Shri Rawatpura Sarkar University, Raipur

Scheme of Teaching ,Examination&

Syllabus

for

M.Tech. (POWER SYSTEM & CONTROL)

Semester-(II)

(Effective from the session: 2022-23)

Two Years M.Tech. Programme

Scheme of Teaching and Examination

M.Tech. Second Semester Power System & Control

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the Academic Year 2022-2023)

S.No.	Course Code	Course Title	Hours / Week			Credits	Maximum Marks			Sem End Exam Duration (Hrs)
			L	T	P		Continuous Evaluation	Sem End Exam	Total	
1	MENPS201T	EHV –AC & DC	3	1	-	4	30	70	100	3
2	MENPS202T	Power Quality	3	1	-	4	30	70	100	3
3	MENPS202P	Power Quality	-	-	2	1	15	35	50	-
4	MENPS203T	Power System Stability and Control	3	1	-	4	30	70	100	3
5	MENPS204T	Power System Generation Operation & Control	3	1	-	4	30	70	100	3
6	MENPS205T	Elective- II	3	1	-	4	30	70	100	3
7	MENPS206P	Power system	-	-	2	1	15	35	50	-
						22			600	

Elective- II

(A) Transient in power system

(B) Restructuring power system

(C) Soft Computing Techniques and Its Applications

Course Title	**EHV-AC & DC**				
Course Code	**MENPS201T**				
Course Credits	**L**	**T**	**P**	**TC**	
	3	**1**	**0**	**4**	
Prerequisites	High voltage engineering				
Course Objectives	• The primary reason that power is transmitted at high voltages is to increase efficiency. • As electricity is transmitted over long distances, there are inherent energy losses along the way. • High voltage transmission minimizes the amount of power lost as electricity flows from one location to the next.				
Course Contents	**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 DCTransmission 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 ofGraetz 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, Overvoltages in a Converter Station , Surge Arresters, Protection Against Over voltages. **Smoothing Reactor and DC Line**: Smoothing Reactors, DC Line, Transient over VoltagesIn 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 ofReactive Power, Static Var Systems, Reactive Power Control during Transients **Harmonics and Filters:** Generation of Harmonics, Design of AC Filters, DC Filters, CarrierFrequency and RI Noise
Course Outcomes	**Upon the completion of the subject, the student will be able to understand** • DC power transmission technology • HVDC Converters, HVDC System Control, • Converter Faults and Protection. • Reactive Power Control. • Harmonics and Filters.
Text Books	1. HVDC Power Transmission System: K.R. Padiyar , Wiley Eastern Limited 2. Power System Stability and Control by Prabha Kundur- EPRI. Mc Graw Hill Inc.
Reference Books	1. EHV-AC, HVDC Transmission and distribution engineering-S.RAO, khanna publication. 2. EHV-AC/DC Transmission ,Shobhit Gupta.

Course Title	**POWER QUALITY**				
Course Code	**MENPS202T**				
Course Credits	**L**	**T**	**P**	**TC**	
	3	**1**	**0**	**4**	
Prerequisites	Power system				
Course Objectives	• A power quality study measures the supply of power to AC power units. • This includes voltage, current or power factor. • A sudden, or even a gradual, change in power can greatly affect your power quality, reducing your efficiency or causing other problems				
Course Contents	**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.
Course Outcomes	**Upon the completion of the subject, the student will be able to understand** • Introduction of harmonics. • Modlingof network • Improvement of power factor, and harmonics filtering.
Text Books	1. Electric power qualityby g.t.heydt 2. Understanding Power Quality Problems by Math H. Bollen
Reference Books	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

Course Title	**POWER SYSTEM STABILITY & CONTROL**				
Course Code	**MENPS203T**				
Course Credits	**L**	**T**	**P**	**TC**	
	3	**1**	**0**	**4**	
Prerequisites	Power system and control				
Course Objectives	• The stability of a system refers to the ability of a system to return back to its steady state when subjected to a disturbance. • As mentioned before, power is generated by synchronous generators that operate in synchronism with the rest of the system.				
Course Contents	**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. Excitationsystem – 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, Loadfrequency 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 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.
Course Outcomes	**Upon the completion of the subject, the student will be able to understand** • Structure and component of power system • Control of power frequency voltage • Reactive power and stability improving techniques.
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. Nagrath IJ, Kothari ., Power System Engineering ," Tata Mc-Graw New Delhi 1994. r d 3. Elgerd, Electric Energy System Theory : an Introduction,Mc-Graw Hill, NX, 1983 (Mainy for Unit –II).

Course Title	**POWER SYSTEM GENERATION OPERATION &CONTROL**				
Course Code	**MENPS204T**				
Course Credits	**L**	**T**	**P**	**TC**	
	3	**1**	**0**	**4**	
Prerequisites	Basic power generation scheme				
Course Objectives	• Learn the characteristics of generation unit input/output curves. • Understand the use participation factors, transmission losses, learn the basics of power flow calculations. • So the course objective is to detailed study of power generation and control.				
Course Contents	**UNIT-I** 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.
Course Outcomes	**Upon the completion of the subject, the student will be able to understands** • Various power generation scheme like hydro thermal • Interchange of power energy etc with economic energy evaluation.
Text Books	1. Power Generation Operation and Control by L.N.J. Wood & B.F. Woolenberge. **2.** P. Kundur, .Power System Stability And Control., McGraw Hill, New York, 1994.
Reference Books	1. 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.

