Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2017/2018

COURSE	:	INSTRUMENTATION AND MEASUREMENT
COURSE CODE	:	BEH 10102
PROGRAMME CODE	:	BEJ
EXAMINATION DATE	:	DECEMBER 2017 / JANUARY 2018
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWER ALL QUESTIONS

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

Q1 (a) Describe an "Instrumentation System" with necessary block diagram.

(5 marks)

(b) Define "Sensitivity of an Instrument" and "Sensitivity of a Voltmeter" with necessary equations.

(5 marks)

(c) Define the followings with necessary equations:

(i) Relative accuracy and % accuracy

(3 marks)

(ii) Precision

(2 marks)

(d) Demonstrate how a particular measurement within a set of measurement data might have low "relative accuracy", yet having high "precision". Use a hypothetical scenario with a set of ten measurement data and perform necessary calculations on the set to support your hypothesis.

(10 marks)

Q2 (a) By using a practical example, explain the meaning of the term *transducer*.

(4 marks)

(b) What is the difference between a passive transducer and an active transducer by providing a practical example for each case?

(6 marks)

(c) **Figure Q2(c)** shows a capacitor displacement sensor designed to monitor small changes in work-piece position. The two metal cylinders are separated by a plastic sheath/bearing of thickness 1 mm and the upper cylinder is free to slide in and out of the lower cylinder through a distance h. The dielectric constant is equal to 2.5 and the permittivity of free space ε_0 = 8.854 pF/m. If the radius $r = 2.5$ cm, plot the variation of the capacitance of the sensor when h varies from 0.5 cm to 2 cm.

(10 marks)

(d) Describe, with illustration, how the effect of temperature can be compensated when a strain gauge is used in a measurement of stress.

(5 marks)

Q3 (a) Describe the operation of the simplest form of DC bridge.

(10 marks)

(b) Identify the key differences between DC and AC bridges.

(5 marks)

(c) Draw the circuit diagram for a Maxwell bridge and explain why it is not suitable for measuring high-Q coil.

(5 marks)

(d) The impedances of the AC bridge in **Figure Q3(d)** are given as follows:

Z_1=200 Ω∠30°
Z_2=150 Ω∠0°
Z_3=250 Ω∠-40°
Z_x= Z_4= unknown

Determine the impedance of the unknown arm.

(5 marks)

Q4 (a) A resistive position transducer with a resistance of 10 kΩ and shaft stroke of 8 cm with a bridge circuit is used to measure the bumpiness of a roadway by moving it to the right as shown in **Figure Q4(a)**.
(Note: the initial position to be used as a reference point is when the shaft is at the middle of stroke).

(i) Illustrate the equivalent circuit of the system.

(2 marks)

(ii) Derive the formula for V_{out} in terms of the value resistor in the circuit.

(2 marks)

(iii) Find out the value of V_{out} when the shaft is at initial position.

(2 marks)

(iv) Calculate the value of V_{out} when the shaft reached point A.

(4 marks)

(b) The worktable of a positioning system as shown in the **Figure Q4(b)** is driven by a ball screw whose pitch is 25mm. The ball screw is connected to the shaft of a stepper motor through a gearbox. An incremental encoder of 100 pulses/rev is connected to the end of the ball screw. The table must move a distance of 250mm from its present position.

(i) Illustrate, with the help of diagram, how the incremental encoder can be made to detect forward and reverse motions.

(4 marks)

(ii) Calculate the resolution of the encoder.

(3 marks)

(iii) Calculate how many pulses of the encoder are to be read to identify that the table is moved to the specified distance.

(3 marks)

(c) (i) Describe the steps to convert a binary number to gray code.

(3 marks)

(ii) Illustrate the conversion of the binary number, 01001 into its gray code equivalent.

