



UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
SEMESTER I
SESSION 2015/2016**

COURSE NAME	:	INSTRUMENTATION AND MEASUREMENT
COURSE CODE	:	BEH20403
PROGRAMME	:	BACHELOR OF ELECTRONIC ENGINEERING WITH HONOURS
EXAMINATION DATE	:	DECEMBER 2015 / JANUARY 2016
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER ALL QUESTIONS

THIS QUESTION PAPER CONSISTS OF SEVEN (7) PAGES

- Q1**
- (a) Both Wheatstone bridge and Maxwell bridge can be used to measure the small change of resistance. Identify the main advantage of using Wheatstone bridge to measure resistance compared to Maxwell bridge with a concise reason. (3 marks)
 - (b) Distinguish the main advantage of Maxwell Bridge over other AC bridges? (2 marks)
 - (c) Two resistors (i.e. R_1 and R_2), two strain gauges (R_{G1} and R_{G2}), a voltage meter, and a 9V battery are given to measure the force applied on an aluminum plate. If $R_1 = R_2 = R_{G1} = R_{G2}$.
 - (i) Design a circuit that can measure the applied force and compensate the effect of temperature change using the given components. (4 marks)
 - (ii) Prove that the designed circuit can compensate the effect of temperature. (4 marks)
 - (d) Discuss the **TWO (2)** differences between active and passive transducers with an example. (6 marks)
 - (e) **Figure Q1(e)** illustrates the characteristics of three different types of thermocouples.
 - (i) Define Seebeck coefficient. (2 marks)
 - (ii) Select the most suitable thermocouple with a concise explanation if a measured temperature ranged from 200 to 400 degree Celsius. (3 marks)
- Q2.**
- (a) A capacitive transducer consists of two parallel plates separated by a dielectric (e.g. air space or insulating material).
 - (i) List **THREE (3)** types of variation in capacitive transducers that will change the capacitance. (3 marks)
 - (ii) Propose a solution to use a capacitive transducer to measure the water level in a tank. (4 marks)

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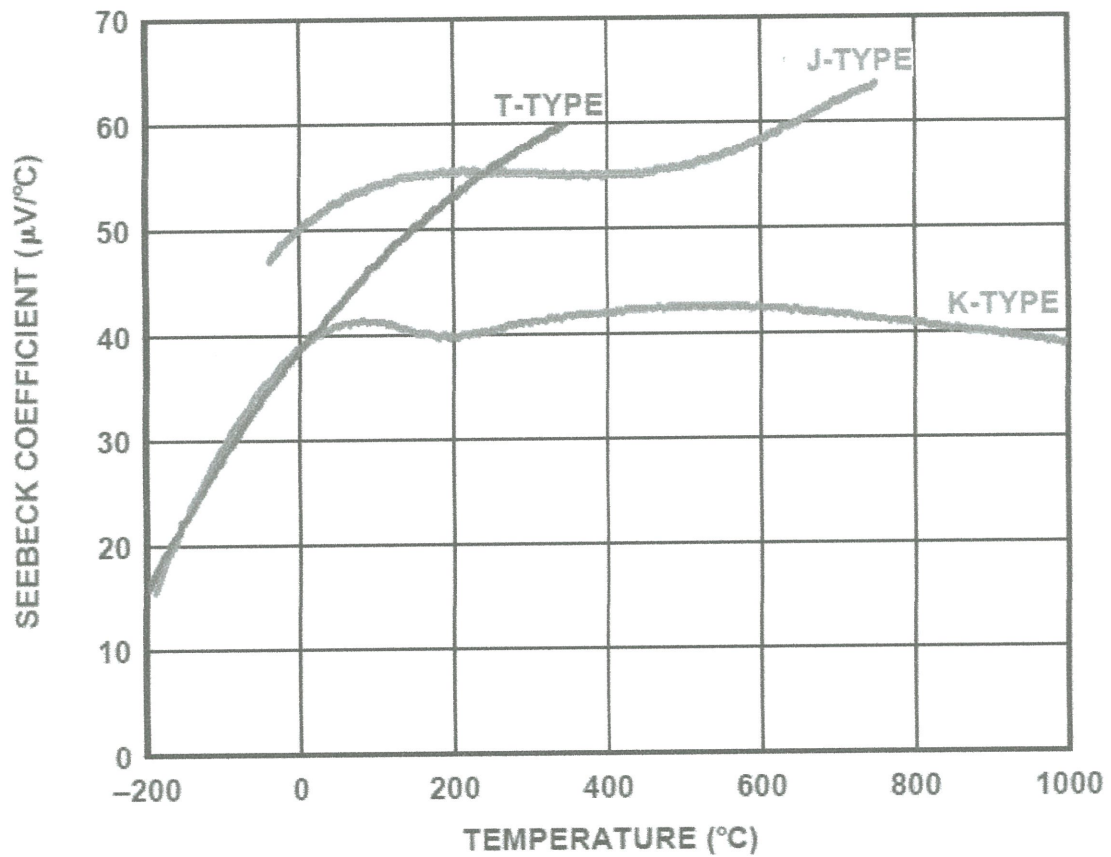


