Roll No. | | | | | | | | | | |

ANNA UNIVERSITY (UNIVERSITY DEPARTMENTS)

B.E. (Full Time) - END SEMESTER EXAMINATIONS, NOV / DEC 2024

ELECTRICAL AND ELECTRONICS ENGINEERING

VII - Semester

EE5702 - Power System Operation and Control

(Regulation 2019)

Time: 3hrs

Max.Marks: 100

CO 1	Analyze the day-to-day operation of electric power system.
CO 2	Analyze the control actions that are implemented to meet the minute-to-minute variation of system real power demand.
CO 3	Analyze the compensators for reactive power control.
CO 4	Prepare day ahead and real time economic generation scheduling.
CO 5	Understand the necessity of computer control of power systems.

BL – Bloom's Taxonomy Levels

(L1 - Remembering, L2 - Understanding, L3 - Applying, L4 - Analysing, L5 - Evaluating, L6 - Creating)

PART- A (10 x 2 = 20 Marks)

(Answer all Questions)

Q. No	Questions	Marks	CO	BL
1	What are the requirements of a good power system?	2	1	1
2	What are the significant benefits of power industry deregulation?	2	1	1
3	Consider the speed governing system of 50 Hz, 100 MW generator, having 4% speed regulation. Find the increase in turbine power, if the frequency drops by 0.12 Hz with the speed changer setting unchanged.	2	2	2
4	A 3-phase, 4-pole synchronous generator is synchronized to the grid and operates at 1480 rpm. Determine the grid frequency.	2	2	2
5	Static error in AVR decreases with increased loop gain. Justify this.	2	3	2
6	Draw the VI characteristics of SVC.	2	3	1
7	What is Priority List method?	2	4	1
8	Distinguish between Economic Dispatch and Unit Commitment problems.	2	4	2
9	List the various functions of an energy control center.	2	5	1
10	Draw the block diagram of PMU.	2	5	2

PART- B (5 x 13 = 65 Marks)

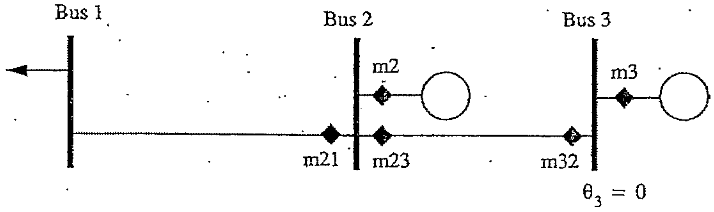
(Restrict to a maximum of 2 subdivisions)

Q. No	Questions	Marks	CO	BL
11 (a)	(i) The annual load duration curve of a certain power station can be considered as a straight line from 20 MW to 4 MW. To meet this load, three turbine-generator units, two rated at 10 MW each and one rated at 5 MW are installed. Determine installed capacity, units generated per annum, load factor, plant capacity factor and plant use factor. (8)	13	1	4

<table>
<tr><td></td><td>(ii). An electric supply company having a maximum load of 60 MW generates 25 × 10^7 units per annum and the supply consumers have an aggregate demand of 75 MW. The annual expenses including capital charges are:
For fuel = Rs 95 lakhs
Fixed charges concerning generation = Rs 30 lakhs
Fixed charges concerning T&D = Rs 35 lakhs
Assuming 90% of the fuel cost is essential to running charges and the loss in transmission and distribution as 15% of kWh generated, deduce a two part tariff to find the actual cost of supply to the consumers. (5)</td><td></td><td></td><td></td></tr>
<tr><td colspan="5">OR</td></tr>
<tr><td>11 (b)</td><td>The annual peak demand of an electric utility for four consecutive years is given below:
<table>
<tr><td>x (Year)</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>y (Maximum demand in GW)</td><td>4</td><td>6</td><td>9</td><td>14</td><td>19</td></tr>
</table>
Forecast the peak demand for the 7-th year by parabolic curve fitting.</td><td>13</td><td>1</td><td>4</td></tr>
<tr><td>12 (a)</td><td>The data pertaining to an uncontrolled single area power system are as follows:
Total rated capacity = 2500MW
Nominal operating load = 1500MW
Nominal frequency = 50Hz
Inertia constant = 4 Sec.
Governor drop = 4%
Assume that the load frequency characteristic of the system is linear. For a decrease of 20 MW load, determine
i) Steady state frequency deviation and frequency. (5)
ii) Change in generation (in MW) and increase in original load (in MW) under steady state conditions. (4)
iii) Find the Transfer Function of the power system. (4)</td><td>13</td><td>2</td><td>3</td></tr>
<tr><td colspan="5">OR</td></tr>
<tr><td>12(b)</td><td>(i). For a two area system, develop the expression for change in tie-line power flow in terms of change in frequency of both the areas and represent it in the form of a block diagram. (6)
(ii). Draw the block diagram representation of uncontrolled two area system and develop the expression for static frequency deviation and static tie line power deviation subjected to sudden load changes. (7)</td><td>13</td><td>2</td><td>3</td></tr>
<tr><td>13 (a)</td><td>With necessary diagrams, briefly describe brushless AC excitation system and develop the transfer function block diagram of the AVR loop.</td><td>13</td><td>3</td><td>3</td></tr>
<tr><td colspan="5">OR</td></tr>
<tr><td>13 (b)</td><td>(i). Explain the working of STATCOM. (7)</td><td>13</td><td>3</td><td>3</td></tr>
</table>

