

**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) Breakdown strength of a dielectric is highest for
 - (a) Switching impulse voltage
 - (b) lightning impulse voltage
 - (c) dc voltage
 - (d) ac power frequency voltage

 - (ii) The lightning on the earth prefers to strike upon
 - (a) the surface of the ground
 - (b) sharp and projected metallic objects on the ground
 - (c) wooden structures
 - (d) tall structures.

 - (iii) For the protection of power system from over-voltage travelling waves, we use
 - (a) Earth wire
 - (b) horn gaps on bushings and insulators
 - (c) lightning arrestors(surge diverters)
 - (d) relays.

 - (iv) Sphere gap is used for measurement of
 - (a) ac voltage only
 - (b) dc voltage only
 - (c) impulse voltage of any wave shape
 - (d) both ac and dc voltages.

 - (v) A generating voltmeter uses
 - (a) a constant speed motor
 - (b) a variable speed motor
 - (c) a variable speed motor with a capacitor
 - (d) a variable speed motor with an inductor.

- (vi) Townsend second ionization co-efficient γ is a function of
- (a) $f\left(\frac{E}{P}\right)$ (b) $f\left(\frac{P}{E}\right)$
(c) $f(E)$ (d) $f(P)$.
- (vii) The statistical time lag for gaseous breakdown between the electrode depends upon the
- (a) the amount of pre-ionization present in the gap
(b) size of the gap
(c) the amount of over voltage
(d) all of the above.
- (viii) According to the Townsend's mechanism of gaseous breakdown the time lag will be
- (a) smaller than that of the experimentally found
(b) higher than that of the experimentally found
(c) nearly equal than that of the experimentally found
(d) slightly lower than that of the experimentally found.
- (ix) If α and γ are the Townsends first and second ionization coefficients, d the distance of separation between the plates, the Townsend Criterion for threshold sparking is given as
- (a) $e^{\alpha d} = 1$ (b) $\gamma e^{\alpha d} = 1$
(c) $e^{\alpha d} / \gamma = 1$ (d) $\gamma e^{\alpha d} = 2$
- (x) For a 3 stage cascaded transformer if P1, P2, P3 are the loading of I, II, III stages primaries, then
- (a) $P1=P2=P3$ (b) $P1>P2>P3$
(c) $P1<P2<P3$ (d) $P2<P1<P3$.

Group – B

2. (a) What is meant by multiple stroke and return stroke?
(b) A rectangular voltage wave of 2000KV is travelling along a line of surge impedance 300Ω towards a lightning arrester. The arrester protective level is 1200 KV and is assumed to be fairly constant at all current values discharged by the arrester. Calculate (i) the current flowing in the line before the surge voltage reaches the arrester terminals, (ii) the current through the arrester and (iii) the value of arrester resistance for this condition.
- 6 + 6 = 12**
3. (a) Explain with neat sketches the mechanism of lightning discharge.
(b) What is insulation coordination? Explain its significance.

6 + 6 = 12

Group – C

4. (a) Explain why the impulse breakdown voltage is higher than the power frequency breakdown voltage for a gaseous gap subjected to a uniform field.
- (b) A steady current of $500\mu\text{A}$ flows through the plane electrode separated by a distance of 0.4 cm when a voltage of 10kV is applied. Determine the Townsend's first ionization co-efficient if a current of $50\mu\text{A}$ flows when the distance of separation is reduced to 0.1 cm and the field is kept constant at previous value.
- (c) Briefly discuss the nature of ac corona loss.

4 + 4 + 4 = 12

5. (a) Explain electromechanical breakdown mechanism in solid dielectric.
- (b) What is 'treeing' and 'tracking'? Explain clearly the two processes in solid dielectric.
- (c) Explain the suspended particle theory of breakdown in liquid dielectric.

4 + 4 + 4 = 12

Group – D

6. (a) What are the differences between testing and power transformer?
- (b) Find the utilization capacity for a four stage cascaded connection of transformer.
- (c) Explain the multistage symmetric dc voltage multiplier circuit.

4 + 4 + 4 = 12

7. (a) Explain the basic principle of impulse voltage generation circuit.
- (b) A Cockroft-Walton voltage doubler circuit is used to test a cable at 150kV. The insulation resistance of the cable is $5 \times 10^9 \Omega/\text{m}$ and the length of the cable is 10m. Stage capacitances are both $0.2\mu\text{F}$. The generator is supplied from a 230V/250kV testing transformer. Calculate the voltage to be applied to the input of the transformer at 50Hz.
- (c) Why it is advisable to test cable insulator with high voltage ac by series resonance circuit in state of testing transformer?

6 + 4 + 2 = 12

Group – E

8. (a) How impulse voltage measurement is possible using a sphere gap? What is the effect of humidity on the measurements using it?

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- (b) Design a peak reading voltmeter along with a suitable micro-ammeter, such that it will be able to read voltages up to 100KV (peak). The capacitance potential divider available is of the ratio 1000:1.
- (c) A generating voltmeter has to be designed so that it can have a range from 20 to 200KV dc. If the indicating meter reads a minimum current of $2\mu\text{A}$ and a maximum current of $25\mu\text{A}$, what should be the value of capacitance of generating voltmeter?

4 + 4 + 4 = 12

9. (a) How Chubb-Forrescue method is used for measurement of high voltage?
- (b) What is Rogowski coil? How is it used for measuring impulse current? How is it different from a current shunt?

4 + 4 + (2 + 2) = 12

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EE	https://classroom.google.com/c/MTIzNjQ2MjY3ODM4/a/MjcxMDA5NTIxNzQ5/details