



KKR & KSR INSTITUTE OF TECHNOLOGY & SCIENCES

(Approved by AICTE, Delhi, Affiliated to JNTU, Kakinada)

Accredited with "A" Grade by NAAC

Department of Electrical and Electronics Engineering

Academic year: 2017-18

Year/Semester: II/II

Regulation: R16

Name of the subject: POWER SYSTEMS-I

Electrical Power plays significant role in day to day life of entire mankind. The aim of this course is to allow the students to understand the concepts of the generation and distribution of power along with economic aspects.

LEARNING OBJECTIVES:

- To study the principle of operation of different components of a thermal power stations.
- To study the principle of operation of different components of a Nuclear power stations.
- To study the concepts of DC/AC distribution systems and voltage drop calculations.
- To study the constructional and operation of different components of an Air and Gas Insulated substations.
- To study the constructional details of different types of cables.
- To study different types of load curves and tariffs applicable to consumers.

SYLLABUS

UNIT-I

Thermal Power Stations

Selection of site, general layout of a thermal power plant showing paths of coal, steam, water, air, ash and flue gasses, ash handling system, Brief description of components: Boilers, Super heaters, Economizers, electrostatic precipitators steam Turbines : Impulse and reaction turbines, Condensers, feed water circuit, Cooling towers and Chimney.

UNIT-II

Nuclear Power Stations

Location of nuclear power plant, Working principle, Nuclear fission, Nuclear fuels, Nuclear chain reaction, nuclear reactor Components : Moderators, Control rods, Reflectors and Coolants. Types of Nuclear reactors and brief description of PWR, BWR and FBR. Radiation: Radiation hazards and Shielding, nuclear waste disposal.

UNIT-III

Distribution Systems

Classification of distribution systems, design features of distribution systems, radial distribution, ring main distribution, voltage drop calculations: DC distributors for following cases - radial DC distributor fed at one end and at both ends (equal / unequal voltages), ring main distributor, stepped distributor and AC distribution, comparison of DC and AC distribution.

UNIT-IV



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Substations

Classification of substations: **Air Insulated Substations** - Indoor & Outdoor substations, Substations layouts of 33/11 kV showing the location of all the substation equipment. Bus bar arrangements in the Sub-Stations: Simple arrangements like single bus bar, sectionalized single bus bar, double bus bar with one and two circuit breakers, main and transfer bus bar system with relevant diagrams.

Gas Insulated Substations (GIS) – Advantages of Gas insulated substations, different types of gas insulated substations, single line diagram of gas insulated substations, constructional aspects of GIS, Installation and maintenance of GIS, Comparison of Air insulated substations and Gas insulated substations.

UNIT-V

Underground Cables

Types of Cables, Construction, Types of insulating materials, Calculation of insulation resistance, stress in insulation and power factor of cable. Capacitance of single and 3-Core belted Cables: Grading of Cables-Capacitance grading and Inter sheath grading.

UNIT-VI

Economic Aspects of Power Generation & Tariff

Economic Aspects - Load curve, load duration and integrated load duration curves, discussion on economic aspects: connected load, maximum demand, demand factor, load factor, diversity factor, power capacity factor and plant use factor, Base and peak load plants.

Tariff Methods- Costs of Generation and their division into Fixed, Semi-fixed and Running Costs, Desirable Characteristics of a Tariff Method, Tariff Methods: Simple rate, Flat Rate, Block-Rate, two-part, three-part, and power factor tariff methods. Learning Outcomes: • Students are able to identify the different components of thermal power plants

PREREQUISITE COURSES

S.no	Name of the course	Year/Semester
1	ECA-I	I/II
2	ECA-II	II/I
3	EM-I	II/I

COURSE OUTCOMES



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Co. No	Course Outcome	Taxonomy Level
C224.1	Describe the different components of Thermal Power Plant.	Knowledge(TL1)
C224.2	Describe the different components of Nuclear Power Plant.	Knowledge(TL1)
C224.3	Analyze AC& DC Distribution Systems.	Analysis(TL4)
C224.4	Classify the Substations.	Analysis(TL4)
C224.5	Calculate the insulation resistance of cables.	Application(TL3)
C224.6	Draw the Power demand in the form of Graph.	Application(TL3)

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C224.1	2					3						
C224.2	2					3						
C224.3		3	2									
C224.4		3			2							
C224.5	1	3										
C224.6	1					3						

