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Paper Code : EE-703A
POWER SYSTEM-III

Time Allotted : 3 Hours   Full Marks : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A
(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following :   10 × 1 = 10

i) The reactive power transfer over a line mainly depends on

   a) power angle

   b) sending end voltage (V_S)

   c) receiving end voltage (V_R)

   d) $| V_S | - | V_R |$.

ii) For economic measure in power system, the generators of a power plant should operate at

   a) equal loads

   b) minimum loads

   c) load proportional to the ratings

   d) equal incremental cost.

iii) A travelling wave 400 × 1 × 50 means crest value of

   a) 400 V with rise tune of 1/50 sec

   b) 400 kV with rise time 1 sec & fall time 50 sec

   c) 400 kV with rise time 1 μ sec & fall time for 1/2 the crest value 50 μ sec

   d) 400 MV with rise time 1 μ sec & fall time 50 μ sec.

iv) If penalty factor of a plant is unity, its incremental transmission loss is

   a) 1·0   b) – 1·0

   c) 0·0   d) 2·0.

v) When a DC source is switched on a purely inductive circuit, the circuit response is

   a) an exponentially rising curve

   b) an exponentially decaying curve

   c) a straight line passing through the origin

   d) a straight line off-set from the origin.

vi) Two neighbouring power system networks, having different frequencies, may be interconnected through

    a) 800 kV HVDC   b) 400 kV AC link

    c) 765 kV AC link   d) 1200 kV AC link.

vii) If α is the angle of voltage wave at which an R-L circuit is switched on and θ is the impedance angle of the R-L circuit, there will be no transient when the circuit is switched on, if

    a) $\alpha = 0$ b) $\alpha = 90° - \theta$

    c) $\alpha = 90° + \theta$ d) none of these.

viii) For a long uncompensated line, the limit to the line loading is governed by

    a) thermal limit   b) voltage drop

    c) stability limit   d) frequency limit.

ix) With the help of a reactive compensation, it is possible to have

    a) constant voltage operation only

    b) unity power factor operation only

    c) both constant voltage & unity power factor

    d) either constant voltage or unity power factor.

x) The unit of Lagrange multiplier 'λ' used in economic dispatch solution is

    a) Rs/hr   b) Rs/MW

    c) Rs/MWh   d) Rs/VAR.

xi) Steady state stability of the power system is improved by

    a) reducing fault clearing time

    b) using double circuit line instead of single circuit line

    c) single pole switching

    d) decreasing generation inertia.

xii) AVR loop is assigned to control

    a) terminal voltage of generator

    b) frequency

    c) reactive power

    d) real power output.

GROUP – B
(Short Answer Type Questions)
Answer any *three* of the following.   3 × 5 = 15

2. What do you mean by distributed & dispersed generation ? Explain with examples.

3. A 200 MVA synchronous generator operates on 80% loading condition with unity power factor load.

   The speed governor of the generator has a regulation of 4% & the no load operating frequency is 50 Hz. The load on the generator is suddenly reduced by 30 MW. Due to time lag in the governing system, the system valve begins to close after 0·5 sec. Determine the change in frequency during this time. Inertia constant of the generator is 50 MW-S/MVA.

4. Explain Bewley's Lattice diagram.

5. In a power system, the fuel input per hour of plant 1 & 2 are given as

$$F_1 = 0 \cdot 20\, P_1^2 + 30\, P_1 + 100 \text{ Rs./hour}$$

$$F_2 = 0 \cdot 25\, P_2^2 + 40\, P_2 + 80 \text{ Rs./hour}$$

The limits of generators are

$$20 \le P_1 \le 80\text{MW}$$

$$40 \le P_2 \le 200\text{MW}$$

Find the economic operating schedule of generation, if the load demand is 130 MW, neglecting transmission losses.

6. An industrial 3-phase bus draws power of (100 + j50) kVA. If the bus voltage is 400 V (L - L), find the compensator rating per phase. Also find the compensator susceptance.

GROUP – C
(Long Answer Type Questions)

Answer any *three* of the following.   3 × 15 = 45

7. a) Derive the condition for economic load dispatch of multi-generator system considering line losses.

   b) What is penalty factor ?

c) A two-bus system has load 400 MW at Unit-1 and 100 MW at Unit-2. The loss of the line connected between Unit-1 and Unit-2 is given by

$$P_L = 0.0008\,(P_{g1} - 100)^2.$$

The cost function of the two units are given as

$$F_{c1} = 500 + 4P_{g1} + 0.003P_{g1}^2 \text{ and}$$

$$F_{c2} = 600 + 4P_{g2} + 0.0035P_{g2}^2$$

Find optimal generation for each plant & total power loss in line.   6 + 2 + 7

8. a) What do you mean by ALFC ?

   b) Two generators rated 200MW and 400MW are operating in parallel. Their droop characteristics of their governors are 4% and 5% respectively from no load to full load. The speed changers are so set that the generators operate at 50 Hz sharing the full load of 600 MW in the ratio of their ratings. If the load reduces to 400 MW, how will it be share among the generators and what will the system frequency be ? Assume free governor operation.

   The speed changers of the governors are reset so that the 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 ?   2 + 13

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9. a) What is transients ? How transients are created in power system ?

   b) How the transients are classified ?

   c) Discuss in short the propagation of lightning currents & overvoltages along transmission lines.

   d) A rectangular surge wave of 100 kV is travelling over overhead line of surge impedance 400 ohms towards a *T*-junction comprising of overhead line of surge impedance of 350 ohms & an underground cable of surge impedance of 50 ohms. Find out the magnitudes of refracted voltage & current waves in the overhead line and underground cable.

                                                    3 + 1 + 4 + 7

10. a) What do you mean by FACTS ? What are its advantages ?

    b) Briefly describe different series & shunt connected FACTS controllers for power system.

    c) Explain how SVC controls the voltage of a power system bus to which it is connected.   2 + 2 + 6 + 5

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11. a) Explain briefly how a power system is protected against surges.

    b) For an isolated single area power system consider the following data : Area capacity = 1000 MW, Normal operating load = 500 MW, Inertia constant = 5 sec, Regulation = 5% = 2.5 Hz/pu MW, Normal frequency = 50 Hz. Load decreases by 1% for decrease in frequency by 1%.

       i) Find the gain and time constant of the power system representing with a first order transfer function.

       ii) If it is an uncontrolled area, find out the change in frequency due to an increase of load by 75 MW.   5 + 10

12. Write short note on any *three* of the following :   3 × 5

    a) Pumped storage plants

    b) Grid failure & network isolating

    c) Exciter & its role in AVR loop of the alternator

    d) Power factor correction.