JABALPUR ENGINEERING COLLEGE, JABALPUR (MP)
(An Autonomous Institute of Govt. of M.P.)
Affiliated to Rajiv Gandhi Technological University, Bhopal (MP)
Scheme of Study and Examination (w.e.f. July 2010)

M.E. II Sem. Branch : Electrical Engg. Specialization : High Voltage Engineering

Course Code	Subject	Periods			EVALUATION SCHEME					Credits
					SESSIONAL EXAM			ESE	SUB TOTAL	
		L	T	P	TA	CT	TOT			
EE-123	Soft Computing Techniques & Applications to Power Systems	3	1	-	10	20	30	70	100	4
EE-124	Overvoltage Protection	3	1	-	10	20	30	70	100	4
EE-125	Insulation Engg.	3	1	-	10	20	30	70	100	4
	Elective – I (Any One)									
EE-126A	HVDC Transmission	3	1	-	10	20	30	70	100	4
EE-126B	FACTS Controllers									
	Elective - II (Any One)									
EE-127A	Electrical Design of super Tension Overhead Transmission Line	3	1	-	10	20	30	70	100	4
EE-127B	Computer Application in Power System Engineering									
(PRACTICAL/DRAWING/DESIGN)										
EE-128L	HV Engg. Lab - III	-	-	2	60	-	60	90	150	6
EE-129L	HV Engg. Lab - IV	-	-	2	60	-	60	90	150	6
	Total	**15**	**5**	**4**	**170**	**100**	**270**	**530**	**800**	**32**

T.A. Teachers Assessment, CT- Class Test, ESE - End Semester Examination, Total Marks 800
Total Periods : 24 Total Credits : 32

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COURSE CONTENT & GRADE (w.e.f. July 2010)

Branch	Subject Title	Subject Code	Grade for End Sem		CGPA at the end of every even semester
			T	P	
	SOFT COMPUTING TECHNIQUES & APPLICATIONS TO POWER SYSTEMS	EE-123	Min "D"	Min "D"	5.0

SOFT COMPUTING TECHNIQUES & APPLICATIONS TO POWER SYSTEMS

Unit I Review of Probability Theory: Random variable, distribution functions, function of random variable, generation of random digit and random variants from various distribution function, Monte Carlo simulation, sampling distribution station evolution using MCS, confidence interval, coefficient of variation.

Unit II Evolution ANN, artificial neurons, activation functions, general network structure, δ – rule, back propagation rule of training, RBF and FLN network.

Unit III Draw back of classical optimization techniques, genetic algorithm: binary and real parameter GA, constraints handling in GA.

Unit IV Evolution Strategies (ES), two members non- recombinative ES, multi member ES, recombinative ES, Optimization based on swarm intelligence particle, swarm optimization and its variants.

Unit V Application of Soft Computing Techniques to Problem of Electrical Engg., e.g. Economic dispatch, reliable optimization, ANN training using evolutionary algorithms.

References:

1. R.Y. Rubinstein," Simulation and the Monte Carlo method", John Wiley & Sons 1st Edition.
2. Paul. L. Mayer," Introducing probability and statical application", Weslay.
3. Rajasekaran and Pai ," Neural Network, Fuzzy logic & Genetic Algorithms", PHI learning.
4. LiMin. Fu," Neural Networks in Computer Intelligence" ,9th Reprint TMH.
5. Kalyanmoy Deb John ,"Multi objective optimization using evolutionary algorithm", Wiley & Sons Ltd.
6. Alberto Leaon Garcia," Probability and Random processes for Electrical Engineering" IInd Pearson.
7. S.N. Shivanandan, S.N. Deepa," Principles of soft computing ",Wiley India (P) Ltd, I edition 2007.
8. Rajaserkharans, Vijaya laxmi Bai.,"Hand Book of genetic algorithm ".
9. PSO Tutorial – Kennedy educhart.
10. Sivanandam & Deepa ," An Introduction to Neural Network using Matlab 6.0", 1st ed., TMH.
11. M. Amirthavalli, Fuzzy logic and neural networks", Scitech publications

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COURSE CONTENT & GRADE (w.e.f. July 2010)

Branch	Subject Title	Subject Code	Grade for End Sem		CGPA at the end of every even semester
			T	P	
	OVER VOLTAGE PROTECTION	EE-124	Min "D"	Min "D"	5.0

OVER VOLTAGE PROTECTION

Unit I Protection from direct lightning strokes with the aid of lightning conductors

General information, protective zones of lightning conductors, permissible distances between the object to be protected and the lightning conductors, specialties of constructional details of lightning arrestors.

