SRM VALLIAMMAI ENGINEERING COLLEGE

(Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF

ELECTRICAL AND ELECTRONICS ENGINEERING

QUESTION BANK

M.E-Power System Engineering (I SEM)

1916102 - Power System operation and Control

Regulation – 2019

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Prepared by

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SUBJECT & SUBJECT CODE: 1916102 - Power System operation & Control

SEM / YEAR: I Sem / I Year

UNIT I –INTRODUCTION				
System load variation: System load characteristics, load curves - daily, weekly and annual, load-duration curve, load factor, diversity factor. Reserve requirements: Installed reserves, spinning reserves, cold reserves, hot reserves. Overview of system operation: Load forecasting, techniques of forecasting, basics of power system operation and control, Functions of load dispatch center.				
PART – A				
Q.No	**Questions**	**BT Level**	**Competence**	**CO**
1.	What is spinning reserve	BT-4	Analyze	CO1
2.	Write short notes of variable load in a power system	BT-1	Remember	CO1
3.	Specify the difference between spinning reserve and cold reserve.	BT-2	Understand	CO1
4.	Develop the formula for finding out the start up cost by cooling and Banking method	BT-3	Apply	CO1
5.	Point out the need for maintaining frequency in a power system	BT-6	Create	CO1
6.	Summarize short note on effect of variable load in power system	BT-4	Analyze	CO1
7.	What is the need for maintaining voltage and frequency in a power system?	BT-1	Remember	CO1
8.	Mention few techniques of load forecasting.	BT-1	Remember	CO1
9.	Explain the role of computers in the operation and control of power system	BT-5	Evaluate	CO1
10.	Define load factor	BT-1	Remember	CO1
11.	Formulate the need for load forecasting	BT-3	Apply	CO1
12.	Decide the need for voltage regulation in power systems?	BT-2	Understand	CO1
13.	Define diversity factor	BT-1	Remember	CO1
14.	Measure the effect of load factor on the cost of generation?	BT-6	Create	CO1
15.	Define the term average load	BT-1	Remember	CO1
16.	Demonstrate the effects of variable load in power system	BT-1	Remember	CO1
17.	List out the objective of power system control	BT-2	Understand	CO1
18.	Distinguish load curve and load duration curve	BT-5	Evaluate	CO1

<table>
<tr><td>19.</td><td>List out the functions of load dispatch centre.</td><td>BT-2</td><td>Understand</td><td>CO1</td></tr>
<tr><td>20.</td><td>Illustrate the significance of load factor and diversity factor</td><td>BT-3</td><td>Apply</td><td>CO1</td></tr>
<tr><td colspan="5">PART – B</td></tr>
<tr><td>1.</td><td>i) Define the following: (1) Hot reserve (2) Cold reserve (3) diversity factor .(BT-1)
ii)A generating station has the following daily load cycle:
<table>
<tr><td>Time (hrs)</td><td>0-6</td><td>6-10</td><td>10-12</td><td>12-16</td><td>16-20</td><td>20-24</td></tr>
<tr><td>Load (M W)</td><td>20</td><td>25</td><td>30</td><td>25</td><td>35</td><td>20</td></tr>
</table>
Draw the load curve and calculate maximum demand, units generated per day, average load, load factor. (13)</td><td>BT-4</td><td>Analyze</td><td>CO1</td></tr>
<tr><td>2.</td><td>What is the need for load forecasting? Why is the load on the power station is variable? What are the effects of variable load as power system. (13)</td><td>BT-1</td><td>Remember</td><td>CO1</td></tr>
<tr><td>3.</td><td>(i) Explain the following terms: Installed reserve, spinning reserve, cold reserve, hot reserve. (7)
(ii)A power station has to meet the following demand: Group A:200KW between 8 A.M and 6 P.M Group B:100KW between 6 A.M and 10 A.M Group C:50KW between 6 A.M and 10 A.M
Group D:100KW between 10 A.M and 6 P.M and then between 6P.M and 6 A.M. Plot the daily load curve and determine diversity factor, units generated per day and load factor. (6)</td><td>BT-2</td><td>Understand</td><td>CO1</td></tr>
<tr><td>4.</td><td>(i) What are objectives of modern trend in real time control of power system? Explain the significant features of computer control in power system. (7)
(ii) Write short notes on load forecasting. (6)</td><td>BT-1</td><td>Remember</td><td>CO1</td></tr>
<tr><td>5.</td><td>Describe briefly about plant level and system level control. (13)</td><td>BT-5</td><td>Evaluate</td><td>CO1</td></tr>
<tr><td>6.</td><td>i)Classify and explain cost involved in power system. (7)
ii) Discuss about the load curve and load duration curve? what information are conveyed by a load curve. (6)</td><td>BT-2</td><td>Understand</td><td>CO1</td></tr>
<tr><td>7.</td><td>i) with Q-V control
struc (7)
ii) Explain the following terms. (6)
i. Maximum Demand
ii. Plant use factor
iii. Plant capacity factor
iv. Reserve capacity</td><td>BT-1</td><td>Remember</td><td>CO1</td></tr>
<tr><td>8.</td><td>(i) Explain the need for voltage and frequency regulation in power system. (7)</td><td>BT-2</td><td>Understand</td><td>CO1</td></tr>
</table>

