Universiti Tun Hussein Onn Malaysia

# UNIVERSITI TUN HUSSEIN ONN MALAYSIA

## FINAL EXAMINATION
## SEMESTER II
## SESSION 2013/2014

| | | |
|---|---|---|
| COURSE | : | ELECTRICAL MEASUREMENTS |
| COURSE CODE | : | BEF 20903 / BEF 23903 |
| PROGRAMME | : | BEF / BEV |
| EXAMINATION DATE | : | JUNE 18th, 2014 |
| DURATION | : | 3 HOURS |
| INSTRUCTION | : | ANSWER ALL **FIVE** QUESTIONS. |

THIS PAPER CONSISTS OF **SEVEN** (7) PAGES

**Q1** (a) Explain the construction and principle of operation of a dynamometer type wattmeter.

(5 marks)

(b) Draw a neat sketch of the single-phase induction-type energy meter and explain its constructional details and working.

(5 marks)

(c) A three-phase 415 V motor load has a power factor of 0.7. The two wattmeters connected to measure power show the input to be 20 kW.

(i) Find the reading on each wattmeter. ( 6 marks )

(ii) Find the total reactive power consumed by the motor. ( 4 marks )

**Q2** (a) Write a short note on instrument transformers. ( 5 marks )

(b) A current transformer has a rating of 50 VA, 400 A/5 A, 36 kV, 50 Hz. It is connected into an a.c. line having a line-to-neutral voltage of 14.4 kV. The ammeters, relays and connecting wires on the secondary side possess a total impedance (burden) of 1.2 Ω. If the transmission line current is 280 A, calculate:

(i) The secondary current ( 3 marks )

(ii) The voltage across the secondary terminals ( 3 marks )

(iii) The voltage drop across the primary. ( 3 marks )

(c) A potential transformer rated 14,400 V/115 V and a current transformer rated 75A/5A are used to measure the voltage and current in a transmission line. If the voltmeter indicates 111 V and the ammeter reads 3 A, calculate the voltage and current in the line.

( 6 marks )

**Q3** (a) Sketch a circuit diagram to show how a voltmeter and ammeter should be connected to measure a very low resistance. Explain briefly.

( 5 marks )

(b) In the Wheatstone bridge circuit shown in **Figure Q3(a)**, $R_T$ is a resistive temperature sensor, while $R_1$, $R_2$, are standard resistors and $R_3$ a variable resistor. Suppose the resistance $R_T$ of the temperature sensor is related to the temperature T, in °C, by the equation

$$R_T = (1500 + 25T) \text{ ohms}$$

The bridge is balanced by adjusting $R_3$ until $R_3 = 250\ \Omega$. What is the value of the temperature?

( 5 marks )

(c) The insulation resistance of a metal-sheathed electric cable is to be measured using the circuit diagram shown in **Figure Q3(b)**. With a 15 kV supply and the guard wire not connected, the measured current is 1.2 μA. The indicated current falls to 0.045 μA when the guard is connected directly to the supply. Calculate the volume resistance and the surface leakage resistance of the cable.

( 10 marks )

**Q4** (a) **Figure Q4** shows the schematic circuit of a peak reading voltmeter that measures the peak value of the input voltage by measuring the rectified charging current $I$ flowing through the standard capacitor C. If the input voltage waveform is sinusoidal and has a peak voltage of $V_m$, show that

$$V_m = \frac{I}{2fC}$$

where $f$ is the frequency of the input voltage.

( 10 marks )

(b) An electrostatic voltmeter has a capacitance of 0.1 μF and full-scale deflection of 10 kV. Determine the capacitance of the capacitor connected in series which will make the full-scale deflection represent 60 kV.

( 10 marks )

**Q5** (a) Explain the four-point method of measuring earth resistivity. ( 5 marks )

(b) It is decided to determine the resistivity of a plot of land at a depth of 450 cm using the 4-point method.

