



**UNIVERSITI TUN HUSSEIN ONN MALAYSIA**

**FINAL EXAMINATION**

**SEMESTER II**

**SESSION 2014/2015**

**COURSE NAME : INSTRUMENTATION AND MEASUREMENTS**

**COURSE CODE : BEH20403**

**PROGRAMME : BACHELOR OF ELECTRONIC ENGINEERING WITH HONOURS**

**EXAMINATION DATE : JUNE 2015/JULY 2015**

**DURATION : 3 HOURS**

**INSTRUCTION : ANSWER ALL QUESTIONS**

**THIS QUESTION PAPER CONSISTS OF SIX (6) PAGES**

- Q1** (a) By using an example, differentiate between a sensor and a transducer. (5 marks)
- (b) A pressure measurement system uses a sensor that converts pressure  $p$ , into voltage  $V_p$  according to the transfer functions,  $V_p = 0.5\sqrt{p}$ . This voltage is then converted into a current. As the pressure varies from 0 to 100 psi, the current varies from 4 to 20 mA.
- (i) Formulate an equation that will relate voltage to current. (5 marks)
- (ii) Determine the change in pressure  $\Delta p$ , when the current changes from 19 mA to 20 mA. (3 marks)
- (iii) Determine the change in pressure  $\Delta p$ , when the current changes from 4 mA to 5 mA. (3 marks)
- (iv) Evaluate the results you obtained in parts (ii) and (iii) above. (4 marks)
- Q2** (a) Explain the basic working principle of a thermistor. (6 marks)
- (b) Describe what is meant by self heating in a temperature measurement. (4 marks)
- (c) A thermistor is to monitor room temperature. It has a resistance of  $3.5\text{k}\Omega$  at  $20^\circ\text{C}$  with a slope of  $-10\%/^\circ\text{C}$ . The dissipation constant is  $P_D = 5\text{mW}/^\circ\text{C}$ . It is proposed to use the thermistor in a divider of **Figure Q2(c)** to provide a voltage of 5.0 V at  $20^\circ\text{C}$ . Analyze the effect of self-heating. (10 marks)

- Q3** (a) Explain the basic principle in the conversion of analog angle directly into its digital value.  
(5 marks)
- (b) Differentiate the working principles between an incremental encoder and an absolute encoder.  
(10 marks)
- (c) Choose a measurement system where an incremental encoder is being used in determining the distance travelled by a wheeled mobile robot in real-time.  
(5 marks)
- Q4** (a) Define the terms *stress* and *strain*.  
(4 marks)
- (b) Discuss the technique that can be implemented in order to compensate the temperature effect in the measurement of strain.  
(4 marks)
- (c) A load cell is being constructed by using a copper column of 150 mm in diameter with temperature compensation is being incorporated in the measurement. Two strain gauges with resistance  $120\ \Omega$  each together with two resistors of value  $120\ \Omega$  each are available for the measurement. The Young's modulus for copper  $E = 11.73 \times 10^{11}\ \text{N/m}$  and its gauge factor  $GF = 2.02$ .
- (i) Describe how the load cell is being constructed by using a schematic and a circuit diagrams.  
(4 marks)
- (ii) Determine the change in resistance of the strain gauge per kg placed on the column.  
(4 marks)
- (iii) Calculate the output voltage that will be produced by the circuit due to this load. Assume that a 10 V supply voltage is available.  
(4 marks)

**Q5** Figure Q5 shows a process control system where flow of liquid in the pipe is being regulated.

- (a) Describe in detail the conversion of current to pressure.

(10 marks)

- (b) Illustrate how the liquid flow can be manipulated by the pressure from the I/P converter.

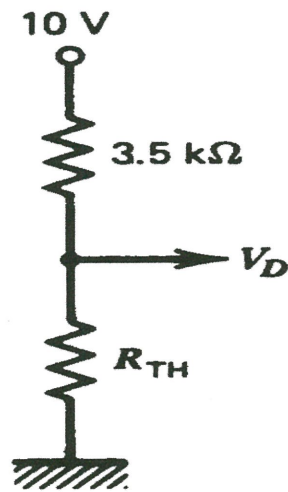
(10 marks)

**– END OF QUESTION –**

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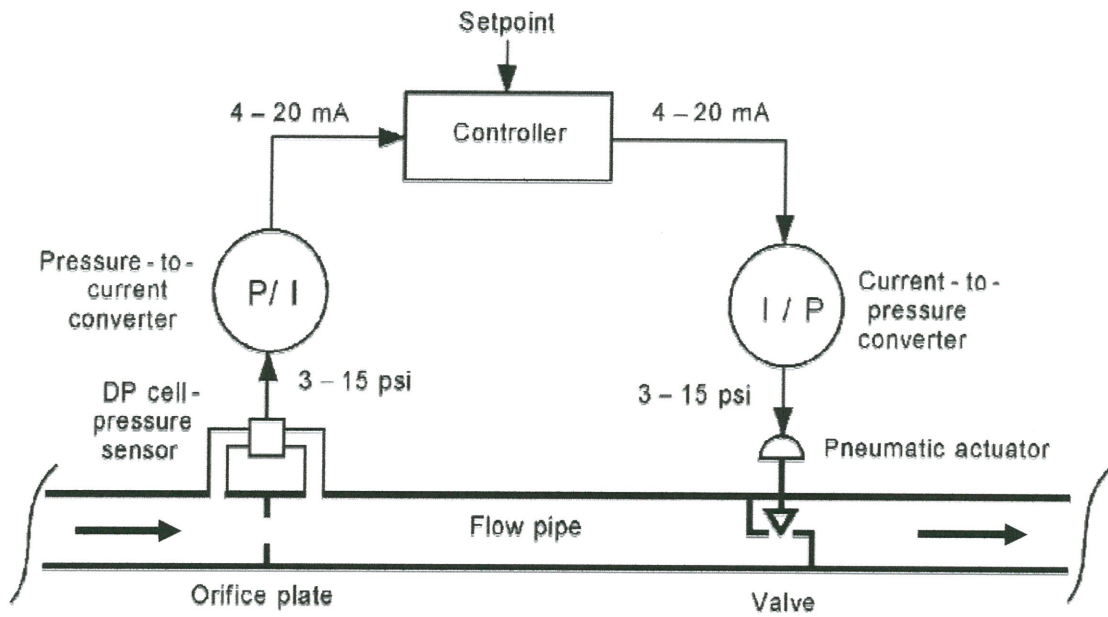


**FIGURE Q2(c)**

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**FIGURE Q5**