Code : 103306

2013 (A)

POWER SYSTEM

Time : 3 hours *Full Marks* : 70

Instructions :

(i) ***ALL*** *questions carry equal marks.*

(ii) There are ***TEN*** *questions in this paper.*

(iii) Attempt any ***FIVE*** *questions.*

1. *(a)* A three-phase line with equilateral spacing of 3 m is to be rebuilt with horizontal spacing ($D_{13} = 2D_{12} = 2D_{23}$). The conductors are to be fully transposed. Find the spacing between adjacent conductors such that the new line has same inductance as the original line.

   (b) Find the capacitance of phase to neutral per kilometre of a 3-phase line having conductors of 2 cm diameter placed at the corners of a triangle with sides 5 m, 6 m and 7 m respectively. Assume that the line is fully transposed and carries balanced load

2. *(a)* What do you mean by 'natural loading' of lines?

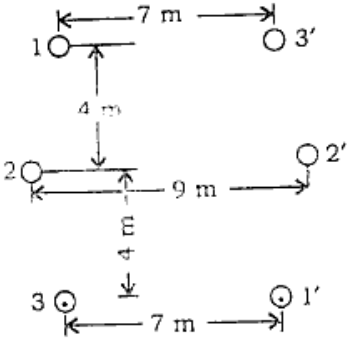
   (b) Differentiate between a 'nominal-T' and an 'equivalent-T' representations of a transmission line.

   (c) Explain the utility of 'vibration dampers' for the transmission lines.

   (d) Why is the charging current more in cables than in transmission lines?

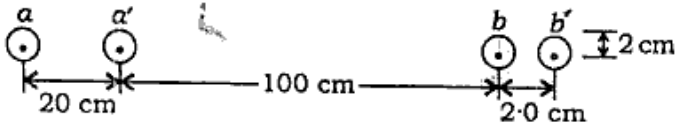
   (e) How is a sag-template useful for location of towers and stringing of power conductors?

3. *(a)* The six conductors of a double-circuit, 3-phase line are arranged as shown in the figure below. The diameter of each conductor is 2·5 cm. Find the capacitative reactance to neutral and the charging current per km per phase at 132 kV and 50 Hz assuming that the line is transposed : 5



   (b) Explain briefly the 'Ferranti effect' with phasor diagram.

4. *(a)* Calculate the total inductance of line per km, assuming that current is equally shared by the two parallel conductors of a single-phase line as shown in the figure below. The conductors a and a' in parallel form one conductor while conductors b and b' parallel form return path :



(b) Describe with a neat sketch, the construction of a 3-core belted-type cable. Discuss the limitations of such a cable.

5. *(a)* Determine the voltage across each disc of suspension insulators as a percentage of the line voltage to earth. The self and capacitative to ground of each disc is 1·0 C and 0·2 C respectively. The capacitance between the link pin and the guard ring is 0·3 C. Also determine the string efficiency.

(b) Explain the classification of lines based on their transmission. Also draw neatly the phasor diagram for nominal-π representation of lines.

6. A 132 kV, 3-ϕ, 50 Hz transmission line 200 km long has the following distributed parameters :

$l = 1{\cdot}3 \times 10^{-3}$ H/km; $C = 9 \times 10^{-9}$ F/km;
$r = 0{\cdot}2\ \Omega$/km; $g = 0$

Find the sending-end voltage, current, power factor and efficiency when delivering 50 MVA at 0·8 p.f. lagging.

7. *(a)* An electric train taking a constant current of 600 amp moves on a section of line between two substations 8 km apart and maintained at 575 volt and 590 volt respectively. The track resistance is 0·04 ohm per km both 'go' and 'return'. Find the point of minimum potential along the track and currents supplied by two substations at that instant.

(b) Distinguish among a feeder, distributor and service main in a distribution scheme.

8. *(a)* An overhead line has the following data :

Span length = 160 metre; conductor diameter = 0·95 cm, weight per unit length of the conductor = 0·65 kg per metre; ultimate stress = 4250 kg/cm^2; wind pressure = 40 kg/cm^2 of projected area; factor of safety = 5

Calculate the sag.

(b) Explain briefly the 'inter-sheath grading method' of insulated cable.

9. Derive the expression for the capacitance of a 3-core cable.

10. Write short notes on any *four* of the following :

(a) Radial main distributors

(b) Ring main distributors

(c) Proximity effect

(d) Skin effect

(e) Arcing horn

(f) Shunt compensation

* * *