UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2018/2019

COURSE NAME	:	INSTRUMENTATION AND MEASUREMENT
COURSE CODE	:	BEJ 10702
PROGRAMME	:	BEJ
EXAMINATION DATE	:	DECEMBER 2018/ JANUARY 2019
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF NINE (9) PAGES

Q1 (a) Discuss the main advantage of Maxwell Bridge over other AC bridges?

(2 marks)

(b) Two resistors (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) Show that the designed circuit can compensate the effect of temperature.

(5 marks)

(c) Discuss the **TWO (2)** differences between DC and AC bridges in a measurement

(4 marks)

(d) A Maxwell bridge is used to measure an inductive impedance as illustrated in **Figure 1 (d).** Show that $R_x = \frac{R_2 R_3}{R_1}$ and $L_x = R_2 R_3 C_1$ when the bridge is balanced.

(10 marks)

Q2 (a) List three selection criteria for each component below;

(i) Selection of transducer classification.

(3 marks)

(ii) Selection criteria of a sensor.

(3 marks)

(b) The relay of **Figure Q2(b)** is to be controlled by a photoconductive cell with the characteristics. The circuit delivers 10 mA at a 30-V setting when the cell is illuminated with about 400 Im/m^2. The circuit becomes deenergized when the cell is dark. Calculate:

(i) The required series resistance.

(4 marks)

(ii) The level of the dark current.

(4 marks)

(c) During experiment with a copper - costantan thermocouple, it was found that $c= 3.75x10^{-2}$ mV/°C and $k = 4.50x10^{-5}$ mV/°C. If T1= 100°C and the cold junction T2 is kept in the ice, compute the resultant electromotive force, emf.

(6 marks)

(d) An inductive transducer as shown in **Figure Q2(d).** Propose a solution to use an inductive transducer to measure the liquid flowmeter.

(5 marks)

Q3 (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 Q3(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 the value of V_{out} when the shaft at initial position.

(2 marks)

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

(4 marks)

(b) An accelerometer in **Figure Q3(b)** has a seismic mass of 0.05 kg and a spring constant of 3.0 x 103 N/m. Maximum mass displacement is ± 0.02 m (before the mass hits the stops).

(i) Analyse the maximum measurable acceleration in **g**.

(5 marks)

(ii) Calculate the natural frequency, F_N.

(5 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)

Q4 (a) List **TWO (2)** advantages and **TWO (2)** disadvantages of a digital instrument compared to analog instrument.

(4 marks)

(b) **Figure Q4(b)** shows a circuit for voltage to frequency converter.

(i) Describe the function of a voltage to frequency converter.

(2 marks)

(ii) Given $V_i = f/50$. Calculate the amplitude input voltage V_i of the voltage to frequency converter, if 600 pulses are passes by the AND gate during a 0.1 sec gating pulse.

(7 marks)

(c) **Figure Q4(c)** shows a block diagram of an Single-slope Analog to Digital Converter (ADC).

(i) Determine the component for "A" and "B" in **Figure Q4(c)**

(2 marks)

(ii) Sketch the output waveform of the circuit labeled 'Vio', 'Vc' and 'Pulse'.

(4 marks)

(iii) A Single-slope ADC as shown in **Figure Q4(c)** consists of a 1000 kΩ resistor and a 1 μF capacitor. The reference is 12 V. Calculate the conversion time for a 6.8 V analog input.

(6 marks)

