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**UNIVERSITI TUN HUSSEIN ONN MALAYSIA**

**FINAL EXAMINATION  
SEMESTER I  
SESSION 2013/2014**

COURSE NAME : ELECTRICAL MEASUREMENT  
AND INSTRUMENTATION  
COURSE CODE : DAE 21402  
PROGRAMME : 2 DAE  
EXAMINATION DATE : DECEMBER 2013/JANUARY 2014  
DURATION : 2½ HOURS  
INSTRUCTION : ANSWER **FOUR (4)** QUESTIONS  
ONLY

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

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- Q1** (a) Describe the difference between accuracy and precision. (3 marks)
- (b) The output of an amplifier was measured by 10 different students using the same analog voltmeter with the following results:
- |        |        |        |        |        |
|--------|--------|--------|--------|--------|
| 36.3 V | 34.2 V | 35.3 V | 33.1 V | 39.0 V |
| 38.4 V | 32.6 V | 35.5 V | 35.3 V | 33.8 V |
- (i) Calculate the precision of each measurement and hence state the most precise measurement.
- (ii) Determine the arithmetic mean and the standard deviation of the readings. (8 marks)
- (c) Draw and label the block diagram of an electronic measuring system and give the function of each component in that system. (8 marks)
- (d) A 0 – 150 V voltmeter has a guaranteed accuracy of 1 percent of full scale reading. The voltage measured by this instrument is 75 V. Calculate the limiting error in percent. Comment on the result. (6 marks)
- Q2** (a) State three(3) differences between analog and digital multimeters. (3 marks)
- (b) Given a PMMC meter movement with a full scale deflection current of 100  $\mu$ A and internal resistance of 2 k $\Omega$ . Design and draw the schematic circuit of the following meters with this meter.
- (i) A 0-5 V and 0 – 10 V multirange DC voltmeter.
- (ii) A 0 – 25 mA and 0 – 0.25 A multirange ammeter.
- (iii) A full wave AC voltmeter with a range of 0 – 10 V<sub>rms</sub>. (16 marks)
- (c) Figure **Q2(c)** shows the block diagram of a Thermocouple temperature measuring system. Describe how this measuring system operates. (6 marks)

- Q3** (a) Define sensitivity rating of a measuring instrument and give its unit. (3 marks)
- (b) Two voltmeters with different sensitivity but same range of 0 – 10 V is used to measure the voltage across resistor  $10\text{ k}\Omega$  in the circuit of **Figure Q3(b)**. Redraw the circuit showing how the voltmeter is connected. Find the % error due to voltmeter loading effect if the following meters are used and compare the two results:
- (i) Voltmeter (range 0 – 10 V) with sensitivity of  $4\text{ k}\Omega/\text{V}$
- (ii) Voltmeter (range 0 – 10 V) with sensitivity of  $1\text{ k}\Omega/\text{V}$  (8 marks)
- (c) Design and draw an ohmmeter with a PMMC meter movement having a full scale current of 0.1 mA and internal resistance of  $1\text{ k}\Omega$  using a 10 V battery. (6 marks)
- (d) For the circuit in **Figure Q3(d)**, an ammeter having an internal resistance of  $2\ \Omega$  is used to measure the current in the  $5\ \Omega$  resistor.
- (i) Redraw the circuit to show the ammeter connections.
- (ii) Calculate the percent error of the reading due to ammeter insertion. (8 marks)
- Q4** (a) There are many special forms of the bridge circuit. With the aid of simple bridge diagram, identify at least four (4) commonly used bridges. (8 marks)
- (b) From the circuit in **Figure Q4(b)**, analyze the circuit mathematically to produce an equation of unknown resistance,  $R_4$ , when the bridge is balance. (7 marks)
- (c) An AC bridge is balanced at 1000 Hz and has the following constants:  
 Arm  $AB$  -  $0.2\ \mu\text{F}$  pure capacitance  
 Arm  $BC$  -  $500\ \Omega$  pure resistance  
 Arm  $CD$  - unknown  
 Arm  $DA$  -  $R = 300\ \Omega$  in parallel with  $C = 0.1\ \mu\text{F}$
- The supply is connected between A and C and the detector is between D and B. Find the R and C or L constants of arm  $CD$ , considered as a series circuit. (10 marks)

