Total No. of Questions: 6 *Total No. of Printed Pages:3*

Enrollment No......................................

Faculty of Engineering
End Sem Examination May-2024
EE3CO56 Power System -I

Programme: B.Tech. Branch/Specialisation: EE

Duration: 3 Hrs. **Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d. Assume suitable data if necessary. Notations and symbols have their usual meaning.

Q.1 i. Bundled conductors are mainly used in high-voltage overhead transmission lines to- **1**
(a) Reduce line loss
(b) Reduce harmonics
(c) Reduce corona
(d) Increase strength

ii. The charging current in a transmission line increases due to the corona effect because the corona increases- **1**
(a) Line current
(b) Effective conductor diameter
(c) Effective line voltage
(d) None of the above

iii. What is the line-to-earth capacitance value of the short transmission line? **1**
(a) Very high (b) Medium (c) Low (d) Negligible

iv. The string efficiency of overhead insulator approaches 100%, when- **1**
(a) Shunt capacitance approaches zero and the potential across each disc is the same
(b) Shunt capacitance approaches infinity and potential across each disc is the same
(c) Shunt capacitance approaches zero and the potential across each disc is different
(d) Shunt capacitance approaches infinity and potential across each disc is different

v. Performance of short transmission lines depends on which of the following? **1**
(a) Resistance and capacitance
(b) Resistance and inductance
(c) Inductance and capacitance
(d) Resistance, inductance and capacitance

vi. What is the number of suspension insulators required for 132 kV transmission? **1**
(a) 6 (b) 8 (c) 12 (d) 10

vii. Sag is independent of- **1**
(a) Length of span (b) Line voltage
(c) Tension in the conductor (d) None of these

viii. If supports are at equal levels and tension in an overhead line is increased to two times, then- **1**
(a) Sag decreases to half of the previous value
(b) Sag also increases to two times
(c) Sag becomes zero
(d) Sag also increases to four times

ix. The area under the load curve represents- **1**
(a) The average load on the power system
(b) Maximum demand
(c) Number of units generated
(d) Load factor

x. The size and cost of installation depends upon- **1**
(a) Average load
(b) Maximum demand
(c) Square mean load
(d) Square of peak load

Q.2 i. Differentiate between GMD and GMR. **2**

ii. The three conductors of a three-phase line are arranged at the corners of a triangle of sides 2 m, 2.5 m, and 4.5. Calculate the inductance per km of the line when the conductors are regularly transposed. The diameter of each conductor is 1.24 cm. **3**

iii. Derive the expression for capacitance of three phase transmission line for symmetrical spacing. **5**

OR iv. Derive the expression for inductance of single phase transmission line for unsymmetrical spacing. **5**

Q.3 i. What do you mean by surge impedance loading? **3**

ii. Derive the A, B, C, D constants for the transmission line represented by the nominal T section and draw its phasor diagram. **7**

OR iii. A single-phase overhead transmission line delivers 1100 kW at 33 KV at 0.8 lagging power factor. The total resistance and inductive reactance of the line are 10 ohm and 15 ohm respectively. Determine (a) Sending end voltage (b) Transmission efficiency and (c) Sending end power factor. Also, draw the phasor diagram of the short transmission line. **7**

Q.4 i. What do you mean by insulators? With a neat schematic diagram, explain the pin-type insulator. **4**

ii. Explain the construction of underground cables. Write an advantage of underground cables over overhead transmission line **6**

OR iii. A three-phase transmission line is being supported by three disc insulators. The potential across the top unit and middle unit are 8 kV and 11 kV respectively. Calculate (a) The ratio of capacitance between the pin and earth to the self-capacitance of each unit (b) The line voltage and (c) String efficiency. **6**

Q.5 i. Explain methods to reduce the corona in transmission lines. **4**

ii. What do you mean by sag? Derive the expression for sag when the supports are at the same level. **6**

OR iii. What do you understand by vibration dampers in overhead transmission line? Describe the different types of dampers. **6**