LESSON PLAN
SUBJECT:POWER SYSTEMS-I

L /T No.	Topic Name	Teaching Aid	Textbook /Reference Number	Page numbers
UNIT-I : Thermal Power Stations				
L 1	Generating Stations & Advantages &Disadvantages of Thermal Power Station	GB & PC	T1	9-10
L 2	Selection of site for Thermal Power Station	GB & PC	T1	12-13
L 3	General layout of a thermal power plant	GB & PC	T1	10-12
L 4	Efficiency of a thermal power plant	GB & PC	T1	13-14
T 1	Schematic Arrangement of Thermal Power Station	GB & PC	T1	10-12
L 5	Brief description of components: Boilers, Super heaters	GB & PC	T1	14-15
L 6	Economizers, Air preheater, Condensers	GB & PC	T1	15
L 7	Impulse and reaction turbines,feed water circuit, cooling towers and chimney	GB & PC	T1	16
T 2	Components of thermal power plant	GB & PC	T1	14-16
UNIT-II : Nuclear Power Stations				
L 8	Nuclear Power Station Advantages &Disadvantages	GB & PC	T1	31
L 9	Location of nuclear power plant	GB & PC	T1	34
L 10	Nuclear fission, Nuclear fuels, Nuclear chain reaction	GB & PC	R1	42
L 11	Nuclear reactor Components	GB & PC	T1	44-45
T 3	Components of Nuclear power plant	GB & PC	T1	32-34
L 12	Types of Nuclear reactors and brief description of Pressurized water Reactor	GB & PC	R1	46-47
L 13	Boiling water Reactor	GB & PC	R1	46
L 14	Fast Breeder Reactor	GB & PC	R1	49-50
L 15	Radiation hazards Shielding and nuclear waste disposal	GB & PC	R2	118-120
T4	Types of Nuclear reactors & their description	GB & PC	R1	46-50

UNIT-III : Distribution Systems

L16	Distribution System & Classification of distribution systems	GB & PC	T1	301
L 17	Radial distribution and ring main distribution	GB & PC	T1	306-307
L 18	Design Considerations & Requirements of a distribution system	GB & PC	T1	308
L 19	Overhead versus Underground System	GB & PC	T1	305
T 5	Classification of distribution systems	GB & PC	T1	301-304
L20	Voltage drop calculations: radial distributor fed at one end	GB & PC	T1	313
L 21	Radial distributor fed at both ends	GB & PC	T1	319-320
T 6	Problems on Radial distributor	GB & PC	T1	321-323
L 22	Uniformly Loaded Distributor Fed at one End	GB & PC	T1	316-317
L 23	Uniformly Loaded Distributor Fed at Both ends	GB & PC	T1	325-327
L 24	Power Loss in Uniformly Loaded Distributor	GB & PC	T1	329-330
T 7	Problems on Uniformly Loaded Distributor	GB & PC	T1	327-328
L 25	Ring main distributor & Problems	GB & PC	T1	334-335
T 8	Problems on Ring main distributor	GB & PC	T1	321-323
L26	AC distribution system & Problems	GB & PC	T1	357-358
T9	Problems on AC distribution	GB & PC	T1	359-360
L 27	Comparison of DC and AC distribution	GB & PC	T1	357

UNIT IV: Substations

L 28	Classification of substations	GB & PC	T1	570-571
L 29	Comparison between Indoor and outdoor substation	GB & PC	T1	571
L 30	Symbols For Equipment in Sub-Stations	GB & PC	T1	574-576
L 31	Equipment in Sub-Stations	GB & PC	T1	576-578
T 10	Classification and Comparison of Sub-Stations	GB & PC	T1	570-571
L 32	Transformer Substations	GB & PC	T1	571-573
L 33	Pole-Mounted Substations	GB & PC	T1	573-574
L 34	Substations layouts of 66/11 kV showing the location of all the substation equipment	GB & PC	T1	581-583
L35	Layout of 11KV/400V Indoor Sub-Station	GB & PC	T1	583-584
L36	Bus bar arrangements in the Sub-Stations Simple arrangements like single bus bar	GB & PC	T1	578-579
L37	Sectionalized single bus bar, double bus bar with one and two circuit breakers	GB & PC	T1	579-580
L38	Main and transfer bus bar system with relevant	GB & PC	R1	495-496