	(ii) A generating station has maximum demand of 400 MW. The annual load factor is 65% and capacity factor is 50% find the reserve capacity of the plant. (6)			
9.	A diesel station supplies the following loads to various consumers Industry load-1100kW Domestic load-550kW Commercial load-850kW Domestic light-550kW.If the maximum demand on the station is 2750kW and the number of kWhr generated per year is 50×10^5, determine the diversity factor and annual load factor. (13)	BT-3	Apply	CO1
10.	(i) Explain the significance of load forecasting in power system planning operation and control. (7) (ii) Explain the load forecasting by least square method.(6)	BT-1	Remember	CO1
11.	(i) Differentiate: Installed reserve and spinning reserve; Hot reserve and cold reserve. (7) (ii) What are the reasons for uncertainty in the forecasting load? (6)	BT-3	Apply	CO1
12.	Evaluate the various stochastically methods for load forecasting. (13)	BT-4	Analyze	CO1
13.	Justify that the Kalman filtering approach to the load forecasting problem is a better way for very short-term forecasting. (13)	BT-6	Create	CO1
14.	Peak demand of a generating station is 90 MW. The load factor and the plant capacity factor are 0.6 and 0.5 respectively. Determine (a) daily energy produced (b) Installed capacity (c) reserve capacity (d) utilization factor (13)	BT-3	Apply	CO1
	PART – C			
1.	Explain the detail about economic dispatch control and automatic voltage regulator. (15)	BT-4	Analyze	CO1
2.	There are three consumers of electricity having different load requirements at different times. Consumer1 has a maximum demand of 5kW at 6p.m and a demand of 3kw at 7p.m and a daily load factor of 20V0. Consumer 2 has a maximum demand of 5kW at 11a.m and a demand of 2kW at7p.m and an average load of 1200 W .Consumer 3 has an average load of 1Kw and his maximum demand is 3kW at 7p.m.Determine(i) the diversity factor (ii) the load factor and average load of each consumer and (iii) the average load and load factor of the combined load. (15)	BT-5	Evaluate	CO1
3.	Briefly discuss the classification of load and list the important characteristics various types of loads. (15)	BT-6	Create	CO1
4.	What is spinning reserve and does this reserve help in operating a power system efficiently? How is cold reserve different from hot reserve. (15)	BT-5	Evaluate	CO1

UNIT II- REAL POWER - FREQUENCY CONTROL				
Fundamentals of speed governing mechanism and modelling: Speed-load characteristics – Load sharing between two synchronous machines in parallel; concept of control area, LFC control of a single-area system: Static and dynamic analysis of uncontrolled and controlled cases, Economic Dispatch Control. Multi-area systems: Two-area system modelling; static analysis, uncontrolled case; tie line with frequency bias control of two-area system derivation, state variable model				
PART – A				
Q.No	**Questions**	**BT Level**	**Competence**	CO
1.	What happens to frequency if load on the generator increase	BT-2	Understand	CO2
2.	Discuss the objective of AGC in multi area control	BT-3	Apply	CO2
3.	Demonstrate why the frequency and voltage to be regulated in a power system?	BT-2	Understand	CO2
4.	Compare the functions of "speed Governor" and " speed changer" in a speed governing systems of a turbine generator set.	BT-3	Apply	CO2
5.	What do you understand by coherent group of generators	BT-2	Understand	CO2
6.	Show how is the real power in power system controlled?	BT-1	Remember	CO2
7.	What is meant by free governor operation?	BT-5	Evaluate	CO2
8.	Show the function of load frequency control on a power system	BT-1	Remember	CO2
9.	Define speed droop	BT-1	Remember	CO2
10.	Draw the dynamic responses of change in frequency for a step load change for single area system	BT-4	Analyze	CO2
11.	What is the use of secondary loop in ALFC system?	BT-2	Understand	CO2
12.	List the advantages of multi area operation	BT-1	Remember	CO2
13.	Discuss the principle of tie line bias control	BT-6	Create	CO2
14.	List out the functions of ALFC	BT-5	Evaluate	CO2
15.	What is meant by control area	BT-3	Apply	CO2
16.	What is AFRC with reference to load frequency control? What does it signify	BT-2	Understand	CO2
17.	Explain the need for state estimation	BT-4	Analyze	CO2
18.	Reason out the necessity of tie line with frequency bias control of two area system.	BT-1	Remember	CO2
19.	Define area control error.	BT-1	Remember	CO2
20.	What is AGC?	BT-6	Create	CO2
PART – B				
1	Two synchronous generators operating in parallel. Their capacities are 300MW and 400MW. The droop characteristics of their governors are 4% and 5% from no load to full load. Assuming that the generators are operating at 50HZ at no load , how would be a load of 600MW shared between them. What will be the system frequency at this load? Assume free governor action. (13)	BT-2	Understand	CO2
2.	Describe the speed governing mechanism which control the real power flow in the power system and derive the mathematical model. (13)	BT-4	Analyze	CO2

