

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 of the following generating power plants has a minimum operating cost?
(a) Nuclear power plant (b) Hydro-electric power plant
(c) Thermal power plant (d) All of the three have same operating cost.
- (ii) Economiser is used to heat
(a) feed water (b) air (c) flue gases (d) all of the above.
- (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) 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
- (v) 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.
- (vi) Bundled conductors in EHV transmission system provide
(a) reduced capacitance (b) increased capacitance
(c) increased inductance (d) increased voltage gradient
- (vii) 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.

- (viii) 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.
- (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) The type of insulators, used on 132 kV transmission lines is _____.
- (xii) The value of the dielectric strength of air is _____.
- (xiii) Series inductance and series resistance of short and medium transmission lines are taken as _____ parameters.
- (xiv) The velocity of propagation of electromagnetic waves on overhead lines is _____.
- (xv) The inductance of a bundle conductor line is _____ than that of the line with one conductor per phase.

Group - B

2. (a) What is the definition of Demand factor and Load factor of an electric power station? [[CO1](Remember/LOCQ)]
- (b) Classify the essential factors which influence the selection of sites for Thermal coal fired power plants. [[CO1](Analyze/IOCQ)]
- (c) Explain the functions of the followings in thermal power plant.
 (i) super heater, (ii) economizer. [[CO2](Apply/IOCQ)]
- (2 + 2) + 6 + 2 = 12**
3. (a) Draw the neat schematic layout of a Thermal(coal-fired) power station. [[CO1](Remember/LOCQ)]
- (b) Explain the functions of the followings in hydroelectric power plant.
 (i) Reservoir, (ii) Dam, (iii) Spillway, (iv) Trash rack, (v) Surge Tank, (vi) Penstock. [[CO1](Analyze/IOCQ)]
- 6 + 6 = 12**

Group - C

4. (a) An overhead transmission line at river crossing is supported from two towers at heights of 45 m and 80m above the water level. The horizontal distance between the towers is 400m. If the weight of the conductor is 1.1 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)]

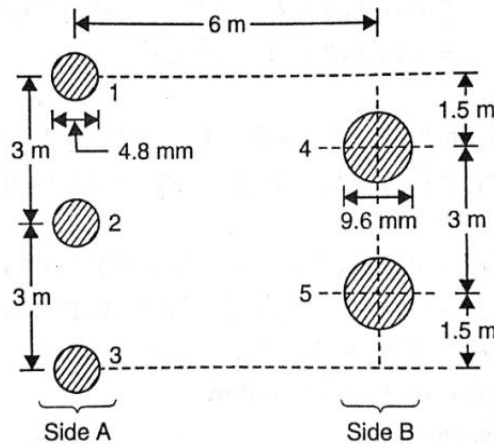


Fig.: 1

6 + 6 = 12

5. (a) Assume in a 4 insulator disc string, capacitance between pin and earth is $1/5$ th of the capacitance of each unit to determine (i) the voltage distribution across each insulator in the string as percentage of voltage of the conductor to earth. (ii) the operating voltage of the line, if each insulator in the string is designed to withstand 20 kV maximum (peak). [[CO2](Analyze/IOCQ)]
- (b) A 300 kV three-phase double conductor line with two sub-conductors per phase has a horizontal configuration as shown in Fig. 2. Find the capacitance per phase, if the radius of each sub-conductor is 1.5 cm. [[CO2](Evaluate/HOCQ)]

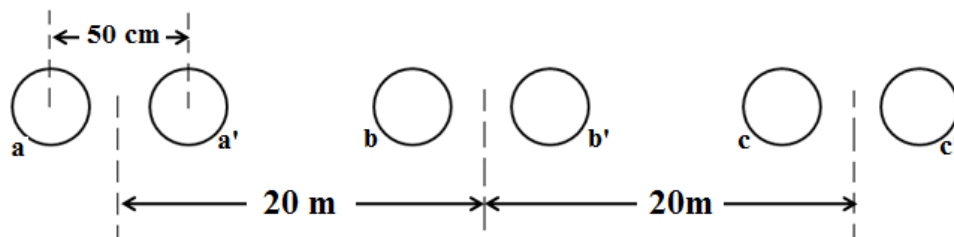


Fig.: 2

6 + 6 = 12

Group - D

6. (a) Explain all the disadvantages of corona effect. [[CO3](Analyze/IOCQ)]
- (b) Determine the efficiency and regulation of a three-phase, 50 Hz transmission line which delivers a balanced load of 24 MVA at 0.8 lagging power factor. The receiving end voltage is 66 kV. Resistance, inductance and capacitance per phase are 9.6Ω , 0.097 H and $0.765 \mu\text{F}$, respectively. Neglect leakages. Use nominal T-method. [[CO3](Evaluate/HOCQ)]

6 + 6 = 12

7. (a) What do you understand by Surge impedance loading? Explain. [[CO3](Analyze/IOCQ)]

- (b) Explain the terms efficiency and regulation in relation to transmission line
[[CO3](Remember/LOCQ)]
- (c) Determine (i) the critical disruptive voltage (ii) the visual critical voltage and (iii) the corona loss under foul weather condition for 3-phase line 210 km long, conductor diameter 1.2 cm; 2.5 m delta spacing. Air temperature 30°C, corresponding to an approximate barometric pressure of 74 cm of mercury, operating voltage 220 kV at 50 Hz, surface irregularity factor 0.85.
[[CO3](Evaluating/HOCQ)]
3 + 3 + 6 = 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 $515 \mu\Omega/\text{km}$. If the core diameter is 3.6 cm and resistivity of insulation is $4.65 \times 10^{14} \Omega\text{-cm}$, 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) Derive the expression for dielectric stress in a single core cable. Where is the potential gradient maximum in a single core cable and why? [[CO4](Understand/LOCQ)]
(b) An electric train, taking a constant current of 550 amps, moves on a section of line between two substations 8.5 km apart and maintained at 570 and 600 volts respectively. The track resistance is 0.045 ohms per km both go and return. Identify the point of minimum potential along the track and currents supplied by two substations at that instant. [[CO4](Applying/IOCQ)]
(4 + 2) + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	26.04	39.58	34.37