Code : 031404

B.Tech. 4th Semester Exam., 2014

POWER SYSTEM—I

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

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

*(iii) Attempt **FIVE** questions in all.*

*(iv) Question No. **1** is compulsory.*

1. Choose the correct answer on any *seven* from the following : 2×7=14

(a) The electric power can be transmitted by

(i) overhead system

(ii) underground system

(iii) either *(i)* or *(ii)*

(iv) None of the above

(b) In a transmission system, the weight of copper used is proportional to

(i) E^2

(ii) E

(iii) $\frac{1}{E^2}$

(iv) $\frac{1}{E}$

(c) ACSR conductors have

(i) all conductors made of aluminium

(ii) outer conductors made of aluminium

(iii) inner conductors made of aluminium

(iv) no conductors made of aluminium

(d) Stranded conductors usually have a central wire around which there are successive layers of 6, 12, 18, 24 wires. For n-layers, the total number of individual wires is

(i) $3n(n+1)$

(ii) $2n(n+1)$

(iii) $3n(n+1)+1$

(iv) $2n(n+1)+1$

(e) The inductance of 1-ϕ, two-wire power transmission line per km gets doubled when the

(i) distance between the wires is doubled

(ii) distance between the wires is increased four-fold

(iii) distance between the wires is increased as square of the original distance

(iv) radius of the wire is doubled

(f) 120 km long transmission line is considered as a

(i) short line

(ii) median line

(iii) long line

(iv) either (i) or (ii)

(g) Percentage regulation of a transmission line is given by the expression

(i) $\frac{V_R - V_S}{V_R} \times 100$

(ii) $\frac{V_R - V_S}{V_S} \times 100$

(iii) $\frac{V_S - V_R}{V_R} \times 100$

(iv) $\frac{V_S - V_R}{V_S} \times 100$

(h) Sheaths are used in cables to

(i) provide proper insulation

(ii) provide mechanical strength

(iii) prevent ingress of moisture

(iv) None of the above

(i) The charging current drawn by the cable

(i) lags behind the voltage by 90°

(ii) leads the voltage by 90°

(iii) leads the voltage by 180°

(iv) None of the above

(j) Transmission line constants are

(i) resistance

(ii) inductance

(iii) capacitance

(iv) All of the above

2. (a) Derive the Kelvin's law for most economical size of conductor 6

(b) The cost per km for each of the copper conductor of a section a sq. cm for a transmission line is ₹ $(2,800a + 1,300)$. The load factor of the load current is 80% and the load factor for the losses is 65%. The rate of interest and depreciation is 10% and the cost of energy is 5 paisa per kW-h. Find the most economical current density for the transmission line by the use of Kelvin's law. Given $\rho = 1 \cdot 78 \times 10^{-8}\ \Omega - m$.

3. The following data refers to a 50 Hz, 1 – ϕ transmission line :

Length = 20 km

Load delivered at receiving end = 5 MW at 0·8 Pf (lag)

Resistance of each conductor = 0·02 Ω/km

Inductance of conductor = 0·65 mH/km

The voltage at the receiving end is required to be kept at 10 kV.

Find—

(a) sending end voltage and voltage regulation of the line;

(b) the value of capacitors to be placed in parallel with the load such that regulation is reduced to 50% of that obtained in (a).

Compare the transmission efficiencies in parts (a) and (b). 14

4. (a) Prove that the vol. gradient at surface of conductor in the cable will be minimum when $\frac{R}{r} = e$; where r is the radius of conductor and R is the inner radius of sheath. 7

(b) Enumerate the different types of losses in a cable. Also, derive the expression for dielectric loss. 7

5. A single-core lead covered cable is to be designed for 66 kV to earth. Its conductor radius is 0·5 cm and its three insulating materials A, B and C have relative permittivities 4, 2·5 and 4 with maximum permissible stresses of 50, 30 and 40 kV/cm respectively. Determine the minimum internal diameter of lead sheath. Discuss the arrangement of insulating materials. 14

6. Derive the expression for tension and sag in conductors if supports of equal height are used. 14

7. A transmission line conductor consists of hard drawn copper conductor 120 mm^2 cross-section, the conductor used is 37/2·11 mm having weight of 1118 kg/km and has a span of 200 meters. The supporting structures being level. The conductor has an ultimate tensile stress of 42·2 kg/mm^2 and allowable tension is not to exceed 1/4th of ultimate strength. Find—

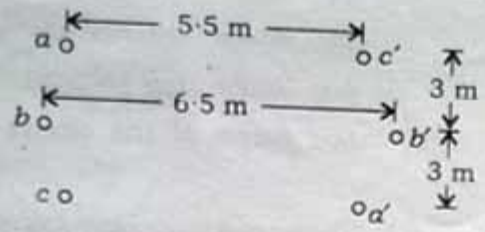
(a) sag in still air;

(b) sag with wind pressure of 60 kg/m^2;

(c) sag with the wind pressure in part b and an ice coating of 10 mm.

Also, find the vertical sag under this condition. Assume density of ice as 0·915 gm/cc. 14

8. Determine the inductance of the double circuit line shown in figure below. The self GMD of the conductor is 0·0069 meter : 14



9. Prove that the capacitance of a 3-ϕ unsymmetrically spaced transposed transmission line is given by

$$C = \frac{2\pi\varepsilon_0}{\ln \frac{\sqrt[3]{abc}}{r}} \text{ F / meter}$$

where a, b, c are the spacing between the conductors of different phases and r is radius of conductor. 14

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