INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

Department of Electrical and Electronics Engineering

QUESTION BANK

Course Name	:	**Power System Operation and Control**
Course Code	:	**A70230**
Class	:	**IV B. Tech I Sem**
Branch	:	**EEE**
Year	:	**2018 - 2019**
Course Faculty	:	**Mr. A Sathish Kumar, Assistant Professor, EEE**

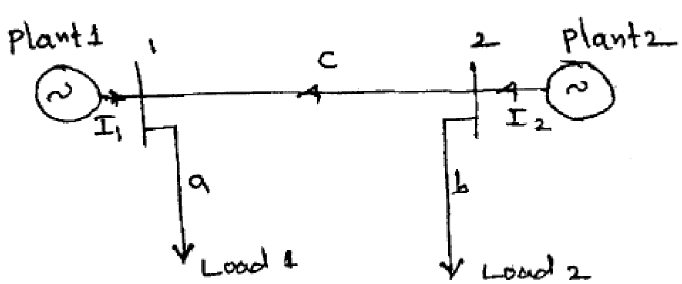
OBJECTIVE:

This course is deals with Economic operation of power system, hydrothermal scheduling and modeling of turbines, generators and automatic controllers. It emphasizes on single area and two area load frequency control and reactive power control.

S. No	Question	Blooms Taxonomy Level	Course Outcome
UNIT – I **ECONOMIC OPERATION OF POWER SYSTEMS - 1**			
Part - A (Short Answer Questions)			
1	Define in detail the following? i. Control variables ii. Disturbance variables iii. State variables.	Remember	01
2	Draw incremental fuel cost curve.	Understand	01
3	Explain the significance of equality and inequality constraints in the economic al- location of generation among different plants in a system?	Understand	01
4	What is Production cost of power generated and incremental fuel rate?	Remember	01
5	Write the expression for hourly loss of economy resulting from error in Incremental cost representation?	Understand	01
6	Discuss in detail about incremental heat rate curve and cost curve.	Understand	01
7	Write the expression for hourly loss of economy resulting from error in incremental cost representation.	Remember	01
8	Define load factor and loss factor and state the criterion for economic operation of power system?	Understand	
9	Explain the following terms with reference to power plants: Heat input - power output curve, Heat rate input, Incremental input, Generation cost and Production cost.	Remember	01
10	List out the methods of scheduling of generation of steam plants? Explain their merits and demerits?	Understand	01
11	Draw flow chart for economic scheduling without considering line losses.	Understand	02
12	Explain optimal load flow solution without inequality constraints?	Remember	02
13	Derive transmission loss formula in terms of B- coefficients.	Understand	02
14	Draw the flow chart for economic scheduling neglecting the transmission loss.	Remember	02
15	Explain about economic load dispatch neglecting the losses?	Understand	02
16	What is the role of spinning reserve in unit commitment?	Understand	02
17	With the help of a flow chart, explain the dynamic programming method in unit commitment.	Remember	03
18	Define ‘‘Load Curve’’?	Remember	03

19	Write the equality and inequality constraints considered in the economic dispatch problem?	Understand	02
20	Define function of load dispatch centre?	Understand	03
	Part - B (Long Answer Questions)		
1	Discuss in detail the terms production costs, total efficiency, incremental efficiency and incremental rates with respect to thermal power plant.	Understand	01
2	Describe the diagram of physical interpretation of coordination equation.	Remember	01
3	Give various uses of general loss formula and state the assumptions made for calculating B_{mn} coefficients.	Understand	01
4	Give step by step procedure for computing economic allocation of generation in a thermal station.	Remember	01
5	Write assumptions involved in deriving a loss formula coefficients.	Understand	02
6	The fuel cost for a two unit steam power plant are given by $C1 = 0.1\ P1^2 + 25\ P1 + 1.6$ Rupees/hour $C2 = 0.1\ P_2^2 + 32\ P2 + 2.1$ Rupees/hour Where p's are in megawatt. If there is an error of 1% in the representation of the input data, and the loss in operating economy for a load of 250 MW.	Understand	02
7	A power System consists of two, 125 MW units whose input cost data are represented by the equations : $C1 = 0.04\ P_1^2 + 22\ P_1 + 800$ Rupees/hour $C2 = 0.045\ P_2^2 + 15\ P_2 + 1000$ Rupees/hour If the total received power PR = 200 MW. Determine the load sharing between units for most economic operation.	Understand	02
8	100 MW, 150 MW and 280 MW are the ratings of three units located in a thermal power station. Their respective incremental costs are given by the following equations: dc1/dp1 = Rs(0.15p1 + 12); dc3/dp3 = Rs(0.21p3 + 13) dc2/dp2 = Rs(0.05p2 + 14) Where P1, P2 and P3 are the loads in MW. Determine the economical load allocation between the three units, when the total load on the station is 300 MW.	Understand	02
9	150 MW, 220 MW and 220 MW are the ratings of three units located in a thermal power station. Their respective incremental costs are given by the following equations: dc1/dp1 = Rs(0.11p1 + 12); dc3/dp3 = Rs(0.1p3 + 13) dc2/dp2 = Rs(0.095p2 + 14) Where P1, P2 and P3 are the loads in MW. Determine the economical load allocation between the three units, when the total load on the station is (a) 350 MW (b) 500 MW.	Understand	02
10	What is mean by unit commitment problem? Discuss a method for solving the same.	Remember	01
11	Discuss the dynamic programming method to solve unit commitment problem in power system.	Understand	02
12	Develop a load flow equation suitable for solutions by Gauss-seidal method using nodal admittance approach.	Remember	02
13	The incremental fuel cost for two plants are dC1 /d PG1 = 0.075 PG1 + 18 Rs./MWh dC2 / d PG2 = 0.08 PG2 + 16 Rs./MWh The loss coefficients are given as B11=0.0015 /MW, B12 = - 0.0004/MW and B22 = 0.0032/MW for R = 25 Rs./MWh. Find the real power generations, total load demand and the transmission power loss.	Understand	02
14	Two power stations A and B operate in parallel. They are interconnected by a short transmission line. The station capacities are 100 MW and 200 MW respectively. The generators A and B have speed regulations of 3 % and 2 % respectively. Calculate the output of each station and load on the	Understand	02

