

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) (i) Derive an expression for inductance of a $1-\phi$ composite conductor system knowing the flux linkages of a subconductor in a group. (ii) What are GMD and GMR?
- (b) Find the GMR for the calculation of inductance of the conductor arrangement shown in figure 1 in terms of radius r of an individual strand. ((5+2)+4)

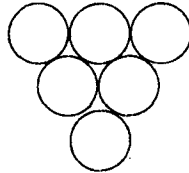


Figure 1: Problem 1(b)

- 2.(a) Derive an expression for capacitance per phase of a two-bundle, unsymmetrical, $3-\phi$ transposed transmission line. Neglect the effect of earth.
- (b) Determine the capacitance in $\mu\text{F}/\text{km}/\text{ph}$ of a $3-\phi$ circuit using two-bundle conductors per phase as shown in Figure 2. The diameter of each conductor is 5.0 cm and the system is transposed on horizontal configuration with $d = 40\text{ cm}$ and $D = 6.5\text{ m}$. Neglect the effect of earth. (7+4)

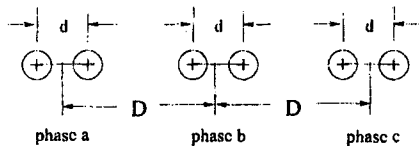


Figure 2: Problem 1(b)

- 3.(a) What are the advantages of per unit method of computation?
- (b) How could you choose base values of a $3-\phi$ transformer for computation of per unit values?

(c) Three 1- ϕ transformers each rated 25MVA, 38.1/3.81KV connected in $\Delta - \Delta$ for 3- ϕ system to supply a star connected resistive load of 0.6Ω per phase. Choose proper bases to show that the pu load resistance is same whether referred to HT or LT. (3+2+6)

4.(a) Why the neutral of a power system be grounded?

(b) Name the methods of neutral grounding.

(c) With necessary diagrams explain the use of zig-zag grounding transformer in power system. (2+3+6)

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

(a) Interconnected power system

(b) P- δ and Q V coupling

(c) Charging current in transmission system

SECOND HALF

6. Justify the function of the following equipments:

- i) Coal pulverizing unit in thermal power station
- ii) Multiple boiler feed pumps in steam generating unit of a thermal station
- iii) Surge tank in a hydel unit
- iv) Trash rack in a hydel station
- v) Moderator in a nuclear reactor. [3 + 2 X 4]

7 a) Find an expression of power factor of power cables.

b) A cable has intersheath grading that satisfies the relation $(R_1/R_2) = (R_2/R_3) = \alpha$. The cable radii are $R_3 = 1.00\text{cm}$; $R_1 = 2.50\text{cm}$. Determine the location of the intersheath and calculate the ratio of maximum electric field strengths with and without intersheath. No derivation of any formulae is required. [4+7]

8a. An overhead line conductor has cross sectional area of 2.5 sqcm. 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.

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. [6+5]

9. a) Show that for a short transmission line,

$$|A| = 1; |B| = |Z|; |C| = 0 \text{ and } |D| = 1$$

b) A three phase 66KV (L-L) 50 Hz transmission line is 120 km long. The primary parameters are:

Resistance /km = $0.1\Omega/\text{ph}$, Inductive reactance /km = $0.3\Omega/\text{ph}$, Capacitive susceptance /km = $0.04 \times 10^{-4} \text{ s/ph}$

The load at the receiving end is 10MW at 66KV, 0.8 p.f. (lag). Find sending end voltage, current and transmission efficiency. Use nominal T-method. [4+7]

10. a) Obtain the expression of real and reactive power at the receiving end of a two bus power line in terms of generalized ABCD parameters and modify these expressions for short line with resistance assumed in the line in addition to line reactance as well as for a medium long line with shunt susceptance assumed to be present.

b) What is surge impedance of a power line? Find an expression for it. What is the surge impedance line loading for a 400KV, 50 Hz 3-phase line having surge impedance of 400 ohms per phase? [7+4]