



- Answer all the following questions.
- Illustrate your answers with sketches when necessary.
- Total mark: 210 marks
- Number of questions: 6
- The exam consists of three pages.

Q.1 Write true or false with correcting the wrong statement

[40 marks]

- 1- Types of conductors commonly used for transmission lines are hard-drawn copper conductors or aluminium-core steel-reinforced.
- 2- In overhead transmission lines, steel wires aren't used as earthing wires.
- 3- The current density at the surface of the conductor being less than the current at the center of the conductor.
- 4- The power loss for a given rms alternating current being higher than the loss when the same value of direct current is flowing in the conductor.
- 5- The skin effect resistance ratio decreases with the permeability, area of cross-section of the conductor and the frequency of the supply.
- 6- The inductance of a transmission line depends on the arrangement of conductors and their size.
- 7- The geometric-mean distance (GMD) depends on the relative conductivity of the material and geometry of the section.
- 8- Receiving-end power circle diagram is used to obtain receiving end voltage and angle between sending end and receiving end voltages.
- 9- Sending-end power circle diagram is used to obtain receiving end voltage and angle between sending end and receiving end voltages.
- 10- If the span is increased, sag will be more and to keep the minimum clearance above the ground, the height of the towers supporting the conductors at both ends should be decreased.
- 11- The choice of the span depends on the size of the conductors necessary and the mechanical loading expected on the conductors due to local conditions.
- 12- The sag of the conductor depends on the span, loading conditions on the conductors, and the tension to be allowed consistent with the breaking strength and the safety factor.
- 13- The materials most commonly used for insulators on overhead lines are porcelain, PVC, XLPE, steatite and special composition materials.



- 14- With the increase in the operating voltage, the insulation required decreases.
- 15- Uniform voltage distribution across units of string of suspension insulators can be achieved by grading the self-capacitance of the units.
- 16- The corona increases with the increase in diameter of conductor.
- 17- The corona effect is reduced with the decrease in spacing between the conductors.
- 18- The most commonly used dielectrics in power cables are impregnated paper, polyvinyl chloride (PVC), cross-linked polyethylene (XLPE).
- 19- It is desirable to choose a higher value of operating stress in order to have a reduced thickness of insulation and, therefore, a reduced size of cable.
- 20- The capacitance of a cable transmission line is larger than that of an overhead line of the same length.

Q.2 **[60 marks]**

- a) Define: The skin-effect phenomena, Geometric mean distance (GMD) and Geometric mean radius (SGMD) between conductors. **(15 marks)**
- b) A single phase line consists of two conductors, a and a' in parallel forming lead connection and conductors b and b' forming return connection. The distance between a and a' is 1.25m and between b and b' is 1.25m and between a and b is 1.5m. The arrangement is horizontally symmetrical. Calculate the inductance of the line (lead and return) per km. Also calculate the capacitance to neutral per km. the diameter of each conductor is 2.3cm. **(20 marks)**
- c) A three-phase, 220 kV, 50 Hz long transmission line, delivers a load of 75000 kW at 0.8 power factor lagging at the receiving-end. The resistance of the line per phase is 16Ω and the reactance per phase is 160Ω . Susceptance per phase is 12×10^{-4} Find (a) Determine A, B, C and D constants of the line, (b) the sending-end voltage, (c) the sending-end current, (d) the sending-end power factor, (e) the phase angle between the sending-end voltage and the receiving-end voltage, (f) the regulation, (g) the transmission loss and (h) the transmission efficiency. **(25 marks)**

Q.3 **[55 marks]**

- a) Calculate the maximum sag of a line with the copper conductor, overall diameter of 0.789cm, weight 418kg/km and breaking strength 1993kg. Assume factor of safety 1.8 and span 220m. Supporting towers at different levels (2m).
- Due to its own weight and additional weight of ice loading of 0.5cm thickness.



- Due to above plus wind load acting horizontally at a pressure of 35 kg/m^2 .
- Find where the sag will be maximum. (35 marks)
- b) What are the advantages, limitations, and applications of high voltage direct current (HVDC) transmission? (20 marks)

Q.4 [25 marks]

- a) Discuss in details: (15 marks)
- The advantages and disadvantages of Liquid fuels
 - Prediction of Future Loads
 - Classification of hydro-power stations
- b) A power station is to supply 4 Loads, whose peak loads are 11000, 6000, 9000 and 8000 Kw, the diversity factor at the station is 1.8 and the annual load factor is 80%. Calculate the maximum demand on the station and the annual energy supplied from the station. If the capacity factor is 75%, find the power reserve. (10 marks)

Q.5 [20 marks]

- a) Discuss in details: (10 marks)
- Methods of equalizing the potential distribution across a string of suspension insulators.
 - The heat produced within a power cable
- b) A 3 phase line has conductors 20 mm in diameter; the conductors are arranged in equilateral formation. Find the minimum spacing between the conductors if the disruptive critical voltage 240 Kv line value, the Irregularity factor of the wire = 0.94 Air density factor = 0.96 (10 marks)

Q.6 [25 marks]

- a) Derive an expression for the capacitance C of a single core cable. (5 marks)
- b) A single core cable has conductor diameter of 2 cm and diameter of the outer sheath 4 cm, $\epsilon_r = 3.5$, the power factor on open circuit ($\cos \Phi_d$) = 0.03, the cable length = 6 Km, Find: (20 marks)
- The charging current.
 - The dielectric losses if the phase voltage of the supply is 11 Kv, 60 Hz.
 - The diameter of the outer sheath R at:
 - 1) g_{\max} is a minimum value
 - 2) Minimum value of the dielectric volume

With our best wishes