

POWER SYSTEM – I

(ELE2202)

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:

$$12 \times 1 = 12$$

Choose the correct alternative for the following

- (i) Economiser is used to heat
 - (a) Feed water
 - (b) Air
 - (c) flue gases
 - (d) all of the above
- (ii) A penstock is used as a conduit between
 - (a) the steam chest and the turbine in thermal station.
 - (b) the turbine and the discharge drain in thermal station.
 - (c) the dam and the turbine in a hydroelectric power plant.
 - (d) the heat exchanger and the turbine in a nuclear power plant.
- (iii) Diversity factor is the ratio of
 - (a) 'Sum of maximum demands of consumers' to 'system maximum demand'
 - (b) 'Maximum demands of consumers' to 'average demand'
 - (c) 'Maximum demand' to 'connected load'
 - (d) 'Average load' to 'peak load'.
- (iv) What should be the value of sag for proper operation of overhead transmission line?
 - (a) Low
 - (b) High
 - (c) Neither too low nor too high
 - (d) zero
- (v) 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
- (vi) 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.

- (vii) A single-phase transmission line of impedance $j0.8 \Omega$ supplies a resistive load of 500 A at 300 V. The sending end power factor is
 (a) Unity (b) 0.8 lagging (c) 0.8 leading (d) 0.6 lagging
- (viii) 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
- (ix) Armouring in cable is used to protect the cable from
 (a) Voltage surge (b) Mechanical injury
 (c) Surge current (d) Increased voltage
- (x) Location of the capacitor used in the power system for VAR compensation
 (a) near the load (b) near the generator
 (c) near the step up transformer (d) anywhere in the transmission line

Fill in the blanks with the correct word

- (xi) Among Thermal Power Station, Hydroelectric Power Station and Nuclear power _____ station is most efficient.
- (xii) An over excited synchronous motor running on no load is known as _____.
- (xiii) Stringing chart is useful for _____.
- (xiv) Series inductance and series resistance of short and medium transmission lines are taken as _____ parameters.
- (xv) In lightly loaded long transmission line, the receiving end voltage may be greater than sending end voltage due to _____ effect.

Group - B

2. (a) What is the definition of Demand factor and Load factor of an electric power station?
 [(C01)(Remember/LOCQ)]
- (b) Classify the essential factors which influence the selection of sites for Thermal coal fired power plants.
 [(C01)(Analyze/IOCQ)]
- (c) Explain the functions of the followings in thermal power plant.
 (i) super heater, (ii) economizer
 [(C02)(Apply/IOCQ)]
(2 + 2) + 6 + 2 = 12
3. (a) Explain the working principle of nuclear reactor with appropriate diagram.
 [(C01)(Analyze/IOCQ)]
- (b) Compare Thermal and hydroelectric power stations.
 [(C01)(Analyze/IOCQ)]
- (c) What is Three part tariff? Explain.
 [(C01)(Remember/LOCQ)]
6 + 4 + 2 = 12

Group - C

4. (a) An overhead transmission line at river crossing is supported from two towers at heights of 50 m and 80m above the water level. The horizontal distance between the towers is 410m. If the weight of the conductor is 1.2 kg/m and the allowable tension is 1100kg, determine the clearance between the conductor and water level at a point mid-way between the towers. [[CO2](Evaluating/HOCQ)]
- (b) The arrangement of conductors of a single-phase transmission line is shown in Fig. 1. The forward circuit is composed of three solid wires of radius 2.4 mm and the return circuit is composed of two wires of radius 4.8 mm placed symmetrically with respect to the forward circuit. Determine the inductance of each side of the line and that of the complete line. [[CO2](Evaluate/HOCQ)]

