Stability: Solution of swing equations, swing curves, stability criterion.

Unit V

Techniques for the improvement of stability: operation under abnormal and distressed condition, Enhancement of small signal stability: use of power system stabilizers, supplementary control of Static VAr compensators, supplementary control of HVDC links, Techniques for improvement of transient stability, Integrated analysis of Voltage and Angle stability, Control of voltage instability, concepts of load shedding.

Text Books:

1.Prabha Kundur, "Power System Stability and Control" Mc-Graw Hill Inc, New York, 1993.

2.Taylor C.W.," Power System Voltage Stability" Mc-Graw Hill Inc, New York, 1993.

Reference Books:

1. K.R.Padiyar,.Power System Dynamic . Stability and Control., Inter Publishing(P)Ltd., Bangalore, 1999 .
2. P.S.R. Murthy , " Power System Operation and Control," Tata Mc-Graw ,New Delhi 1984.
3. Nagrath IJ, Kothari ., " Power System Engineering ," Tata Mc-Graw ,New Delhi 1994.
4. Weedy B.M. " Electric Power System" John Wiley and Sons ,3 rd edition .
5. O.1 Elgerd," Electric Energy System Theory : an Introduction ," Mc-Graw Hill, NX, 1983 (Mainy for Unit –II).

Semester: M.TECH. II **Specialization: Power Systems Engg.**

Subject: Power System generation operation & Control **Branch: Electrical Engineering**

Total Theory Periods: 40 **Code: MT03124**

Total Marks in End Semester Exam. : 70 **Total Tutorial Periods: 12**

Minimum number of class test to be conducted: 02

UNIT-1

Characteristics of Generating Units:- Characteristics of steam Units, Variations in steam Unit Characteristics, Cogeneration Plants, Light Water Moderated Nuclear Reactor Units, Hydroelectric Units, The economics Dispatch Problem, Thermal System Dispatching with Network Losses Considered, The Lambda Iteration Method, Gradient Methods of Economics Dispatch, Newton's Method, The power flow problem and its Solution, The Power Flow Problem on a Direct Current Network, The Formulation of the AC Power Flow, The Decoupled Power Flow, The " DC" Power Flow.

UNIT-II

Unit Commitment:- Introduction, Constraints in Unit Commitment, Spinning Reserve, Thermal Unit Constraints, Other Constraints, Hydro Constraints, Must Run, Fuel Constraints, Unit Commitment Solution Methods, Priority List Methods, Dynamic- Programming Solution, Introduction, Forward DP Approach, Lagrange Relaxation Solution, Adjusting ?.

UNIT-III

Hydro Thermal Coordination:- Introduction, Long-Range Hydro-Scheduling, Short Range Hydro- Scheduling, Hydroelectric Plant Models, Scheduling Problems, Types of Scheduling Problems Scheduling Energy, The Short Term Hydro Scheduling: A Gradient Approach, Hydro Units in series (Hydraulically Coupled), Pumped Storage Hydro plants, Pumped Storage Hydro Scheduling with a ?.-y Iteration, Pumped Storage Scheduling by a Gradient Method, Dynamic Programming solution to the Hydrothermal Scheduling Problem, Hydro Scheduling Using Linear Programming.

UNIT- IV

Control of Generation:- Introduction, Generator Model, Load Model, Prime Mover Model, Governor Model, Tie-Line Model, Generation Control, Supplementary control Action, Tie Line Control, Generation Allocation, Automatic Generation Control (AGC) implementation, AGC Features.

UNIT-V

Interchange of Power & Energy:- Introduction, Economy Interchange between Interconnected Utilities, Inter-utility Economy Energy Evaluation, Interchange Evaluation with Unit Commitment, Multiple Utility Interchange Transactions, Other Types of Interchange, Capacity Interchange Diversity Interchange, Energy Banking, Emergency Power Interchange, Inadvertent Power Exchange.

Text Book:

1.Power Generation a Operation and Control by L.N.J. Wood & B.F. Woolenberge.

