



Name :

Roll No. :

Invigilator's Signature :

CS/B.TECH (EE)/SEM-7/EE-704A/2012-13

2012

HIGH VOLTAGE ENGINEERING

Time Allotted : 3 Hours

Full Marks : 70

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following :

10 × 1 = 10

i) According to Townsend's mechanism breakdown of gases take place when

a) $\gamma.e^{\alpha d} = 1$ b) $\gamma.e^{\alpha d} < 1$

c) $\gamma.e^{\alpha d} > 1$ d) $\gamma.e^{\alpha d} = 0$.

ii) If E_r is radial field due to space charge and E_0 the externally applied field, for the transformation of avalanche into Streamer taking place necessary condition is

a) $E_r < E_0$ b) $E_r > E_0$

c) $E_r = E_0$ d) none of these.



- iii) Partial discharge of a dielectric is due to
 - a) presence of air bubbles or voids
 - b) presence of impurities
 - c) use of low quality impregnants
 - d) all of these.
- iv) A standard lightning impulse wave as per Indian standard specification is
 - a) $1.5/60 \mu\text{-sec}$
 - b) $1.2/50 \mu\text{-sec}$
 - c) $1.8/80 \mu\text{-sec}$
 - d) $1/60 \mu\text{-sec}$.
- v) About 90% of lightning strokes to ground are of
 - a) positive polarity
 - b) negative polarity
 - c) neutral polarity
 - d) can not be determined.
- vi) The most commonly used Lightning Arrester in a sub-station is
 - a) rod gap type
 - b) horn gap type
 - c) thyrite type
 - d) metal oxide type.
- vii) In gapless lightning arrester the non-linear resistance is made of
 - a) oxides of metal
 - b) silicon carbide
 - c) fluorocarbide
 - d) none of these.
- viii) The impulse ratio of sphere gap voltmeter is
 - a) equal to 1
 - b) equal to 2
 - c) equal to 5
 - d) equal to 9.
- ix) The energy rating of Impulse Generator is
 - a) $VI \cos\Phi$
 - b) $VI \sin\Phi$
 - c) $(VI \cos\Phi)T$
 - d) $\frac{1}{2}CV^2$
- x) A multi-stage Impulse generator is called
 - a) cascade transformer
 - b) MARX circuit
 - c) Cockroft-Walton generator
 - d) voltage doubler circuit.
- xi) Measuring range of a Sphere Gap Voltmeter is
 - a) 1-2000 kV
 - b) 2-2500 kV
 - c) 0-5000 kV
 - d) 100-3000 kV.



GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following

3 × 5 = 15

2. What is a partial discharge and how is it developed in a solid dielectric under application of a high voltage *ac* ? Explain the development of voltage across a void in a solid dielectric with the equivalent circuit. 2 + 3
3. For testing a cable what are the advantages of a series resonant transformer over conventional testing transformer with high voltage *ac* ?
4. How would you specify an impulse wave ? How would you determine the wave front time and wave tail time as per Indian Standard Specification ? What are the tolerance limits ? 1 + 3 + 1
5. How induced overvoltage test is carried out on a transformer ? Explain the utility of such test. 3 + 2
6. Explain with a neat sketch the working principle of a Generating Voltmeter for the measurement of a *dc* high voltage.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following.

3 × 15 = 45

7. a) Draw and define the front time and tail time of a standard lightning impulse wave. What are the tolerances allowed as per the specifications ?
- b) Draw the modified Marx-circuit arrangement for 4-stage impulse generator and hence explain its working principle.
- c) An impulse generator has 12 capacitors of 0.12 μF and 200 kV rating. The wave front and wave tail resistances are 1.25 $\text{k}\Omega$ and 4 $\text{k}\Omega$ respectively. If the load capacitance including that of the test object is 1000 pF, find the wave front and the wave tail times of the impulse wave produced. 3 + 8 + 4



8. a) In reference to the electromechanical breakdown in solid dielectric find the expression for critical stress involving the Young's modulus of the solid dielectric. Show that the critical stress is independent of the thickness of the solid.
- b) Establish Townsend's current growth equation for gases considering amplification of electrons due to secondary avalanches.
- c) In an experiment in a certain gas it was found that the steady state current is $5 \cdot 5 \times 10^{-8}$ A at 8 kV at a distance of 0.4 cm between the plane electrodes. Keeping the field constant and reducing the distance to 0.1 cm results in a current of $5 \cdot 5 \times 10^{-9}$ A. Calculate
 - i) Townsend's primary coefficient α
 - ii) Townsend's secondary ionization coefficient, if the breakdown occurred when the gap distance was increased to 0.9 cm. 5 + 6 + 4
9. Write short notes on : 3 × 5
 - i) Measurement of high *dc* voltage using generating voltmeters.
 - ii) Significance of volt-time characteristics curve in insulation coordination.
 - iii) Thermal breakdown in solid insulation.
10. a) Draw the cascade connection of transformer for producing 300 kV, 1.5 A considering three stages. Also mention the voltage and current specification of transformer in each stage.
- b) Differentiate between type test and routine test. Describe the power frequency test on insulators. 7 + 8
11. a) Explain how a sphere gap can be used to measure the peak value of voltages ? Mention the factors influencing the spark over voltage of sphere gaps.
- b) Derive the expression for $(Pd)_{\min}$ and $(Vb)_{\min}$ with the help of Paschen's diagram. 8 + 7

=====