UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2011/2012

COURSE NAME	:	INSTRUMENTATION AND MEASUREMENT
COURSE CODE	:	BEE 2123 / BEX 20703 / BEH 20403
PROGRAMME	:	BEE / BEH
EXAMINATION DATE	:	JUNE 2012
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWER **FIVE (5)** QUESTIONS ONLY

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

Q1 (a) A batch of resistors that each have a nominal resistance of 330 Ω are to be tested and classified as ±5% and ±10% components.

(i) Find the maximum and minimum absolute resistance for each case.
(ii) The resistors are specified at 25°C, and their temperature coefficient is –300ppm/°C. Calculate the maximum and minimum resistance for these components at 100°C.
(iii) Three of the resistors are connected in series. One has a ±5% tolerance, and the other two are ±10%. Determine the range values of the total resistance.

(15 marks)

(b) A DC power supply provides currents to eight electronic circuits. The currents are 37 mA, 42 mA, 40 mA, 38 mA, 13 mA, 10 mA, 8 mA and 6.7 mA. The first four are measured with an accuracy of ±3%, while the other four are measured with ±1% accuracy. Determine the maximum and minimum levels of the total supply current.

(5 marks)

Q2 (a) A Permanent Magnetic Moving Coil (PMMC) instrument with a 750 Ω coil resistance gives full scale deflection (FSD) with a 500 μA current coil. Determine the required shunt resistance to convert the instrument into a DC ammeter with an FSD of

(i) 50 mA.
(ii) 30 mA.

(10 marks)

(b) A DC ammeter consists of an Ayrton shunt in parallel with a PMMC instrument that has a 1.2 kΩ coil resistance and 100 μA FSD. The Ayrton shunt is made up of four 0.1 Ω series-connected resistors. Calculate the ammeter range at each setting of the shunt.

(10 marks)

Q3 Figure Q3 shows a commercial ac voltmeter using a PMMC instrument. The PMMC instrument has 100 Ω coil resistance and an FSD of 1 mA. Shunt resistor is given as 200 Ω, while forward-bias resistance of each diode is 200 Ω.

(a) Briefly explain the function of shunt resistor, R_s and diode D_2.

(2 marks)

(b) Calculate the values of R_1, R_2 and R_3 for measurement ranges of 10 V, 50 V and 100 V.

(15 marks)

(c) Calculate the sensitivity of the voltmeter.

(3 marks)

Q4 An AC bridge is balanced at a frequency of 1 kHz and has the following constants:
Arm AB : 1 kΩ resistance in parallel with 0.25 μF capacitance,
Arm BC : 2 kΩ resistance in series with 0.25 μF capacitance,
Arm CD : 500 Ω resistance in series with 25 mH inductance,
Arm AD : unknown.

(a) Derive the balance condition and find the constant of arm AD.

(12 marks)

(b) Express the result obtained in (a) if arm AD consists of resistance in series with capacitance.

(4 marks)

(c) Express the result obtained in (a) if arm AD consists of resistance in series with inductance.

(4 marks)

Q5 (a) The frequency of the sinewave signal is found to be four times of the frequency of the sinewave signal from the signal generator and has no phase shift. Sketch the Lissajous pattern which appears on the oscilloscope screen.

(5 marks)

(b) Signal A and B from one system was displayed through an oscilloscope as illustrated in Figure Q5(b). Determine:

(i) The amplitudes or peak voltage,
(ii) Peak-to-peak voltage,
(iii) Period,
(iv) Frequency,
(v) Phase difference of two signals.

(10 marks)

(c) Function generator is a device that generate square wave, saw tooth and triangular waveforms. The frequencies can be varying from Hertz to kiloHertz. Give at least five (5) name of the block diagram labeled A to F as shown in Figure Q5(c).

(5 marks)

Q6 (a) List two (2) advantages and disadvantages of a digital meter over an analog meter.

(4 marks)

(b) Figure Q6(b) shows a block diagram of an analog to digital converter (ADC).

(i) Give the name of each component labeled '*a*' to '*f*'.
(ii) Sketch the output waveform of the circuit labeled '1' to '5'.

(8 marks)

(c) An integrator circuit as Figure Q6(c) consists of a 70 kΩ resistor and a 0.2 μF capacitor.

(i) If the voltage applied to the integrator input is 1 V, determine the output voltage of the integrator after 1.25 seconds?
(ii) If the reference voltage, V_{ref} is applied to the integrator at time t_2 is 5 V, determine the time interval from t_2 to t_3?
(iii) Draw the integrator circuit output waveform.

