Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION

SEMESTER I

SESSION 2019/2020

COURSE NAME	:	INSTRUMENTATION & MEASUREMENT
COURSE CODE	:	BEJ 10702 /BEH 10102
PROGRAMME CODE	:	BEJ
EXAMINATION DATE	:	DECEMBER 2019/JANUARY 2020
DURATION	:	2 HOURS
INSTRUCTION	:	ANSWER ALL QUESTIONS

THIS PAPER CONSISTS OF **EIGHT (8)** PAGES

Q1 (a) Draw and explain the block diagram of an instrumentation system.

(9 marks)

(b) The Magnetic Flow Meter is shown in **Figure Q1(b)** as one of the most commonly used to determine the flow of liquid in a pipe.

(i) Sketch the Theory of Operation of the magnetic flow meter.

(6 marks)

(ii) List the advantages and disadvantages of magnetic flow meter.

(6 marks)

(c) The potentiometer is used to make an adjustment to compensate for manufacturing tolerances in photocell sensitivity and relay-operating sensitivity. The relay is to be controlled by a photoconductive cell with the characteristics shown in **Figure Q1(c).** The circuit delivers 10 mA at a 30V setting when the cell is illuminated with about 400 lumens/m^2. The circuit becomes de-energized when the cell is dark. Calculate;

(i) The required series resistance.

(2 marks)

(ii) The level of the dark current.

(2 marks)

Q2 (a) A Wheatstone Bridge is illustrated in **Figure Q2(a)**.

(i) Derive the ratio of the resistor arms when the reading of the galvanometer is null.

(5 marks)

(ii) Determine the value of R_x in the circuit if $R_1 = 400\Omega$, $R_2 = 5k\Omega$ and $R_3 = 2k\Omega$

(2 marks)

(iii) Explain the main problem to measure low resistance using Wheatstone Bridge.

(3 marks)

(b) Discuss the **TWO (2)** differences between DC and AC bridges in a measurement and explain the usage of AC bridges.

(5 marks)

(c) Maxwell bridge is used to measure an inductive impedance as illustrated in **Figure Q2(c).** Show that $R_x = \frac{R_2 R_3}{R_1}$ and $Lx = R_2 R_3 C_1$, when the bridge is balanced.

(10 marks)

Q3 (a) The worktable of a positioning system as shown in **Figure Q3(a)** is driven by a ball screw whose pitch is 25 mm. 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) Suggest the connection of an incremental encoder for the use of detecting forward and reverse motions with the help of a diagram.

(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)

(b) An integrator circuit as illustrated in **Figure Q3(b)** consists of a 70 kΩ resistor and a 0.2 μF capacitor.

(i) If the voltage applied to the integrator input is 1V, determine the output voltage of the integrator after 1.25 seconds.

(3 marks)

(ii) If the reference voltage, V_{ref} is applied to the integrator at time t_2 is 5 V, analyse the time interval from t_2 to t_3.

(3 marks)

(iii) Draw the output waveform of the integrator.

(4 marks)

(c) Illustrate the conversion of the binary number, 01001 into its gray code equivalent and describe the steps of conversion.

(5 marks)

Q4 (a) Discuss the differences between digital instruments and digital readout instruments with their block diagrams.

(5 marks)

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

(i) Prove that a decimal number of 80 equals to an 8-bit binary number of 010100002.

(3 marks)

(ii) Determine the digital number in binary when the reference voltage, Vref is 5V and measured voltage, Vin is 4.5V, for a 10-bit analog-to-digital converter.

(4 marks)

(c) A Dual-slope Analog-Digital Converter (ADC) consists of an operational amplifier integrator that contains an integrator circuit, a logic control circuit, a counter, a clock, a voltage reference, and basic components.

(i) Sketch the Dual-slope ADC with correct labels.

(5 marks)

(ii) Calculate the value of the resistor if the capacitor of 2μF is used so that the integrator will produce 10V output after 2ms when the measured input voltage is 2V and the initial voltage output is zero.