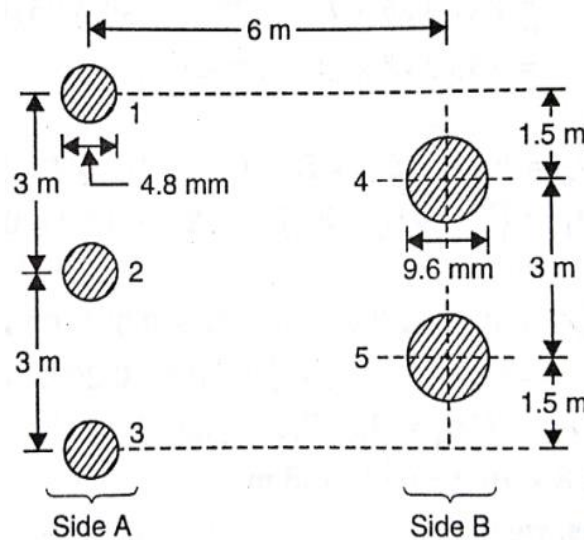


Fig. 1

6 + 6 = 12

5. (a) Derive an expression for the line-to-line capacitance of a single phase line. [[CO2](Apply/IOCQ)]
- (b) What are bundle conductors? Why are they used? [[CO2](Remember/LOCQ)]
- (c) Assume the following arrangement is shown in Fig. 2, to determine (i) the voltage distribution (in terms of 'V') over a string of three suspension insulators and (ii) string efficiency.

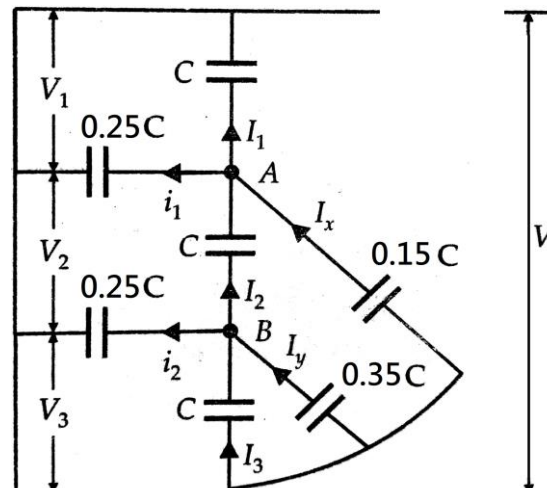


Fig. 2

[[CO2](Apply/IOCQ)]

4 + 2 + 6 = 12

Group - D

6. (a) Classify the factors affecting the corona loss. [[CO3](Analyze/IOCQ)]
 (b) A 3-phase overhead transmission line has total series impedance per phase of $200\angle 80^\circ \Omega$ and a total shunt admittance of $0.0012\angle 90^\circ$ siemens per phase. The line delivers a load of 75 MW at 0.85 power factor lagging and 220 kV between the lines. Determine the sending end voltage and sending end current. [[CO3](Evaluate/HOCQ)]
5 + 7 = 12
7. (a) Derive A, B, C, D constants for a medium transmission line represented by nominal- π configuration. Also show the phasor diagram for this. [[CO3](Analyze/IOCQ)]
 (b) What is the advantage of corona in transmission line? [[CO3](Remember/LOCQ)]
 (c) A 3-phase, 220 kV, 50 Hz transmission line consists of 1.1 cm radius conductors spaced 2.4 m at the corners of an equilateral triangle. Determine the disruptive critical voltage between the lines at temperature 20°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)]
5 + 2 + (4 + 1) = 12

Group - E

8. (a) Explain the methods of power factor improvement. [[CO4](Understanding/LOCQ)]
 (b) The insulation resistance of a single-core cable is $525 \mu\Omega/\text{km}$. If the core diameter is 3.6 cm and resistivity of insulation is $4.7 \times 10^{14} \Omega\text{-cm}$, evaluate the thickness of insulation. [[CO4](Apply/IOCQ)]
 (c) Find the most economical value of the diameter of a single core cable to be used on a 132 kV, 3-phase system. Find also the overall diameter of the insulation if the peak permissible stress is not to exceed 60 kV/cm. [[CO4](Evaluate/HOCQ)]
6 + 3 + 3 = 12
9. (a) 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](Evaluate/HOCQ)]
 (b) Derive the expression for dielectric stress in a single core cable. [[CO4](Apply/IOCQ)]
 (c) A two conductor distributor AB, 500 meters in length, is fed from both ends at 260 volts. Loads of 52 A, 60 A, 43 A and 29 A are tapped at distances of 100 m, 250 m, 350 m and 400 m from side A respectively. If the cross-section of the conductors is 1cm^2 and specific resistance of the material of the conductor is $1.6 \mu\Omega\text{-cm}$, identify the minimum consumer voltage. [[CO4](Applying/IOCQ)]
3 + 3 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	16.67	52.08	31.25