	diagrams.			
T11	Bus bar arrangements in the Sub-Stations	GB & PC	T1	578-580
L39	Advantages of Gas insulated substations and different types of gas insulated substations	GB & PC	*W5	
L40	Single line diagram of gas insulated substations and constructional aspects of GIS	GB & PC	*W5	
L41	Installation and maintenance of GIS	GB & PC	*W5	
L 42	Comparison of AIS and GIS	GB & PC	*W5	
T12	Gas insulated substations	GB & PC	*W5	
UNIT-V: Underground Cables				
L 43	Construction of Cables	GB & PC	T1	265
L 44	Types of Cables	GB & PC	T1	267
L 45	Types of insulating materials	GB & PC	T1	266-267
L46	Calculation of insulation resistance	GB & PC	T1	273
L47	Capacitance of a Single core Cable	GB & PC	T1	275
L48	Capacitance of a 3-Core Cable	GB & PC	T1	288-289
T 13	Problems on Capacitance of a Single core Cable	GB & PC	T1	276
L 49	Dielectric stress in a Cable	GB & PC	T1	277-278
L 50	Problems on Dielectric stress in a Cable	GB & PC	T1	278-279
L 51	Grading of Cables	GB & PC	T1	280-281
L 52	Capacitance Grading	GB & PC	T1	281-282
L 53	Intersheath Grading	GB & PC	T1	284-285
T14	Problems on Grading of Cables	GB & PC	T1	285-287
UNIT-VI: Economic Aspects of Power Generation&Tariff				
L 54	Load curve	GB & PC	T1	44
L 55	Load Duration Curve	GB & PC	T1	47-48
L 56	Connected Load,Maximum Demand,Demand Factor,Average Load	GB & PC	T1	45
L 57	Load Factor,Diversity Factor, Plant Capacity Factor,Plant use Factor,	GB & PC	T1	46-47
L 58	Types of Loads	GB & PC	T1	48
T 15	Problems on Economic Aspects of Power Generation	GB & PC	T1	50-51



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L 59	Base Load and Peak Load Plants	GB & PC	T1	62
L 60	Costs of Electrical Energy	GB & PC	T1	70
L 61	Tariff and objectives of Tariff	GB & PC	T1	87-88
L 62	Desirable Characteristics of a Tariff	GB & PC	T1	88
L 63	Simple rate, Flat Rate, Block-Rate tariff	GB & PC	T1	88-89
L 64	Two-part, three-part, and power factor tariff methods	GB & PC	T1	89-90
T 16	Problems on Tariff Methods	GB & PC	T1	91-92
Total number classes required =64 / Total number Tutorial required =16				

Learning Resources:GB&CP: Glass board & Chalk Piece, **T: Tutorial, L: Lecture**

TEXTBOOK:

T1. principles of power system by V.K Mehta.

T2. Generation, Distribution and Utilization of Electric Energy by C.L.Wadhawa New age International (P) Limited, Publishers.

REFERENCES:

R1. A Text Book on Power System Engineering by M.L.Soni, P.V.Gupta, U.S.Bhatnagarand A. Chakrabarti, DhanpatRai& Co. Pvt. Ltd.

R2. A Text Book on Power Systems by J.B.GUPTA.

FACULTY

HOD

QUESTION BANK
UNIT-I

S.No.	Question	Taxonomy Level	Related to CO	Marks
1	Explain the factors to be considered for the selection of the site for a thermal power station.	Comprehension	C224.1	10
2	Explain the functions of Cooling tower and condenser with respect to a Thermal power station.	Comprehension	C224.1	10
3	Draw the complete schematic diagram of a coal fired thermal power plant. Label each component. Discuss briefly the function of each component	Knowledge	C224.1	10
4	Describe the functions of economizer and super heater in a thermal power plant.	Knowledge	C224.1	10
5	Explain briefly about equipments in a steam power station?	Comprehension	C224.1	10
6	Explain briefly about coal and ash handling mechanism in a thermal plant.	Comprehension	C224.1	10