(8 marks)

Q7 (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 Q7(a). 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.
(ii) Derive the formula for V_{out} in terms of the value resistor in the circuit.
(iii) Find the value of V_{out} when the shaft at initial position.
(iv) Calculate the value of V_{out} when the shaft reached point A.

(15 marks)

(b) Figure Q7(b) shows a magnetic flowmeter to measure liquid flow velocity in a pipe. The diameter of the pipe is 25 cm and magnetic field strength generated by the permanent magnet is 2 T. Calculate the electromagnetic force generated if the flow velocity is 10 m/s.

(5 marks)

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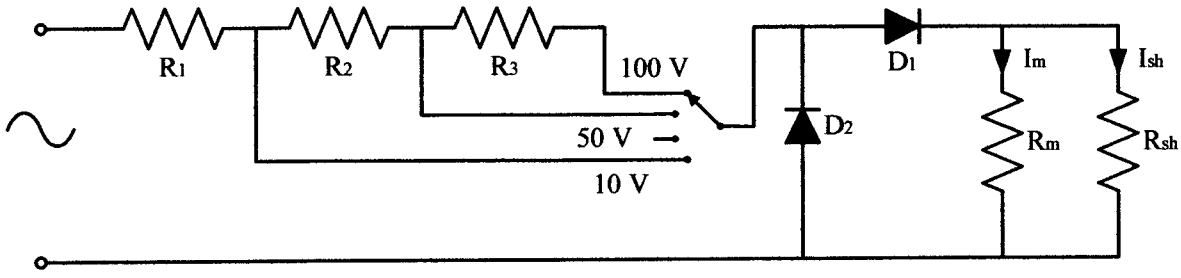

Figure Q3

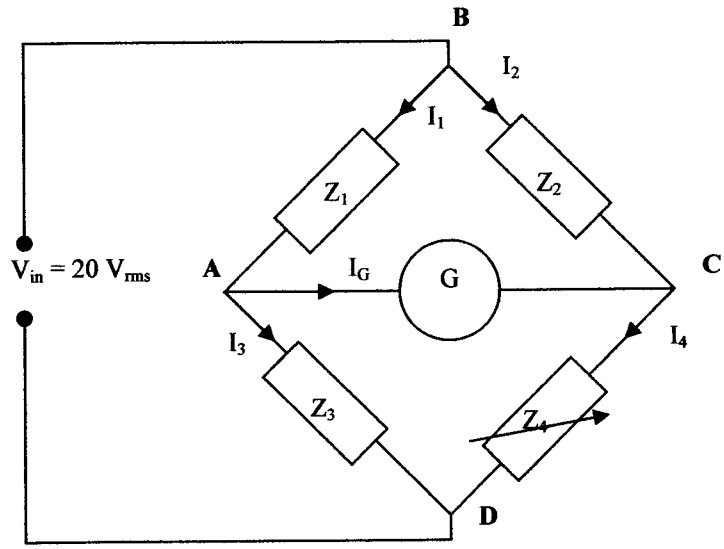

Figure Q4

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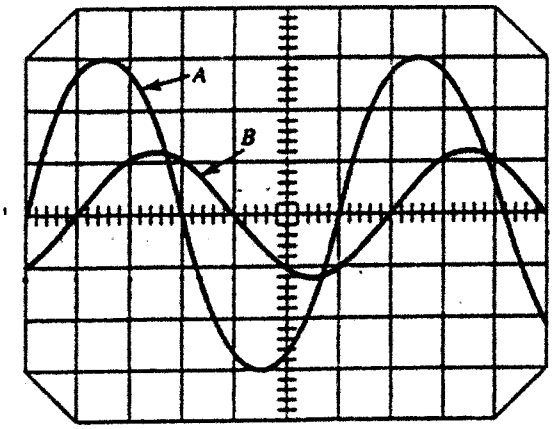

TIME/DIV setting at 0.2 ms, and
VOLTS/DIV setting at 500 mV

Figure Q5(b)