	interconnector, if, (a) The load on each station is 125 MW (b) The load on respective bus bars is 60 MW and 190 MW (c) The load is 150 MW at station A bus bar only.		
15	Give algorithm for economic allocation of generation among generators of a thermal system taking into account transmission losses. Give steps for implementing this algorithm and also derive necessary equations.	Understand	02
16	Write a short notes on: a) Inequality constraints. b) Penalty function.	Remember	02
17	A power system consists of two 100MWunits whose input cost data are represented by equations below C1 = 0.04 $P1^2$ +22P1+800 Rs/hr C2 = 0.045 $P2^2$ +15P2 +1000 Rs/hr If total received power PR = 150 MW. Determine (a) The load sharing between units for most economic operation (b) The corresponding costs of operations	Understand	02
18	Give the computational procedure for optimal power flow without inequality constraints.	Remember	03
19	Discuss optimal power flow problems without and with inequality constraints. How are these problems solved?	Understand	03
20	Using dynamic programming method, how do you find the most economical combination of the units to meet a particular load demand?	Remember	03
	Part – C (Analytical Questions)		
1	Incremental fuel cost is Rs/MWhr for a plant of a two units. dc1/dpg1=0.25 pg1+40; dc2/dpg2=0.3 pg2+30 Assume that both the units are operating at all times and total load varies from 40 MW to250 MW. How will the load be shared for a load of 200 MW? What is the corresponding value of plant incremental cost? Also determine the saving in the fuel cost in Rs/hr for one optimum scheduling of 250 MW as compared to equal distribution of same load between two plants.	Understand	01
2	The incremental fuel cost in rupees per MWhr for a plant consisting of two units are dC1/dPG1 =0.20 PG1+40.0; dC2/dPG2 =0.25 PG2+30.0 Assume that both units are operating at all times and total load varies from 40 MW to 250 MW and maximum and minimum loads on each unit are to be 125 MW and 20MW respectively .How will the load be shared between the units as the system varies over full range? What are the plant incremental costs?	Understand	01
3	The fuel inputs per hour of plants 1 and 2 are given as F1 =0.2 P1 2+40 P1+120 Rs per hr. F2 =0.25 P^2_2+30 P2+150 Rs per hr. Determine the economic operating schedule and the corresponding cost of generation if the maximum and minimum loading on each unit is 100 MW and 25 MW,the demand is 180 MW and transmission losses are neglected. If the load is equally shared by both the units, determine the saving obtained by loading the units as per the incremental production cost.	Understand	01
4	Let us consider a generating station that contains a total number of three generating units. The fuel costs of these units are given by $f_1 = \frac{0.8}{2}P_1^2 + 10P_1 + 25$ Rs./h $f_2 = \frac{0.7}{2}P_2^2 + 5P_2 + 20$ Rs./h $f_3 = \frac{0.95}{2}P_3^2 + 15P_3 + 35$ Rs./h The generation limits of the units are $30\text{ MW} \le P_1 \le 500\text{ MW}$ $30\text{ MW} \le P_2 \le 500\text{ MW}$ $30\text{ MW} \le P_3 \le 250\text{ MW}$ The total load that these units supply varies between 90 MW and 1250 MW.	Understand	02

	Assuming that all the three units are operational all the time, we have to compute the economic operating settings as the load changes.		
5	Consider two generating plant with same fuel cost and generation limits. These are given by $f_i = \frac{0.8}{2}P_i^2 + 10P_i + 25$ Rs./h $\quad i = 1,2$ $100\,\text{MW} \le P_i \le 500\,\text{MW}, \quad i = 1,2$ For a particular time of a year, the total load in a day varies as shown in Fig. 5.2. Also an additional cost of Rs. 5,000 is incurred by switching of a unit during the off peak hours and switching it back on during the during the peak hours. We have to determine whether it is economical to have both units operational all the time	Understand	02
6	The fuel inserts per all of plants I and II are given as $F_1 = 0.1P^2_1 + 40\,P_1 + 120$ Rs/Hr $F_2 = 0.25P\,^2{}_2 + 30P_2 + 150$ Rs/Hr. Determine the economic operating schedule and corresponding cost of generation if the max and min loading on each unit is 100 MW and 25 MW and the demand is 180 MW and transmission losses are neglected. If the load is equally shared by the both the units, determine the saving obtained by loading the units as per equal incremental products and cost.	Understand	02
7	A power system network with a thermal power plant is operating by four generating units. Determine the most economical unit to be committed to a load demand of 8 MW. Also prepare the UC table for the load. The min and max generating capacities and cost curve parameters of the units listed in a tabular form are given.	Understand	02
8	A power system network with a thermal power plant is operating by four generating units Determine the most economical unit to be committed to a load demand of 10 MW. Also prepare the UC table for the load changes in steps of 1 MW starting from the min and max generating capacities and cost curve parameters of the units listed in a tabular form are given.	Understand	02
9	A power system network with a thermal power plant is operating by four generating units Determine the most economical unit to be committed to a load demand of 20 MW. Also prepare the UC table for the load changes in steps of 4 MW starting from the min and max generating capacities and cost curve parameters of the units listed in a tabular form are given.	Understand	02
10	A power system network with a thermal power plant is operating by four generating units Determine the most economical unit to be committed to a load demand of 30 MW. Also prepare the UC table for the load changes in steps of 8 MW starting from the min and max generating capacities and cost curve parameters of the units listed in a tabular form are given.	Understand	02
11	For the system shown in figure, with bus 1 as reference bus with a voltage of 1.0V<00 pu, find the loss formula co-efficient if the branch currents and impedances are: Ia=1.00+j0.15 p.u; Za=0.02+j0.15 p.u Ic =0.20-j0.05pu; Zc =0.02+0.25pu If the base is 100 MVA, what will be the magnitudes of B – coefficients in reciprocal MW? 	Understand	02
12	The fuel cost functions in Rs/hr for two thermal plants are given by $C_1 = 420 + 9.2P_1 + 0.004P^2{}_2$; $C_2 = 350 + 8.5P_2 + 0.0029P^2{}_2$ Where P1, P2 are in MW. Determine the optimal scheduling of generation if the load is 640.82 MW. Estimate value of λ=12 Rs/MWhr. The transmission power loss is given by the expression $P_{L(p.u)} = 0.0346P^2{}_{1(p.u)} + 0.00643P^2{}_{2(p.u)}$	Understand	03

13	The fuel cost functions in Rs/hr for two thermal plants are given by C_1 =420+9.2P_1+0.004$P^2_{2,}$ 100<P_2<200 ; C_2=350+8.5P_2+0.0029P^2_2, 150<P_3<500 Where P1, P2 are in MW. Determine the optimal scheduling of generation if the load is 640.82 MW. Estimate value of λ=12 Rs/MWhr. The transmission power loss is given by the expression $P_{L(p.u)}$ =0.0346$P^2_{1(p.u)}$ +0.00643$P^2_{2(p.u)}$	Understand	03
14	The IFC for two plants are dC_1/dP_{G1}=0.075 Pg1+18 Rs/hr; $dC2/dP_{G2}$=0.08P_{G2}+16 Rs/hr The loss coefficients are given as B_{11}=0.0015/MW, B_{12}= -0.00004/ MW, B_{22} = 0.0032/ MW for λ=25 Rs/MWhr. Find the real power generations, total load demand, and the transmission power loss.	Understand	03
15	A system consists of two power plants connected by a transmission line. The total load located at a plant-2 is as shown in below. Data of evaluating loss coefficients consists of information that a power transfer of 100 MW from station-1 to station-2 results in a total loss of 8 MW. Find the required generation at each station and power received by the load when λ of the system is Rs. 100/MWhr. The IFCs of the two plants are given by dC_1/dP_{G1}=0.12P_{G1}+65 Rs/MWhr ; dC_2/dP_{G2}=0.25P_{G2}+75 Rs/MWhr	Understand	03
16	For above problem with 212.5 MW received by the load, find the savings in Rs/hr obtained by co-coordinating the transmission losses rather than neglecting in determining the load division between the plants	Understand	03
17	Determine the incremental cost of received power and the penalty factor of the plant shown, if the incremental cost of production is dC_1/dP_{G1}=0.1P_{G1}+3.0 Rs/MWhr.	Understand	03
18	Assume that the fuel input in Btu per hour for units 1 and 2 are given by C_1 =(8P_{G1}+0.024P^2_{G2}+80)10^6 ; C_2=6$P_{G!}$+0.04P^2_{G2}+120)10^6 The maximum and min loads on the units are 100 and 10 MW, respectively. Determine the min cost of generation when the following load is supplied. The cost of fuel is Rs.2 per million Btu.	Understand	03
19	Two power plants are connected together by a transmission line and load at plant-2. When 100 MW is transmitted from plant-1, the transmission loss is 100 MW. The cost characteristics of two plants are C_1 =0.05P^{2}_{G1}+13P_{G1}; C_2=0.06P^2_{G2}+12P_{G2} Find the optimum generation for λ=22,λ=25 and λ=30.	Understand	03