References:-

1. P. Kundur, .Power System Stability And Control., McGraw Hill, New York, 1994. O.I. Elgard,
2. .Electric Energy System Theory: An Introduction., II Edition, McGraw Hill, New York, 1982.
3. J. Arrilaga, C.P. Arnold, B.J. Harker, .Computer Modeling Of Electrical Power Systems., Wiley, New York, 1983.

Semester: M.TECH. II **Specialization: Power Systems Engg.**

Subject: Transients in Power System **Branch: Electrical Engineering**

Total Theory Periods: 40 **Code: MT03125(1)**

Total Marks in End Semester Exam. : 70 **Total Tutorial Periods: 12**

Minimum number of class test to be conducted: 02

Unit-I

Origin and nature of transients and surges. Equivalent circuit representations. Lumped and distributed circuit transients. Line energisation and de-energisation transients. Earth and earth wire effects.

Unit-II

Current chopping in circuit breakers. Short line fault condition and its relation to circuit breaker duty. Trapped charge effects. Effect of source and source representation in short line fault studies. Control of transients.

Unit-III

Lightning phenomena. Influence of tower footing resistance and earth resistance. Traveling waves in distributed parameter multi-conductor lines, parameters as a function of frequency.

Unit-IV

Simulation of surge diverters in transient analysis. Influence of pole opening and pole closing. Fourier integra l and Z transform methods in power system transients. Bergeron methods of analysis and use of EMTP and EMTDC/PSCAD package.

Unit-V

Insulation Coordination: over voltage limiting devices, dielectric properties, breakdown of gaseous insulation, tracking and erosion of insulation, high current arcs.

Text Books:

1. Transients in Power System By V. A. Vanikov, Mir Publications, Moscow. 2.Electrical Transients in Power Systems By Greenwood:A., John Wiley & Sons,

References:

1. Power System Transients by C. S. Indulkar and D.P. Kothari Power Circuit breaker theory and design by Flurscheim C.H.
2. Traveling Waves on Transmission Lines Bewley; L.V., Dover Publications Inc., New York. EMTP Rulebook
3. EMTDC/PSCAD Rulebook

Semester: M.TECH. II **Specialization: Power Systems Engg.**

Subject: Restructuring Power System **Branch: Electrical Engineering**

Total Theory Periods: 40 **Code: MT03125(2)**

Total Marks in End Semester Exam. : 70 **Total Tutorial Periods: 12**

Minimum number of class test to be conducted: 02

Unit- I:

Introduction: Basic concept and definitions, privatization, restructuring, transmission open access, wheeling, deregulation, components of deregulated system, advantage s of competitive system.

Unit- II:

Power System Restructuring: An overview of the restructured power system, Difference between integrated power system and restructured power system. Explanation with suitable practical examples.

Unit- III:

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- IV:

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- V:

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.

Text Books:

1. “Power System Restructuring and Deregulation” edited by Loi Lei Lai, John Wiley & Sons Ltd.
2. “Restructured Power Systems”, by S. A. Khaparde, A. R. Abhyankar, Narosa Publishing House, New Delhi

References:

1. . “Operation of Restructured Power Systems”, by Kankar Bhattacharya, Math H.J. Bollen, Jaap E. Daalder, Springer Ltd.
2. “Restructured Electrical Power Systems: Operation, Trading, and Volatility”, by Mohammad Shahidehpour, Muwaffaq Alomoush, CRS Press.
3. “Understanding Electric Utilities and Deregulation”, by Lorrin Philipson and H. Lee Willis, Marcel Dekker Inc, New York.
4. .“Restructured Power Systems (Engineering and Economics)” by David, A. Kumar, Wen, F.S., Springer Ltd.

Semester: M.TECH. II **Specialization: Power Systems Engg.**

Subject: Distribution System Automation **Branch: Electrical Engineering**

Total Theory Periods: 40 **Code: MT03125(3)**

Total Marks in End Semester Exam. : 70 **Total Tutorial Periods: 12**

Minimum number of class test to be conducted: 02

Unit I

Distribution System Automation and Planning, Factors Affecting System Planning, Present Distribution Planning Techniques, Planning in the Future, Power System reliability, Basic Reliability Concepts and Series, Parallel, Series -Parallel Systems, Development of State Transition Model to Determine the Steady State Probabilities.

