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
<u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> 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)   Which type of insulators is used on 11 kV transmission lines?
   (a) Pin type   (b) Suspension type
   (c) Strain type   (d) Both Suspension and Strain type.

   (ii)   When bundled conductors are used in place of single conductors, the effective inductance and capacitance will respectively
   (a) increase and decrease   (b) decrease and increase
   (c) decrease and remain unaffected   (d) remain unaffected and increase.

   (iii) Stringing chart is useful for
   (a) finding the sag in the conductor   (b) in the design of insulator string
   (c) in the design of tower   (d) finding the distance between the tower.

   (iv)   In a cable immediately above metallic sheath is provided
   (a) Armouring   (b) Earthing Connection
   (c) Bedding   (d) None of the above.

   (v)   Transposition of the transmission line is done to
   (a) reduce line loss   (b) reduce skin effect
   (c) balance line voltage drop   (d) reduce corona.

   (vi)   When a conductor carries more alternating current on the surface as compared to its core, this phenomenon is known as
   (a) Proximity effect   (b) Skin effect
   (c) Ferranti effect   (d) Corona effect.

   (vii) 100 % string efficiency means
   (a) zero potential across each insulator disc
   (b) equal potential across each insulator disc
   (c) one of the insulator disc shorted
   (d) infinite potential across each insulator disc.

(viii) If an ACSR conductor has specification 30/7, it means that it has _____ numbers of aluminium strands and _____ numbers of steel strands.
(a) 7, 30   (b) 6, 37   (c) 30, 7   (d) 37, 6

(ix) In cables, the charging current
(a) lags the voltage by 90°   (b) lags the voltage by 180°
(c) leads the voltage by 90°   (d) leads the voltage by 180°

(x)   A conductor with 19 strands, each of same diameter and each having an inductance of L Henry is used for a transmission line. The total inductance of the conductor will be
(a) L/19   (b) L/361   (c) 19L   (d) 38L

Group- B

2. (a) Sketch a diagram of nuclear reactor and explain the working principle.
                                                        [(CO1)(Apply/IOCQ)]
   (b) Compare nuclear, hydroelectric and coal-fired power stations in context of three different issues.   [(CO1)(Analyze/IOCQ)]
   (c) Why is a surge tank provided in a hydroelectric power station?
                                                     [(CO1)(Remember/LOCQ)]
                                                            5 + 6 + 1 = 12

3. (a) Classify the essential factors which influence the selection of sites for hydroelectric power plants.   [(CO1)(Analyze/IOCQ)]
   (b) A steam power plant spends Rs. 90 lacs per annum for coal used in the plant. The coal has a calorific value of 4700 kcal/kg and costs Rs. 6000 per ton. Overall efficiency of the plant is 30%. Determine the average load of the plant. [(CO1)(Evaluating/HOCQ)]
   (c) (i)   What is the load factor?
        (ii) What is two-part tariff?   [(CO1)(Understanding/LOCQ)]
                                                        4 + 4 + (2 + 2) = 12

Group – C

4. (a) Assume an overhead transmission line has a span of 265 meters between the level supports. With the following data, calculate maximum slant sag and maximum vertical sag. Effective diameter of the conductor = 1.6 cm, weight of the conductor = 1 kg/m run, ultimate strength = 7800 kg, radial thickness of ice coating on the conductor = 1.4 cm, wind pressure = 36 kg/m² of projected area, factor of safety = 3 and density of ice = 913 kg/m³.   [(CO2)(Analyze/IOCQ)]
   (b) In a 5 insulator disc string, capacitance between pin and earth is ⅙ᵗʰ of the capacitance of each unit. (i) Determine the voltage distribution across each insulator in the string as percentage of voltage of the conductor to earth. (ii) Determine the operating voltage of the line, if each insulator in the string is designed to withstand 20 kV maximum (peak).   [(CO2)(Evaluating/HOCQ)]
                                                            6 + 6 = 12

5. (a) What is the method of images? Derive an expression for the capacitance per unit length of a single phase transmission line. What is the effect of earth on the capacitance of the line? [(CO2)(Understand/LOCQ)]