Q.6 Attempt any two:

i. With a neat schematic diagram, explain the working of a nuclear power plant. **5**

ii. A generating station has a connected load of 23 MW and a maximum demand of 20 MW, the unit generated being 61.5 x 10^6 per annum. Calculate (a) Demand factor (b) Average demand (c) Load factor. **5**

iii. The block rate tariff is as follows, (a) First 50kWh at Rs. 3.00/ kWh, (b) Next 50kWh at Rs. 2.80/ kWh, (c) Next 40kWh at Rs. 2.50/ kWh, (d) Next 30kWh at Rs. 2.20/ kWh and excess over 170 kWh at Rs. 2.00/ kWh. Determine the cost of electrical energy and the average unit cost for consuming 200 kWh. **5**

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Scheme of Marking

MEDI-CAPS UNIVERSITY Knowledge is Power	Faculty of Engineering End Sem Examination May-2024 Power System -I (T) - EE3CO56 (T)
	Programme: B.Tech. | Branch/Specialisation:

Q.1	i)	Bundled conductors are mainly used in high voltage overhead transmission lines to c) Reduce corona	**1**
	ii)	The charging current in a transmission line increases due to corona effect because corona increases b) Effective conductor diameter	**1**
	iii)	What is the line to earth capacitance value of the short transmission line? d) Negligible	**1**
	iv)	Performance of short transmission lines depends on which of the following? b) Resistance and Inductance	**1**
	v)	String efficiency of overhead insulator approaches to 100%, when a) Shunt capacitance approaches zero and potential across each disc is the same.	**1**
	vi)	What is the number of suspension insulators required for 132 kV transmission? b) 8	**1**
	vii)	Sag is independent of b) Line voltage	**1**
	viii)	If supports are at equal levels and tension in an overhead line is increased to two times, then a) Sag decreases to half of the previous value	**1**
	ix)	The area under the load curve represents c) Number of units generated	**1**
	x)	Size and cost of installation depends upon b) Maximum demand	**1**
Q.2	i.	Each difference between GMD and GMR equal 1 Mark …. 2 difference 2 Marks .	**2**
	ii.	.The Inductance/phase/km = 1.274mH ….. 3 Marks	**3**
	iii.	Diagram with parameters of three phase transmission line for symmetrical spacing………….. 2 Marks Derivation………. 3 marks.	**5**

OR	iv.	Diagram with components of single phase transmission line for unsymmetrical spacing………….. 2 Marks Derivation……………. 3 marks.	**5**
Q.3	i.	Definition ……………. 2 marks Mathematical expression ……… 1 mark.	**3**
	ii.	Derivation……………..5 marks Phasor diagram ……….. 2 marks.	**7**
OR	iii.	Each calculation is equals to………. 2 marks, i.e., (a) sending end voltage = 33709 V …….. 2 Marks (b) transmission efficiency = 98.44 % ………. 2 Marks (c) sending end power factor = 0.79 ……… 2 Marks Phasor diagram …………… one mark	**7**
Q.4	i.	Definition ………… 1 mark, Diagram of pin type insulator ……… one mark Explanation ……….. two marks	**4**
	ii.	Construction ……… 2 mark Each advantage is equal to one mark (total 4 marks).	**6**
OR	iii.	Each calculation is equal to two marks, *i.e.,* (i) The ratio of capacitance between pin and earth to the self-capacitance of each unit = 0.375 ………….2 Marks (ii) The line voltage = 64.28kV…………2 Marks (iii) String efficiency = 68.28%.............2 Marks	**6**
Q.5	i.	Description of different methods ……….. four marks.	**4**
	ii.	(i) Definition ……………. 1 marks and (ii) Derivation…………….. five marks.	**6**
OR	iii.	(i) Definition ………….. 2 marks and (ii) Description of different types ……….. four marks.	**6**
Q.6			
	i.	(i) Schematic diagram ……….. 3 marks and (ii) Working ……………. 2 marks.	**5**
	ii.	(a) demand factor = 0.86956 ………(02 marks) (b) average demand = 7020.5 kW ………..(01 mark) (c) load factor = 0.351 or 35.1% ………….(02 marks)	**5**
	iii.	Average cost of electrical energy = 2.58/kWh…….. 5 Marks	**5**