(4 marks)

(d) A Voltage to frequency Convertor (VFC) consists of a voltage controller oscillator (VCO), a gate pulse generator, and an AND gate. If the output frequency to measure the voltage of the VCO is 100, calculate the measured voltage when 200 pulses are detected during 0.01 seconds.

(4 marks)

- END OF QUESTIONS -

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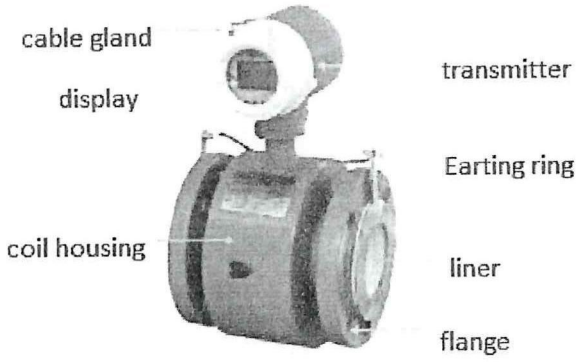

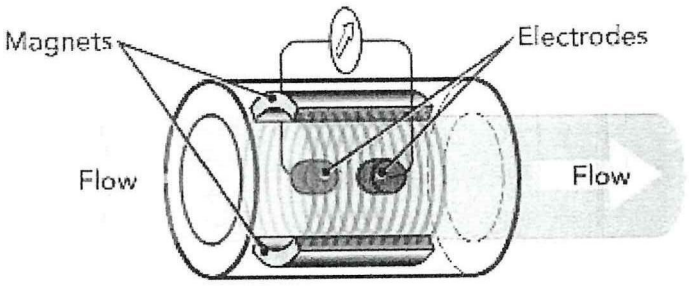

Figure Q1(b)

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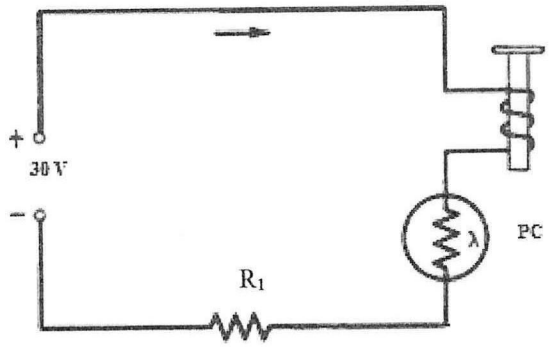
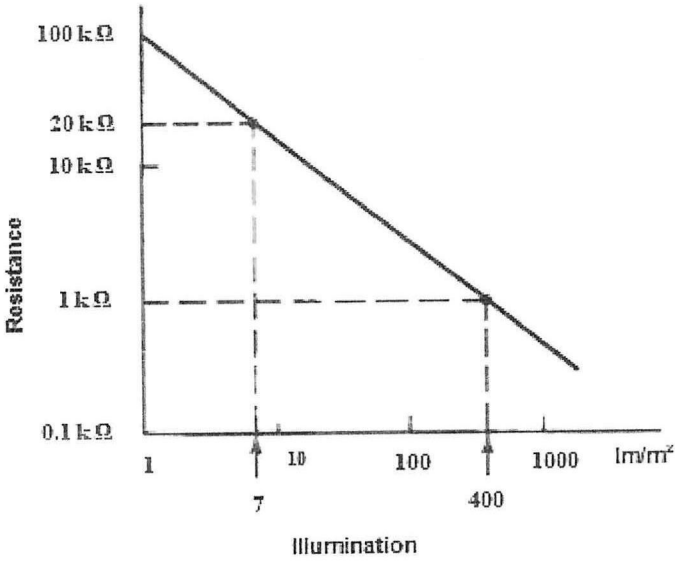


(a)



(b)

Figure Q1(c)