(b) The arrangement of conductors of a single-phase transmission line is shown in Fig.1. The forward circuit is composed of three solid wires of radius 2.4 mm and the return circuit is composed of two wires of radius 4.8 mm placed symmetrically with respect to the forward circuit. Determine the inductance of each side of the line and that of the complete line.
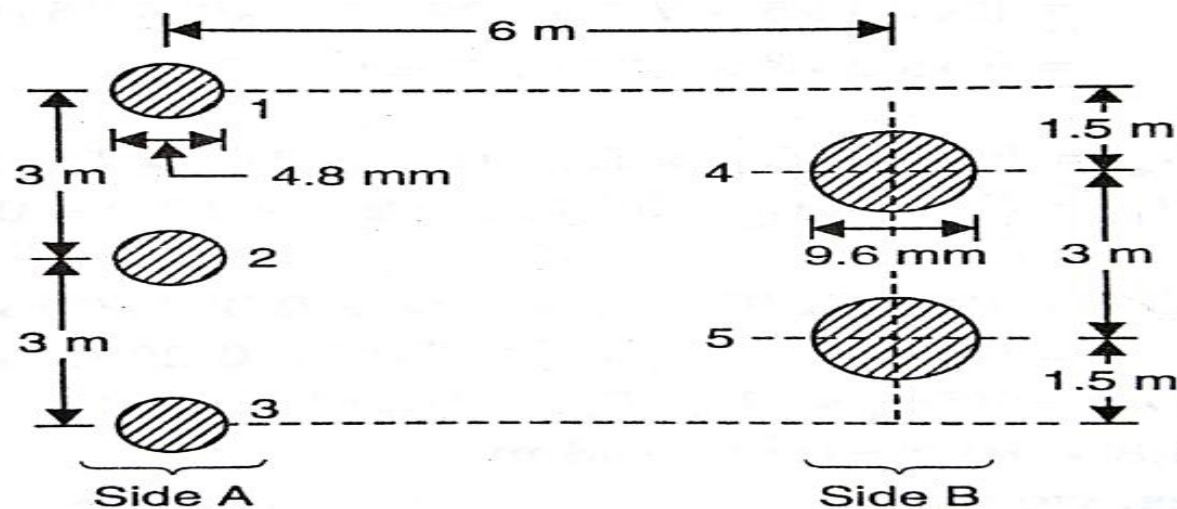

Fig.1

[(CO2)(Evaluate/HOCQ)]
(2 + 3 + 1) + 6 = 12

Group - D

6. (a) What is meant by Surge Impedance Loading? Explain. [(CO3)(Remember/LOCQ)]

(b) A balanced three-phase load of 30 MW is supplied at 132 kV, 50 Hz and 0.9 lagging p.f. The series impedance of a conductor is $(20 + j40)$ Ω and the total phase-neutral admittance is 315×10^{-6} ℧. Use nominal-π method to identify (i) A, B, C, D constant, (ii) sending end voltage, (iii) sending end current, (iv) voltage regulation, (v) transmission efficiency and (vi) sending end power factor.

[(CO3)(Apply/IOCQ)]
3 + 9 = 12

7. (a) A certain 3-phase equilateral transmission line has a total corona loss of 55 kW at 111 kV and a loss of 96 kW at120 kV. Inspect and calculate the value of disruptive critical voltage and also corona loss at 113 kV. [(CO3)(Analyze/IOCQ)]

(b) Classify the factors affecting the corona loss. [(CO3)(Analyze/IOCQ)]

(c) Categorize the disadvantages of corona? [(CO3)(Analyze/IOCQ)]
5 + 2 + 5 = 12

Group - E

8. (a) Describe general construction of a single core cable. What are the necessary requirements of a cable? [(CO4)(Remember/LOCQ)]

(b) A single-core cable used on 33 kV, 50 Hz has a conductor diameter 10 mm and inner diameter of sheath 25 mm. The relative permittivity of insulating material used is 4. Solve to find out
(i) capacitance of the cable per km,

      (ii)   maximum electrostatic stress in the cable,

      (iii) charging current per km.   [(CO4)(Applying/IOCQ)]

                                                        (4 + 2) + 6 = 12

9. (a) An electric train, taking a constant current of 550 amps, moves on a section of line between two substations 8.5 km apart and maintained at 570 and 600 volts respectively. The track resistance is 0.045 ohms per km both go and return. Identify the point of minimum potential along the track and currents supplied by two substations at that instant.   [(CO4)(Applying/IOCQ)]

    (b) What are the disadvantages of low power factor?   [(CO4)(Remember/LOCQ)]

                                                        6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	27.08	56.25	16.66

Course Outcome (CO):

After the completion of the course students will be able to

1. To demonstrate the basic structure of power system, various methods of conventional power generation and tariff.
2. To explain the mechanical design and the electrical design of power transmission system.
3. To analyze the performance of different type of transmission lines.
4. To learn about the underground cables, different type of distribution systems and power factor correction techniques.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question