Unit II

Electrical System Design, Distribution System Design, Electrical Design Aspects of Industrial, Commercials Buildings, Electrical Safety and Earthing Practices at various voltage levels, IS Codes

Unit III

Power Quality: Sags, Swells, Unbalance, Flicker, Distortion, Current Harmonics, Sources of Harmonics in Distribution Systems and its Effects, Energy Management, Energy Conservation Through Energy Management Demand Side Management, Load Management, Reactive PowerControl.

Custom Power: Concept, Custom Power Devices, Operation and Applications

Unit IV

Deregulated Systems: Reconfiguring Power systems, Unbundling of Electric Utilities, Competition andDirect access.

Unit-V

Project planning for distribution automation-communication, sensors, supervisory control and data acquisition, consumer information system (CIS), geographical information system (GIS).

Text Books:

1.Turan Gonen: .Electric Power Distribution System Engineering. - McGraw Hill Company.

2.Pansini: .Electrical Distribution Engineering..

References:

1. IEEE recommended practice for electric power distribution for industrial plants, - December 1993.
2. M.V Deshpande: .Electrical Power System Design. - Tata -McGraw Hill.
3. Pabla H S.: .Electrical Power Distribution Systems.. Tata McGraw Hill.
4. IEEE Slandered 739 . 1984 Recommended Practice for Energy Conservation and Cost Effective Planning in Industrial Facilities.
5. Lakervi & E J Holmes .Electricity distribution Network Design., 2nd Edition Peter Peregrimus Ltd.

Semester: M.TECH. II **Specialization: Power Systems Engg.**

Subject: Power System Lab- II **Branch: Electrical Engineering**

Total Practical Periods: 40 **Code: MT03126**

Tota l Marks in End Semester Exam. : 70

List Of Experiment

1. Reactive Power Control By Excitation System (Simulation Study)

2 Simulation and study of a Power System Stabilizer.

3 Load frequency control of a two area system.(Simulation study)

4 Microprocessor based load frequency control.(Simulation study)

5 Study of a HVDC Transmission system and its simulation.

6 Study of a characteristic of a 12-plus convertor.

7 Analysis of PV & QV curves for voltage stability.

8 Transient stability analysis of a multimachine system.

9 Automatic Generation Control in a Restructured Power system.

10 Characteristic of long transmission Line and compensation**.**

Semester: M.TECH. II **Specialization: Power Systems Engg.**

Subject: Power Quality Lab **Branch: Electrical Engineering**

Total Practical Periods: 40 **Code: MT03127**

Total Marks in End Semester Exam. : 70

List of Experiment

1 Simulation of Power quality disturbanceusing MATLAB/SIMULATION.

2 To measure the performance like THD. PF of a three phase fully controlled converter feeding a resistive load.

3 To measure the performance like DF & CF of a single phase fully controlled converter feeding a RL load.

4 To measure and analyze the harmonic contents of a three phaseinverter fed non line load

5 To study and simulate power filter.

6 To study and simulate active power filter.

7 Application of FFT/wavelet techniques for power quality analysisusing MATLAB/ SIMULATION.

8 Simulation of Dynamic voltage restore (DV Ohms) for sweg. Swell and Flicker problems.

9 Simulation of D-stacom for Powerfactor character using MATLAB /SIMULATION.

10 To measure and analyze the source voltage and input current wave form for three phase induction motor fed through indirect vector control drive unit.

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THIRD SEMESTER

S. No.	Board of Study	Subject Code	Subject	Period sper week			Scheme of exam			Total Marks
				L	T	P	Theory/Practical			
							ESE	CT	TA	
1.	Electrical Engineering	MT03131	Power System planning & Management	3	1	-	70	10	20	100
2.	Refer Table- III		Elective-III	3	1	-	70	10	20	100
3.	Electrical Engineering	MT03133	Project	-	-	28	140	-	60	200
4.	Electrical Engineering	MT03134	Seminar	-	-	3			100	100
TOTAL				6	2	31	280	20	200	500

L-Lecture, T- Tutorial, P- Practical, ESE- End Semester Examination, CT- Class Test, TA- Teacher's Assessment

Table III

Elective- III			
S. No.	**Board of Study**	**Subject Code**	**Subject**
1	Electrical Engg.	MT03132(1)	Energy Conservation & Audit
2	Electrical Engg.	MT03132(2)	ANN & Fuzzy Techniques
3	Electrical Engg.	MT03132(3)	Power System Reliability

Note (1) – $1/4^{th}$ of total strength of students subject to minimum of twenty students is required tooffer an elective in the college in a Particular academic session .