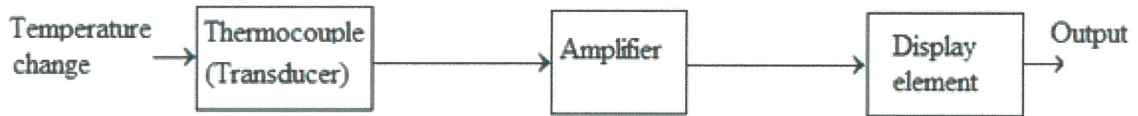
- Q5** (a) Describe the four(4) basic control functions of an oscilloscope. (8 marks)
- (b) **Figure Q5(b)** shows a trace on the screen of an oscilloscope. The Y-sensitivity of the oscilloscope is set at 5.0 V per division and the time base is set at 0.50 ms per division. For the trace, determine
- the maximum positive value of potential difference,
  - the maximum negative value of potential difference,
  - the frequency of the signal.
- (5 marks)
- (c) A Lissajous pattern on an oscilloscope is stationary and has 5 horizontal tangencies and 2 vertical tangencies. The frequency of horizontal input is 1000 Hz. Determine the frequency of vertical input. (3 marks)
- (d) What is a signal generator? (3 marks)
- (e) Name two(2) types of signal generator and describe its difference. (6 marks)
- Q6** (a) Name and describe (with the help of diagrams) a sensor used to measure the following quantity:
- Light
  - Temperature
  - Sound
- (9 marks)
- (b) State the function of transducer and explain its importance in electronic measurements. (3 marks)
- (c) The circuit in **Figure Q6(c)(i)** is to be used for temperature measurement. A “15 k $\Omega$ ” thermistor (**Figure Q6(c)(ii)**) is used. The meter is a 2-mA ammeter with a resistance of 1800  $\Omega$ .  $R_C$  is set to 8 k $\Omega$  and the supply voltage  $V_T$  is 10 V. What will be the meter readings at 50  $^{\circ}$ F and at 300 $^{\circ}$ F? (9 marks)
- (d) A strain gauge having a gauge factor of 4 is used in testing a machine. If the gauge resistance is 90  $\Omega$  and the strain is  $2 \times 10^{-5}$ , how much will the resistance of the strain gauge change? (4 marks)

- END OF QUESTION -

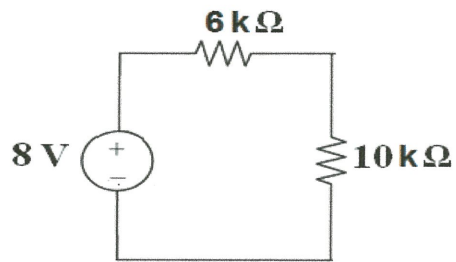
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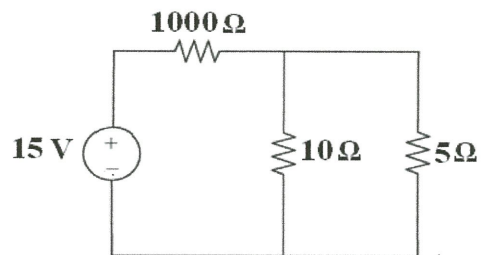
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**FIGURE Q2(c)**



