UTHM
Universiti Tun Hussein Onn Malaysia

# UNIVERSITI TUN HUSSEIN ONN MALAYSIA

## FINAL EXAMINATION
## SEMESTER I
## SESSION 2016/2017

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|---|---|---|
| COURSE NAME | : | ELECTRICAL MEASUREMENTS |
| COURSE CODE | : | BEF 20903 / BEF 23903 |
| PROGRAMME CODE | : | BEV |
| EXAMINATION DATE | : | DECEMBER 2016 / JANUARY 2017 |
| DURATION | : | 3 HOURS |
| INSTRUCTION | : | ANSWER **ALL** QUESTIONS |



THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

**Q1** (a) It is important to know the performance characteristics of the intrument before performing the measurement. Discuss **two (2)** main performance characteristics that should be considered in measurements.

(4 marks)

(b) The voltmeter and ammeter are connected in parallel and series respectively in order to determine the value of unknown resistor as shown in **Figure Q1(b)**. It is found that the voltmeter reads 100 V on the 150 V scale while the ammeter reads 10 mA. The voltmeter has sensitivity of 1 kΩ/V and the internal resistance of ammeter is neglected. From the circuit, determine:

(i) The apparent resistance of the resistor .

(2 marks)

(ii) The actual resistance of the resistor.

(4 marks)

(iii) The percentage error due to loading effect of the voltmeter.

(2 marks)

(c) The Permanent Magnet Moving Coil (PMMC) can be modified to measure the DC and AC voltage.

(i) Construct the AC voltmeter by using full wave rectifier circuit.

(4 marks)

(ii) Illustrate the input and output of the AC voltmeter based on **Q1(c)(i)**.

(2 marks)

(iii) Justify the effectiveness of the full wave rectifier AC voltmeter compared to half wave rectifier circuit.

(2 marks)

**Q2** (a) Wheatstone bridge is the basic DC bridges for measuring the medium resistance.

(i) The wheatstone bridge shows in **Figure Q2(a)(i)** is under unbalanced condition. By using appropriate theorem, calculate the total current through the galvanometer if $V$=8 V, $R_1$=15 kΩ, $R_2$=15 kΩ, $R_3$=2 kΩ, $R_4$=2.2 kΩ and $R_G$=200 Ω.

(6 marks)

(ii) Identify the limitations of wheatstone bridge.

(4 marks)

(b) The Maxwell Bridge is used to measure the unkown inductance in term of a known capacitor as shown in **Figure Q2(b)**.

(i) Under balanced condition, show that the unknown inductance, $L_x$ and resistance, $R_x$ are as follows:
(*Hint: the general equation for balance condition is* $Z_1Z_x=Z_2Z_3$)

$$R_x = \frac{R_2 R_3}{R_1}; \quad L_x = C_1 R_2 R_3$$

(5 marks)

(ii) Define the equation of quality factor, $Q$ of the unknown inductance in **Q2(b)(i)**.
(3 marks)

(iii) Maxwell Bridge is limited to the measurement of material with low quality factor, $Q$ (1-10). Justify this limitation.
(2 marks)

**Q3** (a) The high current AC can be measured by using combination of a current transformer and a low range ammeter. Determine the main function of current transformer in high current measurement.
(2 marks)

(b) The turn of primary and secondary windings of current transformer are 1 and 200 respectively. The secondary winding supplies current of 5 A to a non-inductive burden of 1 Ω resistance. The requisite flux is set up in the core by a magnetomotive force (mmf) of 80 AT. The frequency is 50 Hz and the net cross-section of the core is 1000 $mm^2$. By neglecting the effects of magnetic leakage and iron losses:

(i) Draw the equivalent circuit the current transformer
(3 marks)

(ii) Calculate the actual transformation ratio, $K_{act}$.
(6 marks)

(iii) Sketch the phasor diagram.
(2 marks)

(iv) Determine the phase angle.
(3 marks)

(v) Calculate the maximum flux density in the core.
(4 marks)

**Q4** (a) (i) Explain the main feature of Capacitive Voltage Transformer (CVT).

(2 marks)

(ii) Setup a connection of Electromagnetic Voltage Transformer (EVT) for measuring high voltage line .

