ELECTRICAL POWER SYSTEM – I
(EE–502)

Time: 3 hours   Full Marks: 70

Use separate answer script for each half.
Answer SIX questions, taking THREE from each half.
Two marks are reserved for neatness in each half.

FIRST HALF

1.(a) Derive an expression for inductance in H/m/ph of a parallel circuit 3−ϕ transposed line.

 (b) In such a line, the phases $a-a'$, $b-b'$ and $c-c'$ are arranged as shown in Figure 1. Calculate the inductance in mH/km/phase with the given distances. Assume that the conductor radius is 7 mm.   [7+4]
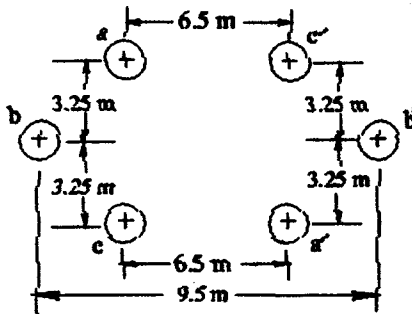

Figure 1: Problem 1(b)

2.(a) Deduce an expression for inductance of a 1−ϕ transmission line which transmits power via composite conductors.

 (b) Calculate the GMR of seven identical strand conventional conductor each having radius 8 mm.   (7+4)

3.(a) Derive an expression for capacitance to neutral of a 3−ϕ transposed line with unsymmetrical spacing. Neglect the effect of earth.

 (b) (i) State the advantages of using bundle conductor in power transmission. (ii) "Charging current is independent of line loading" — Explain.   (7+(2+2))

4.(a) Deriving power flow equations, show that active power flow is strongly dependent on bus voltage angle and reactive power flow is strongly dependent on bus voltage magnitude.

 (b) (i) How could you choose base values of 1−ϕ transformer for pu method of computation? (ii) Distinguish between pu method and percentage method of computation.   (7+(2+2))

5. Write notes on the following: (4+3+2+2)

   (a) Skin effect and proximity effect
   (b) Methods of neutral grounding
   (c) Spinning reserve of a generating station
   (d) Arcing ground

6. (a) What are the basic tests to be carried out on insulators?   5

(b) In a 5 insulator disc string capacitance between each unit and earth is 1/6 th of the mutual capacitance. Find the voltage distribution across each insulator in the string as percentage of voltage of the conductor to earth. Find string efficiency. Will this efficiency increase in rainy weather?   6

7. (a) A graded cable has permittivity ε_1 and ε_2. The dielectric with permittivity ε_2 is nearer to the conductor. If R_1 be the external radius, R_2 be the radius of the cable with dielectric ε_2 and R_3 be the radius of the conductor section then obtain the condition under which maximum values of the dielectric field in the two regions of dielectric are equal.   5

(b) Obtain an expression of power factor of cable.   3

(c) What are the criteria for selection of HT cables?   3

8. (a) Show that for nominal T and Π representation for a medium transmission line,
    AD-BC = 1.   4

(b) What is loadability of transmission line? Explain analytically.   4

(c) What is Ferranti effect? How does it compensated?   3

9. (a) A overhead line has cross sectional area of 2.5 sq.cm. The weight of the conductor is 1.8kg/m. Allowable maximum tension is 6666.67kg. This conductor is suspended between two vertical supports of transmission line at same level. The horizontal wind force is 0.712kg/m. Find the vertical sag of the conductor for a span of 250m. No formula is to be derived.   6

(b) What is lightning? Describe its mechanism of action. State the measures usually adopted to protect transmission lines and high voltage electrical equipments from indirect lightning.   5

10. (a) Briefly state the process of hydraulic electric power generation in a dam. Explain the usage of penstock, forebay and surge tank.   6

(b) A medium voltage short transmission line has per phase impedance of (0.2+ j0.6) ohm. If the receiving end voltage is 6351V/phase and the voltage regulation is not to be exceeded by 7.5%, calculate the maximum real power that can be transmitted through the line. Also calculate the receiving end power factor and total line loss when the line is transferring maximum power.