Unit II Earthing of high voltage electrical apparatus

General information, permissible value of resistance of earthing arrangements, main electrical characteristics of soil, static resistances of simple earthing arrangements, working and protective earthing of power stations and sub stations, impulse impedance of lumped earthing arrangements, impulse impedance of long earthing arrangements, choice and calculations of complicated arrangements, earthing of lightning conductors of sub stations.

Lightning of surge arrestors General information, expulsion tube surge arrestors, auto- valve arrestors.

Unit III Over voltage protection of transmission lines

General characteristics of atmospheric over-voltages on transmission lines, induced over-voltages on transmission lines, direct stroke of lightning in a line without ground wires, direct stroke of lightning in a line with ground wires, recommended methods of lightning protection of transmission lines of different nominal voltages.

Unit IV Protection of substations from lightning

General information, parameters of waves travelling to the sub-station, index of lightning resistance of sub-stations, voltage on the insulation of sub-station in simplest lightning protective schemes, voltage on the insulation in simplest lightning protective schemes containing a long cable, permissive voltage on the insulation, investigation of lightning protection of real sub-station.

Unit V Lightning protection of rotating machines

General information, lightning protection of generators working on over head lines through transformers, lightning protection of generators connected directly to overhead of transmission lines.

Reference:

1. . D.V.Razevig , Dr M.P.Chaurasia.," High Voltage Engg.
2. M.S.Naidu , V. Kamaraju,"High Voltage Engg".

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COURSE CONTENT & GRADE (w.e.f. July 2010)

Branch	Subject Title	Subject Code	Grade for End Sem		CGPA at the end of every even semester
			T	P	
	INSULATION ENGINEERING	EE-125	Min "D"	Min "D"	5.0

INSULATION ENGINEERING

UNIT I CONDUCTION AND BREAKDOWN PHENOMENA Mechanism of conduction in gases, liquid and solids, corona breakdown in composite insulation, mechanism of breakdown, electric and thermal breakdown of insulating material used in power system and apparatus. Line and substation insulation.Types of line insulators in use, its characteristics, principles of design, strings of insulators, distribution of voltage along the strings and methods of equalizing the distribution, choice of number of insulators in a string and minimum clearances in air to ground and between phases.

Types of station apparatus, insulators, their characteristics and principles of design, a detailed study of condenser bushings.

Pollution, its causes, flashover, its mechanism in insulators in polluted atmosphere, a detailed discussion in insulation design and maintenance in polluted atmosphere.

UNIT II LINE AND SUB-STATION INSULATION

Electrical and Mechanical Characteristics of Insulators: Electrical characteristics, Mechanical Characteristics, Materials for the preparation of insulator.

Line Insulators: Pin insulators, Suspension insulators

Insulation of Overhead Transmission Lines: General information, Strings of suspension insulators, Choice of the number of insulators in a string and of minimum insulating distances, utilization of insulating of wood.

Station-apparatus Insulators: Post insulators, Bushing (Entrance insulators)

Insulation of Distribution Equipments: Test voltage for electrical equipment, Insulating distance in air in distribution equipment.

Special Insulators for the regions having Contaminated Atmosphere.

Electrical Characteristics of insulators at Direct Volatage.

UNIT III INSULATION OF TRANSFORMERS, GENERATORS, CABLE AND CONDENSERS Insulation of Power Transformers: General information, Construction of the insulation of power transformers, Transient processes in transformer windings, Internal protection of transformers, Electrical characteristics and testing of transformers.

Insulation of High Voltage Rotating Machines: Requirements of the insulation and its typical construction, New types of generator insulation, Puncture voltages of the insulation of rotating machines, Methods of elimination of corona in the insulation of rotating machines, transient phenomena in windings of electrical machine, factory testing of the insulation of rotating machines.

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Insulation of High Voltage Power Cables: General information, cables with viscous impregnation, oil field cables, other types of high voltage cables, 6.20 kv cables with polymer insulation, factory testing of cable insulation.

Insulation of Power Condensers: General Information, paper-impregnated condenser insulation.

UNIT IV Preventing Testing of Insulation: Objective and Methods of Preventive Testing of Insulation Process in a Multi-layer dielectric.

Measurement of tan δ and capacitance as a Method of Preventive Insulation Testing: Physical basis of the method, apparatus for the measurement of tan δ and capacitance in field condition.

Partial Discharge in an Insulation and Methods of its Detection; Physical basis of the method, method of detection of partial discharges.

Other Methods of Preventive Testing: Measurement of leakage (current) resistance, method of examination by X ray and ultrasonic waves, measurement of voltage distribution, method of testing by increased voltage.

UNIT V Preventive Testing of Bushing, Suspension and Post Insulators: Line insulation, bushing.

Preventive Testing of Transformer insulation: Major insulation, turn insulation.

