

**POWER SYSTEM – I  
(ELEC 3102)**

**Time Allotted : 3 hrs**

**Full Marks : 70**

*Figures out of the right margin indicate full marks.*

*Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.*

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

**Group – A  
(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) Which type of insulators are used on 132 kV transmission lines?  
(a) Pin type (b) Disc type  
(c) Shackle type (d) Both Pin and Shackle type
  - (ii) In a steam power plant heat from the flue gases is recovered in  
(a) condenser (b) chimney  
(c) economiser and preheater (d) pulveriser
  - (iii) In a distributor fed with same voltage at both ends with uniform loads, the point of minimum potential always occurs at  
(a) receiving end (b) mid-point  
(c) sending end (d) near sending end
  - (iv) Sheaths are used in cables to  
(a) provide proper insulation (b) protect the cable from moisture  
(c) provide mechanical strength (d) None of the above
  - (v) Corona loss increases with  
(a) increase in supply frequency and conductor size  
(b) increase in supply frequency and reduction in conductor size  
(c) decrease in supply frequency and reduction in conductor size  
(d) decrease in supply frequency and increase in conductor size
  - (vi) A conductor carries more current on the surface as compared to its core, this phenomenon is known as  
(a) Ferranti effect (b) corona  
(c) Proximity effect (d) Skin effect
  - (vii) Square root of the ratio of line impedance to shunt admittance is called  
(a) regulation of the line (b) surge admittance of the line  
(c) conductance of the line (d) surge impedance of the line.

- (viii) If an ACSR conductor has specification 48/7, it means that it has \_\_\_\_\_ numbers of aluminium strands and \_\_\_\_\_ numbers of steel strands.  
(a) 7, 48                      (b) 6, 47                      (c) 48, 7                      (d) 47, 6.
- (ix) Effect of temperature rise in overhead lines is to  
(a) increase the sag and decrease the tension  
(b) decrease the sag and increase the tension  
(c) increase both  
(d) decrease both.
- (x) The presence of earth in case of overhead lines  
(a) increases the capacitance                      (b) increases the inductance  
(c) decreases the capacitance                      (d) decreases the inductance.

### **Group- B**

2. (a) A Thermal power station consumes 1 kg of coal to generate 1 unit of electrical energy. If the calorific value of fuel is 3800 kilocalories per kg, Estimate the boiler efficiency of the power station. Given: turbine efficiency is 0.94 and alternator efficiency is 0.96. [(CO1)(Evaluating/HOCQ)]
- (b) Explain the factors for selection of site of hydroelectric power stations?  
[(CO1) (Understand/LOCQ)]
- (c) How is nuclear waste disposed of in nuclear power station?  
[(CO1) (Remember/LOCQ)]  
**4 + 4 + 4 = 12**
3. (a) What are the factors of selection of site for nuclear power station?  
[(CO1) (Remember/LOCQ)]
- (b) Draw and explain the schematic layout of a Thermal power station.  
[(CO1) (Analyse/IOCQ)]  
**4 + 8 = 12**

### **Group - C**

4. (a) Develop the expression of the effect of ice and wind pressure on sag in overhead lines. [(CO2) (Applying/IOCQ)]
- (b) An overhead transmission line conductor is subjected to a wind load of 2 kg/m and ice loading of 1 kg/m. If the maximum permissible sag is 7 meters, determine the permissible span between two supports allowing a factor of safety of 2. Weight of the conductor is 0.9 kg/m. [(CO2) (Evaluate/HOCQ)]
- (c) In a transmission line, each conductor is at 20 kV and supported by a string of 3 suspension insulators. The air capacitance between each cap-pin junction and tower is  $\frac{1}{5}$  <sup>th</sup> of the capacitance C of each insulator unit. A guard ring, effectively only over the line end insulator unit is fitted so that the voltages on the two units nearest the line-end are equal. Discover the value of  $C_x$ .

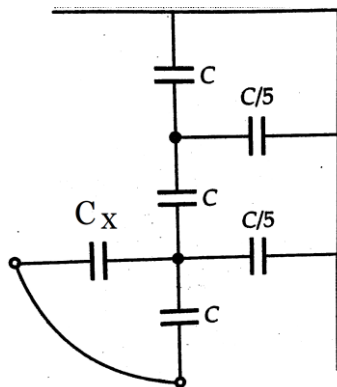


Fig. 1

[[CO2] (Analyze/IOCQ)]

4 + 3 + 5 = 12

5. (a) Explain briefly the 'skin effect' phenomenon in a transmission line. [[CO2] (Understand/LOCQ)]
- (b) What is the meaning of 30/7 ACSR conductor? Explain the advantages of ACSR conductors, when used for overhead lines. [[CO2] (Understand/LOCQ)]
- (c) In a single phase line (as shown in Fig. 2), conductors a and a' in parallel form forward circuit while conductors b and b' in parallel form the return path. Determine the total inductance of the line per km assuming that the current is equally shared by the two parallel conductors. Conductor diameter is 1.8 cm.

