University of Moratuwa, Sri Lanka

Faculty of Engineering

Department of Electrical Engineering

B. Sc. Engineering Honours Degree Course

Level 4 – Semester 2 Examination

EE427 – HIGH VOLTAGE BREAKDOWN & TESTING

Time Allowed: 2 Hours June 2007

Additional Material

Graph Paper will be provided if required.

Instructions to Candidates

This paper contains 5questions in3 pages

This examination accounts for 70% of the module assignment.

Total marks for the paper is 70 marks.

The maximum mark attainable is indicated in square brackets.

Answer All Questions.

This is a closed book examination and only authorized calculators will be permitted.

Technical Information for candidates

Permeability of free space $\mu_0 = 4\pi \times 10^{-7}$ H/m

Permittivity of free space $\varepsilon_0 = 8.854 \times 10^{-12}$ F/m

Velocity of light in free space = 2.998×10^{8} m/s

Question 1

a) List gas ionization process and describe one such process. [*2 marks*]

b) Describe briefly, with the aid of suitable diagrams and equations, the avalanche mechanism in breakdown process of gaseous dielectrics. [*4 marks*]

c) Determine expression for the Townsend's first and second ionization coefficients. [*2 marks*]

d) In a certain Townsend type discharge, the following measurements were made.

d(mm)	1	2	3	4	5	6	8	10	12	14	16
I(pA)	19	21	26	32	40	45	80	106	152	255	430

Determine the values of the Townsend's coefficients. [*6 marks*]

Question 2

a) Derive an expression for the corona inception in a two conductor system with radius of each conductor r and the spacing between the conductors, d. [*4 marks*]

b) Describe the process of stable corona formation by discussing the relationship of the corona radius and electric stress at the corona boundary. [*4 marks*]

c) Describe four processes by which solid insulation may breakdown below their intrinsic strength. [*2 marks*]

d) Discuss the creepage length associated with high voltage insulators and indicate the methods used to increase the creepage length of disc type insulators used in overhead transmission lines. [*4 marks*]

Question 3

a) Describe briefly with the aid of suitable diagrams, one form of electrostatic generators used in generating high dc voltages. [*2 marks*]

b) Describe the operation of the voltage doubler circuit. Determine the relationships for the peak inverse voltage of the diodes and output voltage in terms of input voltage $V_m \sin(wt)$. [*4 marks*]

c) Describe the Cockroft Walton dc generator with suitable diagrams. [*6 marks*]

d) Why direct voltages are commonly used to test the insulation strength of AC cables. [*2 marks*]

Question 4

a) Show that the deflecting torque of an electrostatic voltmeter is proportional to the product of the square of the applied voltage and the rate of change of capacitance. [*4 marks*]

b) Draw a diagram of Abraham Voltmeter and describe its operation principle. [*2 marks*]

c) Describe the use of sphere gap method to measure high voltage and describe the method of implementing air density correction. [*4 marks*]

d) A sphere gap should breakdown at standard atmospheric conditions at voltage of 120kV. Calculate the applied voltage to the sphere gap in the test conditions where the ambient temperature and pressure is 35^{o}C and 765 torr. [*4 marks*]

Question 5

a) Draw the equivalent circuit of a single void solid dielectric and explain the internal discharge phenomenon. [*4 marks*]

b) Describe the use of oscilloscope with elliptical time base for the deflection of internal discharge of a solid dielectric. [*4 marks*]

c) Draw the typical oscillogram for the internal discharge of an oil-impregnated capacitor, where discharges are approximately equal in magnitude and number in two half cycles. [*4 marks*]

d) Explain with suitable diagram, the use of cascade arrangement of transformers for the generation of high alternating voltages. [*2 marks*]