

**M. E. ELECTRICAL ENGINEERING EXAMINATION, 2024**

(1st Year, 2nd Semester)

**HIGH VOLTAGE EQUIPMENT**

Time: Three Hours

Full Marks: 100

**Answer any four questions**

1. a) With a neat sketch, explain the operation of a three-stage cascade connection of testing transformer for producing high ac power frequency voltage. Why the lowest transformer is loaded more? 8+2
- b) Give a comparative analysis between a high voltage power transformer and a high voltage testing transformer. 5
- c) A 125 kVA, 500 V/250 kV testing transformer has 8% leakage reactance and 2% resistance on 125 kVA base. A cable has to be tested at 400 kV using the above transformer as a resonant transformer at 50 Hz. If the charging current of the cable at 400 kV is 0.4 A, find the series inductance required. Assume 2% resistance for the inductor to be used and the connecting leads. Neglect dielectric loss of the cable. What will be the input voltage to the transformer? 10
2. a) Briefly explain the operating procedure of a symmetric voltage multiplier circuit proposed by Allibone. Why an additional isolating transformer is needed in this circuit? 8+2
- b) Draw a properly labelled Cockcroft-Walton voltage multiplier circuit. 3
- c) A Cockcroft-Walton type voltage multiplier has eight stages with capacitances all equal to  $0.04 \mu\text{F}$ . The supply transformer secondary voltage is 100 kV at a frequency of 50 Hz. If the load current to be supplied is 4 mA, find (i) the percentage ripple, (ii) the regulation, and (iii) the optimum number of stages for minimum voltage drop. 12
3. a) Define front time and tail time of a lightning impulse wave. What are the values of front and tail time of a lightning impulse wave and the tolerances allowed as per IS-2071 specifications? How the wave tail times are controlled in an impulse generator? 2+2+2+3
- b) With a neat circuit diagram, show the different section of a Marx multistage impulse generator circuit. 6
- c) An impulse generator has eight stages with each condenser rated for  $0.16 \mu\text{F}$  and 125 kV. The load capacitor available is 1000 pF. Find the series resistance and damping resistance needed to produce 1.2/50  $\mu\text{s}$  impulse wave. What is the maximum output voltage of the generator, if the charging voltage is 120 kV? 10

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4. a) Why is triggering required in an impulse generator? Describe a typical triggering arrangement. 5
- b) Explain the operation of a single-stage impulse generator circuit with the load connected at the discharge end. Show that for this circuit, the lightning impulse waveform is a superposition of two exponential waveforms. Explain the significance of the damping resistor ( $R_d$ ) in the impulse generator circuit. 6+6+2
- c) A 12-stage Impulse Voltage Generator has  $0.12 \mu\text{F}$  capacitors. The wave front and wave tail resistances connected are 700 ohms and 5000 ohms respectively. If the load capacitor is 900 pF, find the front and tail times of the impulse wave produced. 6
5. a) Briefly explain the working principle of a Van-de-Graff generator along with a neat diagram. 12
- b) Explain with neat diagram the operation of a series resonance circuit with multiple transformer/reactor units in series used for producing high a.c. power frequency voltage. 10
- c) A 300/200 kV testing transformer is required to test a cable. The test voltage level is 130 kV and the short-circuit impedance of the transformer is 12%. Calculate the voltage to be applied at the primary of the transformer to conduct the test. 3