	(ii).A 132 kV line is fed through 11 / 132 kV transformer from a constant 11 kV supply. At the load end of the line, the voltage is reduced by another transformer of nominal ratio 132 / 11 kV. The total impedance of the line and transformers at 132 kV is (20+j53) Ω. Both the transformers are equipped with tap changing facilities which are so arranged that the product of the two off-nominal settings is unity. If the load on the system is 40 MW at 0.9 p.f. lagging, calculate the settings of the tap changers required to maintain the voltages at the both ends at 11 kV. (6)			
14 (a)	A power plant has two units with the following cost characteristics: $C_1 = 0.6\,P_1^2 + 200\,P_1 + 2000$ **Rs / hour** $C_2 = 1.2\,P_2^2 + 150\,P_2 + 2500$ **Rs / hour** where P_1 and P_2 are the generating powers in MW. The daily load cycle is as follows: 6:00 AM to 6:00 PM : 150 MW 6:00 PM to 6:00 AM : 50 MW The cost of taking either unit off the line and returning to service after 12 hours is Rs 5000. Considering 24 hour period from 6:00 AM one morning to 6:00 AM the next morning, would it be economical to keep both units in service for this 24 hour period or remove one unit from service for 12 hour period from 6:00 PM one evening to 6:00 AM the next morning?	**13**	4	4
	OR			
14 (b)	(i). Discuss about the constrains on Unit Commitment problem.(7) (ii)A hydroplant and a steam plant are to supply a constant load of 100 MW for 1 week (168 h). The unit characteristics are Hydroplant: $q = 300 + 16\,P_H$ acre-ft/h $0 \le P_H \le 120$ MW Steam plant: $F(P_s) = 0.02\,P_s^2 + 11.3\,P_s + 55.1$ \$/h $12.5 \le P_s \le 60$ MW (1). If Hydroplant energy limited to 12,000 MWh, determine the optimal running time of steam plant. (3) (2). If the maximum drawdown volume of water from the hydroplants' reservoir in 1 week is 250,000 acre-ft, how long should the steam unit run? (3)	**13**	4	4
15 (a)	(i). Draw the layout of a typical SCADA system and explains its main functions. (5) (ii).Draw the state transition diagram and explain the various operating state of a power system and the associated control actions. (8)	**13**	5	3
	OR			
15 (b)	Given the network shown in Figure, the network is to be modeled with a DC power flow with line reactances as follows (assume	**13**	5	3

100-MVA base):



$x_{12} = 0.1$ pu & $x_{23} = 0.2$ pu

The meters are all of the same type with a standard deviation of $\sigma = 0.01$ pu for each. The measured values are
M3 = 105 MW; M32 = 102 MW; M23 = −115 MW
M2 = 49 MW; M21 = 158 MW
i). Find the phase angles that result in a best fit to the measured values. (10)
ii). Find the value of the residual function J. (3)

PART- C (1 x 15 = 15 Marks)

(Q.No.16 is compulsory)

<table>
<tr><th>Q. No</th><th>Questions</th><th>Marks</th><th>CO</th><th>BL</th></tr>
<tr><td>16.</td><td>(i) The following two synchronous generators are operating in parallel:
<table>
<tr><td>Generator 1</td><td>60 MW</td><td>5% speed regulation</td></tr>
<tr><td>Generator 2</td><td>50 MW</td><td>4% speed regulation</td></tr>
</table>
(1). Determine the load taken by each generator for a total load of 80 MW when the speed changers are set to give rated speed at 50% rated output. (6)
(2). The speed changer of generator 1 is so adjusted that 80 MW load is equally shared. Find the output of generator 1 for rated speed and its frequency at no load. (4)</td><td>10</td><td>2</td><td>5</td></tr>
<tr><td></td><td>(ii). Incremental cost of three units in a plant are:
IC1 = 0.8 P1 + 160 Rs / MWh;
IC2 = 0.9 P2 + 120 Rs / MWh;
IC3 = 1.25 P3 + 110 Rs / MWh.
where P1, P2 and P3 are power output in MW.
The optimum schedule for the total load of 242.5 MW is:
P1 = 62.5 MW; P2 = 100 MW; P3 = 80 MW.
Using Participating Factors, determine the optimum scheduling when the load increases to 270 MW. (5)</td><td>5</td><td>4</td><td>5</td></tr>
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