

POWER SYSTEM - I
(ELEC 3102)

Time Allotted : 2½ hrs

Full Marks : 60

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 4 (four) from Group B to E, taking one from each group.*

Candidates are required to give answer in their own words as far as practicable.

Group – A

1. Answer any twelve:

12 × 1 = 12

Choose the correct alternative for the following

- (i) Which type of insulator is used where there is dead end of the line or there is a corner or a sharp curve, for high voltage line?
(a) Strain insulator (b) Shackle insulator
(c) Suspension insulator (d) Pin type insulator.
- (ii) If span length is doubled with no change in other factors, the sag of the line will become
(a) same (b) 2 times (c) 4 times (d) 8 times.
- (iii) Corona effect in transmission can be detected by
(1) the faint luminous glow which is violet in colour
(2) hissing sound
(3) presence of ozone which is detected by odour.
Which of these is/are correct?
(a) Only 1 (b) Only 1 and 2 (c) Only 2 (d) 1, 2 and 3.
- (iv) Corona loss can be reduced by the use of a hollow conductor because
(a) the current density is reduced
(b) for a given cross-section, the radius of the conductor is increased
(c) the eddy current in the conductor is eliminated
(d) for better ventilation in the conductor.
- (v) Transmission lines are transposed to
(a) reduce copper loss
(b) reduce skin effect
(c) prevent interference with neighbouring telephone lines
(d) prevent short-circuit between any two lines.
- (vi) The thickness of the layer of insulation on the conductor, in cables, depends upon
(a) reactive power (b) power factor
(c) voltage (d) current carrying capacity.

- (vii) Armouring in cable is used to protect the cable from
 (a) voltage surge (b) mechanical injury
 (c) surge current (d) increased voltage.
- (viii) If the length of transmission line is increased, the charging current
 (a) decreases (b) increases
 (c) remains same (d) not affected.
- (ix) Shunt capacitance is usually neglected in the analysis of
 (a) medium transmission lines
 (b) long transmission lines
 (c) medium as well as long transmission lines
 (d) short transmission lines.
- (x) The propagation constant of a transmission line with impedance and admittance of 9 and 16 respectively is
 (a) 25 (b) 144 (c) 12 (d) 81.

Fill in the blanks with the correct word

- (xi) An over excited synchronous motor running on no load is known as _____.
- (xii) The inductance of a bundle conductor line is _____ than that of the line with one conductor per phase.
- (xiii) In a cable immediately above metallic sheath, _____ is provided.
- (xiv) Capacitance of a transmission line _____ with increase in its length.
- (xv) The maximum dielectric stress in a cable is at _____.

Group - B

2. (a) What are the advantages of thermal power stations? [[CO1](Remember/LOCQ)]
 (b) Compare nuclear and hydroelectric power stations. [[CO1](Analyze/IOCQ)]
 (c) Estimate the coal consumption per hour when a steam power station of 100 MW capacity uses coal of calorific value 7400 kCal/kg and is delivering its full rated output. Thermal efficiency of the station is 29% and electrical efficiency is 94%. [[CO1](Evaluating/HOCQ)]
4 + 4 + 4 = 12
3. (a) What is Two part tariff? Explain. [[CO1](Remember/LOCQ)]
 (b) An industrial consumer has a maximum demand of 100 kW. Two alternative tariffs are available:
 (i) A fixed charge of Rs. 800 per kW of maximum demand per year plus a running charge of Rs. 1.30 per kWh of energy consumed.
 (ii) A flat rate of Rs. 1.83 per kWh.
 Which tariff is economical if the factory runs for 3600 hours per year with a load factor of 0.8? [[CO1](Apply/IOCQ)]
 (c) Classify the essential factors which influence the selection of sites for nuclear power plants. [[CO1](Analyze/IOCQ)]
3 + 4 + 5 = 12

Group - C

4. (a) An overhead transmission line at river crossing is supported from two towers at heights of 40 m and 80 m above the water level. The horizontal distance between the towers is 400 m. If the weight of the conductor is 1.1 kg/m and the allowable tension is 1100 kg, determine the clearance between the conductor and water level at a point mid-way between the towers. [[CO2](Evaluate/HOCQ)]
- (b) Assume in a 6 insulator disc string, capacitance between pin and earth is $1/7^{\text{th}}$ of the capacitance of each unit to determine the voltage distribution across each insulator in the string as percentage of voltage of the conductor to earth. [[CO2](Analyze/IOCQ)]

$$6 + 6 = 12$$

5. (a) What is the effect of earth on line capacitance? Explain the method of images to calculate the capacitance of a single phase two wire line. [[CO2](Analyse/IOCQ)]
- (b) A two-conductor, three-phase transmission line is arranged horizontally as shown in Fig.-1. The spacing between conductors of the bundle is 40 cm. The phase-to-phase spacings are 8, 8 and 16 m, respectively. Determine the inductance of the line per phase per kilometre. The conductor diameter is 3 cm.

