

**HIGH VOLTAGE ENGINEERING  
(ELEC 4102)**

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) All the parameters remaining same, the breakdown voltage is  
(a) higher with negative polarity at all pressures  
(b) lower with negative polarity at all pressures  
(c) higher with negative polarity at low pressures  
(d) higher with negative polarity at high pressures.
- (ii) If  $p$  is the pressure of gas and  $d$  is the distance of separation between the electrodes, the discharge voltage according to Paschen's law is directly proportional to  
(a)  $p$                       (b)  $d$                       (c)  $pd$                       (d) none of (a), (b), (c).
- (iii) The breakdown voltage of a specimen is 65kV at STP. The breakdown voltage at 73 cm Hg pressure and 35°C is  
(a) 69 kV                      (b) 63.25 kV                      (c) 64.33 kV                      (d) 60.39 kV.
- (iv) Paper insulation is mainly used in  
(a) Cables and capacitors                      (b) Transformers  
(c) Rotating machines                      (d) Circuit breakers.
- (v) The dielectric strength of air under normal conditions is around  
(a) 30 kV<sub>P</sub> per cm                      (b) 100 kV<sub>P</sub> per cm  
(c) 150 kV<sub>P</sub> per cm                      (d) 60 kV<sub>P</sub> per cm.
- (vi) An impulse voltage wave defined by its  
(a) wave front time  
(b) wave tail time  
(c) both wave front and wave tail time  
(d) wave front time, wave tail time and peak of its waveform.

- (vii) The mechanism responsible for dielectric loss in a dielectric are  
(a) conduction                      (b) polarization  
(c) ionization                      (d) (b) and (c).
- (viii) A generating voltmeter has  
(a) linear scale                      (b) non-linear scale  
(c) no contact with high voltage electrode                      (d) both (a) and (c).
- (ix) The voltage measurements using spark gap are  
(a) affected by nearby earth objects                      (b) affected by polarity of supply  
(c) affected by dust particles                      (d) all of (a), (b), (c).
- (x) A generating voltmeter uses  
(a) a constant speed motor  
(b) a variable speed motor  
(c) a variable speed motor with a capacitor  
(d) a constant speed motor with a capacitor.

**Group – B**

2. (a) What are volt-time curves? What is their significance in power system studies?  
(b) An AC voltage of 60 kV is applied between two parallel plates round at the edges and placed 2 cm apart in air. A press board sheet of thickness 0.2 cm is placed on the lower plate. Calculate the voltage across the air gap and the press board sheet. Given permeability of press board = 4.  
**(2 + 5) + 5 = 12**
3. (a) With a neat diagram describe the principle and operation of a valve type lightning arrester.  
(b) Explain the advantage of ground wire in lightning protection to overhead lines.  
(c) How the switching over voltages is controlled in power systems?  
**6 + 4 + 2 = 12**

**Group – C**

4. (a) Define Townsend's first and second ionization co-efficient.  
(b) Derive the expression of current growth due to in a gas discharge due to secondary mechanism.  
(c) Explain the Townsend's criterion for spark.  
**4 + 4 + 4 = 12**

5. (a) Explain briefly suspended particle theory of breakdown in liquid dielectrics.
- (b) State the various process which lead to formation of bubbles in liquid dielectrics.
- (c) A solid insulating block of thickness 2 cm and having a dielectric constant of 5 is subjected to a 50 Hz ac voltage. The specimen contain an air void of thickness 1 mm. considering the breakdown strength of air as 30 kV/cm (peak), find the maximum voltage which can be applied across the specimen without any internal discharge.
- (d) What do you mean by tracking in solid insulating materials?

$$4 + 2 + 4 + 2 = 12$$

### **Group – D**

6. (a) Explain how impulse voltages are generated in a laboratory using Marx circuit and represent it in a single stage generator circuit.
- (b) Why the multi stage impulse generator circuit is used instead of single stage impulse generator circuit.
- (c) Why the damping resistance  $R_d$  is used in impulse generator circuit?

$$7 + 3 + 2 = 12$$

7. (a) Explain the working principle of Cockroft Walton voltage doubler circuit with schematic diagram.
- (b) A Cockroft-Walton voltage doubler circuit is used to test a cable at 160 kV. The insulation resistance of the cable is  $6 \times 10^9 \Omega/m$  and the length of the cable is 10m, stage capacitance are both 0.1  $\mu F$  the generator is supplied from a 230 V/250 V testing transformer. Calculate the voltage to be applied to the input of transformer at 50 Hz.

$$7 + 5 = 12$$

### **Group – E**

8. What is Capacitive Voltage Transformer? Explain how power frequency extra high voltage is measured using a Capacitive Voltage Transformer.

$$(2 + 10) = 12$$

9. With a neat sketch explain the Chubb-Fortescue method for the measurement of peak value of AC voltages. State its advantages over other methods.

$$(2 + 7 + 3) = 12$$