Note (2) – Choice of elective course once made for an examination cannot be changed i n future examinations.

Semester: M.TECH. III **Specialization: Power Systems Engg.**

Subject: Power System Planning & Management **Branch: Electrical Engineering**

Total Theory Periods: 40 **Code: MT03131**

Total Marks in End Semester Exam. : 70 **Total Tutorial Periods: 12**

Minimum number of class test to be conducted: 02

Unit- I:

Introduction of power planning, National and Regional Planning, structure of P.S., planning tools, Electricity Regulation, Electrical Forecasting, techniques and modeling.

Unit- II:

Generation planning, Integrated power generation cogeneration/captive power, Power pooling and power trading. Transmission and distribution planning. Power System Economics. Power sector finance, financial planning, private participation Rural Electrification investment, concept of rational tariffs.

Unit- III:

Power supply Reliablity, Reliability planning. System operation planning, load management, load prediction, reactive power balance, online power flow studies, state estimation, computerized management, power system simulator.

Unit- IV:

Computer aided planning, wheeling. Environmental effects, the green house effect, Technological impacts. Insulation coordination. Reactive compensation.

Unit- V:

Optimal power system expansion planning : Formulation of least cost optimization problem incorporating the capital, operating and maintenance cost of candidate plants of different types (Thermal, Hydro, Nuclear, Non-conventional etc.) and minimum assured reliability constraint – optimization techniques for solution by programming.

Text Books:

1.Electrical Power System Planning by A.S.Pabla – Macmillan India Ltd.

2.X.Wang & J.R. Mc Donald , “Modern Power system planning”, McGraw. Hill, 1993

References:

1. A.S Pabla , “Electrical Power system planning”, Mac Millan,Delhi,1998
2. Sullivan, “Power system planning”, McGraw. Hill, 1977
3. Power Distribution Planning Reference Book By H. Lee Willis, CRC Press, 2004.
4. Makridakis, Spyros, “Forecasting methods and application”, John Wiley, 1993

Semester: M.TECH. III **Specialization: Power Systems Engg.**

Subject: Energy Conservation & Audit **Branch: Electrical Engineering**

Total Theory Periods: 40 **Code: MT03132(1)**

Total Marks in End Semester Exam. : 70 **Total Tutorial Periods: 12**

Minimum number of class test to be conducted: 02

Unit I

System approach and End use approach to efficient use of Electricity; Electricity tariff types; Energy auditing: Types and objectives -audit instruments- ECO assessment and Economic methods -specific energy analysis-Minimum energy paths-consumption models-Case study.

Unit II

Electric motors, Energy efficient controls and starting efficiency, Motor Efficiency and Load Analysis, Energy efficient /high efficient Motors, Case study; Load Matching and selection of motors.

Variable speed drives; Pumps and Fans, Efficient Control strategies, Optimal selection and sizing, Optimal operati on and Storage; Case study

Unit III

Transformer Loading/Efficiency analysis, Feeder/cable loss evaluation, case study, Reactive Power management, Capacitor Sizing, Degree of Compensation, Capacitor losses-Location, Placement, Maintenance, case study;

Peak Demand controls- Methodologies, Types of Industrial loads, Optimal Load scheduling - case study.

Unit -IV

Lighting- Energy efficient light sources-Energy conservation in Lighting Schemes- Electronic ballast- Power quality issues -Luminaries, case stu dy;

Cogeneration - Definition and scope, topping and bottoming cycles, cogeneration technologies, industry suitable for cogeneration, sale of electricity to utility, impact of pricing on cogeneration, integrated energy system, potential of cogeneration in India.