(4 marks)

(b) A potential transformer rated 14.4 KV/115 V and a current transformer rated 75A/5A are used to measure the voltage and current in a transmission line as shown in **Figure Q4(b)**. The voltmeter and ammeter indicate 101 V and 3 A respectively. Calculate the line voltage and current.

(4 marks)

(c) (i) Compare the **two (2)** main features of dynamometer wattmeter and induction wattmeter.

(4 marks)

(ii) Select a suitable method for measuring the total power in unbalanced load condition.

(2 marks)

(d) There are various methods can be used to measure the power in single phase AC circuit. Construct a measurement circuit for measuring power without using wattmeter.

(4 marks)

**Q5** (a) The resistance can be classified into three categories. Distinguish the **three (3)** categories of resistance by using appropriate examples.

(6 marks)

(b) There are several approaches can be used to measure the low resistance.

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

(3 marks)

(ii) Describe the related formulas that can be used to calculate the unknown resistance based on the ammeter-voltmeter method in **Q5(b)(i)**.

(2 marks)

(iii) Identify an error that contribute in low resistance measurements and propose a solution in order to significantly minimize this error.

(3 marks)

(c) The insulation resistance of a metal-sheath electrical cable shown in **Figure Q5(c)** is tested using 20 kV supply and a micro ammeter. A current of 5 μA is measured when the components are connected without guard wire. When the circuit is connected with a guard wire, the current is 1.5 μA. Calculate:

(i) The volume resistance of the cable insulation, $R_v$.

(2 marks)

(ii) The surface leakage resistance, $R_l$.

(4 marks)

**- END OF QUESTIONS -**

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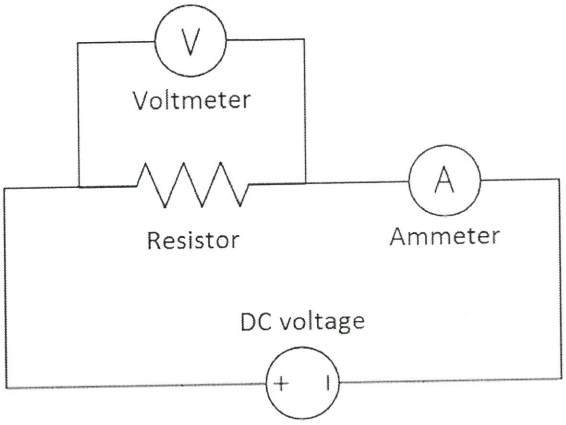
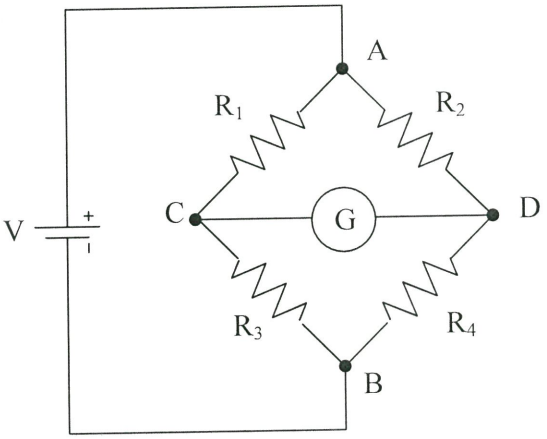



**Figure Q1(b)**




$V = 8\ V$
$R_1 = 15\ k\Omega$
$R_2 = 15\ k\Omega$
$R_3 = 2\ k\Omega$
$R_4 = 2.2\ k\Omega$
$R_G = 200\ \Omega$