Course Title	**TRANSIENTS IN POWER SYSTEM**				
Course Code	**MENPS205TA**				
Course Credits	**L**	**T**	**P**	**TC**	
	3	**1**	**0**	**4**	
Prerequisites	Transients basic				
Course Objectives	• A transient event is a short-lived burst of energy in a system caused by a sudden change of state. • The source of the transient energy may be an internal event or a nearby event. • The energy then couples to other parts of the system, typically appearing as a short burst of oscillation. • Detailed study of the transient.				
Course Contents	**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				

Course Outcomes	**Upon the completion of the subject, the student will be able to understand** • Origin and nature of transient. • Lightning phenomena • Insulation coordination .
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
Reference Books	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 EMTDC/PSCAD Rulebook

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<tr><td>Course Title</td><td colspan="5">RESTRUCTURING POWER SYSTEM</td></tr>
<tr><td>Course Code</td><td colspan="5">MENPS205TB</td></tr>
<tr><td rowspan="2">Course Credits</td><td>L</td><td>T</td><td>P</td><td>TC</td><td></td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td><td></td></tr>
<tr><td>Prerequisites</td><td colspan="5">Power system</td></tr>
<tr><td>Course Objectives</td><td colspan="5">The main objectives of the course is
To provide electricity for all reasonable demands.
To encourage the competition in the generation and supply of electricity.
To improve the continuity of supply and the quality of services.
To promote efficiency and economy of the power system.</td></tr>
<tr><td>Course Contents</td><td colspan="5">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</td></tr>
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	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.
Course Outcomes	**Upon the completion of the subject, the student will be able to understand** • Basic restructuring. • Transmission pricing. • Congestion management.
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
Reference Books	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, MuwaffaqAlomoush, 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.

<table>
<tr><td>Course Title</td><td colspan="5">Soft Computing Techniques and Its Applications</td></tr>
<tr><td>Course Code</td><td colspan="5">MENPS205TC</td></tr>
<tr><td rowspan="2">Course Credits</td><td>L</td><td>T</td><td>P</td><td>TC</td><td></td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td><td></td></tr>
<tr><td>Prerequisites</td><td colspan="5">NIL</td></tr>
<tr><td>Course Objectives</td><td colspan="5">• To explain the basic knowledge representation, problem solving, and learning methods of soft computing techniques and Artificial Intelligence, Applications of soft computing techniques in intelligent-system engineering, Assess the applicability in solving engineering problems</td></tr>
<tr><td>Course Contents</td><td colspan="5">UNIT- I
Introduction of soft computing techniques
Introduction of soft computing techniques, Conventional Hard computing, Origin and history of different soft computing techniques, it basic principle and comparison with hard computing.
UNIT-II
Biological Neural Network
Introduction to Biological neural network, human brain, structure of Human Brain, its characteristics and functioning.
UNIT- III
Artificial Neural Network & Its Applications
Introduction to Artificial Neural Network: Evolution of ANN, Basic neuron modeling, comparison between ANN and human brain, characteristics, neuron models/ Architectures, activation functions, Learning (Supervised & Unsupervised) strategies, Back propagation network, Kohonen's Self organization map, competitive network. Applications of Neural network.
UNIT-IV
Fuzzy Logic& Its Applications
Fuzzy Logic: Introduction to classical sets and operations, Fuzzy set theory and operations, Fuzzy set versus crisp set, Crisp relation & fuzzy relations, Membership functions, Fuzzy rule base, fuzzification and defuzzification methods, fuzzy inference systems, Applications of fuzzy logic.
UNIT-V
Genetic algorithms and its applications
Genetic algorithm: Introduction, working principle, Basic operators and Terminologies like individual, gene, encoding, fitness function and reproduction, Genetic modeling: Significance of Genetic operators, cross over, mutation, GA optimization problems.</td></tr>
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Course Outcomes	• **At the end of this course student will be able to:** • Learn the evolution of different Soft Computing techniques. • Know the details of different Soft Computing/ Artificial Intelligence (AI) techniques: Artificial Neural Network, Fuzzy systems and Genetic Algorithm. • Simulate different ANN, Fuzzy systems and Genetic Algorithm in Matlab software. • 4. Undertake projects on Soft Computing/ArtificialIntelligence application in power system, protection and power electronics area.
Text Books	1. HowardB Demuth, Mark H Beale, Orlando de Jesus, "Neural Network Design", 2Nd edition, Martin Hagan, 2014. 2. S. N. Shivnandam, "Principles of soft computing", Wiley, Third edition, 2018. 3. S. Rajasekaran, G. A. Vijayalakshmi Pai, " Neural Networks, Fuzzy Systems and Evolutionary Algorithms: Synthesis and Applications ", PHI Learning, 2nd edition, 2017.
Reference Books	1. Devendra K. Chaturvedi, "Soft Computing: Techniques and Its Applications in Electrical Engineering", Springer, 2008. 2. Edited by Kevin Warwick, Arthur Ekwue, Rag Aggarwal, "Artificial Intelligence Techniques in Power Systems (Energy Engineering)", Institution of Engineering and Technology, 1997. 3. El-Hawary, M., "Electric Power Applications of Fuzzy Systems", Wiley-IEEE Press, 1st edition, 1998.

M.Tech
Semester-(II)
2019-20

Course Title	**POWER SYSTEM LAB- II**				
Course Code	**MENPS201P**				
Course Credits	**L**	**T**	**P**	**TC**	
	0	**0**	**2**	**1**	
Prerequisites	Basic knowledge of power system				
Course Contents	**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**.**				
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.				

M.Tech
Semester-(II)
2019-20

Course Title	**POWER QUALITY LAB**				
Course Code	**MENPS202P**				
Course Credits	**L**	**T**	**P**	**TC**	
	0	**0**	**2**	**1**	
Prerequisites	Basic knowledge of power system				
Course Contents	**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 / 10. SIMULATION. 11. To measure and analyze the source voltage and input current wave form for three phase induction motor fed through indirect vector control drive unit.				
Text Books	1. Handbook of MATLAB 2. Manual for practical				