3.	Derive the transfer function model and draw the block diagram for single control area provided with governor system. From the transfer function derive the expression for steady state frequency error for a step load change. . (13)	BT-2	Understand	CO2
4.	Draw the schematic diagram of an automatic voltage regulator of a generator and explain them in detail . (13)	BT-1	Remember	CO2
5.	Two 1000KW alternators operate in parallel. The speed regulation of first alternator is 100% to 103% from full load to no load and that of other 100% to 105%. How will the two alternators share load of 1200KW and at what will one machine cease to supply any portion of the load. (13)	BT-4	Analyze	CO2
6.	Two identical synchronous machines of rating 100MW,50Hz operating in parallel the following characteristics Machine 1: Governor speed drop:4% Speed Changer set to give 50% rated load at rated speed Machine 2: Governor speed droop:4 Speed changer set to give 75% rated load at rated speed (i) Determine the load taken by each machine for total of 150 MW and the frequency of operation (ii) What adjustment should be made by the speed change of the machine to share the loads as in (i) but with a frequency of 50 Hz (13)	BT-3	Apply	CO2
7.	Derive the expression for steady state frequency change for single area system with the following cases. (i)Changes in load with fixed speed (7) (ii)changes in speed with fixed demand. (6)	BT-2	Understand	CO2
8.	Derive an expressing for steady state frequency change and tie line power flow of two area system. (13)	BT-3	Apply	CO2
9.	i) Determine the primary ALFC loop parameters for a control area having the following data. (13) Total rated area capacity Pr=2000MW. Normal operating load Pd=1000MW. Inertia constant H=5.0 Regulation R=2.40 Hz/pu MW (all area generators) We shall assume that the load frequency dependency as linear meaning that the old load would increase 1% for 1% frequency increase. ii) Highly brief the importance of regulating frequency and voltage of the power system.	BT-5	Evaluate	CO2
10.	Develop the state variable model of a two area system and state the advantages of the model. (13)	BT-6	Create	CO2
11.	Draw the block diagram of uncontrolled two area load frequency control system and explain the salient features under static condition. (13)	BT-1	Remember	CO2
12.	A two area system connected by tie-line has the following identical parameters. R=3Hz/p.u MW B=0.006p.u MW/Hz. A 1000MW control area 1 is interconnected with a 5000MW area 2 Base value of area 2 is 5000MW. If a 30 MW load is	BT-5	Evaluate	CO2

	increases in area 1, find the static frequency drop and tie-line power changes. (13)			
13.	Develop the state variable model of a single area system and state the advantages of the model. (13)	BT-6	Create	CO2
14.	A two area power system has two identical areas with parameters are given below: (13) Rated capacity of the area=3000MW, Nominal operating load=1500MW, Inertia constant=4sec, Speed regulation=4%, Load damping factor=1p.u, Nominal frequency=50Hz Governor time constant=0.06sec.Turbine time constant=0.3sec. A load increase M2=30MW,occurs in area 2 Determine (i) the steady state frequency deviation (ii) ΔP12s	BT-3	Apply	CO2
	PART C			
1.	Consider the power frequency control of single system, assume that TG=TT=0.Compute the time error caused by a step disturbance of magnitude ΔPD, prove that the error is reduced by increasing gain KI. Express the errors in seconds and cycles(of 50Hz. (15)	BT-4	Analyze	CO2
2.	Two generators rated 200MW and 400Mw are operating in parallel. The droop characteristics of their governors are 4V0 and 5V0, respectively from no-load to full load. Assuming that the generators are operating at 50HZ at no load, how would a load of 600 MW be shared between them? What will be the system frequency at this load? Assume free governor operation. (15)	BT-5	Evaluate	CO2
3.	Illustrate the load sharing between two synchronous machine in parallel through a case study. (15)	BT-4	Analyze	CO2
4.	A two area system connected by the tie line has the following identical parameters R=3hz/pu,B=0.996MW/Hz. A 1000MW control area 1 is interconnected with a 5000 MW area 2. Base value of area 2 is 5000MW. If a 30MW load is increase in area 1 find the static frequent drop and tie line power change. (15)	BT-5	Evaluate	CO2