Preventive Testing of Insulation of Rotating Machines: Major insulation, turn insulation.

Preventive Testing of Cables with Viscous impregnation

Reference Books:

1. Razvig,"High Voltage Engineering".
2. High Voltage Technology by Alston
3. L B Loab ,"Basic processes of Gaseous Electronics".
4. R Von Hipple ,"Dielectrics and Waves".
5. Bradwell A,"Electrical Insulation".
6. Sillars R N,"Electrical Insulating Materials and their Application".
7. Arora R Mosch,." High Voltage insulation engineering "

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COURSE CONTENT & GRADE (w.e.f. July 2010)

Branch	Subject Title	Subject Code	Grade for End Sem		CGPA at the end of every even semester
			T	P	
	HVDC TRANSMISSION	EE-126A	Min "D"	Min "D"	5.0

HVDC TRANSMISSION

UNIT I Introduction comparison of ac and dc transmission. Application of dc transmission. Description of dc transmission system. Planning for hvdc transmission modern trend in dc transmission.

UNIT II Simplified analysis of gratez circuit. Detailed analysis of converter. 6 hour control , power reversal limitation of manual control, constant voltage verses constant current control, desired feature of control, actual control characteristic, constant minimum ignition angle control, constant current control , constant excitation angle control, stability of control tap changer, control power, control and current limits. Frequency analog and digital controller, hvdc link operation & regulation. Mtdc system.

UNIT III PROTECTION: general dc reactor, prevention of consequent communication failure, Converter fault , clearing line fault and re energizing the line, dc circuit breaker, surge arrester, over voltage protection.

UNIT IV HARMONICS AND FILTER CIRCUIT: CHARACTERISTIC AND UNCHARACTERISTIC Harmonics troubles caused by harmonics, means of reducing harmonics, telephone interference, harmonics filters, design of ac filter, dc filter.

UNIT V SIMULATION OF HVDC SYSTEM: introduction, system simulation: philosophy and Tools ,HVDC system for digital dynamic simulation.

Reference Books

1 K R Padiyar," Hvdc Power Transmission System"

2 E W Kimbark ,"Direct Current Transmission " Volume I Wiley Futerscience, 1971.

3 Arrilaga, "Hvdc Transmission "Peter Peregrinus Ltd 1983.

4 Uhlmann," Power Transmission" By Dc Springer 1975.

5 S. Rao Ehv Ac&Hvdc," Transmission Engineering And Practice", Khanna Publisher, 1990

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COURSE CONTENT & GRADE (w.e.f. July 2010)

Branch	Subject Title	Subject Code	Grade for End Sem		CGPA at the end of every even semester
			T	P	
	FACTS CONTROLLERS	EE-126B	Min "D"	Min "D"	5.0

FACTS CONTROLLERS

Unit I Power Electronic Controllers Basic , challenges and needs, static power converter structure, Ac controller based structures, DC link converter topologies, converter output and harmonic control, power converter control issues.

Unit II Shunt Compensation SVC and STATCOM: operation and control of SVC, STATCOM configuration, Control & applications.

Unit III Series Compensation Principle of operation, application of TCSC for damping of electromechanical oscillations, application of TCSC for mitigation of sub-synchronous resonance, TCSC layout and protection ,static, synchronous, series compensator (SSSC).

Unit IV Unified Power Flow Controller Steady state operation, control and characteristics, introduction to transient performance, power flow studies in UPFC embedded systems, operational constraints on UPFC.

Other FACTS Controllers

Circuit, model and operating features of Dynamic Voltage Regulator (DVR), Thyristor Controlled, Braking Resistors (TCBR), Thyristor Controlled Phase Angle Regulator (TCPAR), comparison of all FACTS controllers.

Unit V Control Strategies and Co-ordination Conventional control, Hysteresis control, Artificial neural network, fuzzy logic controls, comparison between different control schemes, co-ordination between different FACTS controllers.

Text Books:

1. E. Acha, Agelidis, Anaya- Lara," Power Electronic Control in Electrical Systems" Miller (Newnes Power Engg. Series, Londan) (International student edition).
2. Hingorani and Gyugui," Understanding FACTS", (IEEE Press, New York, IndianEdition0

References:

1. Yong Hua Song and Johns,"Flexible AC Transmission Systems (FACTS)", (IEE Power and Energy series 30)
2. Mathur & Verma," Thyristor based FACTS controllers" (IEEE Press, New York)
3. K. R. Padiyar, "Sub-synchronous Resonance", B.S. Publication, Hyderabad.
4. K. R. Padiyar ,"FACTS Controllers in Transmission & Distribution", New Age Publishers, Delhi, May 2007.

