UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2016/2017

COURSE NAME	:	ELECTRICAL MEASUREMENTS
COURSE CODE	:	BEF 23903
PROGRAMME CODE	:	BEV
EXAMINATION DATE	:	JUNE 2017
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

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

Q1 (a) There are different types of error can be occurred during measurement process. State the **three (3)** types of systematic errors with appropriate examples.

(3 marks)

(b) A voltmeter reading 80 V on its 100 V range and an ammeter reading 100 mA on its 150 mA range are used to determine the power dissipated in a resistor. Both instruments are guaranteed to be accurate within ±1.5% at full scale deflection. Determine the limiting error of the power.

(6 marks)

(c) **Figure Q1(c)** shows an AC voltmeter using half wave rectifier. The two diodes (D_1 and D_2) have an average forward resistance of 50 Ω and infinite resistance in reverse biased.

(i) Describe the function of diode, D_2.

(2 marks)

(ii) Illustrate the input and output waveform of the voltmeter.

(2 marks)

(iii) Determine DC sensitivity, S_{dc} and AC sensitivity, S_{ac} of the voltmeter. Given that $R_{sh} = 250\ \Omega$, $I_m = 100\ \mu A$, $R_m = 200\ \Omega$.

(2 marks)

(iv) Based on **Q1(c)(iii)**, calculate the value of multiplier, R_s that required to measure the input voltage, $V_{in} = 20\ V_{rms}$.

(5 marks)

Q2 (a) The wheatstone bridge can be used for measuring the medium resistance as shown in **Figure Q2(a)**.

(i) Under balance condition, analyze the circuit in order to determine the equation of unknown resistance, R_x.

(6 marks)

(ii) Explain the limitation of wheatstone bridge in measurement of low resistance.

(2 marks)

(iii) Choose a suitable bridge for measuring low resistance.

(2 marks)

(b) Explain the purpose of Maxwell's Bridge in electrical measurement.

(2 marks)

(c) Compare **one (1)** main feature of Maxwell's Bridge and Hay Bridge.

(3 marks)

(d) The Wien bridge is primarily known as a frequency determining bridge. It also can be used for the measurement of an unknown capacitor with great accuracy. Prove that the equation of unknown frequency, f in **Figure Q2(d)** is as follows:

$$f = \frac{1}{2\pi\sqrt{C_1 C_3 R_1 R_3}}$$

(5 marks)

Q3 (a) Instrument transformers are employed in conjunction with standard low-range AC instruments for measuring high current or voltage.

(i) Explain the **two (2)** advantages of instrument transformers.

(2 marks)

(ii) Draw and label the equivalent circuit of the current transformer.

(3 marks)

(iii) Suggest **two (2)** solutions in order to reduce the errors in the current transformer.

(4 marks)

(b) A current transformer has one turn on primary and 300 turns on secondary winding. The secondary current is 5 A and secondary burden is 1.5 Ω. The magnetomotive force (mmf) is 90 AT. The frequency is 50 Hz and core area is 20 mm^2. By neglecting the effects of magnetic leakage and iron losses, calculate:

(i) The secondary voltage of the current transformer.

(1 mark)

(ii) The maximum flux in the core.

(2 marks)

(iii) The flux density in the core.

(2 marks)

(iv) The magnetising current, I_o.

(2 marks)

(v) Phase angle, δ.

(4 marks)

Q4 (a) **Figure Q4(a)** shows a circuit of high voltage measurement using Capacitance Potential Divider.

(i) Derive the equation of voltage across capacitor, C_2.

(4 marks)

(ii) If an electrostatic voltmeter has a capacitance of 0.2 μF and full-scale deflection of 10 kV. Determine the value of series capacitance which will make the full-scale deflection represent 50 kV.

(3 marks)

(b) Capacitor Voltage Transformer (CVT) is used for voltage metering and protection in high voltage network systems. Draw and label the electrical connection of a Capacitive Voltage Transformer (CVT) for measuring high voltage.

(3 marks)

(c) Various methods can be used for the measurements of power in single-phase AC circuit.

(i) Compare the configuration of three-voltmeters method and three-ammeters method for measurement of power.

(4 marks)

(ii) Describe **one (1)** disadvantage of the three-voltmeters method.

(2 marks)

(d) Construct a circuit of power measurement using wattmeter in conjuction with instrument transformer.

(4 marks)

Q5 (a) Differentiate the characteristic of low resistance and high resistance by using appropriate examples.