UNIT III - HYDROTHERMAL SCHEDULING PROBLEM				
Hydrothermal scheduling problem: short term and long term-mathematical model, algorithm. Dynamic programming solution methodology for Hydro-thermal scheduling with pumped hydro plant: Optimization with pumped hydro plant-Scheduling of systems with pumped hydro plant during off-peak seasons: algorithm. Selection of initial feasible trajectory for pumped hydro plant- Pumped hydro plant as spinning reserve unit-generation of outage induced constraint-Pumped hydro plant as Load management plant				
PART – A				
Q.No	**Questions**	**BT Level**	**Competence**	**CO**
1.	Explain short range hydro scheduling	BT-6	Create	CO3
2.	What is the need of hydro thermal scheduling	BT-4	Analyze	CO3
3.	Analysis different methods for solving hydro thermal scheduling	BT-3	Apply	CO3
4.	Draw input - output characteristics of thermal power stations. What is minimum up and minimum down time in unit commitment	BT-1	Remember	CO3
5.	Define participation factor	BT-1	Remember	CO3
6.	Describe participation factor with respect to economic load dispatch			CO3
7.	Formulate the co-ordination equation taking losses into account.	BT-4	Analyze	CO3
8.	How long term model differs from short term model in hydrothermal scheduling problem?	BT-2	Understand	CO3
9.	Compare with unit commitment and Economic load dispatch	BT-5	Evaluate	CO3
10.	Select the few constraints that are accounted in hydro unit commitment problem	BT-2	Understand	CO3
11.	Mention the assumption made in the formation of loss formula matrix B	BT-3	Apply	CO3
12.	Mention the importance of pumped hydro plant as spinning reserve unit	BT-1	Remember	CO3
13.	Formulate Hydro thermal co-ordination with necessary equations	BT-1	Remember	CO3
14.	Describe the penalty facto	BT-1	Remember	CO3
15.	How can the economic controller be added as the tertiary loop of LFC control?	BT-5	Evaluate	CO3
16.	Discuss the assumption for deriving loss coefficients?	BT-2	Understand	CO3
17.	Write the name of pumped storage plants available in India	BT-6	Create	CO3
18.	Draw the model of hydro plant on different stream	BT-1	Remember	CO3
19.	Discuss the statement of optimization problem oh hydro-thermal system	BT-2	Understand	CO3
20.	List of the advantages pumped hydro plant	BT-3	Apply	CO3
PART – B				
1.	What is short term hydr-thermal scheduling? What is the objective function and constraints of short term hydrothermal scheduling? Explain in detail (13)	BT-3	Apply	CO3

2.	(i) Explain input - output characteristics of thermal power stations. (7) (ii) Define in detail cost curve of thermal stations. (6)	BT-6	Create	CO3
3.	Discuss the combined hydro- electric and steam station operation. (13)	BT-3	Apply	CO3
4.	In a two plant operation system, the Hydro plant is operate 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 $C_T = 0.3\ P_{GT}^2 + 20\ P_{GT} + 5$ Rs/hr $W_H = 0.4 P_{GH}^2 + 20\ P_{GH}$ m^3/ sec When both plants are running, the power flow 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 $180\times10^6 m^3$. Determine the generation of hydro plant and cost of water used. (13)	BT-2	Understand	CO3
5.	Describe different methods for solving hydro thermal scheduling. (13)	BT-1	Remember	CO3
6.	Explain about Hydro thermal co-ordination with necessary equations. (13)	BT-5	Evaluate	CO3
7.	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 $C_T = 0.04\ P_{GT}^2 + 30\ P_{GT} + 10$ Rs/hr W_H $W_H = 0.12\ P_{GH}^2 + 30\ P_{GH}$ m^3/ sec When both plants are running, the power flow 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 $150\times10^6\ m^3$. Determine the generation of hydro plant and cost of water used. Neglect the transmission losses. (13)	BT-4	Analyze	CO3
8.	Explain pumped storage hydro scheduling with a lambda gamma iteration method. (13)	BT-1	Remember	CO3
9.	A steam station and a hydro station feed an area jointly. The hydro station is run for 14 hours daily and the steam station is run for all the 24 hours. The production cost characteristics for steam station is $C=5+8P_s+0.05P_s^2$ Rs/Hr. If the load on the steam station, when bothplants are in operation 250MW the incremental water rate of hydro plants is $dW/dP_h=30+0.05P_h^2$ m^3/MW-sec. The total quantity of water used during the 14 hours is 500 million cubic meters. Find the load and hydro plant and cost of water use. Assume that load on hydro plant is constant for 14hours period. (13)	BT-4	Analyze	CO3
10.	Demonstrate the algorithmic steps of short range variable head hydrothermal scheduling using classical method. (13)	BT-1	Remember	CO3
11.	(i) Explain hydro-thermal scheduling. (7)	BT-2	Understand	CO3