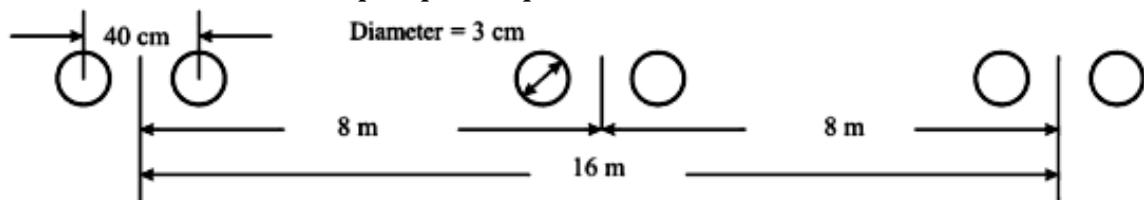


Fig.1

[[CO2](Evaluate/HOCQ)]

$$(2 + 4) + 6 = 12$$

Group - D

6. (a) What do you mean by Surge Impedance Loading (SIL)? [[CO3](Understand/LOCQ)]
- (b) A three-phase, 50 Hz, 90 km long overhead line has the following line constants:
 Resistance per kilometer = 0.15Ω
 Inductance per kilometer = 1.2 mH
 Capacitance per kilometer = $0.009 \mu\text{F}$
 The line supplies 25 MW at 0.85 power factor (lag) and 170 kV, Using nominal π -representation, determine the sending end voltage, current, power factor, regulation of the line and efficiency of transmission. [[CO3](Evaluate/HOCQ)]

$$3 + (2 + 1 + 2 + 2 + 2) = 12$$

7. (a) What is corona in transmission line and how does it form? [[CO3](Remember/LOCQ)]
- (b) Classify the factors affecting the corona loss. [[CO3](Analyze/IOCQ)]
- (c) A 3-phase, 220 kV, 50 Hz transmission line consists of 1.2 cm radius conductors spaced 2.5 cm at the corners of an equilateral triangle. Determine the disruptive critical voltage between the lines at temperature 21°C , barometric pressure 70 cm of mercury, surface irregularity factor 0.96 while dielectric

strength of air is 21.21 kV(rms)/cm. Also conclude whether the corona is visible or not.

[[CO3](Evaluate/HOCQ)]

3 + 4 + (4 + 1) = 12

Group - E

8. (a) Describe general construction of a single core cable. [[CO4](Understand/LOCQ)]
 (b) Show that the most economical size of conductor in a single-core cable is obtained when radius of cable sheath (R) equals $(e \times r)$ where, e is the base of natural log and r is the radius of conductor. [[CO4](Apply/IOCQ)]
 (c) Determine the economical-core diameter of a single-core cable working on 210 kV, three-phase system. The maximum permissible stress in the dielectric is not to exceed 230 kV/cm. [[CO4](Apply/IOCQ)]
4 + 4 + 4 = 12
9. (a) An 800 meter distributor fed from both ends A and B is loaded uniformly at the rate of 2 A per meter run, the resistance of each conductor being 0.05 Ω per km. Determine the minimum voltage and the point where it occurs if feeding points A and B are maintained at 250 V and 245 V, respectively. Also determine the current supplied from feeding points A and B. [[CO4](Evaluate/HOCQ)]
 (b) What are the causes and disadvantages of low power factor? [[CO4](Remember/LOCQ)]
5 + 7 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	25	38.54	36.46

Course Outcome (CO):

After the completion of the course students will be able to

- To demonstrate the basic structure of power system, various methods of conventional power generation and tariff.
- To explain the mechanical design and the electrical design of power transmission system.
- To analyze the performance of different type of transmission lines.
- To learn about the underground cables, different type of distribution systems and power factor correction techniques.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.