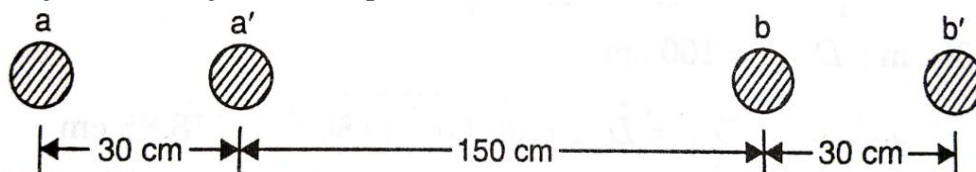


Fig. 2

[[CO2](Evaluate/HOCQ)]

3 + (1 + 2) + 6 = 12

### Group - D

6. (a) Explain the basic theory of Ferranti effect with proper phasor diagram. [[CO3] (Understand/LOCQ)]
- (b) A 3-phase 50 Hz transmission line has resistance, inductance and capacitance per phase of  $10 \Omega$ ,  $0.1 \text{ H}$  and  $0.9 \mu\text{F}$  (as shown in Fig. 3) and delivers a load of 35 MW at 132 kV and 0.8 power factor lagging. Determine the efficiency and regulation of the line using nominal-T network.

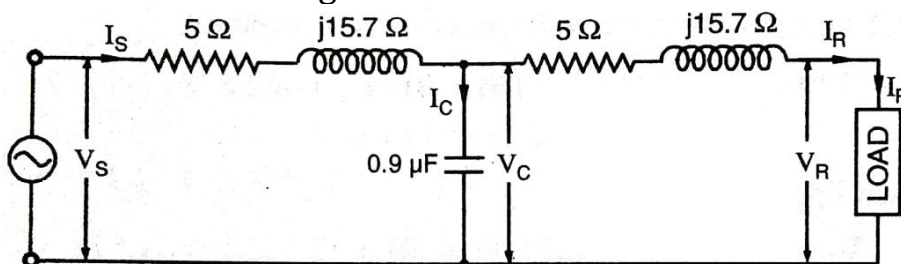


Fig. 3

[[CO3] (Evaluate/HOCQ)]

4 + 8 = 12

7. (a) A 3-phase overhead transmission line consists of 32 mm diameter conductors arranged in the form of an equilateral triangle. Assume the temperature 34° C, atmospheric pressure 73 cm, irregularity factor 0.9 and breakdown strength of air 30 kV per cm (peak). Inspect the minimum spacing between conductors, if the disruptive critical voltage is not to exceed 220 kV between the lines.  
[(CO3) (Analyze/IOCQ)]
- (b) What are the advantages of corona? [(CO3) (Remember/LOCQ)]
- (c) Classify the factors affecting the corona loss. [(CO3) (Analyze/IOCQ)]
- 5 + 1 + 6 = 12**

**Group - E**

8. (a) Prove that insulation resistance of a cable is inversely proportional to its length.  
[(CO4) (Evaluate/HOCQ)]
- (b) Construct the expression for dielectric loss in a single core cable.  
[(CO4) (Apply/IOCQ)]
- (c) Identify the most economical value of the diameter of a single core cable to be used on a 132 kV, three phase system. Also identify the overall diameter of the insulation if the peak permissible stress is not to exceed 60 kV/cm.  
[(CO4) (Apply/IOCQ)]
- 3 + 3 + 6 = 12**
9. (a) An 850 m long, 2-wire DC distributor fed from both ends, is loaded uniformly at the rate of 1.25 A/m run. If the resistance of the distributor is 0.1 Ω/km (go and return) and feed points A and B are maintained at 250 V and 240 V respectively, identify: (i) the minimum voltage and its point of occurrence, (ii) the currents supplied from feeding points A and B. [(CO4) (Applying/IOCQ)]
- (b) Illustrate the methods of power factor improvement.  
[(CO4) (Understanding/LOCQ)]
- 6 + 6 = 12**

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	30.20%	44.80%	25%

**Course Outcome (CO):**

After the completion of the course students will be able to

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

**B.TECH/EE/5<sup>TH</sup> SEM/ELEC 3102/2021**

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

<b>Department &amp; Section</b>	<b>Submission Link</b>
<b>EE</b>	<a href="https://classroom.google.com/c/NDA0Nzk3MDUxMzQw/a/NDYzMDAwMTg4ODg5/details">https://classroom.google.com/c/NDA0Nzk3MDUxMzQw/a/NDYzMDAwMTg4ODg5/details</a>