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COURSE CONTENT & GRADE (w.e.f. July 2010)

Branch	Subject Title	Subject Code	Grade for End Sem		CGPA at the end of every even semester
			T	P	
	ELECTRICAL DESIGN OF SUPER TENSION OVERHEAD TRANSMISSION LINES	EE-127A	Min "D"	Min "D"	5.0

ELECTRICAL DESIGN OF SUPER TENSION OVERHEAD TRANSMISSION LINES

Unit I Introduction: Modern trends in the field, super tension transmission lines,Basic Line Parameters, Choice of transmission voltage, number of parallel circuits, cross section and material of conductors, bundle conductors, corona discharge method reducing corona energy loss and radio noise.

Unit II Construction of Super tension Transmission Lines (330-750kv lines)
Reference atmospheric conditions, conductors and spans, insulators and line hardware, dimensions of transmission towers.

Unit III Transmission Line Insulation Ratio of switching surge over voltage and nominal phase voltage used in calculations. Choice of insulators meant for operation in clean and slightly polluted atmospheric conditions ,heavily polluted atmospheric conditions ,spark over a long gaps at power frequency and in use voltage, insulation coordination of inter phase clearances.

Unit IV Switching Surge Over Voltage in Super tension Transmission Lines: The switching Surge over voltage problems long duration over voltage due to resonance at power frequency, super harmonics and sub harmonics, short duration over voltage switching, surge protection of transmission lines, limitations of long duration over voltage and creation of rational transmission schemes, limitations of short duration over voltages, auto valve meters with magnetic extinctions.

Unit V Atmospheric Over Voltages Protection and Earthing Devices:

(a) Protection of 330-750 kv transmission lines from atmospheric over volatage, the atmospheric over voltage problem, light line, resistance level of transmission lines and protective measures, lightning protection characteristics of 330-750kv line.

(b) Earthing devices: Function of earthing devices, construction and design of earthing devices.

References:

1. R.D.Begamudre.,"EHV AC Transmission Engg".
2. S.Rao,"EHV AC HVDC Transmission & Distribution Engg".

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COURSE CONTENT & GRADE (w.e.f. July 2010)

Branch	Subject Title	Subject Code	Grade for End Sem		CGPA at the end of every even semester
			T	P	
	COMPUTER APPLICATION IN POWER SYSTEMS ENGINEERING	EE-127A	Min "D"	Min "D"	5.0

COMPUTER APPLICATION IN POWER SYSTEMS ENGINEERING

UNIT I Bus incidence matrix, primitive admittance matrix, Y-bus by singular transformation, algorithm for formation of bus impedance for single phase system.

UNIT II Load frequency control, turbine speed governing system modelling, block diagram representation of single area, steady state and dynamic response, two area load frequency control.

UNIT III Load flow studies, static load flow equations, types of buses, Gauss Siedel interactive method using Y bus including PV bus, acceleration of convergence, Newton Raphson method in polar co-ordinates, Fast Decoupled Load Flow method. Representation of transformer, fixed tap setting transformer, tap changing under load transformer.

UNIT IV Economic operation of power system, Optimal distribution of loads between units within a plant, Transmission loss as a function of plant generation, determination of loss coefficients. Automatic economic load dispatch using computer.

UNIT V Transient stability studies, Numerical solutions of differential equations, modified Eulers method, Runge-Kutta IV order method, Milne's predictor-corrector method, Swing equation, representation of synchronous machine for transient stability studies, load representation, Network performance equation, solution techniques with flowcharts.

Reference Books:

1. Stag and El-Abiad, "Computer methods in power system analysis".
2. Nagrath & Kothari, "Modern Power System Analysis".
3. Grover& Sharma, "Power system analysis and design".
4. M A Pai, "Computer techniques in power system".

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COURSE CONTENT & GRADE (w.e.f. July 2010)

Branch	Subject Title	Subject Code	Grade for End Sem		CGPA at the end of every even semester
			T	P	
	H.V. ENGG. LAB- III	EE-128L	Min "D"	Min "D"	5.0

H.V. ENGG. LAB- III

The exercises in this component shall be designed to demonstrate the basic principles outlined in different units of the theory paper. After completing the exercises the student should have developed a good grasp of the practical utilities of the theory content.

(Suggested Exercise)

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COURSE CONTENT & GRADE (w.e.f. July 2010)

Branch	Subject Title	Subject Code	Grade for End Sem		CGPA at the end of every even semester
			T	P	
	H.V. ENGG. LAB- IV	EE-129L	Min "D"	Min "D"	5.0

H.V. ENGG. LAB- IV

The exercises in this component shall be designed to demonstrate the basic principles outlined in different units of the theory paper. After completing the exercises the student should have developed a good grasp of the practical utilities of the theory content.

(Suggested Exercise)

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