	(ii) Explain in detail, how a pumped hydro plant can act as load management plant. (6)			
12.	Derive the mathematical model for Hydrothermal scheduling with pumped hydro plant. Explain the method for selection of initial feasible trajectory for pumped hydro plant. (13)	BT-5	Evaluate	CO3
13.	Narrate the method of optimal scheduling applied to hydro thermal system. (13)	BT-2	Understand	CO3
14.	Consider the two-plant case with the steam-plant characteristics with $F=700+4.8Ps+(Ps^2/2000)$ Rs/hr for $200=Ps<=1200$MW. The hydro unit is a constant head plant with $q=290+10Ph$ for $Ph>0$ and $q=0$ for $Ph=0$. There is no spillage and the initial volume is 10,000 acre-ft. The discharge rate is in acre-ft/hr. Storage volume limits are 6000 and 16,000acre-ft. The natural inflow is 860 acre-ft-hr. The scheduling problem is to be examined for six hours and individual periods taken as three hours each. The loads for the time periods are 600 and 1000MW respectively. Find the hydro-thermal schedule. (13)	BT-3	Apply	CO3
	PART C			
1	Discuss how the Dynamic programming applied to find the solution of hydro thermal scheduling problem. (15)	BT-4	Analyze	CO3
2	Discuss how the linear programming is useful to solve large hydro scheduling problem. (15)	BT-3	Apply	CO3
3	i) Explain the hydro scheduling with storage limitations in power system. (8) ii) Explain method for a selection of initial feasible trajectory for pumped hydro plant. (7)	BT-3	Apply	CO3
4	Speculate and specify a design procedure to justify the pumped hydro plant as the best load management plant. (15)	BT-4	Analyze	CO3

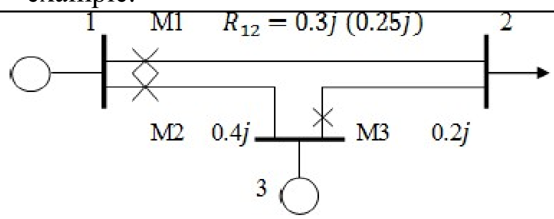
UNIT IV - UNIT COMMITMENT AND ECONOMIC DISPATCH				
Statement of Unit Commitment (UC) problem; constraints in UC: spinning reserve, thermal unit constraints, hydro constraints, fuel constraints and other constraints; UC solution methods: Priority-list methods, forward dynamic programming approach, numerical problems. Incremental cost curve, co-ordination equations without loss and with loss, solution by direct method and λ-iteration method. Base point and participation factors.-Economic dispatch controller added to LFC control.				
Part-A				
Q.No	**Questions**	**BT Level**	**Competence**	**COs**
1	List the various constraints of unit commitment problem	BT-1	Remember	CO4
2	What is the objective of economic dispatch problem	BT-4	Analyze	CO4
3	Draw the incremental fuel cost curve	BT-2	Understand	CO4
4	Why cascading outages are preferred?	BT-4	Analyze	CO4
5	Write the significance of Unit Commitment	BT-2	Understand	CO4
6	Draw the incremental cost curve of a thermal power plant	BT-1	Remember	CO4
7	Write the equality and inequality constraints considered in the economic dispatch problem	BT-3	Apply	CO4
8	What is meant by FLAC?	BT-1	Remember	CO4
9	What is minimum up and minimum down time in unit commitment	BT-6	Create	CO4
10	Define participation factor	BT-1	Remember	CO4
11	What is participation factor with respect to economic load dispatch	BT-5	Evaluate	CO4
12	Write the co-ordination equation taking losses into account.	BT-3	Apply	CO4
13	What is meant by incremental cost curve	BT-1	Remember	CO4
14	Compare with unit commitment and Economic load dispatch			CO4
15	List the few constraints that are accounted in unit commitment problem	BT-2	Understand	CO4
16	What is meant by priority list method	BT-1	Remember	CO4
17	Mention the assumption made in the formation of loss formula	BT-6	Create	CO4
18	What are the advantages of using forward dynamic programming method	BT-2	Understand	CO4
19	In what way the fuel constraints are dealt with unit commitment?	BT-1	Remember	CO4
20	What is difference between load frequency controller and economic dispatch controller	BT-3	Apply	CO4
Part-B				
1	Discuss the dynamic programming method in optimal unit commitment. (13)	BT-1	Remember	CO4
2	The fuel inputs per hour of plants 1 and 2 are given as $F1= 0.2P1^2 +40P1+120$Rs/hr, $F2=0.25P2^2 +30P2+150$Rs/hr Determine the economic operating schedule and the corresponding cost of generation. The maximum and the minimum loading on each unit are 100MW and 25MW. Assume the transmission losses are ignored and the total demand is 180MW. Also determine the saving obtained if the load is equally shared by both the units. (13)	BT-3	Apply	CO4
3	(i) With the help of Flow chart explain Economic dispatch by λ Iteration method without loss.	BT-4	Analyze	CO4