(4 marks)

(b) The ammeter-voltmeter method can be used to measure the low resistance.

(i) Sketch the electrical connection of the ammeter-voltmeter method.

(3 marks)

(ii) Based on answer in **Q5(b)(i)**, derive the equation of unknown resistance.

(4 marks)

(iii) By using ammeter-voltmeter method, the reading of voltmeter and ammeter are 3.5 V and 4.5 A respectively. Given the internal resistance of voltmeter is 450 Ω. Calculate the percentage of error for low resistance measurement.

(4 marks)

(c) There are several factors that contribute to the error in low resistance measurements.

(i) Point out **two (2)** main factors that contribute to the error in low resistance measurements.

(2 marks)

(ii) Propose the possible solution in order to minimize the errors in **Q5(c)(i)**.

(3 marks)

- END OF QUESTIONS -

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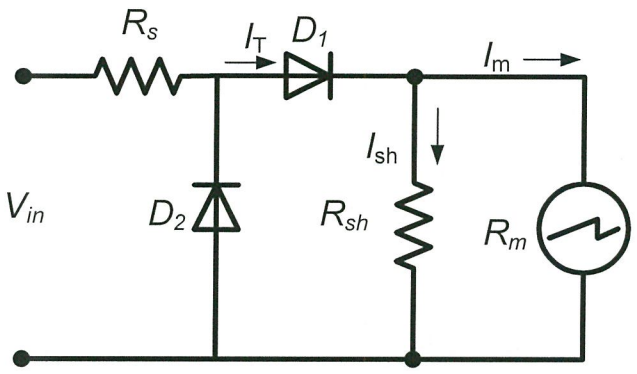

Figure Q1(c)

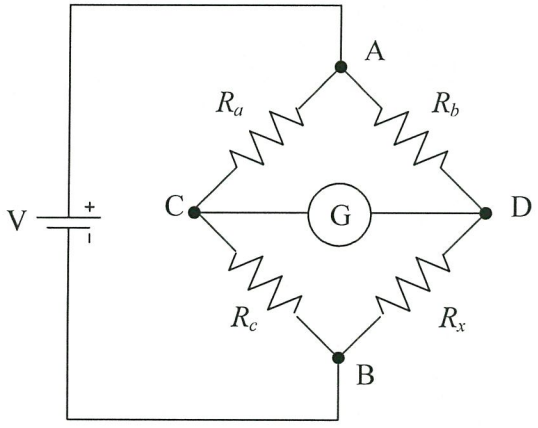

Figure Q2(a)

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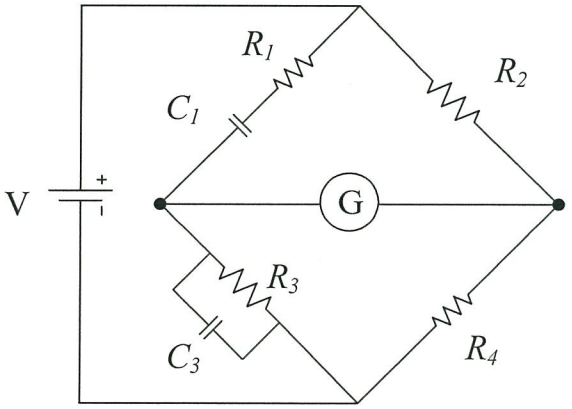

Figure Q2(d)

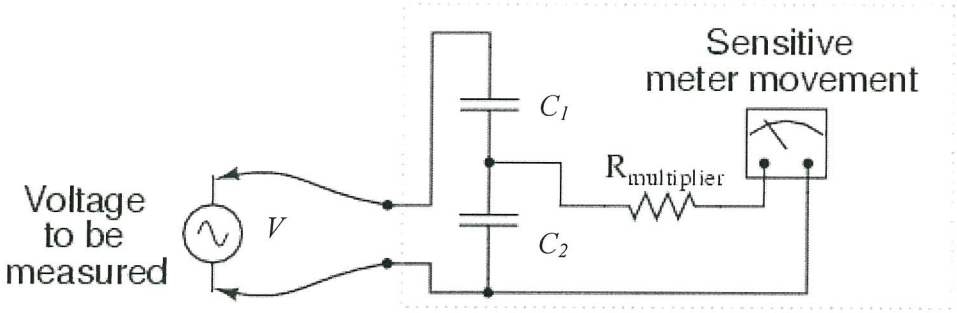

Figure Q4(a)