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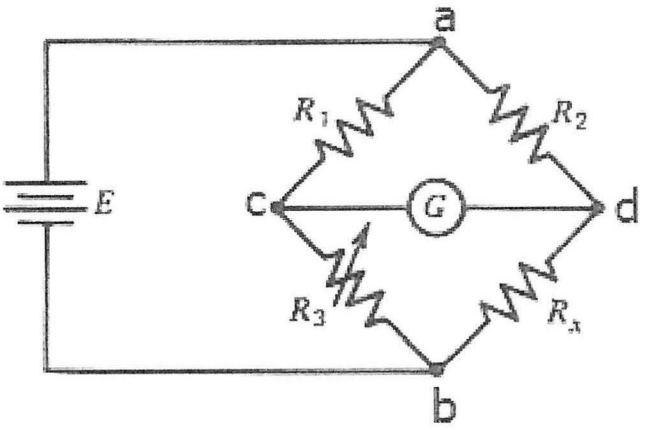

Figure Q2(a)

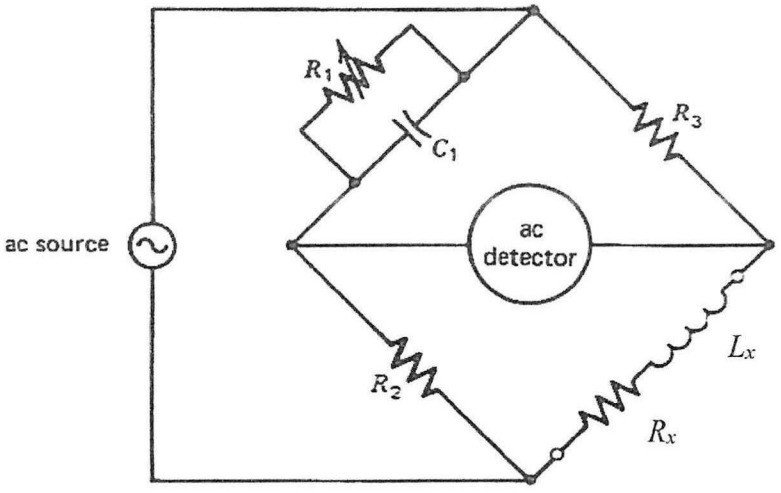

Figure Q2(c)

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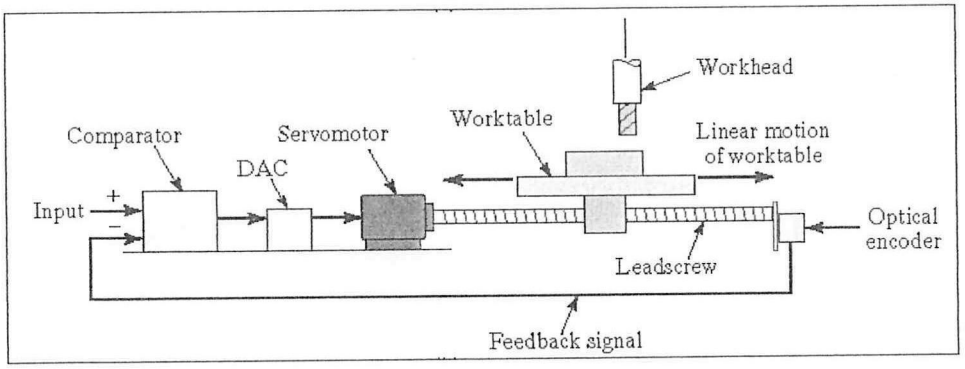

Figure Q3(a)

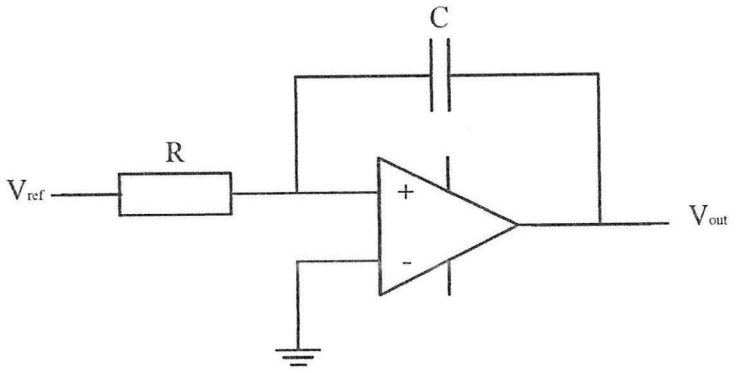

Figure Q3(b)