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

**Enrollment No.....**

Faculty of Engineering

End Sem Examination May-2023

EE3CO39 / EE3CO11 / EX3CO11 Power System -I

Programme: B.Tech. Branch/Specialisation: EE/EX

**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. What is the shape of the load duration curve? **1**

(a) Triangular (b) Rectangular

(c) Circular (d) Parabolic

ii. Which one is a good value of power factor? **1**

(a) 0.1 (b) 0.3 (c) 0.98 (d) 0.4

iii. Which of the following power plants is most efficient but has high initial cost? **1**

(a) Diesel power plant (b) Nuclear power plant

(c) Hydroelectric power plant (d) Steam power plant

iv. Which is used as a fuel in thermal power plant? **1**

(a) Coal (b) Natural Gas

(c) Petroleum (d) All of these

v. Which of the following are the constants of the transmission lines? **1**

(a) Resistance (b) Inductance

(c) Capacitance (d) All of these

vi. When is the transposition of conductors in a transmission line done? **1**

(a) When the conductors are not equally spaced

(b) When the conductors are spaced equilaterally

(c) When a telephone line runs parallel to the power line

(d) None of these

vii. For transmission line which one of the following relations is true? **1**

(a) AD - BC = 0 (b) AD + BC = 0

(c) AD - BC = 1 (d) AD - BC = -1

P.T.O.

viii. Length of short transmission line is less than- **1**
(a) 80 km (b) 120 km (c) 200 km (d) 250 km

ix. Which type of insulator is used on 132KV transmission lines? **1**
(a) Pin type (b) Disc type
(c) Shackle type (d) Pin & Shackle type

x. If span length is doubled with no change in other factors, the sag of the line will become? **1**
(a) 2 times (b) 8 times (c) 4 times (d) 0.5 times

Q.2 i. Define the following terms in connection with a power supply system: Connected load, Maximum demand, Demand factor, Load factor **4**

ii. Derive for the calculation of total energy generation in hydroelectric power station. **6**

OR iii. Compare the following tariffs: **6**
(a) Flat rate tariff (b) Two-part tariff
(c) Block rate tariff

Q.3 i. Write the comparison of hydroelectric and thermal power plants. **4**

ii. Explain with a neat block diagram the complete operation of thermal power plant. **6**

OR iii. Explain with a neat block diagram the complete operation of hydroelectric power plant. **6**

Q.4 i. A 3-phase transmission line has a horizontal configuration with spacing of 6m between adjacent conductors & 12m between outer conductors. The radius of each conductor is 1.81cm. Find the inductance/phase/km of the line. **4**

ii. A bundled conductor line has 4 conductors per bundle. The four sub-conductors are placed at the corners of square of side 25c.m. The radius of each sub-conductor is 1.573c.m. Find GMR of this configuration. **6**

OR iii. Derive expression for inductance of a conductor due to internal flux linkages. **6**

Q.5 i. Draw phasor diagram for nominal T-circuit of medium length line. **4**

ii. A 15 km long 3-phase line has a resistance of 5.31Ω / phase & inductive reactance of 5.54 Ω / phase. The sending end voltage is 11 kV. The receiving end load is 1200 KW at a power factor of 0.8 lagging. Find the receiving end voltage and line current. **6**



OR iii. A 15 Km long 3-phase overhead lines delivers 5MW at 11 KV at a p.f of 0.8 lagging. Line loss is 12% of the power delivered. Line inductance is 1.1mH/ Km/ phase. Calculate sending end voltage and regulation. **6**

Q.6 i. Derive the expression for voltage across each unit for a string of 4 insulator discs. **4**

ii. A 3-phase overhead line is being supported by three disc insulators. The potential across top unit and middle unit are 9 KV & 11KV respectively. Calculate (a) The line Voltage and (b) String efficiency. **6**

OR iii. Deduce expression of sag for transmission line conductor between two supports at equal heights. **6**