FIGURE Q1(e)

- (b) Linear potentiometers, linear variable differential transformers (LVDT), and synchro systems can be used measure the position or displacement of a moving object.
- (i) Differentiate the linear potential meters and LVDT. (4 marks)
- (ii) Differentiate the synchro system and the LVDT. (4 marks)
- (c) A proximity sensor uses a modulated light beam to determine whether an object is in within a given boundary.
- (i) Identify the main advantage of using a modulated light in the application. (2 marks)
- (ii) Differentiate the two scan techniques of thru beam and retroreflective. (4 marks)
- (d) An optical tachometer can be used to remotely measure the rotational speed of a shaft. Explain the working principle of this non-contact measurement technique. (4 marks)

- Q3.** (a) The accelerometer is capable of measuring the acceleration of an object. **Figure Q3(a)** illustrates the structure of an accelerometer.
- (i) List out the **THREE (3)** forces in the accelerometer. (3 marks)
- (ii) Prove that the measured acceleration, $a = \frac{Kx - Bx'}{M}$, where K is the constant of the spring, M is the mass, B is the constant of the damper, and x is the displacement. (4 marks)
- (iii) Deduce the consequence for the accelerometer if the damper is removed. (2 marks)
- (b) Tachometers are widely used to measure the angular velocity of a rotating shaft.
- (i) Propose a way of using a DC tachometer in measuring the angular velocity of a rotating shaft. (4 marks)
- (ii) Distinguish **TWO (2)** differences between analog tachometers and digital tachometers. (4 marks)

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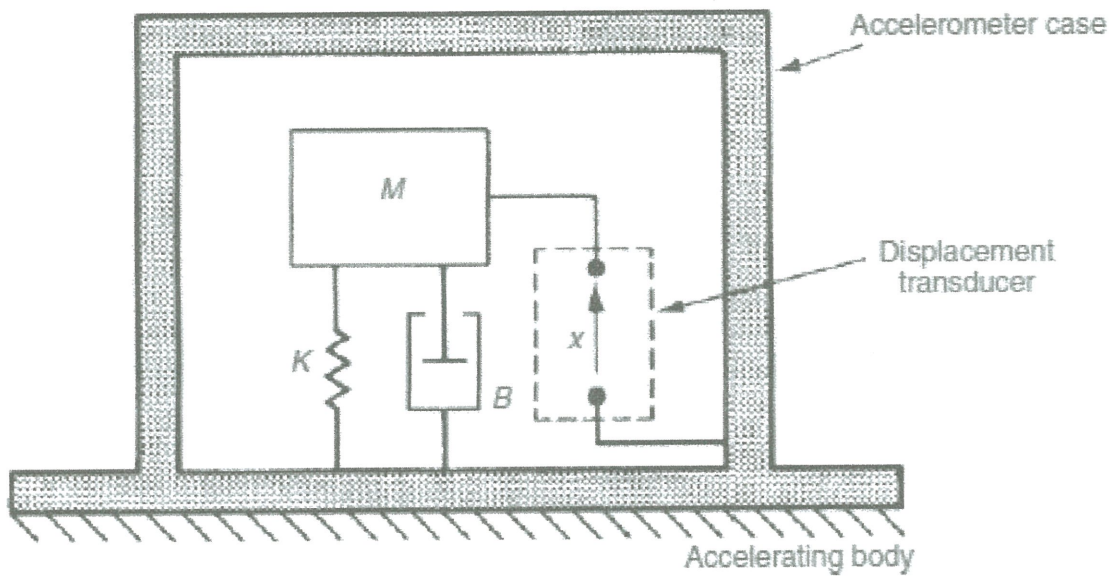


FIGURE Q3(a)

(c) Load cells are widely used to measure mass by using suitable elastic elements and strain gauges. There are lots of different designs of elastic elements.