UNIT-II

1	Explain the factors considered for location of a nuclear power plant.	Comprehension	C224.2	10
2	With the help of neat diagram, describe the working of pressurized water reactor.	Knowledge	C224.2	10
3	With the help of a neat diagram explain the working principle of a fast breeder reactor used in a nuclear power plant.	Comprehension	C224.2	10
4	Explain briefly about essential components of a nuclear reactor?	Comprehension	C224.2	10
5	Describe with the help of a neat sketch, construction and working of a boiling water reactor.	Knowledge	C224.2	10
6 a)	Explain the radiation hazards and shielding in nuclear power plants.	Comprehension	C224.2	6
b)	Discuss about the nuclear waste disposal mechanism in a nuclear	Knowledge	C224.2	4

power plant.			
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UNIT-III

1	Explain, in detail the radial and ring main distribution systems. Discuss the characteristics of each system. Also explain the design features of each system.	Comprehension	C224.3	10
2	Give the classification of distribution systems and compare AC and DC distribution systems.	Analysis	C224.3	10
3	Explain the radial distribution system with neat diagram and list out its merits and demerits compared to ring main distributor.	Comprehension	C224.3	10
4	A 2 wire d.c distributor cable AB is 2 km long and supplies loads of 100A,150A,200A and 50A situated 500m,1000m,1600m,and 2000m from the feeding point A.Each conductor has a resistance of 0.01 ohm per 1000m.calculate the p.d at each load point if a p.d of 300V is maintained at point A.	Application	C224.3	10
5	A 2-wire street mains AB,600m long is fed from both ends at 220V.loads of 20A,40A,50A and 30A are tapped at distances of 100m,250m,400m, and 500m from the end A respectively.If the area of cross section of distributor conductor is 1cm^2 ,find the minimum consumer voltage .Take $\rho=1.7\times 10^{-6}$ ohm cm.	Application	C224.3	10
6	Derive an expression for the power loss in a uniformly loaded distributor fed at both ends with equal voltages	Application	C224.3	10

UNIT-IV

1	Discuss the different ways of classifying the sub-stations and explain each one in detail.	Knowledge	C224.4	10
2a)	What are the factors which are to be considered for a selection of a site of a substation.	Knowledge	C224.4	10
b)	What is the difference between indoor and outdoor substations?	Knowledge		
3	Explain with a neat lay out diagram of main and transfer bus bar system	Comprehension	C224.4	10
4	What are the various types of bus bar arrangements in the substations? Explain sectionalized single bus bar arrangement with suitable diagrams	Knowledge	C224.4	10
5	Draw the single line diagram of a GIS and explain.	Knowledge	C224.4	10
6a)	Explain the constructional features of gas insulated substations.	Comprehension	C224.4	5

b)	What are the merits and demerits of GIS over air insulated substations.	Knowledge	C224.4	5
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UNIT-V

1a)	Deduce an expression for insulation resistance of a single core cable in terms of specific resistance of dielectric, its core and sheath diameter.	Application	C224.5	6
b)	A single core cable has a conductor diameter of 1cm and insulation thickness of 0.4 cm .if the specific resistance of insulation is 5×10^{14} ohm cm.calculate the insulation resistance of cable	Application	C224.5	4
2	What is the most general criterion for the classification of cables? Draw the sketch of a single core low tension cable and label the various parts.	Knowledge	C224.5	10
3	Derive the expression for electrostatic stress in a single core cable. Where does maximum stress occur and where is it minimum and why?	Application	C224.5	10
4	Discuss the methods for grading of cables. What are the limitations of grading of cables?	Knowledge	C224.5	10
5	Derive the necessary equation for finding the capacitance of a single core cable	Application	C224.5	10
6	A Single core cable for use on 11 kv ,50 hz system has conductor area of 0.645cm^2 and internal diameter of sheath is 2.18 cm .the permittivity of the dielectric used in the cable is 3.5.find i)the maximum electrostatic stress in the cable ii)minimum electrostatic stress in the cableiii)capacitance of the cable per km lengthiv)charging current	Application	C224.5	10

UNIT-VI

1	Explain the following with respect to the economic aspects power generation: (i) Load duration curve, (ii) Diversity factor ,(iii) Maximum demand and (iv) Plant Capacity factor.	Comprehension	C224.5	10
2	Explain the following i)Connected load ii) average demand iii)Load Factor iv)Demand Factor.	Comprehension	C224.5	10
3	Explain the various power factor tariff methods	Comprehension	C224.5	10
4	Discuss the flat rate and block rate tariff methods for cost calculation of generation.	Analysis	C224.5	
5	Explain briefly about two part and three part tariff methods?	Comprehension	C224.5	10



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6	A Generating station has a maximum demand of 25 MW, A Loadfactor of 50% and a plant use factor of 72%. Find i) the reserve capacity of the plant ii) the daily energy produced iii) maximum energy that could be produced daily if the plant while running as per schedule, were fully loaded	Application	C224.5	10
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