UNIT - II
HYDROTHERMAL SCHEDULING

Part - A (Short Answer Questions)

1	Discuss the combined hydro- electric and steam station operation.	Remember	04
2	Describe different methods for solving hydro thermal scheduling.	Understand	05
3	What are the requirements of control strategy in integral control?	Understand	04
4	Explain about Hydro thermal co-ordination with necessary equations?	Remember	04
5	Describe the objective function is minimize the cost of generation of hydro thermal scheduling	Understand	05
6	Explain problem formation and solution procedure of optimal scheduling for hydro thermal plants.	Understand	05
7	Briefly explain about the plant level.	Understand	04
8	Discuss Constant Hydro Generation method?	Remember	04
9	Discuss Constant Thermal Generation method?	Remember	04
10	Describe Maximum Hydro Efficiency method?	Remember	04
11	Describe the role played by the controller's gain setting in the frequency control?	Understand	05
12	Briefly explain about the system level controls?	Understand	04

Part - B (Long Answer Questions)

1	In a two plant operation system, the hydro plant is operation for 10 hrs, during each day and the steam plant is to operate all over the day. The characteristics of the steam and hydro plants are CT = 0.04 PGT^2 +30 PGT + 10 Rs/hr WH =0.12 PGH^2+30 PGH m3/ sec When both plants are running, the power own from steam plant to load is 150	Understand	04

<table>
<tr><td></td><td>MW and the total quantity of water is used for the hydro plant operation during 10 hrs is 150x106 m3. Determine the generation of hydro plant and cost of water used. Neglect the transmission losses.</td><td></td><td></td></tr>
<tr><td>2</td><td>In a two plant operation system, the Hydro plant is operating for 12 hrs. During each day and the hydro plant is operate all over the day. The characteristics of the steam and hydro plants are
CT = 0.3 PGT^2+20 PGT + 5 Rs/hr
WH =0.4PGH^2+20 PGH m3/ sec
When both plants are running, the power own from steam plant to load is 300 MW and the total quantity of water is used for the hydro plant operation during 12 hrs is 180x10^6 m3. Determine the generation of hydro plant and cost of water used.</td><td>Understand</td><td>04</td></tr>
<tr><td>3</td><td>Two generators rated 300 MW and 400 MW are operating in parallel. The droop characteristics of their governors are 4% and 6% respectively from no load to full load. The speed changers of the governors are set so that a load of 400 MW is shared among the generators at 50 HZ in the ratio of their ratings. What are the no load frequencies of the generators.</td><td>Understand</td><td>05</td></tr>
<tr><td>4</td><td>A two plant hydro-thermal system with negligible losses has the following characteristics. Fuel cost as a function of active power generated at the thermal plant is F = ($2p_1$=$0.01p_2^2$) RS/hr. The optimal water conversion co-efficient is found to be 12.01RS/MCF. The load on the system is
<table><tr><td>Duration (b)</td><td>9</td><td>15</td></tr><tr><td>DD (MW)</td><td>700</td><td>350</td></tr></table>Compute the optimal active thermal and hydro power generations (in MW) in each of the subintervals and the allowable volume of water at the hydro plant.</td><td>Understand</td><td>05</td></tr>
<tr><td>5</td><td>A 3-phase single circuit, 220kV, line runs at no load. Voltage at the receiving end of the line is 205kV. Find the sending end voltage, if the line has resistance 21.7ohms, reactance of 85.2ohms and the total susceptance of 5.32X10^{-4} mho. The transmission line is to be represented by Pie-model.</td><td>Understand</td><td>05</td></tr>
<tr><td>6</td><td>Explain the problem of scheduling hydro thermal power plants. What are the constraints in the problem?</td><td>Understand</td><td>05</td></tr>
<tr><td>7</td><td>Explain clearly the mathematical formulation of optimal scheduling of hydrothermal system with a typical example.</td><td>Understand</td><td>04</td></tr>
<tr><td>8</td><td>Two generators rated 400 MW and 500 MW are operating in parallel. The droop characteristics of their governors are 5% and 6% respectively from no load to full load. The speed changers of the governors are set so that a load of 400 MW is shared among the generators at 50 HZ in the ratio of their ratings. What are the no load frequencies of the generators.</td><td>Understand</td><td>04</td></tr>
<tr><td>9</td><td>A two plant hydro-thermal system with negligible losses has the following characteristics. Fuel cost as a function of active power generated at the thermal plant is F = ($2p_1$=$0.01p_2^2$) RS/hr. The optimal water conversion co-efficient is found to be 12.01RS/MCF. The load on the system is
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<tr><td>10</td><td>A 3-phase single circuit, 220kV, line runs at no load. Voltage at the receiving end of the line is 210kV. Find the sending end voltage, if the line has resistance 21.7ohms, reactance of 86.2ohms and the total susceptance of 5.35X10^{-4} mho. The transmission line is to be represented by Pie-model.</td><td>Understand</td><td>04</td></tr>
<tr><td>11</td><td>In a two plant operation system, the Hydro plant is operating for 12 hrs. During each day and the hydro plant is operate all over the day. The characteristics of the steam and hydro plants are
CT = 0.29 PGT^2+22 PGT + 4 Rs/hr
WH =0.398PGH^2+21 PGH m3/ sec
When both plants are running, the power own from steam plant to load is 300 MW and the total quantity of water is used for the hydro plant operation during 12 hrs is 180x10^6 m3. Determine the generation of hydro plant and cost of water used.</td><td>Understand</td><td>04</td></tr>
<tr><td>12</td><td>In a two plant operation system, the hydro plant is operation for 10 hrs, during</td><td>Understand</td><td>04</td></tr>
</table>

	each day and the steam plant is to operate all over the day. The characteristics of the steam and hydro plants are CT = 0.038 PGT^2 +32 PGT + 9 Rs/hr WH =0.13 PGH^2+29 PGH m3/ sec When both plants are running, the power own from steam plant to load is 150 MW and the total quantity of water is used for the hydro plant operation during 10 hrs is 150x106 m3. Determine the generation of hydro plant and cost of water used. Neglect the transmission losses.		
	Part – C (Analytical Questions)		
1	Incremental fuel cost is Rs/MWhr for a plant of a two units. dc1/dpg1=0.25 pg1+40; dc2/dpg2=0.3 pg2+30 Assume that both the units are operating at all times and total load varies from 40 MW to250 MW. How will the load be shared for a load of 200 MW? What is the corresponding value of plant incremental cost? Also determine the saving in the fuel cost in Rs/hr for one optimum scheduling of 250 MW as compared to equal distribution of same load between two plants.	Understand	04
2	The incremental fuel cost in rupees per MWhr for a plant consisting of two units are dC1/dPG1 =0.20 PG1+40.0; dC2/dPG2 =0.25 PG2+30.0 Assume that both units are operating at all times and total load varies from 40 MW to 250 MW and maximum and minimum loads on each unit are to be 125 MW and 20MW respectively .How will the load be shared between the units as the system varies over full range? What are the plant incremental costs?	Understand	04
3	The fuel inputs per hour of plants 1 and 2 are given as F1 =0.2 $P1^2$+40 P1+120 Rs per hr. F2 =0.25 P^2_2+30 P2+150 Rs per hr. Determine the economic operating schedule and the corresponding cost of generation if the maximum and minimum loading on each unit is 100 MW and 25 MW, the demand is 180 MW and transmission losses are neglected. If the load is equally shared by both the units, determine the saving obtained by loading the units as per the incremental production cost.	Understand	04
4	Let us consider a generating station that contains a total number of three generating units. The fuel costs of these units are given by $f_1 = \frac{0.8}{2}P_1^2 + 10P_1 + 25$ Rs./h $f_2 = \frac{0.7}{2}P_2^2 + 5P_2 + 20$ Rs./h $f_3 = \frac{0.95}{2}P_3^2 + 15P_3 + 35$ Rs./h The generation limits of the units are $30\text{ MW} \le P_1 \le 500\text{ MW}$ $30\text{ MW} \le P_2 \le 500\text{ MW}$ $30\text{ MW} \le P_3 \le 250\text{ MW}$ The total load that these units supply varies between 90 MW and 1250 MW. Assuming that all the three units are operational all the time, we have to compute the economic operating settings as the load changes.	Understand	05
5	Consider two generating plant with same fuel cost and generation limits. These are given by $f_i = \frac{0.8}{2}P_i^2 + 10P_i + 25$ Rs./h $\quad i = 1,2$ $100\text{ MW} \le P_i \le 500\text{ MW}, \quad i = 1,2$ For a particular time of a year, the total load in a day varies as shown in Fig. 5.2. Also an additional cost of Rs. 5,000 is incurred by switching of a unit during the off peak hours and switching it back on during the during the peak hours. We have to determine whether it is economical to have both units operational all the time	Understand	05