******

# Marking Scheme

## EE3CO39-EE3CO11-EX3CO11[T] Power System-I

| | | | |
|---|---|---|---|
| Q.1 | i) | What is the shape of the load duration curve?<br>(b) Rectangular | **1** |
| | ii) | Which one is a good value of power factor?<br>(c) 0.98 | **1** |
| | iii) | Which of the following power plants is most efficient but has high initial cost?<br>(c) Hydro electric power plant | **1** |
| | iv) | Which is used as a fuel in thermal power plant?<br>(a) Coal | **1** |
| | v) | Which of the following are the constants of the transmission lines?<br>(d) All of the above | **1** |
| | vi) | When is the transposition of conductors in a transmission line done?<br>(a) When the conductors are not equally spaced. | **1** |
| | vii) | For transmission line which one of the following relations is true?<br>(c) AD - BC = 1 | **1** |
| | viii) | length of short transmission line is less than 180 km | **1** |
| | ix) | Which type of insulator is used on 132KV transmission lines?<br>(b) Disc type | **1** |
| | x) | If span length is doubled with no change in other factors, the sag of the line will become?<br>(c) 4 times | **1** |
| Q.2 | i. | Define the following terms in connection with a power supply system: Connected load, Maximum demand, Demand factor, Load factor<br>each definition ------ 1M | **4** |
| | ii. | A generating station supplied the following loads: 150MW, 120MW, 85MW, 60MW and 5MW. The annual load factor of the station is 48%. Calculate (a) the number of units supplied annually (b) the diversity factor and (c) the demand factor<br>(a) sub question ------ 2M<br>(b) sub question ------- 2M<br>(c) sub question -------- 2M | **6** |
| OR | iii. | Compare the following tariffs:<br>(a) Flat rate tariff (b) Two part tariff (c) Block rate tariff<br>(a) sub question ------ 2M | **6** |



(b) sub question ------- 2M
(c) sub question -------- 2M

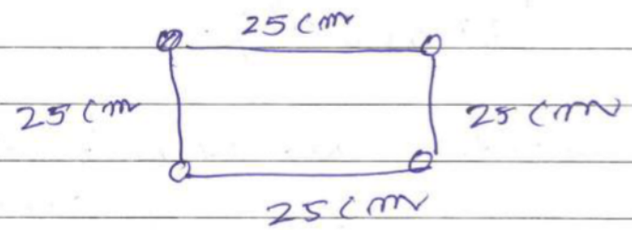
| | | | |
|---|---|---|---|
| Q.3 | i. | Write the comparison of hydroelectric and thermal power plants?<br>any 4 comparisons ------- 4M | **4** |
| | ii. | Explain with a neat block diagram the complete operation of thermal power plant.<br>block diagram -------- 2M<br>explanation of complete operation ------ 4M | **6** |
| OR | iii. | Explain with a neat block diagram the complete operation of hydroelectric power plant.<br>block diagram -------- 2M<br>explanation of complete operation ------ 4M | **6** |
| Q.4 | i. | A 3-phase transmission line has a horizontal configuration with spacing of 6m between adjacent conductors & 12m between outer conductors. The radius of each conductor is 1.81cm.Find the inductance/phase/KM of the line.<br>complete solution --------- 4M | **4** |
| | ii. | A bundled conductor line has 4 conductors per bundle. The four sub-conductors are placed at the corners of square of side 25c.m. The radius of each sub-conductor is 1.573c.m. Find GMR of this configuration.<br>complete solution --------- 6M | **6** |
| OR | iii. | Derive expression for inductance of a conductor due to internal flux linkages.<br>complete derivation -------- 6M | **6** |
| Q.5 | i. | Draw phasor diagram for nominal T-circuit of medium length line.<br>phasor diagram and its explanation -------- 4M | **4** |
| | ii. | A 15Km long 3-phase line has a resistance of 5.31Ω / phase & inductive reactance of 5.54 Ω / phase. The sending end voltage is 11 kV. The receiving end load is 1200 KW at a power factor of 0.8 lagging. Find the receiving end voltage and line current.<br>receiving end voltage ------ 3M<br>line current --------- 3M | **6** |
| OR | iii. | A 15 Km long 3-phase overhead lines delivers 5MW at 11 KV at a p.f of 0.8 lagging. Line loss is 12% of the power delivered. Line inductance is 1.1mH/ Km/ phase. Calculate sending end voltage and regulation.<br>sending end voltage --------- 4M<br>regulation ---------- 2M | **6** |
| Q.6 | i. | Derive the expression for voltage across each unit for a string of 4 insulator discs.<br>complete derivation ------- 4M | **4** |
| | ii. | A 3-phase overhead line is being supported by three disc | **6** |

insulators. The potential across top unit and middle unit are 9 KV & 11KV respectively. Calculate (a) The value of m (b) The line Voltage (c) String efficiency
(a) sub question -------- 2M
(b) sub question -------- 2M
(c) sub question -------- 2M