-END OF QUESTIONS-

FINAL EXAMINATION

SEMESTER/SESSION	: SEM I / 2018/2019	PROGRAMME	: BEJ
COURSE	: INSTRUMENTATION AND MEASUREMENT	COURSE CODE	: BEJ10702

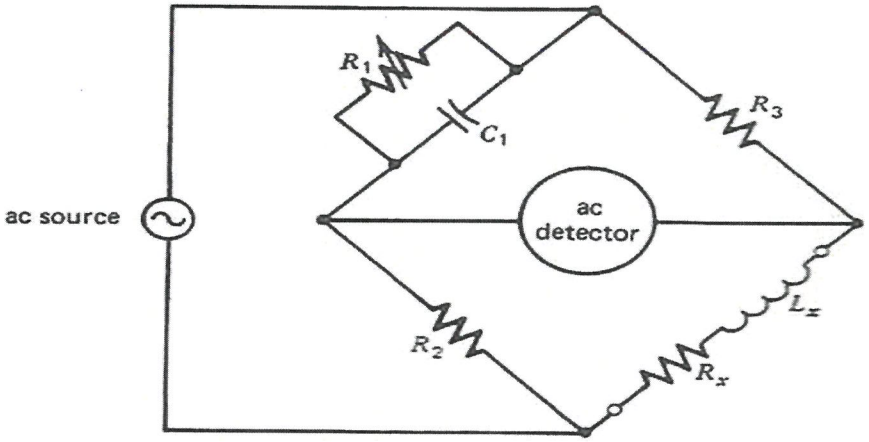
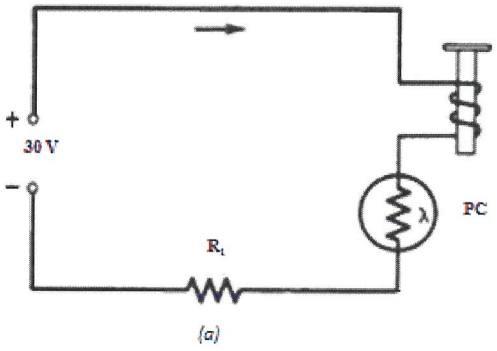
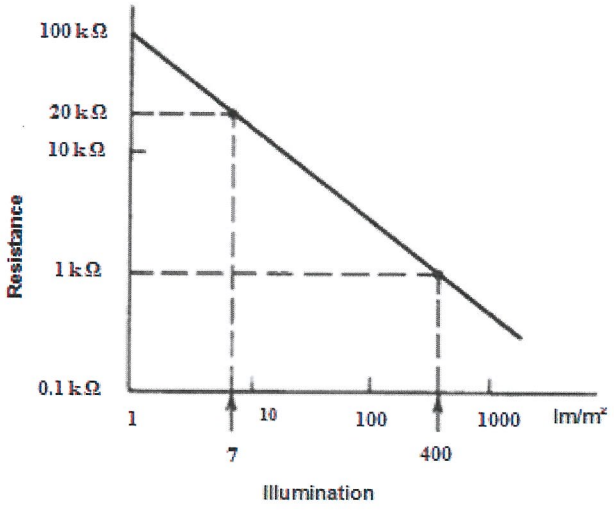


Figure Q1(d)



(a)



(b)

Figure Q2(b)

FINAL EXAMINATION

SEMESTER/SESSION	: SEM I / 2018/2019	PROGRAMME	: BEJ
COURSE	: INSTRUMENTATION AND MEASUREMENT	COURSE CODE	: BEJ10702

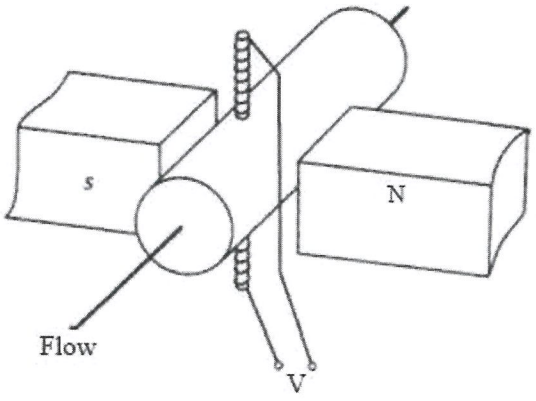


Figure Q2 (d)

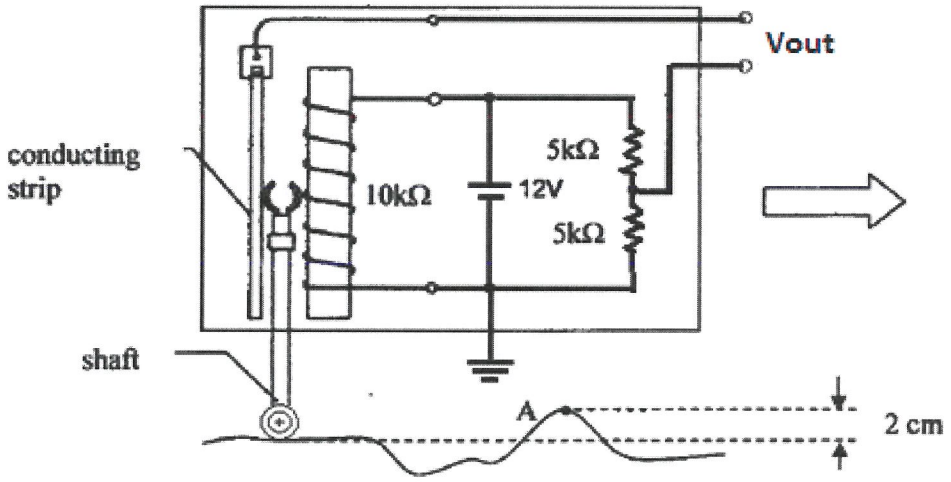


Figure Q3(a)

FINAL EXAMINATION

SEMESTER/SESSION	: SEM I / 2018/2019	PROGRAMME	: BEJ
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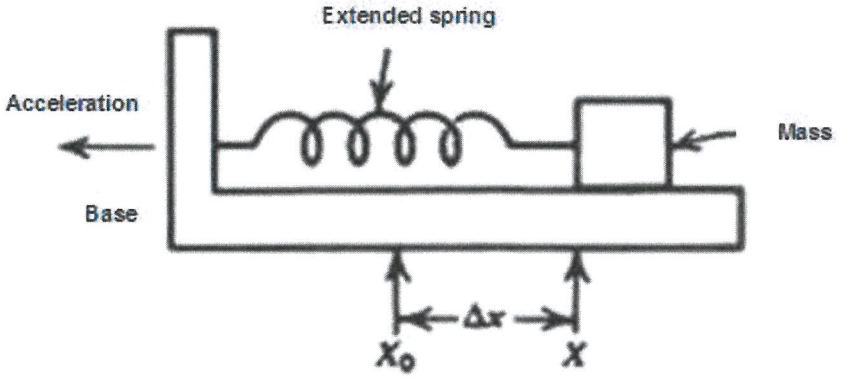

