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Code : 031404

2013

## 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) :  $2 \times 7 = 14$ 

(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)

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( Turn Over )

( 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

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( Continued )



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(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

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

(b) The daily load cycle of a 3- $\phi$ , 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- $\phi$  short line operating at 50 Hz with the following conditions :

Line length = 10 km

Line impedance =  $0.5 \angle 60^\circ \Omega/\text{km}$

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

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( Continued )



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4. A 3- $\phi$ , 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  $0.4 \mu\text{F}/\text{km}$
- (ii) Capacitance between bunched conductors and sheath  $0.625 \mu\text{F}/\text{km}$ 
  - (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.

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

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

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

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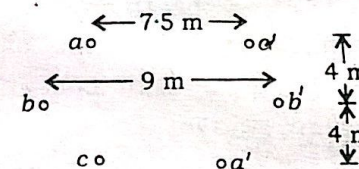
7. (a) Explain different types of vibration in overhead transmission line.

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(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  $1 \text{ kg}/\text{m}$  and the working tension is 2000 kg. Determine the clearance between the conductor and the water level midway between the towers.

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8. Determine the inductance per km of a transposed double-circuit 3- $\phi$  line shown in the figure below. Each circuit of the line remains on its own side. The dia of the conductor is  $2.532 \text{ cm}$  :



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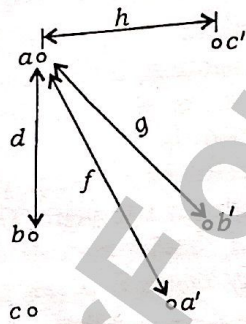
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9. Prove that the capacitance per phase of a double-circuit transposed line having the following specification as shown in the figure is given by

$$C = \frac{4\pi\epsilon_0}{\ln \sqrt[3]{2} \frac{d}{r} \cdot \left(\frac{g}{f}\right)^{2/3}} \text{ F/meter/phase}$$

where  $r$  is the radius of conductor :



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