

**POWER SYSTEM - I  
(ELEC 3102)**

**Time Allotted : 3 hrs**

**Full Marks : 70**

*Figures out of the right margin indicate full marks.*

*Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.*

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

**Group – A  
(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) The presence of earth in case of overhead lines  
(a) increases the capacitance (b) increases the inductance  
(c) decreases the capacitance (d) decreases the inductance.
- (ii) The insulation resistance of a 2 km long cable is 200 MΩ. For a length 20 km, the insulation resistance will be  
(a) 20 MΩ (b) 400 MΩ  
(c) 2000 MΩ (d) 5MΩ.
- (iii) In a long transmission line, the propagation constant is  
(a)  $\sqrt{(z + y)}$  (b)  $z/y$   
(c)  $\sqrt{z/y}$  (d)  $\sqrt{zy}$
- (iv) ACSR conductor consists of a central core of  
(a) copper (b) steel  
(c) stainless steel (d) cadmium.
- (v) Which of the following protects a cable against mechanical injury  
(a) bedding (b) sheath  
(c) armouring (d) paper.
- (vi) Pulverised coal is  
(a) non-smoking coal (b) coal free from ash  
(c) coal which burns for long time (d) coal broken in fine particles.
- (vii) Distributor are designed from the point of view of  
(a) current carrying capacity (b) voltage drop in it  
(c) operating voltage (d) operating frequency.

- (viii) Which type of insulator are used on 400 kV transmission lines?  
(a) Pin type (b) Disc type  
(c) Shackle type (d) both Pin and Shackle type.
- (ix) If number of insulator disc is increased in a string of a system, string efficiency would be  
(a) increased (b) decreased  
(c) infinity (d) zero.
- (x) AC resistance of a conductor is more than DC resistance due to  
(a) corona effect (b) spirality effect  
(c) skin effect (d) proximity effect.

### **Group – B**

2. (a) What are the advantages of hydroelectric power plants?  
(b) Name any one materials used for moderator in nuclear power station.  
(c) Explain the working principle of nuclear reactor with appropriate diagram.  
(d) A thermal power station consumes 10 kg of coal to generate one unit of electrical energy. If the calorific value of the fuel is 6400 kilocalories per kg, find the thermal efficiency of the station.

**3 + 1 + 5 + 3 = 12**

3. (a) Write a short notes on the following :  
(i) Power factor tariff and  
(ii) Three-part tariff.
- (b) The following rates are offered to a consumer:  
(i) Rs. 300 plus Rs. 1.34 per kWh;  
(ii) A flat rate of Rs. 1.64 per kWh.  
Find the number of units consumed for which the first tariff is more economical?

**6 + 6 = 12**

### **Group – C**

4. (a) A transmission line conductor at a river crossing is supported from two towers at heights of 60 meters and 95 meters above water level. The horizontal distance between the towers is 340 meters. If the tension in the conductor is 2100 kg, Calculate the clearance between the conductor and water level at a point midway between the towers. Weight of the conductor per metre is 0.9 kg. Assume that the conductor takes the shape of parabolic curve.
- (b) Prove with an example how string efficiency improves in presence of the guard ring.

**6 + 6 = 12**

5. (a) Derive expressions for line-to-line capacitance and line-to-neutral capacitance of a single-phase line.
- (b) Determine the inductance per km per phase of a single circuit 460 kV line using two bundle conductors per phase as shown in the Figure-1. The diameter of each conductor is 5 cm.

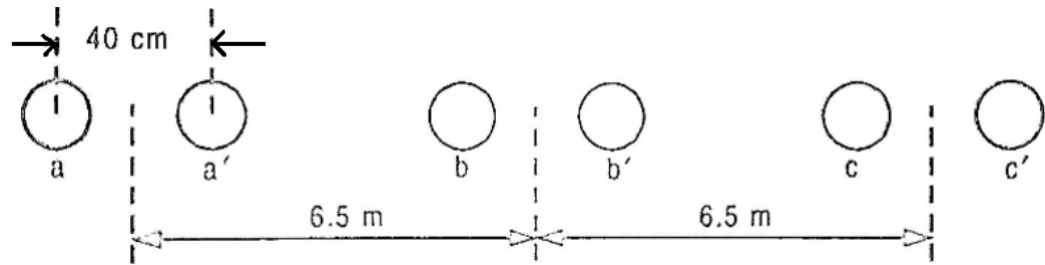


Figure-1

6 + 6 = 12

### Group - D

6. (a) What do you mean by Ferranti effect? Explain with proper phasor diagram.
- (b) A 50 Hz, 3-phase transmission line is 250 km long. It has a total series impedance of  $(35+j140) \Omega$ /phase and shunt admittance of  $j930 \times 10^{-6} \text{ U/phase}$  (as shown in Figure-2). It delivers 50 MW power at 220 kV with 0.9 power factor (lagging). Using Nominal- $\pi$  method determine
- Sending end voltage
  - Sending end current
  - Transmission efficiency.

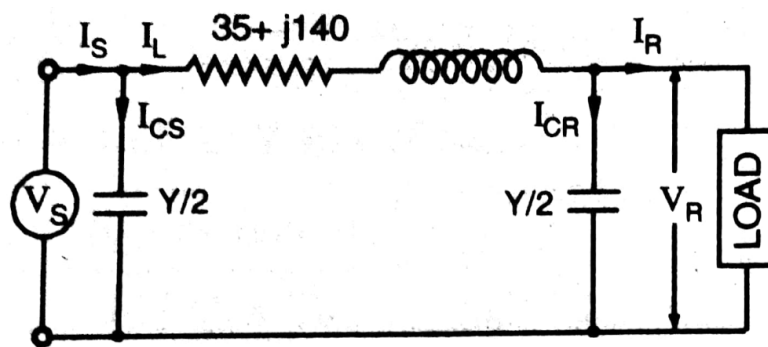


Figure-2

(2 + 4) + 6 = 12

7. (a) What are the factors affecting corona loss?
- (b) Calculate the corona loss for stormy weather conditions of 220 kV, 50 Hz, 3-phase transmission line, 175 km long consisting of three 1.2 cm diameters stranded copper conductors spaced in 3 metre delta arrangement. Consider temperature 26 °C and barometric pressure is 74 cm,  $m_0=0.85$ , dielectric strength of air is 30 kV (peak).

5 + 7 = 12

**Group – E**

8. (a) Derive an expression for dielectric stress of a single core cable. Where the stress is maximum? Where the stress is minimum and why?
- (b) A single core cable 2 km long has core diameter of 2 cm and the diameter of inside sheath is 5 cm. The relative permittivity of insulating material is 4. The power factor of the circuit is 0.07 and the supply voltage is 33 kV, three phase, 50 Hz. Determine (i) the capacitance of the cable, (ii) the charging current per conductor and (iii) Dielectric loss.

**6 + 6 = 12**

9. (a) A dc two line distributor AB, 600 meters in length is fed at 440 V from substation A and at 430 V from substation B, the loads are :
- 100 amp at C, 150 metres from A
  - 200 amp at D, 150 metres from C
  - 250 amp at E, 50 metres from D
  - 300 amp at F, 100 metres from E

If the resistance of each conductor is  $0.01 \Omega$ , per 100 meters, calculate the current supplied from substation A and B and voltage across each load.

- (b) What are the methods of power factor improvement? Explain any one method.

**6 + 2 + 4 = 12**

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