Chhattisgarh Swami Vivekanand Technical University, Bhilai

SCHEME OF EXAMINATION
DEPARTMENT OF ELECTRICAL ENGINEERING

M.E. in Power Systems Engineering

SECOND SEMESTER

S. No	Board of Study	Subject Code	Subject	Periods per week			Scheme of exam			Total Marks	Credit L+(T+P)/2
							Theory/Practical				
				L	T	P	ESE	CT	TA		
1.	Electrical Engg.	559211 (24)	EHV-AC & DC	3	1	-	100	20	20	140	**4**
2.	Electrical Engg.	559212 (24)	Power Quality	3	1	-	100	20	20	140	**4**
3.	Electrical Engg.	559213 (24)	Power System Stability and Control	3	1	-	100	20	20	140	**4**
4.	Electrical Engg.	559214 (24)	Power System Generation Operation & Control	3	1	-	100	20	20	140	**4**
5.	Refer Table- II		Elective-II	3	1	-	100	20	20	140	4
6.	Electrical Engg.	559221 (24)	Power System Lab-II	-	-	3	75	-	75	150	**2**
7.	Electrical Engg.	559222 (24)	Power Quality Lab	-	-	3	75	-	75	150	**2**
TOTAL				**15**	**5**	**6**	**650**	**100**	**250**	**1000**	**24**

Table - II

Elective II			
Sr. No.	**Board of Study**	**Subject Code**	**Subject**
1	Electrical Engg.	559231 (24)	Transients in Power System
2	Electrical Engg.	559232 (24)	Restructuring Power System
3	Electrical Engg.	559233 (24)	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.

Chhattisgarh Swami Vivekanand Technical University Bhilai (C.G.)

Semester: **M.E. IInd** Specialization: **Power Systems Engg.**
Subject: **EHV-AC & DC** Branch: **Electrical Engineering**
Total Theory Periods: **40** Code: 559211 (24)
Total Marks in End Semester Exam. : **100** Total Tutorial Periods: **12**
Minimum number of class test to be conducted: **02**

UNIT-1
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-2
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-3
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-4
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-5
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

Text:
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.

Chhattisgarh Swami Vivekanand Technical University Bhilai (C.G.)

Semester: **M.E. IInd**
Subject: **Power Quality**
Total Theory Periods: **40**
Total Marks in End Semester Exam. : **100**
Minimum number of class test to be conducted: **02**

Specialization: **Power Systems Engg.**
Branch: **Electrical Engineering**
Code: 559212 (24)
Total Tutorial Periods: **12**

Unit-1

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-2

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-3

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-4

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-5

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

Text books:-
Electric power quality by g.t.heydt
Understanding Power Quality Problems by Math H. Bollen

ReferenceS:

1. J. Arrillaga, .Power System Quality Assessment., John wiley, 2000
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.
Surya Santoso, H. Wayne Beaty, Roger C. Dugan, Mark F. McGranaghan, Electrical Power System Quality , MC Graw Hill, 2002

Chhattisgarh Swami Vivekanand Technical University Bhilai (C.G.)

Semester: **M.E. IInd** Specialization: **Power Systems Engg.**
Subject: **Power System Stability & Control** Branch: **Electrical Engineering**
Total Theory Periods: **40** Code: 559213 (24)
Total Marks in End Semester Exam. : **100** Total Tutorial Periods: **12**
Minimum number of class test to be conducted: **02**

Unit 1
Power System Structure: Operating states, control problem, control loops. Power System Stability – classification, terms and definitions.
Power system components: Hydraulic and steam turbine, Effect of exciter and governor. Excitation system – requirements, functions, types and modeling of excitation systems, IEEE standards and models.

Unit 2
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 controllers for AGC, AI applications automatic generation control.

Unit 3
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 4
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 5
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:
Prabha Kundur, “Power System Stability and Control” Mc-Graw Hill Inc, New York, 1993.
Taylor C.W.,” Power System Voltage Stability” Mc-Graw Hill Inc, New York, 1993.