(i) Determine the distance between the electrodes. ( 3 marks )

(ii) If the meter readings are $V = 30$ V and $I = 2$ A, determine the resistivity ρ.

( 3 marks )

(c) The Fall-of-Potential method was used to obtain earth resistance value of an earth electrode using the setup shown in **Figure Q5** and the readings obtained are as shown in **Table Q5**. Determine the earth resistance of the earth electrode.

( 9 marks )

**Table Q5**

| P rod distance from E rod | Resistance (Ω) |
|---|---|
| 10 % | 71.5 |
| 20 % | 82.3 |
| 30 % | 83.2 |
| 40 % | 83.6 |
| 50 % | 83.7 |
| 60 % | 84.1 |
| 70 % | 84.6 |
| 80 % | 85.3 |
| 90 % | 94.8 |

**END OF QUESTIONS**

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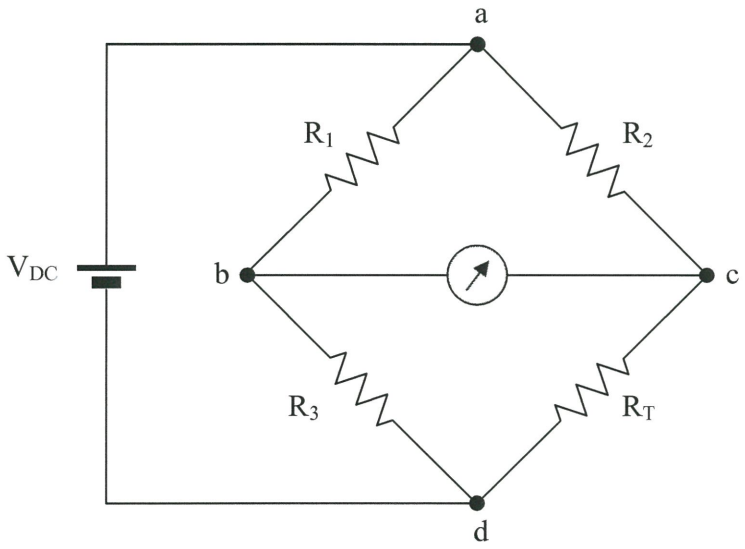


