

EE427 – HIGH VOLTAGE BREAKDOWN & TESTING

Time Allowed: Two Hours

30 April 2004

Answer **All** Questions.

Total marks for the paper is 70 marks

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

Permittivity of free space $\epsilon_0 = 8.854 \times 10^{-12}$ F/m

- 1 Describe briefly with the aid of suitable diagrams, where appropriate, the following:
- (a) time lag characteristic of spark breakdown for a standard impulse waveform, [3 marks]
 - (b) thermal breakdown of a solid dielectric, [2 marks]
 - (c) breakdown of solid insulating materials due to internal discharges, [2 marks]
 - (d) breakdown of liquids below intrinsic strength due to the 3 types of impurities, [3 marks]
 - (e) A 132 kV, three-phase, 50Hz transmission line uses 18 mm diameter, equally spaced ACSR conductors. What should be the spacing between these conductors, if it is to be designed such that the corona inception voltage is 5% higher than the normal operating voltage of the line at normal temperature and pressure conditions. [4 marks]

- 2 Briefly explain the Townsend's breakdown process for gaseous dielectrics. [3 marks]

Determine expressions for the Townsend's first and second ionization coefficients. [3 marks]

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. [8 marks]

- 3 (a) Describe briefly with the aid of suitable diagrams one form of electrostatic generator used to obtain high direct voltages. [3 marks]
- (b) Give the basic circuit and explain briefly a resonance method used to control the output of a high voltage test transformer. [3 marks]
- Why is this method not suitable for power transmission? [1 marks]
- (c) 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. [3 marks]
- (d) Outline the significance of type tests, sample tests and routine tests performed on high voltage equipment, making use of suitable examples. [4 marks]

- 4 (a) Describe briefly with the aid of suitable diagrams a method of detecting internal discharges in solid dielectrics. [4 marks]
- (b) With the aid of suitable diagrams briefly describe the operation of the Klydonograph for the measurement of lightning. [3 marks]
- (c) With the aid of suitable diagrams briefly describe the measurement of dielectric constant and loss tangent of an insulating liquid. [4 marks]
- (d) In a high voltage laboratory, a capacitive potential divider is to be used with a delay cable to observe the surge waveform on an oscilloscope. Explain how the cable may be matched to minimise possible waveform distortion. [3 marks]

- 5 Figure Q5 shows a modified form of high Voltage Schering Bridge used in a particular measurement. The values of the components at balance are shown on the diagram. Determine the value of the unknown capacitor and its loss tangent.

[10 marks]

It is later detected that the standard capacitor used is not lossless, but has a loss factor of 0.0014. What are the actual values of the unknown capacitor and its loss tangent.

[4 marks]

All necessary equations must be derived.

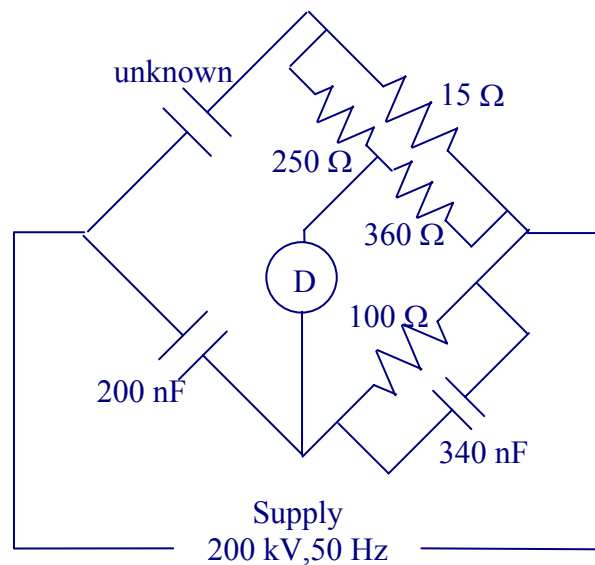


Figure Q5