6	The fuel inserts per all of plants I and II are given as $F_1 = 0.1P^2_1 + 40\ P_1 + 120$ Rs/Hr $F_2 = 0.25P\ ^2{}_2 + 30P_2 + 150$ Rs/Hr. Determine the economic operating schedule and corresponding cost of generation if the max and min loading on each unit is 100 MW and 25 MW and the demand is 180 MW and transmission losses are neglected. If the load is equally shared by the both the units, determine the saving obtained by loading the units as per equal incremental products and cost.	Understand	05
7	A power system network with a thermal power plant is operating by four generating units. Determine the most economical unit to be committed to a load demand of 8 MW. Also prepare the UC table for the load. The min and max generating capacities and cost curve parameters of the units listed in a tabular form are given.	Understand	05
8	A power system network with a thermal power plant is operating by four generating units Determine the most economical unit to be committed to a load demand of 10 MW. Also prepare the UC table for the load changes in steps of 1 MW starting from the min and max generating capacities and cost curve parameters of the units listed in a tabular form are given.	Understand	04
9	A power system network with a thermal power plant is operating by four generating units Determine the most economical unit to be committed to a load demand of 20 MW. Also prepare the UC table for the load changes in steps of 4 MW starting from the min and max generating capacities and cost curve parameters of the units listed in a tabular form are given.	Understand	04
10	A power system network with a thermal power plant is operating by four generating units Determine the most economical unit to be committed to a load demand of 30 MW. Also prepare the UC table for the load changes in steps of 8 MW starting from the min and max generating capacities and cost curve parameters of the units listed in a tabular form are given.	Understand	05
11	Let us consider a generating station that contains a total number of three generating units. The fuel costs of these units are given by $f_1 = \frac{0.8}{2}P_1^2 + 10P_1 + 25$ Rs./h $f_2 = \frac{0.7}{2}P_2^2 + 5P_2 + 20$ Rs./h $f_3 = \frac{0.95}{2}P_3^2 + 15P_3 + 35$ Rs./h The generation limits of the units are $30\ \text{MW} \le P_1 \le 500\ \text{MW}$ $30\ \text{MW} \le P_2 \le 500\ \text{MW}$ $30\ \text{MW} \le P_3 \le 250\ \text{MW}$ The total load that these units supply varies between 80 MW and 1260 MW. Assuming that all the three units are operational all the time, we have to compute the economic operating settings as the load changes.	Understand	05
12	Consider two generating plant with same fuel cost and generation limits. These are given by $f_i = \frac{0.8}{2}P_i^2 + 10P_i + 25\ \text{Rs./h} \quad i = 1,2$ $100\ \text{MW} \le P_i \le 500\ \text{MW}, \quad i = 1,2$ For a particular time of a year, the total load in a day varies. Also an additional cost of Rs. 6,000 is incurred by switching of a unit during the off peak hours and switching it back on during the during the peak hours. We have to	Understand	05

	determine whether it is economical to have both units operational all the time		
13	The fuel inserts per all of plants I and II are given as $F_1 = 0.21P^2_1 + 30 P_1 + 122$ Rs/Hr $F_2 = 0.28P^{2}_{2} + 20P_2 + 155$ Rs/Hr. Determine the economic operating schedule and corresponding cost of generation if the max and min loading on each unit is 100 MW and 25 MW and the demand is 180 MW and transmission losses are neglected. If the load is equally shared by the both the units, determine the saving obtained by loading the units as per equal incremental products and cost.	Understand	05
14	A power system network with a thermal power plant is operating by four generating units. Determine the most economical unit to be committed to a load demand of 9 MW. Also prepare the UC table for the load. The min and max generating capacities and cost curve parameters of the units listed in a tabular form are given.	Understand	05
15	A power system network with a thermal power plant is operating by four generating units Determine the most economical unit to be committed to a load demand of 12 MW. Also prepare the UC table for the load changes in steps of 2 MW starting from the min and max generating capacities and cost curve parameters of the units listed in a tabular form are given.	Understand	05
UNIT - III **MODELING OF TURBINES**			
Part - A (Short Answer Questions)			
1	Describe the mathematical model of Speed - Governing System.	Understand	06
2	Distinguish D.C excitation system and A.C excitation system.	Remember	06
3	Derive the model of a speed governing system and represent it by a block diagram.	Understand	06
4	Explain the objectives and functions of automatic generation control (AGC) in a power system.	Understand	06
5	Describe how mathematical model of speed governing system is developed for automatic generation control?	Understand	06
6	Distinguish between AVR and ALFC control loops of a generator.	Remember	07
7	What is AVR?	Remember	07
8	What is ALFC?	Remember	07
9	What is ‘‘AGC’’?	Remember	07
10	What decides the loading of generating stations?	Understand	06
11	Compute the Selecting frequency control?	Remember	06
12	Explain TIE Line bias control?	Understand	07
13	Describe the mathematical model of Speed - Governing System.	Understand	07
14	Estimate the importance of turbine modeling?	Understand	06
15	Generalize the importance of Generator modeling?	Understand	07
16	Compute the importance of Exciter modeling?	Understand	06
17	Explain the importance of dynamic modeling of generators?	Understand	06
18	Define Swing Equation?	Remember	06
19	Derive Small signal transfer function?	Understand	07
20	Write short notes on modeling of speed governing system?	Remember	07
21	Define speed-governing system	Remember	07
22	What is the function of speed governor?	Remember	07
23	Compute the function of speed charger?	Remember	06
24	Define function of hydraulic amplifier?	Remember	07
25	What is function of linkage mechanism?	Remember	06
26	Write short notes on modeling of excitation?	Remember	07
27	List the two fundamental characteristics of modeling of excitation?	Remember	07
28	Define transfer function?	Understand	07