**FIGURE Q3(b)**



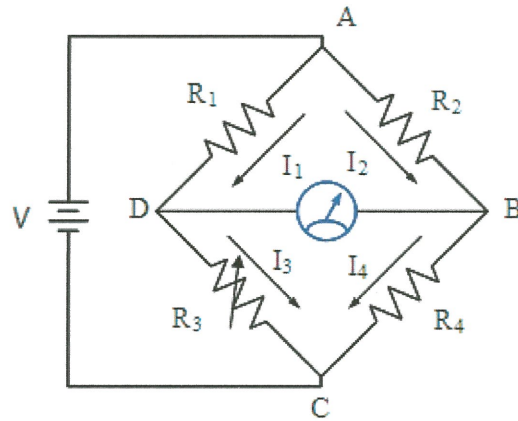
**FIGURE Q3(d)**



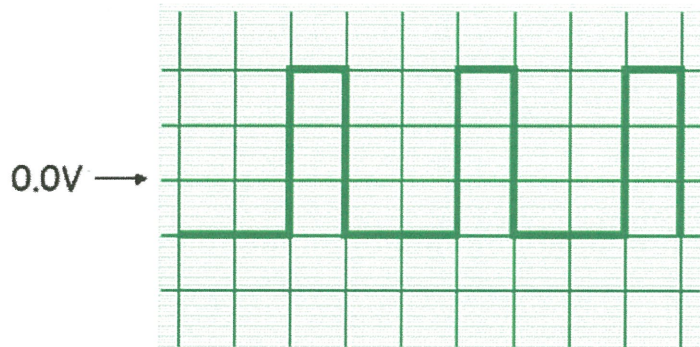
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**FIGURE Q4(b)**



**FIGURE Q5(b)**

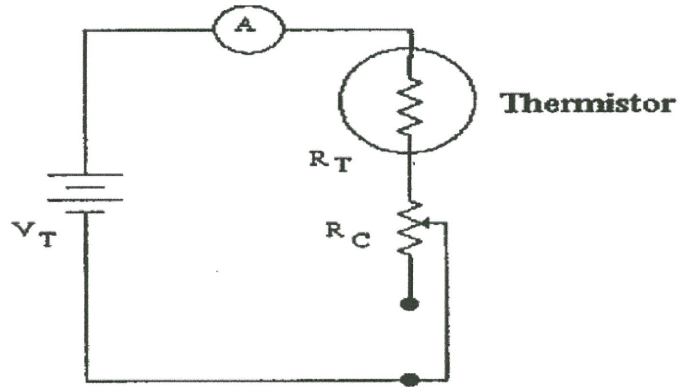
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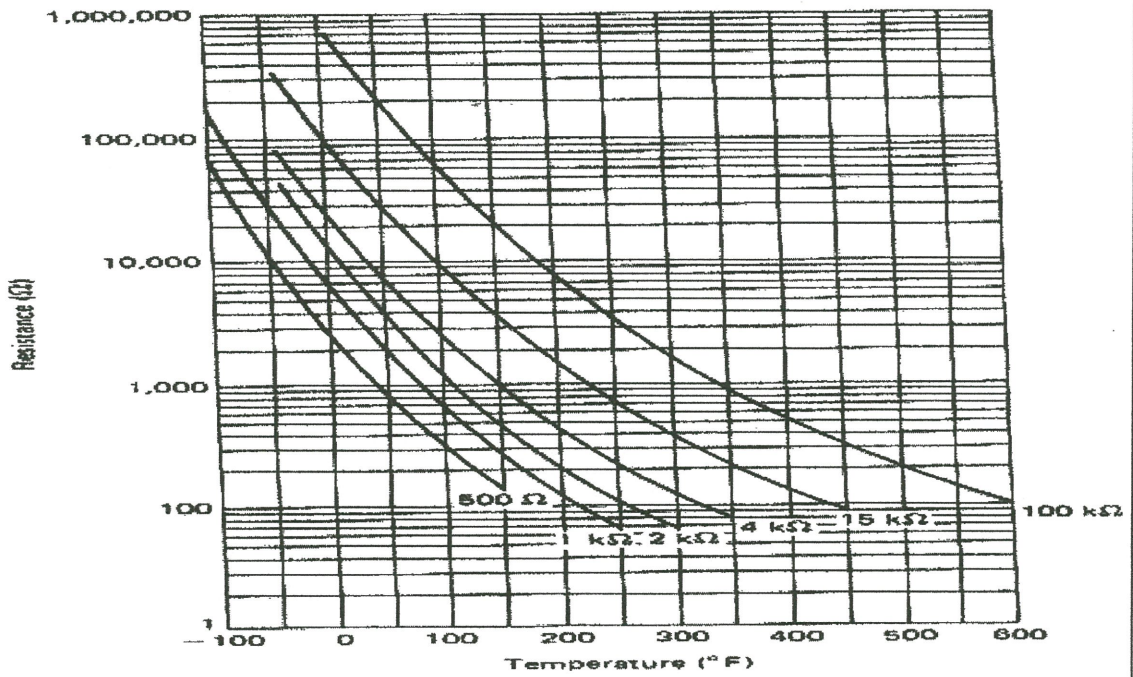
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**FIGURE 6(c)(i)**



**FIGURE 6(c)(ii)**