(i) Discuss **TWO (2)** reasons to have different designs of an elastic element. (4 marks)

(ii) Demonstrate the ways of using load cells as force transducers. (4 marks)

Q4 (a) An analog-to-digital converter (ADC) is used to convert an analogue current into a digital signal that can be read by a computer.

(i) Find the decimal number of the 8-bit binary number of 01010000_2 . (3 marks)

(ii) Calculate the digital number in binary when the reference voltage, V_{ref} is 5V and measured voltage, V_{in} is 4.5V, for a 10-bit analog-to-digital converter. (4 marks)

(iii) Demonstrate the working principle of an analog-to-digital converter (ADC) to convert analog signals to digital signals. (5 marks)

(b) For the measurement system that illustrated in **Figure Q4(b)**,

(i) Explain the function of the crystal oscillator. (2 marks)

(ii) Explain the function of the trigger. (2 marks)

(iii) Explain the function of the main gate. (2 marks)

(iv) Find an application for the measurement system with a concise reason. (3 marks)

(c) **Figure Q4(c)** illustrates a measurement system that consists of a Voltage-to-Frequency converter (V/F), an optoisolator and a frequency counter.

(i) Identify the function of the optoisolator. (2 marks)

(ii) Find an application for the measurement system with a concise reason. (3 marks)

- END OF QUESTION -

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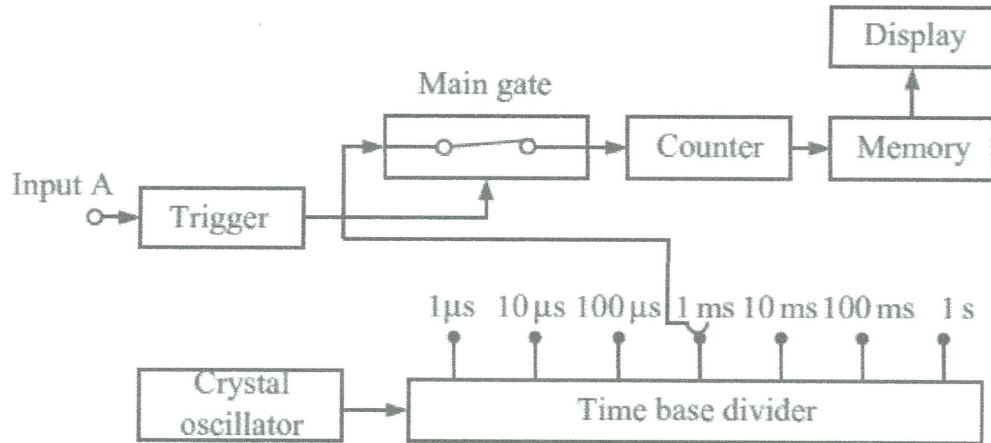


FIGURE Q4(b)

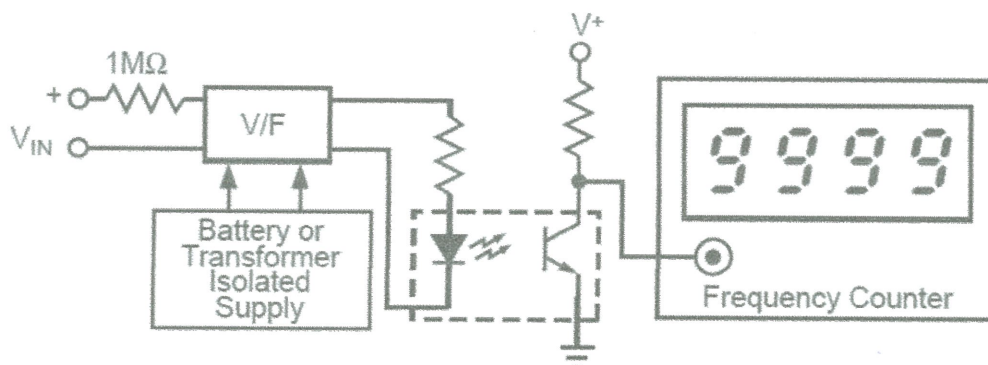


FIGURE Q4(c)