29	Write transfer function of modeling of excitation?	Understand	07
30	What is the IEEE-I model?	Understand	06
Part - B (Long Answer Questions)			
1	Discuss the hydro thermal co- ordination in brief.	Understand	06
2	Describe the co- ordination for Run-Off river and steam plan	Remember	06
3	Draw the block diagram of a power system showing the governor, turbine and Synchronous generator, indicating their transfer functions. For a step disturbance of PD, obtain the response of increment in frequency", making suitable assumptions. (a) Without proportional plus integral controller and (b) With proportional plus integral control.	Remember	06
4	Derive general mathematical formulation of long term hydro thermal scheduling.	Understand	07
5	Derive general mathematical formulation of Short term hydro thermal scheduling	Understand	06
6	Discuss the problem discretization principle.	Remember	07
7	Solution of short term hydro thermal scheduling problems by Kirchamayers method.	Understand	06
8	List advantages of operation of hydro thermal combination.	Remember	06
9	Give a typical block diagram for a two area system interconnected by a tie line and explain each block. Also deduce relations to determine the frequency of oscillations of the tie line power and static frequency drop. List out assumptions made.	Understand	06
10	List disadvantages of operation of hydro thermal combination.	Remember	07
12	Derive the mathematical modeling of Speed governing system.	Understand	07
13	Discuss the first order modeling of turbine with neat block diagram?	Understand	07
14	Explain the Second order modeling of turbine with neat block diagram?	Understand	06
15	Outline the fundamental characteristics of excitation system?	Remember	06
Part – C (Analytical Questions)			
1	Determine the primary ALFC loop parameters for a control area with the following data: Total generation capacity = 2500 MW Normal operating load =1500 MW Inertia constant=5 kW-seconds per kVA; Load damping constant, B=1 %; frequency, f=50 Hz; and Speed regulation, R=2.5 Hz / p.u MW.	Understand	06
2	A 100 MVA Synchronous generator operates at 50 Hz, runs at 3000 rpm under no- load. A load of 25 MW is suddenly applied to the machine. Due to the time lag in the governor system the turbine commences to open after 0.6 sec. Assuming inertia constant H= 5 MW- sec per MVA of generator capacity, calculate the frequency of the system before steam own commences to increase to meet the new load.	Understand	07
3	Two generating stations 1 and 2 have full load capacities of 200 MW and 100 MW respectively at a generating frequency of 50 Hz. The two stations are interconnected by an induction motor and synchronous generator with a full load capacity of 25 MW. The speed regulation of station 1, station 2 and induction motor and synchronous generator sets are 4 %, 3.5% and 2.5% respectively. The load on respective bus bars is 75 MW and 50 MW respectively. Find the load taken by the motor generator set.	Understand	06
4	Two turbo alternators rated for 110 MW and 220 MW have governor drop characteristics of 5% from no load to full load. They are connected in parallel to share a load of 250 MW. Determine the load shared by each machine assuming free governor action.	Understand	06
5	Two generating stations 1 and 2 have full load capacities of 300 MW and 200 MW respectively at a generating frequency of 50 Hz. The two stations are interconnected by an induction motor and synchronous generator with a full load capacity of 50 MW. The speed regulation of station 1, station 2 and induction motor and synchronous generator sets are 45%, 4% and 3% respectively. The load on respective bus bars is 70 MW and 60 MW respectively. Find the load taken by the motor generator set.	Understand	07

6	Two turbo alternators rated for 150 MW and 250 MW have governor drop characteristics of 8% from no load to full load. They are connected in parallel to share a load of 300 MW. Determine the load shared by each machine assuming free governor action.	Understand	07
7	Two generators rated 200MW and 400MW are operating in parallel. Draw the characteristics of their governors are 4% and 5% respectively from no load to full load. Assuming that the generators are operating at 50 Hz at no load, how would a load of 600MW is shared between them? What will be the system frequency at this load, Assume free governor operation, repeat the problem if both governors have drop of 4%.	Understand	07
8	Two generators rated 400MW and 700MW are operating in parallel. Draw the characteristics of their governors are 6% and 8% respectively from no load to full load. Assuming that the generators are operating at 50 Hz at no load, how would a load of 900MW be shared between them? What will be the system frequency at this load, Assume free governor operation, repeat the problem if both governors have drop of 7%.	Understand	07
9	Determine the primary ALFC loop parameters for a control area with the following data: Total generation capacity = 3500 MW Normal operating load =2500 MW Inertia constant=25 kW-seconds per kVA; Load damping constant, B=2 %; frequency, f=50 Hz; and Speed regulation, R=3.5 Hz / p.u MW	Understand	06
10	A 400 MVA Synchronous generator operates at 50 Hz, runs at 3000 rpm under no- load. A load of 50 MW is suddenly applied to the machine. Due to the time lag in the governor system the turbine commences to open after 0.6 sec. Assuming inertia constant H= 9 MW- sec per MVA of generator capacity, calculate the frequency of the system before steam own commences to increase to meet the new load.	Understand	06
11	Two generating stations 1 and 2 have full load capacities of 200 MW and 100 MW respectively at a generating frequency of 50 Hz. The two stations are interconnected by an induction motor and synchronous generator with a full load capacity of 25 MW. The speed regulation of station 1, station 2 and induction motor and synchronous generator sets are 4 %, 3.5% and 2.5% respectively. The load on respective bus bars is 75 MW and 50 MW respectively. Find the load taken by the motor generator set.	Understand	06
12	Two turbo alternators rated for 110 MW and 220 MW have governor drop characteristics of 5% from no load to full load. They are connected in parallel to share a load of 250 MW. Determine the load shared by each machine assuming free governor action.	Understand	06
13	Two generating stations 1 and 2 have full load capacities of 300 MW and 200 MW respectively at a generating frequency of 50 Hz. The two stations are interconnected by an induction motor and synchronous generator with a full load capacity of 50 MW. The speed regulation of station 1, station 2 and induction motor and synchronous generator sets are 45%, 4% and 3% respectively. The load on respective bus bars is 70 MW and 60 MW respectively. Find the load taken by the motor generator set.	Understand	07
14	Two turbo alternators rated for 150 MW and 250 MW have governor drop characteristics of 8% from no load to full load. They are connected in parallel to share a load of 300 MW. Determine the load shared by each machine assuming free governor action.	Understand	06
15	Two generators rated 200MW and 400MW are operating in parallel. Draw the characteristics of their governors are 4% and 5% respectively from no load to full load. Assuming that the generators are operating at 50 Hz at no load, how would a load of 600MW is shared between them? What will be the system frequency at this load, Assume free governor operation, repeat the problem if both governors have drop of 4%.	Understand	06