	(ii) The fuel cost of two units are given by $F1=F1\ (PG1) = 1.5+20PG1+0.1PG1^2$ Rs\hr $F2=F2\ (PG2) = 1.9+30PG2+0.1PG2^2$ Rs\hr If the total demand on the generator is 200 MW. Find the economic load scheduling of the two units. (BT-4) (iii) What is the significance of equality and inequality constraints in the formulation of optimum dispatch problem? (13)			
4	(i) What is unit commitment problem? Discuss the constraints that are to be accounted in unit commitment problem. (7) (ii) Obtain the priority list of unit commitment using full load average production cost for the given data: (6) Heat rate of unit1 $H1= 510+7.2PG1+0.00142 PG1^2$ MW\hr Heat rate of unit2 $H2= 310+7.85PG2+0.00194PG2^2$ MW\hr Heat rate of unit3 $H3= 78+7.97PG3+0.00482PG3^2$ MW\hr. PD=500MW Unit — Mm(MW) 1 — 150 2 — 100 3 — 50	BT-3	Apply	CO4
5	The fuel inputs per hour of plants 1 and 2 are given as $F1= 0.2P1^2 +40P1+120$ Rs/hr $F2=0.25P2^2 +30P2+150$ Rs/hr Determine the economic operating schedule and the corresponding cost of generation if the maximum and minimum loading on each unit is 100MW and 25MW.Assume the transmission losses are ignored and the total demand is 180 MW. Also determine the saving obtained if the load is equally shared by both the units. (13)	BT-5	Evaluate	CO4
6	The fuel cost functions for three thermal plants in \$/h are given by $F1=0.004Pg1^2+5.3Pg1+500$ $F2=0.006Pg2^2+5.5Pg2+400$ $F3=0.009Pg3 +5.8Pg3+200$ where Pg1,Pg2,Pg3 are in MW. Find the optimal dispatch and the total cost when the total load is 925 MW with the following generator limits. $100MW \le Pg1 \le 450MW$, $100MW \le Pg2 \le 350MW$, $100MW \le Pg3 \le 225MW$. (13)	BT-3	Apply	CO4
7	(i)Construct the priority list for the units given below. $H1=510+7.20P1+0.00142P1^2$. Pmin=150MW.Pmax=600MW. Fuel cost=1.1Rs/MBtu. $H2=310+7.85P2+0.00194P2^2$	BT-4	Analyze	CO4

	.Pmin=100MW.Pmax=400MW. Fuel cost=1.0Rs/MBtu $H3=78+7.97P3+0.00482P3^2$ .Pmin=50MW.Pmax=200MW. Fuel cost=1.2Rs/MBtu (BT-2) (7) ii)Formulate the coordination equation with losses neglected. (6)			
8	(i) The cost characteristics of three plants of a system are $C1=0.05P1^2+17.0P1+160$ Rs/hour $C2=0.06P2^2+14.4P2+200$ Rs/hour $C3=0.08P3^2+9.0P3+240$ Rs/hour Where P1,P2,P3 are in MW. The incremental transmission losses for the network with respect to plants 1,2 and 3 are 0.05,0.10 and 0.15 MW per MW of generation. Find the optimal dispatch for a total load of 100MW and also its incremental cost of received power. (7) ii) The input output curve characteristics of three units are $F1=750+6.49Pg1+0.0035Pg1^2$. $F2=870+5.75Pg2+0.0015P\ g2^2$. $F3=620+8.56Pg3+0.001P\ g3^2$. The fuel cost of unit 1 is 1.0 Rs/MBtu, 1.0 Rs/MBtu for unit 2 and 1.0 Rs/MBtu for unit 3. Total load is 800MW. Use the participation factor method to calculate the dispatch for a load is increased to 880MW. (6)	BT-5	Evaluate	CO4
9	The fuel-cost functions for three thermal plants are given by $F1=0.004Pg1^2+5.3Pg1+500$ \$/hr $F2=0.006Pg2^2+5.5Pg2+400$ \$/hr $F3=0.009Pg3^2+5.8Pg3+200$\$/hr Where Pg1,Pg2and Pg3 are in MW. Find the optimum scheduling and the total cost per hour for a total load of 975 MW with the following generator limits. $100MW \leq Pg1 \leq 450MW$ $100MW \leq Pg2 \leq 350MW$ $100MW \leq Pg3 \leq 225MW$. (13)	BT-4	Analyze	CO4
10	(i) Explain the Forward Dynamic Programming method of solving unit commitment problem with neat flow chart. (7) (ii) Explain the priority list method of solving unit commitment Problem. State merits and limitations of this method. (6)	BT-1	Remember	CO4
11	A plant has two generators supplying the plant by and neither is to be operated below 20MW or above 135MW. Incremental costs with PG1 and PG2 in MW are $dF1/dPG1=0.14PG1+21$ Rs/MWhr $dF2/dPG2=0.225PG2+16.5$Rs/MWhr For economic dispatch, find the plant when the demand equals (a) 45MW (b) 125 MW (c) 250MW. (13)	BT-6	Create	CO4