Unit -V

Electric loads of Air conditioning & Refrigeration -Energy conservation measures- Cool storage .Types- Optimal operation-case study; Electric water heating-Gysers-Solar Water Heaters-Power Consumption in Compressors, Energy conservation measures; Electrolytic Process; Computer Controls- softwares-EMS

Text Books:

1.IEEE Bronze Book- .Recommended Practice for Energy Conservation and cost effective planning in Industrial facilities. IEEE Inc, USA.

2 Giovanni Petrecca, .Industrial Energy Management: Principles and Applications., The Kluwer international series -207,(1999)

References:

1. Anthony J. Pansini, Kenneth D. Smalling, .Guide to Electric Load Management., Pennwell Pub; (1998)
2. Howard E. Jordan, E. nergy-Efficient Electric Motors and Their Applications., Plenum Pub Corp; 2nd edition (1994)
3. Turner, Wayne C., .Energy Management Handbook., Lilburn, The Fairmont Press, 2001
4. Albert Thumann , .Handbook of Energy Audits., Fairmont Pr; 5th edition (1998)
5. Albert Thumann, P.W, Plant Engineers and Managers Guide to Energy Conservation. - Seventh Edition-TWI Press Inc, Terre Haute.
6. Donald R. W., .Energy Efficiency Manual., Energy Institute Press
7. Tripathy S.C.,'Electric Energy Utilization And Conservation', Tata McGraw Hill.
8. NESCAP -Guide Book on Promotion of Sustainable Energy Consumption

Semester: M.TECH. III **Specialization: Power Systems Engg.**

Subject: ANN & Fuzzy Techniques **Branch: Electrical Engineering**

Total Theory Periods: 40 **Code: MT03132(2)**

Total Marks in End Semester Exam. :70 **Total Tutorial Periods: 12**

Minimum number of class test to be conducted: 02

Unit I :

Biological neurons and their artificial models, models of artificial neural networks, feed forward and feed backward networks, supervised and unsupervised learning,

Neural network learning rules - Hebbian rule, perceptron rules, delta rules, Widrow -Hoff rule, correlation rule, winner- take- all rule, outstar learning rule.

Unit II:

Single Layer Perceptron Classifier: Classification model, features, decision regions, discriminant functions, linear machine and minimum distance classification, training and classification using discrete Perceptron algorithm, single layer continuous Perceptron networks for linearly separable classification, multi category single layer Perceptron networks.

Multi Layer Feed Forward Networks- Linearly non-separable pattern classification, delta learning rule for multi Perceptron layer, genaralised delta rules, error back propagation training

Unit III:

Single Layer Feedback Networks: Basic concepts of dynamical systems, mathematical foundation of discrete time Hopfield networks, mathematical foundation of gradient type Hopfield networks transient response of continuous time networks, relaxation modeling in single layer feedback networks, optimization problems.Associative Memories: Basic concepts, linear associator, basic concept of and performance analysis of recurrent auto associative memory, bi-directional associative memory, associative memory of spatio-temporal patterns.

Unit-IV

Fuzzy sets. Fuzzy set operations . Properties, Membership functions, Fuzzy to crisp

conversion. fuzzification and defuzzification methods, applications in engineering problems.

Unit V :

Fuzzy control systems. Introduction, simple fuzzy logic controllers with examples, special forms of fuzzy logic models, classical fuzzy control problems. Inverter pendulum. image processing . home heating system . Adaptive fuzzy systems, hybrid systems.

Textbooks:

1. J.M. Zurada, .Introduction to artificial neural systems., Jaico Publishers, 1992.
2. Simon Haykins, .Neural Networks . A comprehensive foundation., Macmillan College, Proc, Con, Inc, New York, 1994.

References

1. D. Driankov, H. Hellendorn, M. Reinfrank, .Fuzzy Control . An Introduction., Narora Publishing House, New Delhi, 1993.
2. H.J. Zimmermann, .Fuzzy set theory and its applications., III Edition, Kluwer Academic Publishers, London.
3. G.J. Klir, Boyuan, .Fuzzy sets and fuzzy logic., PHI (P) Ltd., 1997.