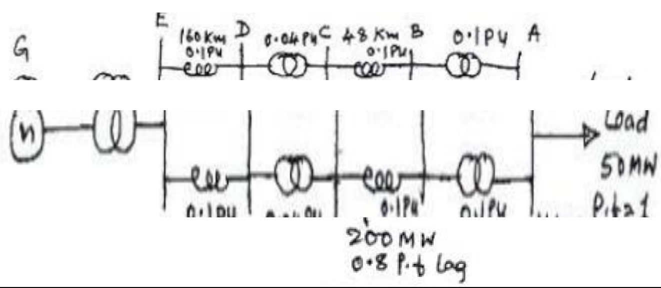
UNIT - IV **AREA CONTROL AND LOAD FREQUENCY CONTROLLERS**			
Part - A (Short Answer Questions)			
1	Compute the necessity of keeping the frequency constant in a power system.	Understand	09
2	Define control area. Obtain the transfer function model and explain ALFC of a single area of an isolated power system	Understand	09
3	Write Short notes on: i) Control area concept. ii) Area control error.	Remember	08
4	Describe isolated power system?	Remember	09
5	Describe the steady state analysis in controlled case?	Remember	08
6	Describe the steady state analysis in un-controlled case?	Understand	08
7	Explain what are the methods to keep the frequency constant?	Remember	08
8	Define the dynamic response?	Understand	09
9	A 100 MVA synchronous generator operates on full load at a frequency of 50 Hz. The load is suddenly reduced to 50 MW. Due to time lag governor system, the steam valve begins to close after 0.4 sec. Determine the change in frequency that occurs in this time. Given the initial constant H=5 KW-sec/ KVA.	Understand	08
10	A control area has total rated capacity of 10000MW. The regulation R for all the units in the area is 2 HZ/P.U, A 1% change in frequency causes a 1% change in load. If the system operates at half the rated capacity and increases by 2% i) Find the static frequency drop ii) If the speed governor loop were open, what will be the frequency drop? Determine the formula.	Understand	08
11	Explain the state variable model of single area load frequency controller with integral action.	Understand	08
12	Discuss the importance of combined load frequency control and economic dispatch control with a neat block diagram.	Understand	09
13	List out the requirements of control strategy in integral control? Explain the role played by the controller's gain setting in the frequency control.	Remember	09
14	Obtain an expression for steady state response of a load frequency controller with integral control. How it is different from without integral control.	Understand	08
15	Discuss the merits of proportional plus integral load frequency control of a system with a neat block diagram.	Understand	09
16	List out the various methods of voltage control in transmission system?	Remember	08
17	Explain the need for voltage and frequency regulation in power system.	Remember	09
18	What is the function of Load Frequency Control?	Understand	09
19	Identify the purpose power factor primary ALFC?	Understand	09
20	List out the various needs for frequency regulation in power system.	Remember	08
Part - B (Long Answer Questions)			
1	Discuss the governor characteristics of a single generator.	Understand	09
2	Describe the nature of the steady state response of the uncontrolled LFC of a single area?	Remember	09
3	State briefly how the time response of the frequency error depends upon the gain setting of the integral control.	Remember	09
4	List out the basic requirements of a closed loop control system employed for obtaining the frequency constant?	Understand	09
5	Compute the nature of the generator load frequency characteristic?	Remember	09
6	With a neat block diagram explain the load frequency control for a single area system.	Understand	08
7	Draw and explain complete block diagram representation of single area having a turbo-generator supplying an isolated load for load frequency problem.	Remember	08

	Discuss the response of the system for a sudden change in load demand.		
8	Give a brief account on tie line bias bar control.	Remember	08
9	Explain speed governing mechanism in two generators or machines system.	Understand	08
10	Develop and explain the load frequency control of a single area system of an uncontrolled case drive the transfer function of each block.	Understand	08
11	Two areas of a power system network are interconnected by a tie-line, whose capacity is 250MW, operating at a power angle of 450. If each area has a capacity of 2000 MW and the equal speed regulation of 3 Hz/Pu MW, determine the frequency of oscillation of the power for step change in load. Assume that both areas have the same inertia constants of H = 4 sec. If a step load change of 100MW occurs in one of the areas determine the change in tie-line power.	Understand	08
12	Two power systems, A and B, having capacities of 3000 and 3000 MW, respectively, are interconnected through a tie-line and both operate with frequency-bias-tie-line control. The frequency bias for each area is 1 % of the system capacity per 0.1 Hz frequency deviation. If the tie-line interchange for A is set at 100 MW and for B is set (incorrectly) at 200 MW, calculate the steady state change in frequency.	Understand	09
13	Two control areas have the following characteristics: Area-1: Speed regulation = 0.02 pu ,Damping coefficient = 0.8 pu ,Rated MVA = 1500 Area-2: Speed regulation = 0.025 pu, Damping co-efficient = 0.9 pu, Rated MVA = 500 Determine the steady state frequency change and the changed frequency following a load change of 120MW occurs in area-1. Also find the tie-line power flow change.	Understand	08
14	The two area system has the following data: Capacity of area 1, Pr1 =1000 MW, Capacity of area 2, Pr2 =2000 MW, Nominal load of area 1, PD1=500 MW Nominal load of area 1, PD1=1500 MW Speed regulation of area 1=4% Speed regulation of area 2=3% Find the new steady state frequency and change in the line ow for a load change of area 2 by 125 MW. For both the areas each percent change in frequency causes 1 percent change in load. Find also the amount of additional frequency drop if the interconnection is lost due to certain reasons.	Understand	08
15	Explain the state variable model of two area load frequency controller with integral action. Two control areas connected by a tie line have the following characteristics. Area 1 Area 2 R=0.01 pu R=0.02 pu D=0.8 pu D=1.0 pu Base MVA=2000 Base MVA=500 A load change of 100 MW (0.2 pu) occurs in area 1. What is the new steady state frequency and what is the change in the tie own? Assume both areas were at nominal frequency (60 Hz) to begin.	Understand	08
16	Two generators rated 250 MW and 500 MW are operating in parallel. The droop characteristics are 4% and 6% respectively. Assuming that the generators are operating at 50 HZ at no load, how a load of 750 MW would be shared. What is the system frequency? Assume free governor action	Understand	08
17	Draw the block diagram of load frequency control of 2- area control systems with gain blocks.	Understand	08
18	Define area control error? List out the control strategies?	Remember	08
19	Explain proportional plus integral control for load frequency control for a single area system.	Remember	08
20	Give a typical block diagram for a two area system interconnected by a tie line and explain each block. Also deduce relations to determine the frequency of oscillations of tie line power and static frequency drop. List out assumptions made.	Understand	08

<table>
<tr><th colspan="4">Part – C (Analytical Questions)</th></tr>
<tr><td>1</td><td>A 125 MVA turbo alternator operates on full load at 50 Hz. A load of 50MWis suddenly reduced on the machine. The steam valves to the turbine commence to close after 0.5 seconds due to the time lag in the governor system. Assuming inertia constant H= 6 kW - sec per kVA of generator capacity, calculate the change in frequency that occurs in this time.</td><td>Understand</td><td>09</td></tr>
<tr><td>2</td><td>The single area control system has the following data: TP=10 sec, Tg = 0.3 sec, Tt=0.2 sec, KP =200 Hz/pu MW, R=6 Hz/pu MW, PD=0.5 pu MW, Ki=0.5. Compute the time error caused by a step disturbance of magnitude 0.5 pu (as given above). Prove, in particular, that the error is reduced by increasing the given Ki. Express the error in seconds and cycles if the system frequency is 50 Hz.</td><td>Understand</td><td>09</td></tr>
<tr><td>3</td><td>A single area consists of two generators with the following parameters: Generator 1 = 1200 MVA; R=6 % (on machine base) Generator 2 = 1000 MVA; R=4 % (on machine base) The units are sharing 1800 MW at normal frequency 50 Hz. Unit supplies 1000 MW and unit 2 supplies 800 MW. The load now increased by 200 MW.
(a) Find steady state frequency and generation of each unit if B=0.
(b) Find steady state frequency and generation of each unit if B=1.5.</td><td>Understand</td><td>08</td></tr>
<tr><td>4</td><td>A single area consists of two generating units with the following
<table><tr><th>unit</th><th>Rating in MVA</th><th>Speed regulation R (p.u on unit MVA base)</th></tr><tr><td>1</td><td>600</td><td>6%</td></tr><tr><td>2</td><td>500</td><td>4%</td></tr></table>characteristics. The units are operating in parallel, sharing 900 MW at a nominal frequency. Unit 1 supplies 500 MW and unit 2 supplies 400 MW at 60 Hz. The load is increased by 90 MW.
(a) Assume there is no frequency dependent load i,e., B=0. Find the steady state frequency deviation and new generation on each unit.
(b) The load varies 1.5 % for every 1 % change in frequency i.e., B= 1.5. Find the steady state frequency deviation and new generation on each unit.</td><td>Understand</td><td>08</td></tr>
<tr><td>5</td><td>A Generator in single area load frequency control has the following parameters: Total generation capacity = 2500 MW Normal operating load =1500 MW Inertia constant=5 kW-seconds per kVA; Load damping constant, B=1 %; frequency, f=50 Hz; and Speed regulation, R=2.5 Hz / p.u MW. If there is a 1.5 % increase in the load, find the frequency drop
(a) without governor control
(b) With governor control.</td><td>Understand</td><td>08</td></tr>
<tr><td>6</td><td>A250MVA synchronous generator is operating at 1500 rpm, 50 Hz. A load of 50 MW is suddenly applied to the machine and the station valve to the turbine opens only after 0.35 sec due to the time lag in the generator action. Calculate the frequency at which the generated voltage drops before the steam flow commences to increase to meet the new load. Given that the valve of H of the generator is 3.5 KW-s per KVA of the generator energy.</td><td>Understand</td><td>08</td></tr>
<tr><td>7</td><td>Two Generating Stations A And B have full load capacities of 250 and 100MW, respectively. The interconnector connecting the two stations has an induction motor/synchronous generator of full load capacity 30 MW; percentage changes of speeds of A, B and C are 4, 3 and 2 respectively. Determine the load taken by plant C and indicate the direction of the power flow.</td><td>Understand</td><td>09</td></tr>
<tr><td>8</td><td>A 750 MW generator has a speed regulation of 3.5%. If the frequency drops by 0.1Hz with an Unchanged reference, determine the increase in turbine power. And also find by how much the reference power setting should be changed if the turbine power remains unchanged</td><td>Understand</td><td>09</td></tr>
<tr><td>9</td><td>A500MVA synchronous generator is operating at 1500 rpm, 50 Hz. A load of 100 MW is suddenly applied to the machine and the station valve to the turbine opens only after 0.5 sec due to the time lag in the generator action. Calculate the frequency at which the generated voltage drops before the steam flow commences to increase to meet the new load. Given that the valve of H</td><td>Understand</td><td>09</td></tr>
</table>

