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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 (any *seven*) :　2×7=14

   (a) In India, high-voltage transmission is mostly by

   (i) overhead system

   (ii) underground system

   (iii) Both (i) and (ii)

   (iv) None of the above

   (b) The volume of copper required for an a.c. transmission line is inversely proportional to

   (i) current

   (ii) voltage

   (iii) p.f.

   (iv) Both (ii) and (iii)

(2)

   (c) The function of steel wire in an ACSR conductor is to

   (i) compensate for skin effect

   (ii) take care of surges

   (iii) provide additional mechanical strength

   (iv) reduce inductance

   (d) In transmission line, sag depends upon

   (i) span length

   (ii) tension in conductor

   (iii) weight of conductor per unit length

   (iv) All of the above

   (e) The diameter of each strand is d, then the diameter of n-layer stranded conductor will be

   (i) $(2n+1)d$

   (ii) $3(n+1)d$

   (iii) $(2n-1)d$

   (iv) $3(n-1)d$

   (f) The ratio of line-to-line capacitance and line-to-neutral capacitance is

   (i) 1/2

   (ii) 1/4

   (iii) 2

   (iv) 4

(g) A 25 km 33 kV transmission line is considered to be

  (i) short transmission line

  (ii) medium transmission line

  (iii) long transmission line

  (iv) high power line

(h) Which of the following regulations is considered best?

  (i) 21/2%

  (ii) 15%

  (iii) 25%

  (iv) 40%

(i) The material commonly used for sheaths of underground cable is

  (i) copper

  (ii) lead

  (iii) steel

  (iv) rubber

(j) The dielectric stress in a cable is maximum at

  (i) conductor surface

  (ii) bedding

  (iii) lead sheath

  (iv) armour

2. (a) Explain in detail the factors on which transmission line voltage is chosen. 4

   (b) The daily load cycle of a 3-ϕ, 110 kV transmission line can be approximated as follows :

   (i) 24 mW for 6 hours

   (ii) 8 mW for 6 hours

   (iii) 4 mW for 12 hours

   The load p.f. is 0·8 lagging.

   Determine the most economical cross-section, if the cost of line including erection is Rs (12000+8000a) per km, where a is the cross-section of each conductor in sq. cm. The line is in use throughout the year. The resistance per km of each conductor is $\frac{0.19}{a}$ ohm. Energy costs 8 paisa per unit. Assume any additional data, if required. 10

3. The following data refers to a 1-ϕ short line operating at 50 Hz with the following conditions :

   Line length = 10 km

   Line impedance = $0.5\angle 60°\,\Omega$/km

   Load side power = 316·8 kW

   Load side p.f. = 0·8(lag)

   Load bus voltage = 3·3 kV

   Find % voltage regulation and sending-end voltage, line loss and sending-end p.f. 14

4. A 3-ϕ, 3-core metal sheathed cable gave the following results on test for capacitance :

   (i) Capacitance between two conductors bunched with the sheath and the third conductor 0·4 μF/km

   (ii) Capacitance between bunched conductors and sheath 0·625 μF/km

   (a) Determine the capacitance between any two conductors.

   (b) Determine the capacitance between any two bunched conductors and the third conductor if the sheath is insulated.

   (c) Also calculate the charging current per phase per km when it is connected to 10 kV, 50 Hz supply. 14

5. (a) What is grading of cable? Explain. 2

   (b) What is intersheath grading? Explain in detail. Derive the formula for maximum vol. gradient and compare it with 'without grading'. 12

6. Prove that the shape of conductor between two supports in case of overhead line is 'catenary'. 14

7. (a) Explain different types of vibration in overhead transmission line. 5

   (b) An overhead line at a river crossing is supported from two towers of heights 30 meters and 90 meters above water level with a span of 300 meters. The weight of the conductor is 1 kg/m and the working tension is 2000 kg. Determine the clearance between the conductor and the water level midway between the towers. 9

8. Determine the inductance per km of a transposed double-circuit 3-ϕ line shown in the figure below. Each circuit of the line remains on its own side. The dia of the conductor is 2·532 cm :
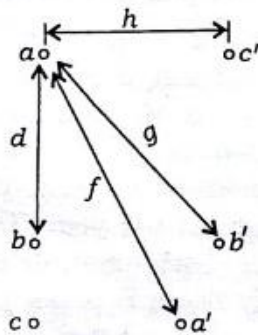

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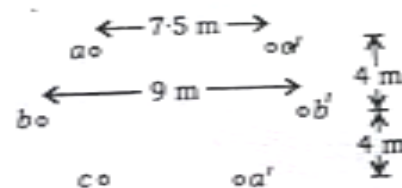
9. Prove that the capacitance per phase of a double-circuit transposed line having the following specification as shown in the figure is given by

$$C = \frac{4\pi\varepsilon_0}{\ln \sqrt[3]{2}\,\dfrac{d}{r}\cdot\left(\dfrac{g}{f}\right)^{2/3}} \quad \text{F/meter/phase}$$

where r is the radius of conductor :

14

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