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B.Tech DEGREE EXAMINATION, NOVEMBER 2023

Seventh Semester

18EEC401J - POWER SYSTEM OPERATION AND CONTROL

(For the candidates admitted during the academic year 2020 - 2021 & 2021 - 2022)

Note:

i. **Part - A** should be answered in OMR sheet within first 40 minutes and OMR sheet should be handed over to hall invigilator at the end of 40th minute.

ii. **Part - B** and **Part - C** should be answered in answer booklet.

Time: 3 Hours **Max. Marks: 100**

PART - A (20 × 1 = 20 Marks)

Answer **all** Questions

		Marks	BL	CO
1.	The heart of the speed governor system, which controls the change in speed is -------- --- (A) Linkage mechanism (B) Flyball speed governor (C) Speed changer (D) Hydraulic amplifier	1	1	1
2.	Time constant of the power system is in the order of (A) 20 sec (B) 2 sec (C) 0.2 sec (D) 0.02 sec	1	1	1
3.	The speed regulation parameter R of a control area is 0.025 Hz/MW and load frequency constant D is 2 MW/Hz. The area frequency response characteristics (AFRC) is (A) 50 (B) 42 (C) 2.025 (D) 0.525	1	1	1
4.	The power flow in the tie-line between two area system depends on (A) Voltage difference between buses in the two areas (B) Reactive power flow across a transmission line (C) Relative phase angle between buses in the two areas (D) Current flow across a transmission line	1	1	1
5.	By drawing high currents at low voltages, the motor gets (A) Overheated (B) Cooled (C) Constant heat (D) No effect	1	1	2
6.	Find the minimum value of open loop gain K, for the static error less than 3% (A) 32.3 (B) 34.3 (C) 31.3 (D) 30.3	1	1	2
7.	The role of the stability compensator in the AVR loop is to (A) add a pole to the AVR loop transfer function (B) decrease the relative stability of the system (C) add a zero to the AVR loop transfer function (D) introduce a complex pole	1	2	2
8.	The tap changing transformers ----------. (A) do not generate reactive power (B) do generate reactive power (C) do generate power factor (D) do generate real power	1	1	2
9.	For economic measure, the generators at a power plant operate at _____. (A) Equal incremental cost (B) Equal loads (C) Equal power rating (D) Equal voltage	1	1	3

10.	The penalty factor in power system economic operation is a measure of ---------- (A) Line loss (B) Generation cost (C) Fuel cost (D) Maintenance cost	1	1	3
11.	For the two-power plant system, the loss equation is ---------- (A) $P_2^2B_{11} + 2P_1B_{12}P_2 + P_2^2B_{22}$ (B) $P_1^2B_{11} + 2P_1B_{12}P_2 + P_2^2B_{22}$ (C) $P_1^2B_{11} + 2P_1B_{11}P_2 + P_1^2B_{22}$ (D) $P_1^2B_{12} + 2P_1B_{12}P_2 + P_2^2B_{22}$	1	1	3
12.	Which of the following factors is used to move one optimal schedule to another when load changes are small? (A) Base point factor (B) Maximum point factor (C) Penalty factor (D) Participation factor	1	1	3
13.	Different combination of generators are connected in the system to meet the varying load is called as (A) Economic dispatch (B) Unit commitment (C) Penalty factors (D) Participation factor	1	1	4
14.	Must run unit is to run one or two units from the consideration of ---------- (A) Voltage support and system stability (B) Temperature constraint (C) Cold and Hot start (D) To avoid transition cost	1	1	4
15.	When the status of unit changed some ---------- cost is involved. (A) Transition (B) Crew (C) Incremental (D) Maintenance	1	1	4
16.	The UC problem based on dual optimization approach is (A) Dynamic Programming (B) Lagrange Relaxation (C) Priority listing (D) Penalty function	1	1	4
17.	If the control action taken during the emergency state is insufficient, then the system enters into an ---------- (A) Extremis state (B) Restorative state (C) Normal state (D) Alert state	1	1	6
18.	State estimation gives the best possible values of ---------- (A) Power factor (B) Reactive power (C) Current (D) Voltage and angles	1	1	5
19.	Which of the following is not a part of Remote Terminal Unit of SCADA system? (A) Transducer (B) Relay (C) A/D converter (D) Arrester	1	1	5
20.	The device used to collect the data is ---------- (A) EMS (B) SCADA (C) RTU (D) LAN	1	1	5

