

Name :

Roll No. :

Invigilator's Signature :

CS/B.Tech (EE-NEW)/SEM-7/EE-702/2010-11

2010-11

POWER SYSTEMS – 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 capacitance & inductance per unit length of a line
operating at 110 kV are 0.1 μ F & 2 mH. The surge
impedance loading of the line is

- | | |
|-----------|-------------------|
| a) 40 MVA | b) 30 MVA |
| c) 27 MVA | d) None of these. |

ii) A synchronous condenser is a/an

- a) d.c. generator
- b) induction motor
- c) overexcited synchronous motor
- d) underexcited synchronous motor.

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- iii) If P_m is the maximum power transferred, the loss of the system is

- a) $P_m/4$ b) $P_m/2$
c) $3P_m/4$ d) none of these.

- iv) TCSC is a

- a) shunt controller
- b) series controller
- c) combination of (a) & (b)
- d) none of these.

- v) **Series compensation in transmission lines**

- a) increases stability limit
- b) decreases stability limit
- c) has no effect on stability limit
- d) none of these.

- vi) The propagation constant is given by

- a) $\gamma = \sqrt{(Z/Y)}$ b) $\gamma = \sqrt{(ZY)}$
c) $\gamma = \sqrt{(Z+Y)}$ d) $\gamma = \sqrt{(Z-Y)}$.

- vii) A generating unit has an incremental production cost of Rs. 60 per MWh. If the penalty factor for this unit is 1.2, the incremental cost of power delivered is

- Rs. 50 per MWh
- Rs. 72 per MWh
- Rs. 61.20 per MWh
- Rs. 48 per MWh.

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- viii) An uncompensated transmission line on open circuit leads to
- a) Ferranti effect
 - b) Line-charging current flowing into generators is more
 - c) Both (a) & (b)
 - d) None of these.
- ix) In a two plant system, the load is connected to plant no. 2. The loss coefficients
- a) B_{11}, B_{12}, B_{22} are non-zero
 - b) B_{11} is non-zero but B_{12} and B_{22} are zero
 - c) B_{11} and B_{12} are non-zero but B_{22} is zero
 - d) B_{11} and B_{22} are non-zero but B_{12} is zero.
- x) Load compensation is used to improve
- a) voltage profile and power factor
 - b) voltage profile and reactive power
 - c) reactive power and power factor
 - d) none of these.
- xi) Lightning arrester should be located
- a) near the circuit breaker
 - b) away from the circuit breaker
 - c) near the transformer
 - d) away from the transformer.

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- xii) Steady state stability of the power system is improved by
- a) reducing fault clearing time
 - b) using double circuit line instead of single circuited line
 - c) single pole switching
 - d) decreasing generation inertia.

GROUP - B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. Explain reflection coefficient, surge impedance and surge impedance loading.
3. Explain why series compensation leads to improvement in system stability. Compare the performances of series and shunt capacitors in a power system.
4. a) What do you mean by a $1.2/50 \mu s$ lightning surge ? 2
b) How is the rating of surge arrester determined for each phase in a 3-phase 220 V kV system ? 3
5. How do you model the tie-line power flow in a two area system using analytical technique ?
6. Explain the phenomena of lightning and the travelling waves caused by it on transmission lines.

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GROUP - C**(Long Answer Type Questions)**Answer any *three* of the following. $3 \times 15 = 45$

7. a) Describe the solution methodology of economic load despatch with transmission loss. What are penalty factor and incremental transmission loss ? 8
- b) Determine economic operating point for the following three units when delivering a load of 850 MW : 7

Unit 1 : Coal fired steam unit :

$$P_{1\max} = 600 \text{ MW}, P_{1\min} = 150 \text{ MW}$$

Input-output curve :

$$H_1 = 510 + 7 \cdot 2 P_1 + 0 \cdot 00142 P_1^2 \text{ MBtu/hr}$$

Unit 2 : Oil fired steam unit :

$$P_{2\max} = 400 \text{ MW}, P_{2\min} = 100 \text{ MW}$$

Input-output curve :

$$H_2 = 310 + 7 \cdot 85 P_2 + 0 \cdot 00194 P_2^2 \text{ MBtu/hr}$$

Unit 3 : Oil fired steam unit :

$$P_{3\max} = 200 \text{ MW}, P_{3\min} = 50 \text{ MW}$$

Input-output curve :

$$H_3 = 78 + 7 \cdot 97 P_3 + 0 \cdot 00482 P_3^2 \text{ MBtu/hr}$$

Cost of coal : 1.1 \$/MBtu

Cost of oil : 1.0 \$/MBtu

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8. a) What is basic impulse level ? Derive the expression for reflection and refraction co-efficients for voltage and current travelling waves. 8

b) The line is open circuited with a receiving end voltage of 220 kV. Find the rms value and phase angle of the following :

i) The incident and reflected voltages to neutral at the receiving end.

ii) The incident and reflected voltages to neutral at 200 km from the receiving end.

$$\alpha = 0.163 \times 10^{-3}, \beta = 1.068 \times 10^{-3} \quad 7$$

9. a) What is the significance of reactive power in power system ? Prove that voltage regulation in a transmission line mainly depends on reactive power. 2 + 5

b) An inductive load draws power of $(2 + j1)$ MVA at a receiving end bus of a radial three phase line. The receiving end bus voltage is 11 kV at 50 Hz and the system reactance is $0.5 \Omega/\text{phase}$. Calculate

i) the receiving end current

ii) voltage regulation

iii) the sending end voltage and

iv) the short capacity of the system.

Assume the system to be lossless.

8

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10. What is FACTS ? What are FACTS controllers ? Classify the FACTS controllers. What is STATCOM ? Why is STATCOM used in load flow ? 3 + 3 + 3 + 3 + 3

11. Write short notes on any *three* of the following : 3 × 5

- a) Spinning reserve
 - b) Exciter and its role in AVR loop of the alternator
 - c) Bewly's Lattice diagram
 - d) Gapless surge arrester
 - e) Hydrothermal scheduling.
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