

**HIGH VOLTAGE ENGINEERING
(ELEC 4231)**

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) The statistical time lag in gas breakdown refers to
 - (a) The time taken for electron multiplication
 - (b) The time delay before the first free electron appears
 - (c) The time required for full discharge
 - (d) The recombination time of ions
- (ii) Paschen's Law relates the breakdown voltage of a gas to
 - (a) Current and resistance
 - (b) Pressure and electrode spacing
 - (c) Temperature and gas density
 - (d) Ionization energy and gas velocity
- (iii) The main disadvantage of solid dielectrics compared to liquid dielectrics is
 - (a) Higher cost
 - (b) They cannot self-heal after breakdown
 - (c) Lower dielectric strength
 - (d) Lower resistance
- (iv) Partial discharges occur due to
 - (a) Complete dielectric failure
 - (b) Small voids or imperfections in insulation
 - (c) Excessive heat generation
 - (d) Pure liquid dielectric breakdown
- (v) A testing transformer is primarily used for:
 - (a) Measuring high voltage
 - (b) Generating high-frequency signals
 - (c) Testing insulation strength of electrical equipment
 - (d) Rectifying AC to DC
- (vi) If the no of transformer unit increase in cascaded connection the utilization factor will
 - (a) increase
 - (b) decrease
 - (c) remain same
 - (d) not depend on no of transformer unit

- (vii) In a multi-stage impulse generator, the total impulse voltage is obtained by
 (a) Connecting capacitor banks in parallel
 (b) Connecting stages in a series configuration
 (c) Connecting stages in a series-parallel configuration
 (d) Reducing the discharge time
- (viii) The Chubb & Fortescue Method is used for measuring:
 (a) RMS value of high AC voltage (b) Peak value of high AC voltage
 (c) High DC voltage (d) Power in AC circuits
- (ix) High voltage Schering bridge is used to measure
 (a) large capacitance without additional element
 (b) small capacitance without additional element
 (c) medium value capacitances
 (d) all values of capacitances
- (x) An overhead line with surge impedance 400 ohms is terminated through a resistance R. A surge travelling over the line does not suffer any reflection at the junction if
 (a) 20 ohms (b) 200 ohms
 (c) 800 ohms (d) none of the above

Fill in the blanks with the correct word

- (xi) Lightning impulse tests are made using a standard wave shape of _____ μ s.
- (xii) The primary advantage of composite dielectrics is that they combine multiple materials for enhanced _____ properties.
- (xiii) In series resonance circuit the low value of inductance is converted to high value by using _____.
- (xiv) The primary winding of a CT consists of _____ turns compared to the secondary winding.
- (xv) A Capacitive Voltage Transformer (CVT) is used to _____ the measuring voltage.

Group - B

2. (a) State and explain Paschen's law. [[CO1](Understand/LOCQ)]
 (b) Derive expressions for $(pd)_{\min}$ and $V_{b\min}$ [[CO1](Understand/LOCQ)]
 (c) Assume $A=10$, $B=360$ and $\gamma = 0.025$ for air. Determine $(pd)_{\min}$ and $V_{b\min}$. [[CO1](Evaluate/HOCQ)]
(2 + 2) + (3 + 2) + 3 = 12
3. (a) What are 'Treeing' and 'Tracking'? Explain clearly the two processes in solid dielectrics. [[CO1](Understand/LOCQ)]
 (b) What do you mean by 'Intrinsic strength' of a solid dielectric? [[CO1](Remember/LOCQ)]
(2 + 2 + 3 + 3) + 2 = 12

Group - C

4. (a) What is Cascaded transformer? [[C02](Understand/LOCQ)]
(b) Explain why Cascading is done? [[C02](Remember/LOCQ)]
(c) Describe with net diagram a three stage Cascaded transformer. Label the power rating of various stages of the transformer. [[C02](Apply/IOCQ)]
2 + 3 + (5 + 2) = 12
5. (a) What are the difference between a power transformer and a testing transformer. [[C02](Understand/LOCQ)]
(b) Explain with the help of a schematic diagram the working of a Symmetric voltage Doubler Multi-Stage circuit. [[C02](Apply/IOCQ)]
6 + 6 = 12

Group - D

6. (a) What are the requirements of a sphere gap for measurement of high voltage? Discuss the effect of dust particles on the measurements using sphere gap. [[C03](Apply/IOCQ)]
(b) State the difficulties in measurement of high voltages. [[C03](Understand/IOCQ)]
(c) Discuss the advantages of Chubb-Fortescue Circuit for measurement for peak value of a.c voltages over other methods. [[C03](Understand/IOCQ)]
6 + 2 + 4 = 12
7. (a) Explain the principle of operation of Generating Voltmeter for the measurement of high direct voltages with necessary diagrams. [[C03](Understand/LOCQ)]
(b) Compare the performance of Series Capacitance Voltmeter and Capacitance Potential Divider. [[C03](Analyse/IOCQ)]
(c) A generating voltmeter is required to measure voltage between 15 kV to 250 kV. If the indicating meter reads a minimum current of 2 μ A and maximum of 35 μ A, determine the capacitance of the generating voltmeter. Assume that the speed of driving of synchronous motor is 1500 rpm. [[C03](Evaluate/HOCQ)]
4 + 6 + 2 = 12

Group - E

8. (a) What is an Infinite Line? [[C05](Remember/LOCQ)]
(b) Sketch the variation of Ground Resistance as a function of Rod Length. [[C05](Apply/IOCQ)]
(c) Derive the expression of capacitance and dissipation factor obtained from a High Voltage Schering bridge circuit. [[C04](Analyse/IOCQ)]
(d) A Schering bridge used to measure the capacitance and dissipation factor of a high voltage bushing at 50 Hz gave the following results at balance:
Arm I – Standard condenser of 100 pF Arm II – Resistance of 720 ohm
Arm IV – A capacitance of 1200 pF in parallel with a resistance of 3315 ohms.
Determine the capacitance and dissipation factor of the bushing. [[C04](Evaluate/HOCQ)]

- (e) A surge of 10 kV travels along the cable towards its junction with an overhead line. The surge impedances of the cable and the line are 50 ohm and 450 ohm respectively. Determine the surge voltage transmitted in to the overhead line.
[[CO5](Evaluate/HOCQ)]
2 + 2 + 4 + 2 + 2 = 12
9. (a) Define the following: (i) flashover (ii) creepage distance. *[[CO4](Remember/LOCQ)]*
 (b) Prove that the magnitude of transmitted voltage is doubled in an open-circuited transmission line. *[[CO5](Analyse/IOCQ)]*
 (c) A lightning arrester is tested with a 1.2/50 μ s impulse voltage waveform, where the peak voltage is 120 kV and the duration of the wave is 50 μ s. What is the energy absorbed by the arrester during the test? *[[CO4](Evaluate/HOCQ)]*
 (d) A 300 Ω transmission line is terminated in a resistive load of 150 Ω . A wave with a magnitude of 80 kV is incident on the load. Calculate the transmitted voltage and current at the load. *[[CO5](Evaluate/LOCQ)]*
3 + 2 + 3 + 4 = 12
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Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	47	41	12