	of the generator is 5 KW-s per KVA of the generator energy.		
10	Two Generating Stations A And B have full load capacities of 350 and 500MW, respectively. The interconnector connecting the two stations has an induction motor/synchronous generator of full load capacity 40 MW; percentage changes of speeds of A, B and C are 5, 4 and 2 respectively. Determine the load taken by plant C and indicate the direction of the power flow	Understand	09
11	Two areas A and D are interconnected. The generating capacity of area A is 36000 MW and its regulating characteristic is 1.5% of capacity per 0.1 Hz. Area D has a generating capacity of 400 MW and its regulating characteristic is 1% of capacity per 0.1 Hz. Find each area's share of a +400 MW disturbance (increase in load) occurring in area D and the resulting tie- line flow.	Understand	08
12	Find the static frequency drop if the load is suddenly increased by 25 MW on a system having the following data: Rated capacity P_r=500MW ; operating load P_D=250 MW Inertia constant H=5s ; Governor regulation R=2 Hz p.u.MW Frequency f= 50 Hz. Also find the additional generation.	Understand	09
13	Two areas of a power system network are interconnected by a tie-line, whose capacity is 250MW, operating at a power angle of 450. If each area has a capacity of 2000 MW and the equal speed regulation of 3 Hz/P.u MW, determine the frequency of oscillation of the power for step change in load. Assume that both areas have the same inertia constants of H = 5 sec. If a step load change of 100MW occurs in one of the areas determine the change in tie-line power.	Understand	08
14	Two power systems, A and B, having capacities of 3000 and 2000 MW, respectively, are interconnected through a tie-line and both operate with frequency-bias-tie-line control. The frequency bias for each area is 3 % of the system capacity per 0.1 Hz frequency deviation. If the tie-line interchange for A is set at 100 MW and for B is set (incorrectly) at 200 MW, calculate the steady state change in frequency.	Understand	09
15	Two control areas have the following characteristics: Area-1: Speed regulation = 0.2 p.u ,Damping coefficient = 0.8 p.u ,Rated MVA = 1500 Area-2: Speed regulation = 0.25 p.u, Damping co-efficient = 0.9 p.u, Rated MVA = 500 Determine the steady state frequency change and the changed frequency following a load change of 120MW occurs in area-1. Also find the tie-line power flow change.	Understand	08
16	The two area system has the following data: Capacity of area 1, Pr1 =1000 MW, Capacity of area 2, Pr2 =2000 MW, Nominal load of area 1, PD1=500 MW Nominal load of area 1, PD1=1500 MW Speed regulation of area 1=4% Speed regulation of area 2=3% Find the new steady state frequency and change in the line ow for a load change of area 2 by 125 MW. For both the areas each percent change in frequency causes 1 percent change in load. Find also the amount of additional frequency drop if the interconnection is lost due to certain reasons.	Understand	08
17	Explain the state variable model of two area load frequency controller with integral action. Two control areas connected by a tie line have the following characteristics. Area 1 Area 2 R=0.01 p.u R=0.02 p.u D=0.8 p.u D=1.0 p.u Base MVA=2000 Base MVA=500 A load change of 100 MW (0.2 p.u) occurs in area 1. What is the new steady state frequency and what is the change in the tie own? Assume both areas were at nominal frequency (60 Hz) to begin.	Understand	08
18	Two generators rated 250 MW and 500 MW are operating in parallel. The	Understand	09

	droop characteristics are 4% and 6% respectively. Assuming that the generators are operating at 50 HZ at no load, how a load of 750 MW would be shared. What is the system frequency? Assume free governor action		
19	Two control areas have the following characteristics: Area-1: Speed regulation = 0.04 p.u ,Damping coefficient = 0.6 p.u ,Rated MVA = 1300 Area-2: Speed regulation = 0.03 p.u, Damping co-efficient = 0.85 p.u, Rated MVA = 500 Determine the steady state frequency change and the changed frequency following a load change of 150MW occurs in area-1. Also find the tie-line power flow change.	Understand	08
20	Two areas of a power system network are interconnected by a tie-line, whose capacity is 350MW, operating at a power angle of 450. If each area has a capacity of 3000 MW and the equal speed regulation of 6Hz/P.u MW, determine the frequency of oscillation of the power for step change in load. Assume that both areas have the same inertia constants of H = 5 sec. If a step load change of 120MW occurs in one of the areas determine the change in tie-line power.	Understand	08
UNIT - V **REACTIVE POWER CONTROL**			
Part - A (Short Answer Questions)			
1	Compute the losses that occur due to VAR own in power systems?	Remember	10
2	Generalize how the generators act as VAR sources in a power network?	Understand	10
3	Generalize how the voltage control is achieved by injection of power at nodes?	Understand	10
4	Define voltage instability?	Understand	10
5	List out the different sources of reactive power generation in a power system?	Remember	11
6	Define sub synchronous resonance? Briefly explain?	Remember	11
7	Briefly explain voltage instability and voltage collapse?	Understand	10
8	Define series compensation?	Understand	11
9	Explain about the generation and absorption of reactive power in an electrical power system?	Remember	10
10	Derive the equations to get the relation between voltage, power and reactive power at a node.	Understand	11
11	Discuss phenomenon of voltage collapse with relevant PV and QV diagram?	Understand	10
12	List out the advantages of series compensation?	Understand	11
13	List out different sources of reactive power absorbers in a power system?	Remember	10
14	Compute the need for voltage and frequency regulation in power system?	Remember	11
15	Distinguish between different type of compensators	Understand	11
Part - B (Long Answer Questions)			
1	Discuss about the losses occurred due to VAR flow in power system?	Remember	10
2	Describe the generators are acted as VAR sources in a power network?	Remember	10
3	List notes on compensated and uncompensated transmission lines.	Remember	11
4	Describe briefly about the shunt and series compensation?	Understand	11
5	Define load compensation? Discuss its objectives in power systems?	Understand	11
6	The load at receiving end of a three-phase, over head line is 25.5 MW, power factor 0.8 lagging, at a line voltage of 33 kV. A synchronous compensator is situated at receiving end and the voltage at both the ends of the line is maintained at 33 kV. Calculate the MVAR of the compensator. The line has a resistance of 4.5 ohms per phase and inductive reactance (line to neutral) of 20 ohms per phase.	Understand	10
8	A long transmission line has the constants A=0.971<2°, B=<75°, find the additional reactive power requirement at the receiving end to meet a load of 63 MW at 0.8 pf. lagging, when both the sending end and receiving end voltages are to be maintained at 132 KV.	Understand	10
9	Give the reason for variations of voltages in power systems	Understand	10
10	Explain clearly what you mean by compensation of line and discuss briefly different methods of compensation.	Understand	11