OR iii. Deduce expression of sag for transmission line conductor between two supports at equal heights. **6**
complete derivation -------- 6M

******

(ii)




$r = 1.573$ cm

$r' = 0.7788 \times 1.573 = 1.225$ cm

$D_{sb} = \sqrt[16]{(D_s \cdot d \cdot d \cdot d\sqrt{2})4}$

$= \sqrt[16]{(1.225 \times 25 \times 25 \times 25\sqrt{2})4}$

$= 12.826$ cm

Q.5 (ii) $V_s = \frac{11000}{\sqrt{3}} = 6351$ V

$I_r = \frac{1200 \times 10^3}{3 \times V_r \times 0.8} = 500 \times 10^3 / V_r$

Again $V_s \simeq V_r + I_r R \cos\phi_r + I_r X \sin\phi_r$

$\Rightarrow 6351 = V_r + \frac{500 \times 10^3 \times 5.31 \times 0.8}{V_r} + \frac{500 \times 10^3 \times 5.54 \times 0.6}{V_r}$

$\Rightarrow V_r = 5685$ V

Line current $I_r = \frac{500 \times 10^3}{5685} = 87.95$ A

*enlivo
Date: ___/___/_____
Page: _____

# Solution

power system-I
EE3C039.

Q.2 (ii) Load factor = $\frac{\text{No. of units supplied annually}}{\text{Max. gen capacity} \times 8760}$

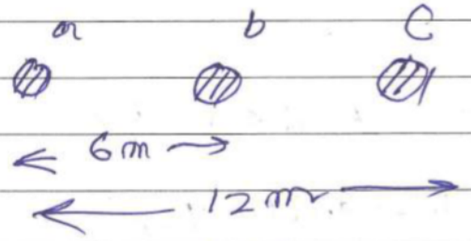
$\Rightarrow 0.48 = \frac{\text{Number of units supplied}}{220 \times 8760}$

(a) No. of units supplied annually
$= 0.48 \times 220 \times 8760 = 9.25 \times 10^5$ units

(b) Diversity factor
$= \frac{\text{sum of max. dem. of individual consumers}}{\text{station Max demand}}$
$= \frac{150+120+85+60+5}{220} = 1.909.$

(c) demand factor
$= \text{Max. demand} / \text{connected load.}$
$= \frac{220}{420} = 52.4\%.$

Q.4(i)




radius $r = 1.81$ cm
$r' = 0.7788r = 0.7788 \times 1.81 = 1.4096$ cm

Line Losses = $\frac{12}{100} \times 5 \times 10^6 = 60 \times 10^4$ W

$\Rightarrow 3I_r^2 R = 60 \times 10^4$.

$\Rightarrow R = \frac{60 \times 10^4}{3 \times (328)^2} = 1.86\ \Omega$

$X = 2\pi f L = 2\pi \times 50 \times 1.7 \times 10^{-3} \times 15$

$= 5.184\ \Omega$

$V_S = V_r + I_r R \cos\phi_r + I_r X \sin\phi_r$

$= 6351 + 328 \times 1.86 \times 0.8 + 328 \times 5.184 \times 0.6$

$= 7859.27$ V

$V.R = \frac{V_S - V_r}{V_r} = \frac{7859.27 - 6351}{6351}$

$= 23.75\%$.

Q.6 (ii)

$m = \frac{\text{self capacitance}}{\text{capacitance bet}^n \text{ pin \& earth}}$

(a) $V_2 = V_1 \left(\frac{1+m}{m}\right)$

$\Rightarrow 11 = 9 \left(\frac{1+m}{m}\right)$

$\Rightarrow m = 4.5$

(b) $V_3 = V_1 + V_2 (1+m)$

voltage between line & earth.

$V = V_1 + V_2 + V_3 = 9 + 11 + 15.42 = 35.42 kV$

(c) $\eta = \frac{\text{voltage across the strums}}{\text{No: of units} \times V_3}$

$= \frac{35.42}{3 \times 15.42} \times 100 = 76\%$