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

Chhattisgarh Swami Vivekanand Technical University Bhilai (C.G.)

Semester: **M.E. IInd** Specialization: **Power Systems Engg.**
Subject: **Power System Generation Operation & Control** Branch: **Electrical Engineering**
Total Theory Periods: **40** Code: 559214 (25)
Total Marks in End Semester Exam. : **100** 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 aOperation 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, .Electric Energy System Theory: An Introduction., II Edition, McGraw Hill, New York, 1982.
2. J. Arrilaga, C.P. Arnold, B.J. Harker, .Computer Modeling Of Electrical Power Systems., Wiley, New York, 1983.

Chhattisgarh Swami Vivekanand Technical University Bhilai (C.G.)

Semester: **M.E. II**
Subject: **Transients in Power System**
Total Theory Periods: **40**
Total Marks in End Semester Exam. : **100**
Minimum number of class test to be conducted: **02**

Specialization: **Power Systems Engg.**
Branch: **Electrical Engineering**
Code: 559231 (24)
Total Tutorial Periods: **12**

Unit-1
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-2
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-3
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-4
Simulation of surge diverters in transient analysis. Influence of pole opening and pole closing. Fourier integral and Z transform methods in power system transients. Bergeron methods of analysis and use of EMTP and EMTDC/PSCAD package.

Unit-5
Insulation Coordination: over voltage limiting devices, dielectric properties, breakdown of gaseous insulation, tracking and erosion of insulation, high current arcs.

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

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

Chhattisgarh Swami Vivekanand Technical University Bhilai (C.G.)

Semester: **M.E. II** Specialization: **Power Systems Engg.**
Subject: **Restructuring Power System** Branch: **Electrical Engineering**
Total Theory Periods: **40** Code: 559232 (24)
Total Marks in End Semester Exam. : **100** Total Tutorial Periods: **12**
Minimum number of class test to be conducted: **02**

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

Unit- 2:
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- 3:
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- 4:
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- 5:
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.

Chhattisgarh Swami Vivekanand Technical University Bhilai (C.G.)

Semester: **M.E. II**
Subject: **Distribution System Automation**
Total Theory Periods: **40**
Total Marks in End Semester Exam. : **100**
Minimum number of class test to be conducted: **02**

Specialization: **Power Systems Engg.**
Branch: **Electrical Engineering**
Code: 559233 (24)
Total Tutorial Periods: **12**

Unit 1
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 2
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 3
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 Power Control.
Custom Power: Concept, Custom Power Devices, Operation and Applications

Unit 4
Deregulated Systems: Reconfiguring Power systems, Unbundling of Electric Utilities, Competition and Direct access.

Unit-5
Project planning for distribution automation-communication, sensors, supervisory control and data acquisition, consumer information system (CIS), geographical information system (GIS).

TEXTS :

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.
1 Pabla H S.: .Electrical Power Distribution Systems.. Tata McGraw Hill.
2 IEEE Slandered 739 . 1984 Recommended Practice for Energy Conservation and Cost Effective Planning in Industrial Facilities.
3 Lakervi & E J Holmes .Electricity distribution Network Design., 2nd Edition Peter Peregrimus Ltd.

Chhattisgarh Swami Vivekanand Technical University Bhilai (C.G.)

Semester: **M.E. II**
Subject: **Power System Lab- II**
Total Practical Periods: **40**
Total Marks in End Semester Exam. : **75**

Specialization: **Power Systems Engg.**
Branch: **Electrical Engineering**
Code: 559221 (24)

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.

Chhattisgarh Swami Vivekanand Technical University Bhilai (C.G.)

Semester: **M.E. II**
Subject: **Power Quality Lab**
Total Practical Periods: **40**
Total Marks in End Semester Exam. : **75**

Specialization: **Power Systems Engg.**
Branch: **Electrical Engineering**
Code: 559222 (25)

List of Experiment

1. Simulation of Power quality disturbance using 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 phase inverter 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 analysis using 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.