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Power system -I

EE3CO56

solution

Q.2 (ii)

$D_{12} = 2m$, $D_{23} = 2.5m$, $D_{31} = 4.5m$

$D = 1.24\ cm \Rightarrow r = \frac{1.24}{2} = .62\ cm$

$$L = 2\times10^{-7} \ln \frac{D_{eq}}{r'} \ H/m/p$$

$$D_{eq} = \sqrt[3]{D_{12}D_{23}D_{31}} = \sqrt[3]{2\times2.5\times4.5} = \boxed{2.823\ m}$$

$$r' = 0.7788r = 0.7788\times0.62 = 0.4828\ cm$$
$$= \boxed{0.4828\times10^{-2}\ m}$$

Now $L = 2\times10^{-7} \ln \frac{2.823}{0.4828\times10^{-2}}\ H/m$

$$= 2\times10^{-7} \ln (584.71)\ H/m = 2\times10^{-7}\times6.3711$$
$$= 12.742\times10^{-7}\ H/m = 12.742\times10^{-4}\ H/km$$
$$= \boxed{1.2742\ mH/km}$$

Q.3 (ii)

$P_r = 1100KW = 1100\times103\ W$

$V_r = 33KV$, $\cos\phi = 0.8$ (lag)

$R = 10\Omega$, $X_L = 15\Omega$

$V_s = ?$ $\%\eta = ?$ $P_s = ?$

(a) $P_r = \sqrt{3}\, V_{rp} I_r \cos\phi$

$$\Rightarrow I_r = \frac{P_r}{\sqrt{3}V_r\cos\phi} = \frac{1100\times\cancel{10}3}{\sqrt{3}\times33\times\cancel{10}3\times0.8}$$
$$= \boxed{24.05\ A}$$

2

$$V_{rp} = \frac{V_r}{\sqrt{3}} = \frac{\cancel{1100}\,33 \times 10^3}{\sqrt{3}} = \cancel{6}\ \boxed{19052.55\ V}$$

Now $V_{s_p} = V_{rp} + I_r R \cos\phi + I_r X \sin\phi$

$= 19052.55V + 24.05 \times 10 \times 0.8 + 24.05 \times 15 \times 0.6$

$= 19052.55 + 192.4 + 216.45$

$= \boxed{19461.4\ V}$

2

$\therefore V_s\ (\text{line}) = 33708.1\ V = \boxed{33.7\ KV}$

(b) I^2R loss $= (24.05)^2 \times 10 = 5784.025\ W$

$= 5.784\ KW$

$\therefore$ sending end power

$P_s = P_r + I^2R$

$= 1100\ KW + 5.784\ KW$

$= 1105.\boxed{784\ KW}$

Transmission efficiency

$$\%\eta = \frac{P_r}{P_s} \times 100$$

2

$$= \frac{1100}{1105.784} \times 100 = 99.47\%$$

(c) sending end p.f

$P_s = \sqrt{3} V_s I_s \cos\phi_s$

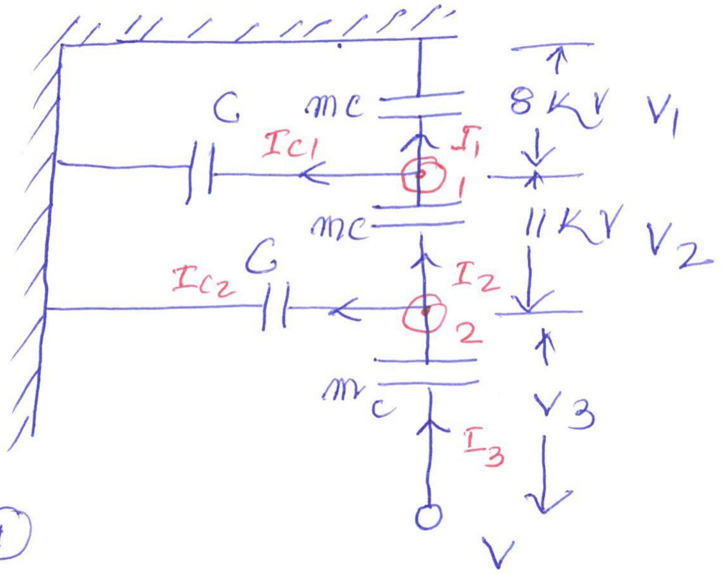
$$\Rightarrow \cos\phi_s = \frac{P_s}{\sqrt{3} \times V_s I_s} = \frac{1105.784 \times 10^3}{\sqrt{3} \times 33.7 \times 10^3 \times 24.05}$$