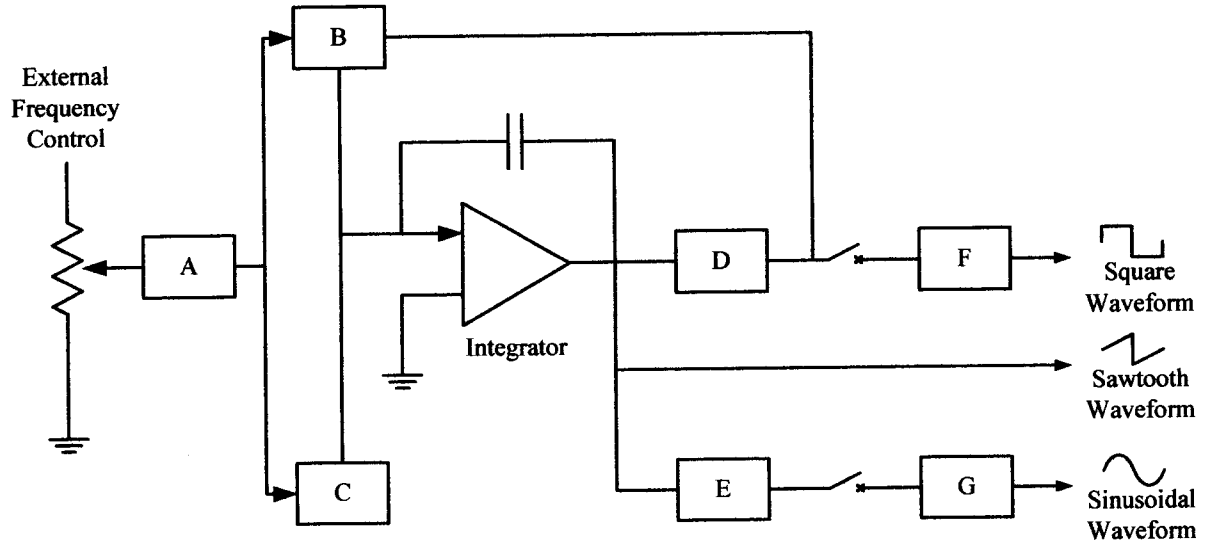

Figure Q5(c)

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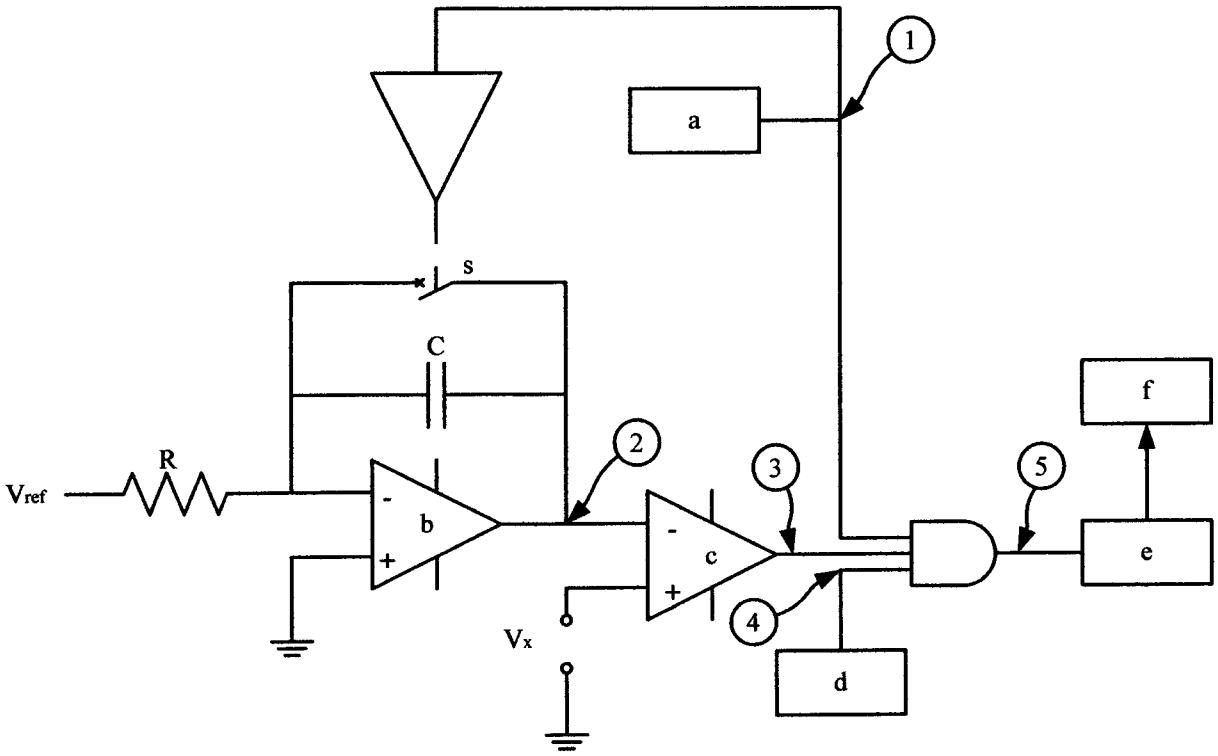