**FIGURE Q3(a)**

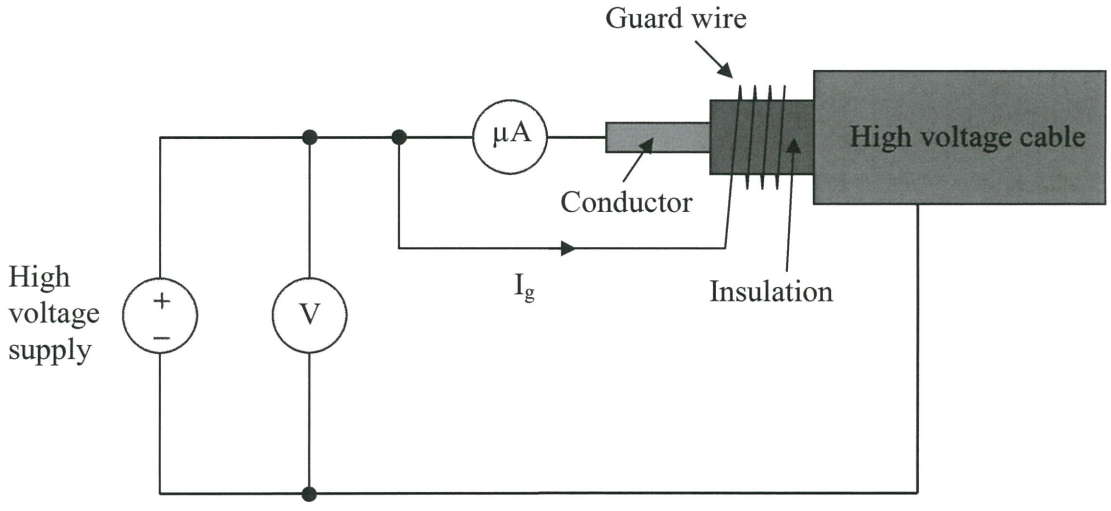


**Figure Q3(b)**

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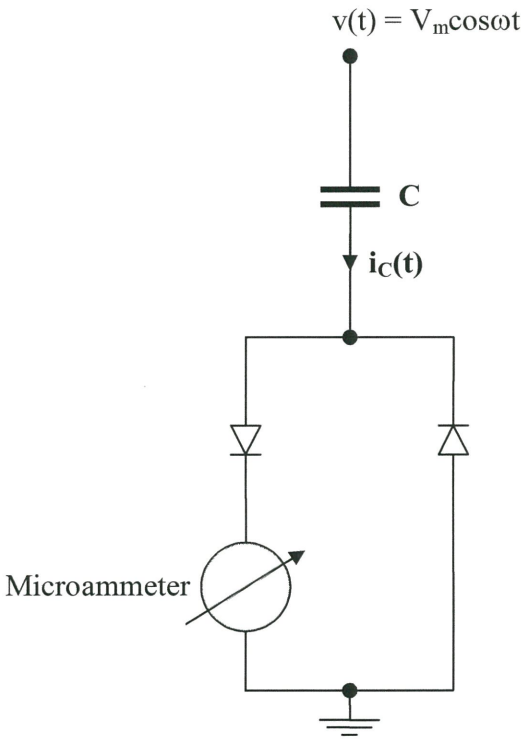


**Figure Q4**

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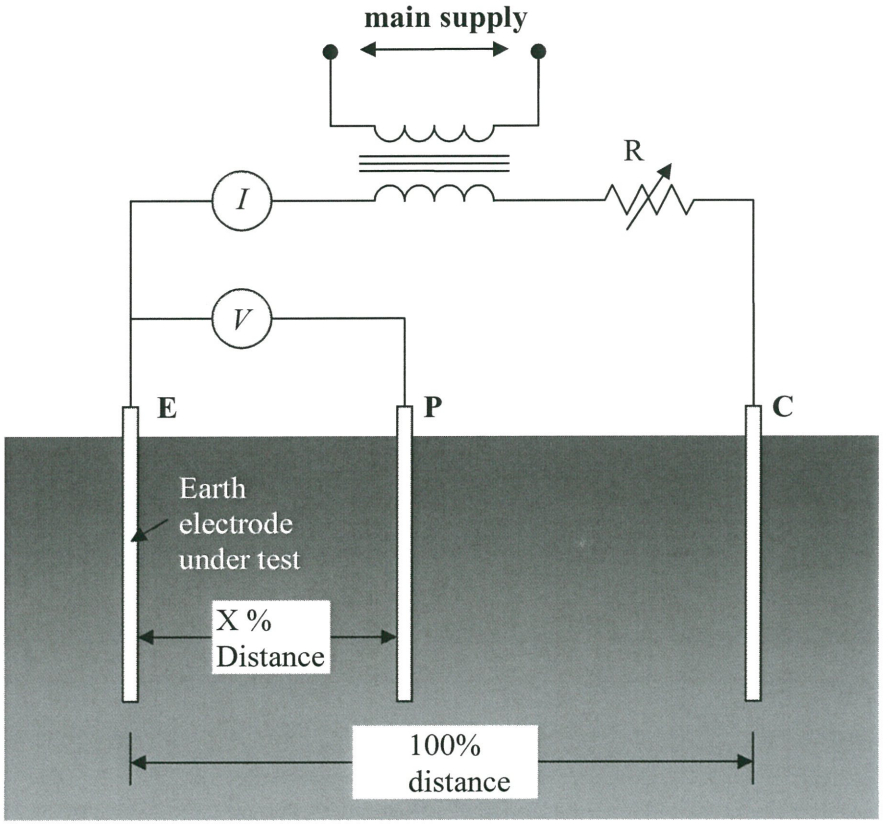


**Figure Q5**