(2 marks)

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END OF QUESTIONS –

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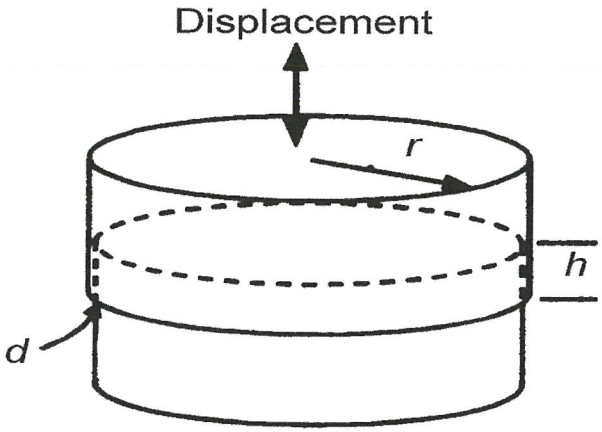

Figure Q2(c)

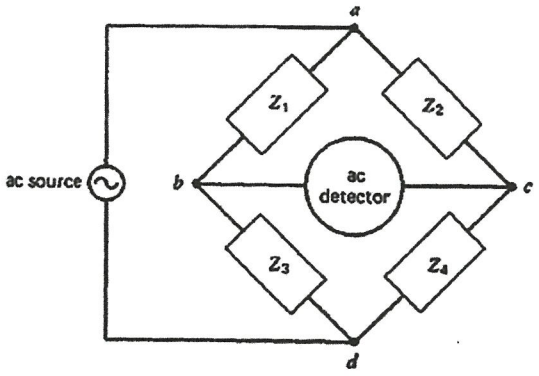

Figure Q3(d)

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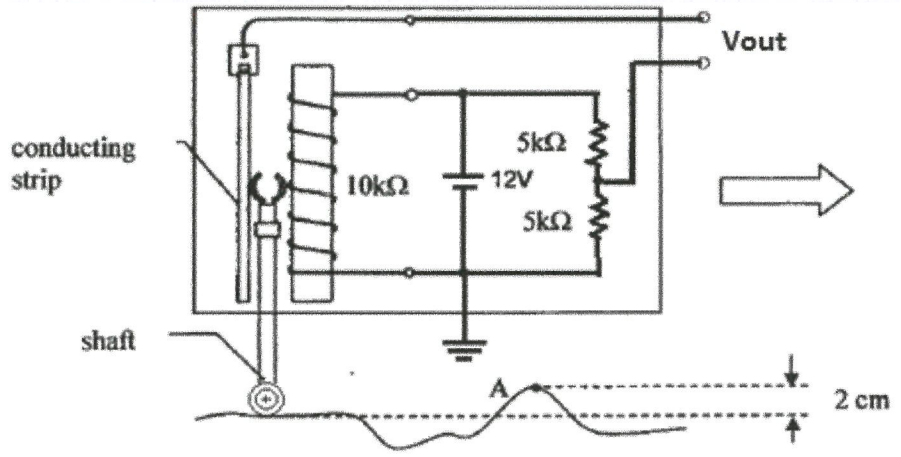

Figure Q4(*a*)

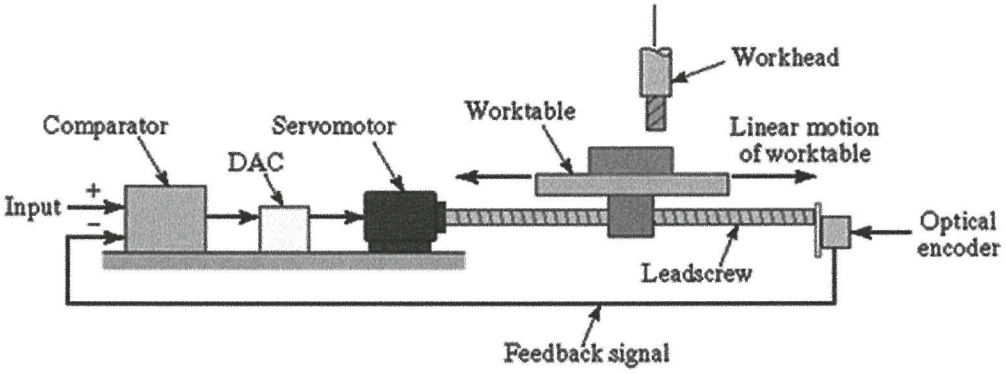

Figure Q4(b)