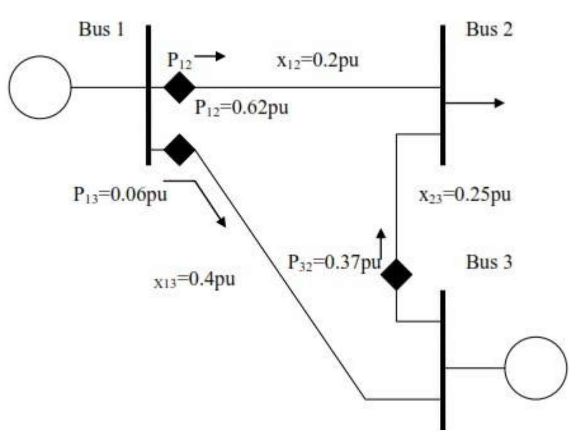
12	Derive the exact co-ordination equation in optimal generation scheduling. (13)	BT-2	Understand	CO4
13	i) Obtain the priority list of unit commitment using full load average production cost for the given data for the load level of 900MW $F1=392.7+5.544+0.001093P1^2$ $F2=217+5.495P2+0.001358P2^2$ $F3=65.5+6.695P3+0.004049P3^2$ P1,P2,P3 are in MW Generation limit are:150<=P1<=600MW;100<=P2<=400MW.Obtain the optimum unit commitment table. (7) (ii) Explain the base point and participation factors methods in details. (6)	BT-6	Create	CO4
14	Explain with a neat flow chart, to find economic generation for the unit commitment problem. (13)	BT-1	Remember	CO4
Part-C				
1	Discuss with a neat flow chart the procedure for finding the solution for unit commitment problems using forward DP method. (15)	BT-4	Analyze	CO4
2	Describe the flow chart for obtaining the optimum dispatch strategy of N bus system taking in to account the system transmission losses. (15)	BT-5	Evaluate	CO4
3	Analyse the coordination equation for economic dispatch including losses and give the steps for economic dispatch calculation, neglecting losses. (15)	BT-4	Analyze	CO4
4	Give λ iteration algorithm for solving economic scheduling problem without losses. (15)	BT-5	Evaluate	CO4

