University of Moratuwa, Sri Lanka
B. Sc. Engineering Honours Degree Course
Level 4 – Semester 2 Examination 2004/05

EE427 – HIGH VOLTAGE BREAKDOWN & TESTING

Time Allowed: Two Hours | 16 August 2005
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 $\varepsilon_o = 8.854 \times 10^{-12}$ F/m

1. Describe briefly, with the aid of suitable diagrams, equations and/or examples, where appropriate, the following:
   (a) the avalanche process in the breakdown process of gaseous dielectrics *[2 marks]*
   (b) an expression for the critical corona inception voltage in a 2 conductor line *[3 marks]*
   (c) breakdown of liquids below intrinsic strength due to the 3 types of impurities, *[3 marks]*
   (d) the process of surface breakdown, tracking and erosion *[2 marks]*

   In a certain high voltage equipment, coconut oil ($\varepsilon_{r1} = 3.0$, $\xi_{max1} = 25$ kV/mm) is present between 2 electrodes 4 mm apart.
   (e) Determine the maximum permissible voltage across the electrodes. *[1 mark]*
   (f) A solid dielectric material ($\varepsilon_{r2} = 4.5$, $\xi_{max2} = 100$ kV/mm) of thickness 1 mm is introduced into the oil between the electrodes in an attempt to increase the maximum voltage. Calculate the new maximum voltage and comment on the decision. *[3 marks]*

2. Describe briefly, with the aid of suitable diagrams the following.
   (a) the cascade arrangement of transformers to obtain high alternating voltage for testing purposes. *[3 marks]*
   (b) the operation of a Voltage Multiplier Circuit to obtain high voltage direct current for testing purposes *[4 marks]*
   (c) one form of electrostatic generator used to obtain high direct voltages. *[3 marks]*
   (d) 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]*

3. Describe briefly, with the aid of suitable diagrams the following.
   (a) why a capacitive potential divider needs to be matched to the cable connecting it to an oscilloscope, and how the matching may be achieved *[4 marks]*
   (b) dielectric loss measurement using the oscilloscope *[4 marks]*
   (c) type tests, sample tests and routine tests in high voltage equipment, making use of suitable examples. *[3 marks]*
   (d) measurement of capacitance and loss tangent in a liquid dielectric *[3 marks]*

4. Describe briefly with the aid of suitable diagrams the following.

(a) a method of detecting internal discharges in solid dielectrics. *[4 marks]*

(b) the measurement of high voltages using the Abraham Voltmeter. *[3 marks]*

(c) With the aid of suitable diagrams briefly describe the operation of the Klydonograph for the measurement of lightning. *[3 marks]*

(d) With the aid of suitable diagrams briefly describe the measurement of dielectric constant and loss tangent of an insulating liquid. *[4 marks]*

5 (a) Describe a high voltage Schering Bridge which uses a guarded standard capacitor, explaining how the guard is maintained at the required voltage during balance. *[4 marks]*

(b) Figure Q5 shows a 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. All necessary equations must be derived. *[10 marks]*

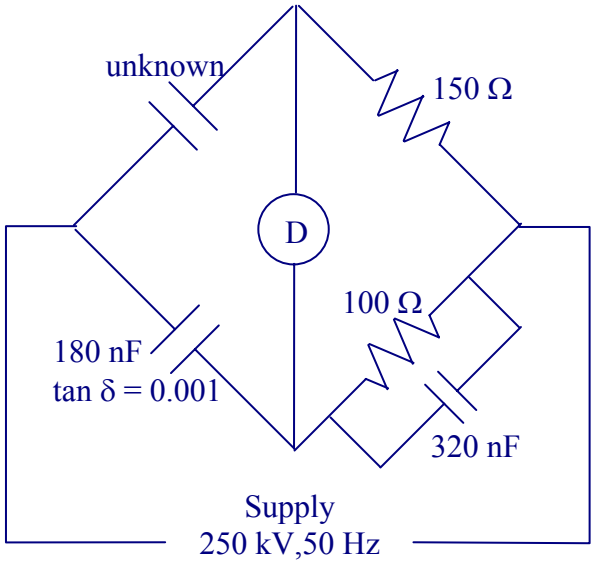

Figure Q5