Figure Q3(b)

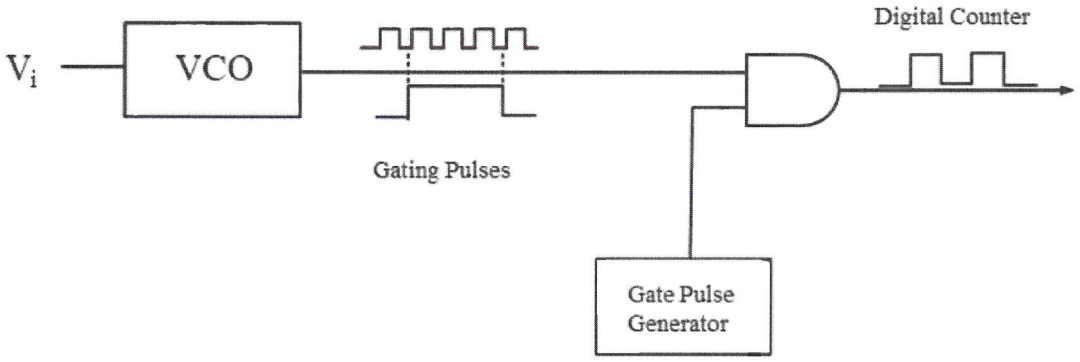

Figure Q4(b)

FINAL EXAMINATION

SEMESTER/SESSION	: SEM I / 2018/2019	PROGRAMME	: BEJ
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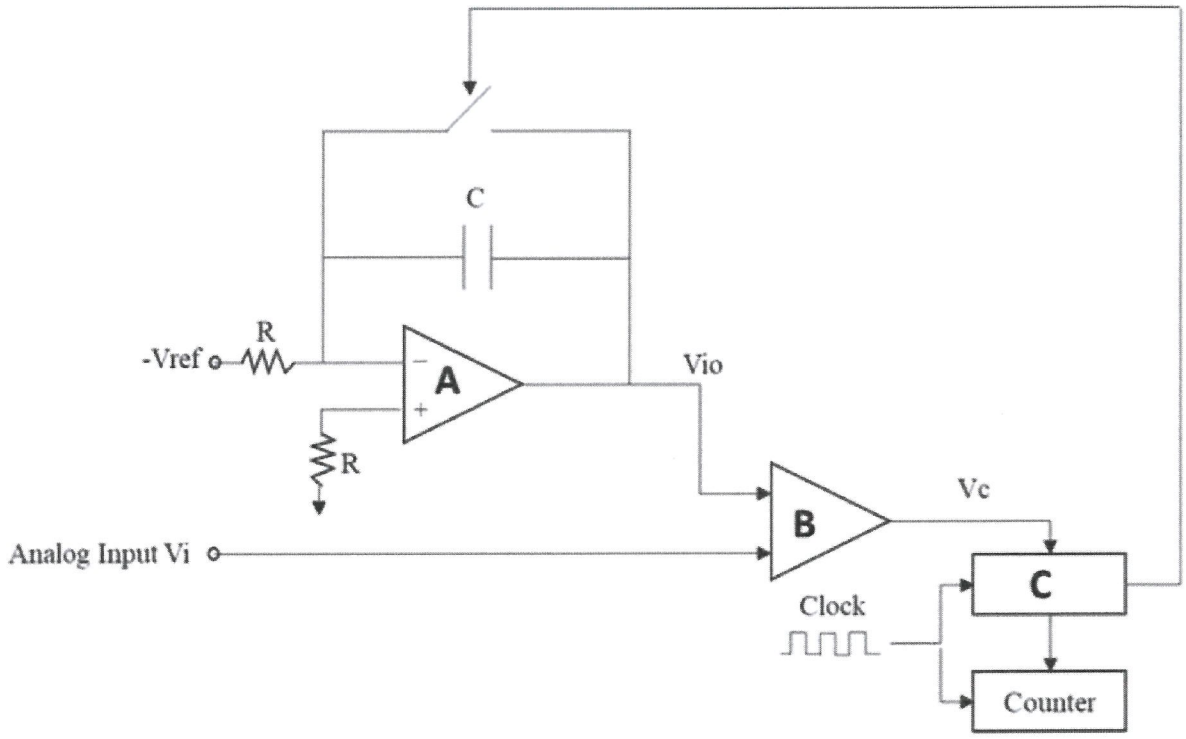

Figure Q4(c)