**Figure Q2(a)(i)**

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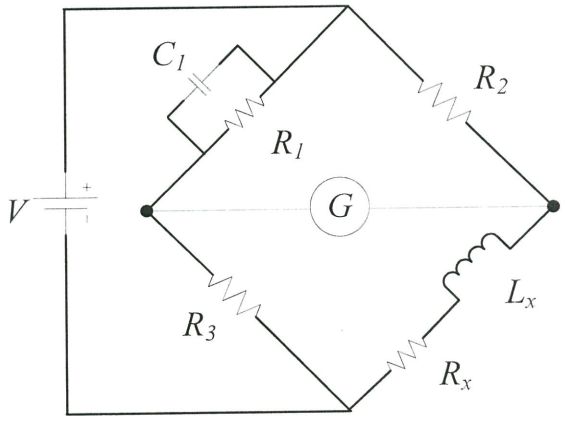


**Figure Q2(b)**

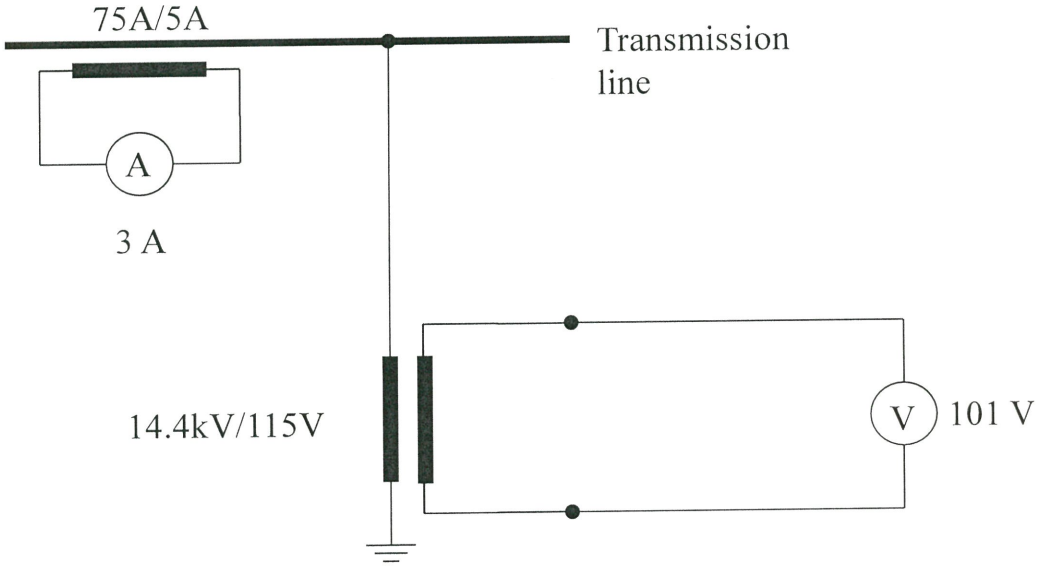


**Figure Q4(b)**

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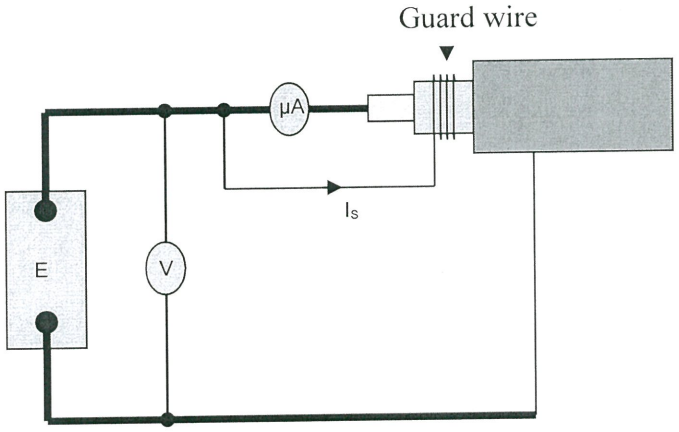


**Figure Q5(c)**