11	Write short notes on un compensated transmission lines.	Remember	11
12	A long transmission line has the constants A=0.8971<2°, B=<72°, find the additional reactive power requirement at the receiving end to meet a load of 65 MW at 0.8 pf. lagging, when both the sending end and receiving end voltages are to be maintained at 133 KV.	Understand	10
13	The load at receiving end of a three-phase, over head line is 25.4 MW, power factor 0.86 lagging, at a line voltage of 34 kV. A synchronous compensator is situated at receiving end and the voltage at both the ends of the line is maintained at 33 kV. Calculate the MVAR of the compensator. The line has a resistance of 4.5 ohms per phase and inductive reactance (line to neutral) of 20 ohms per phase.	Understand	10
14	Describe the any one method to improve voltage profile.	Understand	11
15	Discuss its objectives in power systems	Understand	11
	Part – C (Analytical Questions)		
1	Briefly explain the different methods of reactive power injection in the power system. 10 In a radial transmission system shown in figure, all p.u values are referred to the voltage bases shown and 100 MVA. Determine the power factor at which the generator must operate.  	Understand	10
2	Find the rating of synchronous compensator connected to the tertiary winding of a 132 kV star connected, 33 kV star connected, 11 kV delta connected three winding transformer to supply a load of 66 MW at 0.8 p.f. lagging at 33 kV across the secondary. The equivalent primary and secondary winding reactances are 32 ohms and 0.16 ohms respectively while the secondary winding reactance is negligible. Assume that the primary side voltage is essentially constant at 132 kV and maximum of nominal setting between transformer primary and secondary is1.1.	Understand	11
3	A 3-phase single circuit, 220kV, line runs at no load. Voltage at the receiving end of the line is 205kV. Find the sending end voltage, if the line has resistance of 21.7ohms, reactance of 85.2ohms and the total susceptance of 5.32X10^{-4} mho. The transmission line is to be represented by Pie-model.	Understand	10
4	Design a static VAR compensator for a low voltage distribution system with the following specifications: System voltage = 440 V System frequency = 50 Hz Coil inductance, L=5.37 mH The inductor saturates at 950 A and settles to a value of 1.8 mH at 1800 A. Compensation is required over a range of -80 kVAR to +30 kVAR per phase.	Understand	11
5	The load at receiving end of a three-phase, over head line is 25.5 MW, power factor 0.8 lagging, at a line voltage of 33 kV. A synchronous compensator is situated at receiving end and the voltage at both the ends of the line is maintained at 33 kV. Calculate the MVAR of the compensator. The line has a resistance of 4.5 ohms per phase and inductive reactance (line to neutral) of 20 ohms per phase.	Understand	10
6	A 3-ph transmission line has resistance and inductive reactance of 25 and 90 respectively. With no load at the receiving end a synchronous compensator there takes a current lagging by 900, the voltage at the sending end is 145 kV and 132 kV at the receiving end. Calculate the value of the current taken by the compensator. When the load at the receiving end is 50 MW, it is found that the line can operate with unchanged voltages at sending and receiving ends, provided that the compensator takes the same current as before but now	Understand	10

	leading by 900. Calculate the reactive power of the load.		
7	A 440V, 3-Ø distribution feeder has a load of 100 KW at lagging p.f. with the load current of 200A. If the pf. is to be improved, determine the following: i) Uncorrected pf. and reactive load ii) New corrected pf. after installing a shunt capacitor of 75 KVAR.	Understand	10
8	A synchronous motor having a power consumption of 50 KW is connected in parallel with a load of 200KW having a lagging pf. of 0.8. If the combined load has a pf. of 0.9, what is the value of leading reactive KVA supplied by the motor and at what pf. is it working?	Understand	10
9	A 400V, 50Hz, 3-Ø supply delivers 200KW at 0.7 pf. lagging. It is desired to bring the line pf. to 0.9 by installing shunt capacitors. Calculate the capacitance if they are (a) Star connected and (b) Delta connected.	Understand	10
10	A 3-Ø, 500HP, 50Hz, 11KV star connected induction motor has a full load efficiency of 85% at lagging pf. of 0.75 and is connected to a feeder. If the p.f. of load is desired to be corrected to 0.9 lagging, determine the following: (a) Size of the capacitor bank in KVAR and (b) Capacitance of each unit if the capacitors are connected in delta as well as in star.	Understand	10
11	Find the rating of synchronous compensator connected to the tertiary winding of a 132 kV star connected, 66 kV star connected, 11 kV delta connected three winding transformer to supply a load of 33 MW at 0.8 pf. lagging at 33 kV across the secondary. The equivalent primary and secondary winding reactance are 32 ohms and 0.16 ohms respectively while the secondary winding reactance is negligible. Assume that the primary side voltage is essentially constant at 132 kV and maximum of nominal setting between transformer primary and secondary is1.1.	Understand	11
12	A 3-phase single circuit, 230kV, line runs at no load. Voltage at the receiving end of the line is 210kV. Find the sending end voltage, if the line has resistance of 21.7ohms, reactance of 85.25ohms and the total susceptance of $5.32X10^{-5}$ mho. The transmission line is to be represented by Pie-model.	Understand	10
13	Design a static VAR compensator for a low voltage distribution system with the following specifications: System voltage = 420 V System frequency = 50 Hz Coil inductance, L=5.4 mH The inductor saturates at 950 A and settles to a value of 1.8 mH at 1800 A. Compensation is required over a range of -80 kVAR to +30 kVAR per phase.	Understand	11
14	The load at receiving end of a three-phase, over head line is 25.6 MW, power factor 0.85 lagging, at a line voltage of 33 kV. A synchronous compensator is situated at receiving end and the voltage at both the ends of the line is maintained at 33 kV. Calculate the MVAR of the compensator. The line has a resistance of 4.35ohms per phase and inductive reactance (line to neutral) of 22 ohms per phase.	Understand	10
15	A 3-ph transmission line has resistance and inductive reactance of 26 and 91 respectively. With no load at the receiving end a synchronous compensator there takes a current lagging by 900, the voltage at the sending end is 144 kV and 133 kV at the receiving end. Calculate the value of the current taken by the compensator. When the load at the receiving end is 50 MW, it is found that the line can operate with unchanged voltages at sending and receiving ends, provided that the compensator takes the same current as before but now leading by 940. Calculate the reactive power of the load.	Understand	10

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