UNIT V – STATE ESTIMATION				
Need for power system state estimation- Network observability – DC state estimation model State estimation of power system – Methods of state estimation: Least square state estimation, Weighted least square state estimation, Maximum likelihood- Bad data detection and identification.				
Part-A				
Q.No	**Questions**	**BT Level**	**Competence**	**Cos**
1	What is state estimation	BT-5	Evaluate	CO5
2	List the methods of state estimation	BT-1	Remember	CO5
3	State the need for power system state estimation	BT-1	Remember	CO5
4	Describe the function of state estimation	BT-4	Analyze	CO5
5	What is mean by state vector	BT-2	Understand	CO5
6	List down the different method for standard scheme of measurement	BT-3	Apply	CO5
7	Differentiate the least square state estimation and weighted square state estimation.	BT-3	Apply	CO5
8	Define static state estimation	BT-1	Remember	CO5
9	Why weighted least square method used for state estimation	BT-6	Create	CO5
10	What is meant by probabilistic static estimation	BT-3	Apply	CO5
11	What are the sources of bad data	BT-2	Understand	CO5
12	Differentiate Load flow analysis and State estimation	BT-1	Remember	CO5
13	What is meant by virtual measurement	BT-5	Evaluate	CO5
14	How bad data identified	BT-4	Analyze	CO5
15	What is meant by DC state estimation	BT-2	Understand	CO5
16	What are the approximation for DC state estimation	BT-1	Remember	CO5
17	What is meant by network observability	BT-6	Create	CO5
18	Demonstrate the importance of state estimation in power system	BT-1	Remember	CO5
19	Write down application of state estimation	BT-3	Apply	CO5
20	What do you mean by static stare and dynamic state estimation modes	BT-2	Understand	CO5
Part-B				
1	Estimate two random variable by least square estimation method for a given measurement vector z as follows [0.5][1 1] Z=[0.45];H=[1 0] [0.51] [0 1]. (13)	BT-1	Remember	CO5
2	Estimate two values random variables x by weighted least square estimation method [1 0 0] [1 1] [0.5] W=[0 0.5 0]; H=[1 0]; Z=[0.45] [0 0 0.1] [0 1][0.51]. (13)	BT-3	Apply	CO5
3	Explain the security monitoring using state estimation with necessary diagram. (13)	BT-4	Analyze	CO5
4	Discuss the least square state estimation in detail. (13)	BT-3	Apply	CO5
5	Explain the neat flow chart DC state estimation in power system. (13)	BT-1	Remember	CO5
6	Briefly explain different methods of state estimation in power system with suitable example. (13)	BT-6	Create	CO5
7	Explain different methods of bad data detection and identification in power system state estimation. (13)	BT-1	Remember	CO5

<table>
<tr><td>8</td><td>Elaborate the weighted square state estimation method. (13)</td><td>BT-2</td><td>Understand</td><td>CO5</td></tr>
<tr><td>9</td><td>Explain network observability and pseudo measurements. (13)</td><td>BT-2</td><td>Understand</td><td>CO5</td></tr>
<tr><td>10</td><td>Derive the maximum likelihood weighted least square estimation. Explain with an example. (13)</td><td>BT-3</td><td>Apply</td><td>CO5</td></tr>
<tr><td>11</td><td>Briefly explain the detection and identificationof bad measurements and pseudo measurement. (13)</td><td>BT-2</td><td>Understand</td><td>CO5</td></tr>
<tr><td>12</td><td>Formulate how bad data are detected, identified and suppressed in power system state estimation. (13)</td><td>BT-2</td><td>Understand</td><td>CO5</td></tr>
<tr><td>13</td><td>Write down the application power system state estimation and Cleary explain anyone supplication with suitable example. (13)</td><td>BT-6</td><td>Create</td><td>CO5</td></tr>
<tr><td>14</td><td>


<table>
<tr><th>Quantity measured</th><th>Metering point</th><th>Error variance</th><th>Meter reading</th></tr>
<tr><td>Real power from bus 1 to 2</td><td>M1</td><td>0.0001</td><td>0.72</td></tr>
<tr><td>Real power from bus 1 to 3</td><td>M2</td><td>0.0001</td><td>0.09</td></tr>
<tr><td>Real power from bus 3 to 2</td><td>M3</td><td>0.0001</td><td>0.65</td></tr>
</table>

Find state of the given three bus system using DC state estimation model. (13)</td><td>BT-6</td><td>Create</td><td>CO5</td></tr>
<tr><td colspan="5">Part-C</td></tr>
<tr><td>1</td><td>Find state estimation using DC power flow equation for given power system Real power measurements are taken as follows: P12 =0.62 pu=0.06 pu, and P 32=0.37 pu. All voltages are 1.0 per unit, and all. (15)


</td><td>BT-4</td><td>Analyz e</td><td>CO5</td></tr>
</table>

2	List the various contingencies that are generally considered for steady state security analysis. Explain the major functions of system security control. (15)	BT-5	Evaluate	CO5
3	Explain various method of power system state estimation and write the application of power system state estimation. (15)	BT-5	Evaluate	CO5
4	Using DC load flow model, Calculate the best estimate for the phase angle using WLS estimation by deterministic method. (15)	BT-4	Analyze	CO5

Line	X	Measured quantity	Accuracy	Standard deviation	Measured (Z) in MW
1-2	j0.2	P1,2	6	0.02	64
2-3	j0.25	P1,3	3	0.01	4
3-1	J0.4	P3,2	0.6	0.002	40.5

Course Outcome

- Learners will be able to understand system load variations and get an overview of power system operations.
- Learners will understand the real power frequency control on single and multi-area power system.
- Learners will attain knowledge about hydrothermal scheduling.
- Learners will understand the significance of unit commitment and different solution methods.
- Learners will understand the need for state estimation in real time operation.