Figure Q6(b)

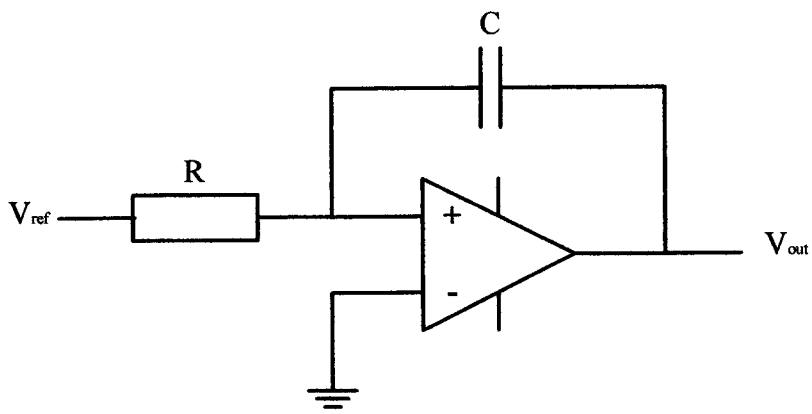

Figure Q6(c)

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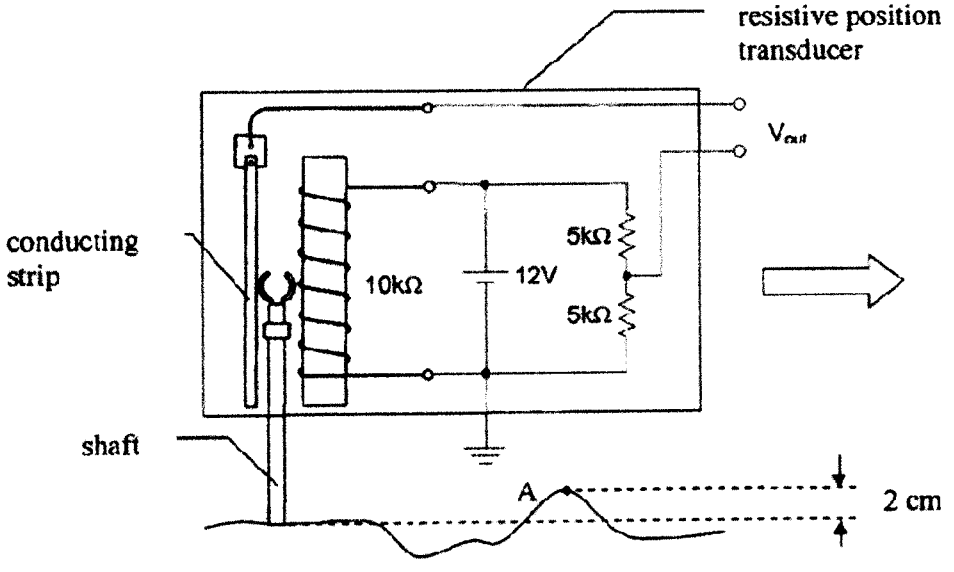

Figure Q7(a)

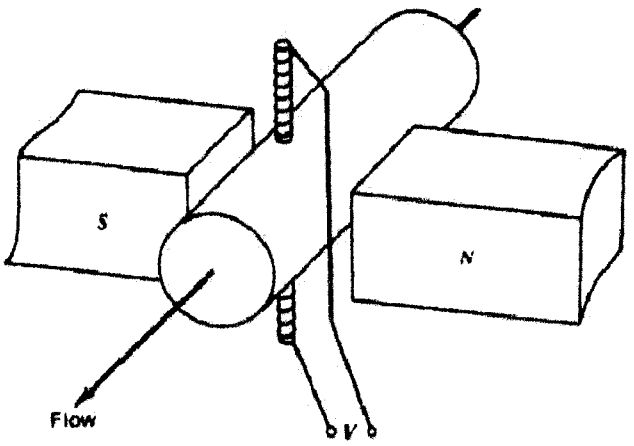

Figure Q7(b)