$= \boxed{0.7877}$

2

Q. 4 (iii)

3



At node ①

$I_2 = I_1 + I_{C1}$ ... ①

$$\Rightarrow \frac{V_2}{\frac{1}{\omega mC}} = \frac{V_1}{\frac{1}{\omega mC}} + \frac{V_1}{\frac{1}{\omega C}} \Rightarrow V_2 \omega mC = V_1 \omega mC + V_1 \omega C$$

$$\Rightarrow V_2 m = V_1 m + V_1 \Rightarrow V_2 m = V_1 (1+m)$$

$$\Rightarrow 11m = 8(1+m) = 8 + 8m$$

$$\Rightarrow 3m = 8 \Rightarrow m = \frac{8}{3} \Rightarrow \frac{1}{m} = \frac{3}{8} = \boxed{0.375}$$

2

At node-②

$I_3 = I_2 + I_{C2}$

$$\Rightarrow V_3 m\omega C = V_2 m\omega C + (V_1 + V_2)\omega C$$

$$\Rightarrow V_3 m = V_2 m + V_1 + V_2$$

$$\Rightarrow V_3 = V_2 + 0.375 (V_1 + V_2)$$

$$= 11 + 0.375(11+8) = 18.125 \text{ KV}$$

$$\therefore V = V_1 + V_1 + V_3 = 8 + 11 + 18.125 = \boxed{37.125 \text{ KV}}$$

Line voltage $V_L = \sqrt{3} \times 37.125 = \boxed{64.3 \text{ KV}}$

2

% string efficiency $\eta = \frac{V}{n \times V_3}$

2

$$= 6 \frac{37.125}{3 \times 18.125} = \boxed{68.27\%}$$

Q 6 (i) - connected Load = 23 MW

Maximum demand = 20 MW

unit generated = 61.5×106 per annum

(i) Demand factor

$$= \frac{\text{Max. demand}}{\text{connected Load}} = \frac{20\,MW}{23\,MW} = \boxed{0.869}$$ 2

(ii) Average demand

$$= \frac{\text{unit generated/annum}}{\text{Hours in a year}}$$ 1

$$= \frac{61.5 \times 106}{8760} = \boxed{7020.5\ KW}$$

(iii) Load factor $= \frac{\text{Average demand}}{\text{Max. demand}}$ 2

$$= \frac{7020.5\ KW}{20{,}000\ KW} = \boxed{0.351}$$

(ii) (a) First 50 KWh @ Rs 3.00 / KWh

cost (a) = $50 \times 3 = \boxed{Rs\ 150}$

(b) Next 50 KWh @ Rs 2.80 / KWh

cost (b) = $50 \times Rs\ 2.80 = \boxed{Rs\ 140}$

(c) Next 40 KWh @ Rs 2.50 / KWh

cost (c) = $40 \times 2.50 = \boxed{Rs\ 100}$

(d) Next 30 KWh @ Rs 2.20 / KWh

cost (d) = $30 \times 2.20 = \boxed{Rs\ 66}$

(e) Next 30 KWh @ 2 / KWh

cos (d) = $30 \times 2 = \boxed{Rs\ 60}$

3

Total cost of 200 KWh

= Rs 150 + Rs 140 + Rs 100 + Rs 66 + Rs 60 = $\boxed{Rs\ 516}$ 1

Average unit cost = 516/200 = $\boxed{2.58}$ 1