4 . Stamatios V Kartalopoulos, .Understanding neural networks and fuzzy logic . basic concepts and applications., Prentice Hall of India (P) Ltd., New Delhi, 2000.

5. Timothy J. Ross, .Fuzzy logic with engineering applications., McGraw Hill, New York.

6. Suran Goonatilake, Sukhdev Khebbal (Eds), .Intelligent hybrid systems., JohnWiley&Sons,NewYork,1995

Semester: M.TECH. IIIrd **Specialization: Power Systems Engg.**

Subject: Power System Reliability **Branch: Electrical Engineering**

Total Theory Periods: 40 **Code: MT03132(3)**

Total Marks in End Semester Exam. : 70 **Total Tutorial Periods: 12**

Minimum number of class test to be conducted: 02

UNIT I

Generating Capacity Basic Probability Methods:- Introduction, The generation system model, Generating unit unavailability , Capacity outage probability tables, Comparison of deterministic and probabilistic criteria, Recursive algorithm for capacity model building , Recursive algorithm for unit removal, Alternative model – building techniques , Loss of load indices , Concepts and evaluation techniques , Numerical examples, Equivalent forced outage rate, capacity expansion analysis , Evaluation techniques , Perturbation effects, Scheduled outages , Evaluation methods on period bases , Load forecast uncertainty, Forced outage rate uncertainty , Exact method , Approximate method , Application, LOLE computation .

UNIT II

Generating Capacity, Frequency and Duration Method, Introduction , The generation model ,Fundamental development , Recursive algorithm for capacity model building , System risk indices, Individual state load model , Cumulative state load model , Practical system studies , Base case study

, System expansion studies , Load forecast uncertainty .

UNIT –III

Interconnected Systems:-Introduction , Probability array method in two interconnected system , Concepts , Evaluation techniques , Equivalent assisting unit approach to two interconnected system, Factors affecting the emergency assistance available through the interconnections, Introduction , Effect of tie capacity , Effect of tie line reliability , Effect of number of tie line , Effect of tie capacity uncertainty, Effect of load forecast uncertainty , Variable reserve versus maximum peak load reserve , Reliability evaluation in three interconnected systems, Direct assistance from two systems, Indirect assistance from two systems.

UNIT – IV

Operating Reserve:- General concepts, PJM method, Concepts, Outage replacement rate, Generation model , Unit commitment , Extensions to PJM method , Load forecast uncertainty, Derased (Partial output) stanes. Modified PJM method, Concepts, Area risk curves. Modelling rapid start unit, Modelling hot reserve units, Unit commitment risk, Numerical examples, Postponable outage, Concepts m Modelling postponable outages, Unit commitment risk , Security function approach , Concepts , Security function model, Response risk, Concepts, Evaluation techniques, Effect of disturbing spinning reserve, Effect of hydro- electric units, Effect of rapid start units, Interconnectedsystems. .

UNIT- V

Composite Generation and Transmission systems:- Introduction , Radial configurations , Conditional probability approach, Network configurations, State selection, Concepts , Application , System and load point indices , Concepts , Numerical evaluation, Application to practical systems. Data requirements for composite system reliability evaluation , Concepts , Deterministic data, Stochastic data , Independent outages, dependent outages, common mode outages, station originated outages.

Text Book:

1. Reliability Evaluation of Power System by Roy Billinton, Ronald and Allan, Plenun Press,NY-London

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FOURTH SEMESTER

S. No.	Board of Study	Subject Code	Subject	Periods per week			Scheme of exam			Total Marks
				L	T	P	Theory/Practical			
							ESE	CT	TA	
1.	Electrical Engg.	**MT03141**	Project + Seminar	6	-	34	350	-	150	500
Total				**6**	**-**	**34**	**350**	**-**	**150**	**500**

L- Lecture T- Tutorial P-Practical

ESE- End Semester Exam CT- Class Test TA- Teachers Assessment

Scheme of Marks Allotment

Semester	Total Marks	Grand Total
I	**700**	**2400**
II	**700**	
III	**500**	
IV	**500**	