PART - B (5 × 4 = 20 Marks)
Answer **any 5** Questions

		Marks	BL	CO
21.	Discuss the interaction between AVR and ALFC loops.	4	2	1
22.	Explain the need for the integral controller in a single-area system	4	2	1
23.	Justify the need for reactive power injection.	4	1	2
24.	What are the requirements of AVR loop?	4	1	2
25.	What do you understand by the Equal Incremental Cost Rule?	4	1	3

		Marks	BL	CO
26.	What is the Unit Commitment problem?	4	1	4
27.	Compare SCADA with PMU	4	1	5

PART - C (5 × 12 = 60 Marks)

Answer **all** Questions

		Marks	BL	CO
28.	(a) (i) Two synchronous generators are operating in parallel. Their capacities are 200 MW and 400 MW. The droop characteristics of their governors are 4% and 5% from no load to full load. Assuming that the governors of the generators are operating at 50 Hz at full load, the total load on the system is 450 MW. Assume linear governor operation. Determine the load shared by each generator and the operating frequency. (8 marks) (ii) Discuss the concept of Control area in ALFC (4 marks) **(OR)** (b) Draw the complete block diagram of an uncontrolled single area ALFC loop and develop the expression for static frequency drop for a step load increase.	12	2	1
29.	(a) (i) Explain the working of static VAR compensator. (4 marks) (ii) A 132 kV transmission 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 + j 50) 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 45 MVA at 0.9 p.f. lagging, calculate the settings of tap changers required to maintain the voltages at both ends at 11 kV. (8 marks) **(OR)** (b) (i) In AVR, higher open loop gain is needed for better static accuracy. Justify this. (6 marks) (ii) With the necessary diagram, briefly describe the working of the brushless AC excitation system (6 marks)	12	3	2
30.	(a) (i) Derive the coordination equation for the power system having N number of power plants. (6 Marks) (ii) The cost characteristics of three units in a power plant are given by $C_1 = 0.5\,P_1^2 + 220\,P_1 + 1800$ Rs / hour $C_2 = 0.6\,P_2^2 + 160\,P_2 + 1000$ Rs / hour $C_3 = 1.0\,P_3^2 + 100\,P_3 + 2000$ Rs / hour where P_1, P_2 and P_3 are the generating powers in MW. Maximum and minimum loads on each unit are 150 MW and 25 MW respectively. Obtain the economic dispatch when the total load is 270 MW. What will be the loss per hour if the units are operated with equal loading? (6 marks) **(OR)** (b) Consider a power system with two plants having incremental cost as $IC_1 = 1.0\,P_1 + 200$ Rs / MWh $IC_2 = 1.0\,P_2 + 150$ Rs / MWh Loss coefficient matrix is given by $B = \begin{bmatrix} 0.001 & -0.0005 \\ -0.0005 & 0.0024 \end{bmatrix}$ It is required to find the optimum scheduling for a system load of 100 MW. Taking the initial value of λ as 250 Rs./ MWh, obtain the schedule. Also calculate the schedule with the improved value of λ with 4 % change.	12	3	3
31.	(a) 1. Obtain the mathematical model of Newton OPF with equality and inequality constraints (6 marks) 2. Discuss the constraints on the Unit commitment problem. (6 marks) **(OR)** (b) (i) With the help of a flowchart explain the Lagrangian Relaxation method for unit commitment. (6 marks) (ii) Write a short note on the Gradient method of the OPF problem. (6 marks)	12	2	4

32. (a) Explain the hardware components and functional aspects of SCADA system using necessary block diagram. 12 2 6

(OR)

(b) (i) Explain the different operating states of the power system. (8 mark) 8 2 6
(ii) Discuss the integration issues of distributed generation with grid. (4 marks) 4 2 6

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