Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2013/2014

COURSE NAME	:	ELECTRONIC INSTRUMENTS AND MEASUREMENTS
COURSE CODE	:	BEF 24002
PROGRAMME	:	BEV
EXAMINATION DATE	:	JANUARY 2014
DURATION	:	2 ½ HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

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

Q1 (a) One of the measurement errors is due to equipment errors which come under the category of systematic errors. List any four factors causing the equipment errors and specify methods of reduction or elimination of the listed errors.

(8 marks)

(b) The following 10 observations with units in mA for an ammeter reading were recorded: 43.7, 44, 44.8, 44, 44.1, 43.9, 44, 43.9, 44.5 and 43.8. Find:

(i) The mean

(2 marks)

(ii) The average deviation

(2 marks)

(iii) The standard deviation

(3 marks)

(iv) The probable error

(1 marks)

(c) In DC circuit power measurement $P = VI$. If $V = 120 \pm 2$ volt (measured) and $I = 12 \pm 0.2$ Amp (measured), determine:

(i) The nominal value of power

(2 marks)

(ii) The maximum allowable uncertainty in power

(3 marks)

(iii) The expected uncertainty in power

(4 marks)

Q2 (a) A Wheatstone bridge shown in **FIGURE Q2(a)** is being modified to measure temperature of an oven with Rx as the temperature sensor. Find the value of Ig that flows through the galvanometer G and the deflection if the sensitivity of the galvanometer is 1 division per μA. Given that internal resistance of the galvanometer is 100 Ω, R_1 is 2 kΩ, R_2 is 3 kΩ, R_3 is 20 kΩ, the battery E is 12V while R_x is 25.5 kΩ.

(10 marks)

(b) **FIGURE Q2(b)** shows an AC bridge (Maxwell bridge) for measuring inductor parameters L_x and R_x.

(i) Show that when the bridge is at null point

$$R_x = \frac{R_2 R_3}{R_1}$$

$$L_x = R_2 R_3 C_1$$

(9 marks)

(ii) Obtain the value of R_x and L_x given that $R_1 = 318\ \Omega$, $R_2 = R_3 = 10\ \Omega$, and $C_1 = 1.0\ \mu F$. Finally, obtain the quality factor Q for the inductor

(6 marks)

Q3 (a) **FIGURE Q3(a)** shows an opamp integrator. By analyzing the circuit, obtain an expression for the output voltage V_{out} in terms of the input voltage and the circuit parameters.

(5 marks)

(b) **FIGURE Q3(b)** shows a single ramp method of voltage measurement utilizing an integrator, a comparator, a clock, a frequency counter and the display. Show the waveforms at all the indicated points sequentially in a proper column and explain briefly how the circuit work with reference to the waveforms shown.

(10 marks)

(c) With the aid of schematic diagrams, explain the two-slope method of analog-to-digital converter operation. Show, in a mathematical expression, how the time for charging and discharging can be related to finding the magnitude of an unknown input signal.

(10 marks)

Q4 (a) **FIGURE Q4(a)** shows a block diagram of an oscilloscope. Identify and state the function of each of the items indicated (number 1 to 10) in the diagram.

(10 marks)

(b) With reference to **FIGURE Q4(b)**, determine the vertical frequency for the Lassajous pattern shown if the horizontal frequency is 52 Hz.

(3 marks)

(c) With reference to **FIGURE Q4(c)**, given that the distance Y1 is 1.8 cm and Y2 is 2.3 cm determine the phase angle in radians and in degrees.

(3 marks)

(d) Draw the block diagram of a digital oscilloscope and name the principal subsystems of this oscilloscope. Describe briefly the purpose of each of these subsystem.

(9 marks)

Q5 (a) With reference to **FIGURE Q5(a)**, obtain the gain equation of the amplifier with positive feedback. From the gain equation, to satisfy Barkhausen criteria, specify the two conditions that must be satisfied for the circuit to sustain oscillation.

(7 marks)

(b) With reference to **FIGURE Q5(b)**, assuming that the condition for oscillation to happen for the Wien Bridge is when $Z_1 Z_4 = Z_2 Z_3$:

(i) Show that by equating real terms and imaginary terms the following are obtained:

$$\frac{R_3}{R_4} = \frac{R_1}{R_2} + \frac{C_2}{C_1} \qquad \textit{and} \qquad \omega C_1 R_1 = \frac{1}{\omega C_2 R_2}$$

(6 marks)

(ii) Show that if $\omega = 2\pi f$, then

$$f = \frac{1}{2\pi (C_1 R_1 \; C_2 R_2)^{1/2}}$$

(2 marks)

(iii) Show also that if $C_1 = C_2 = C$ and $R_1 = R_2 = R$, then

$$\frac{R_3}{R_4} = 2 \quad \textit{and} \quad f = \frac{1}{2\pi RC}$$

(2 marks)

(c) With reference to **FIGURE Q5(c)**, obtain the frequency of operation of the circuit.

(4 marks)

(d) List two advantages of using Wien Bridge Oscillator as audio generator when compared to the Phase–Shift Oscillator.

(4 marks)

- END OF QUESTION -

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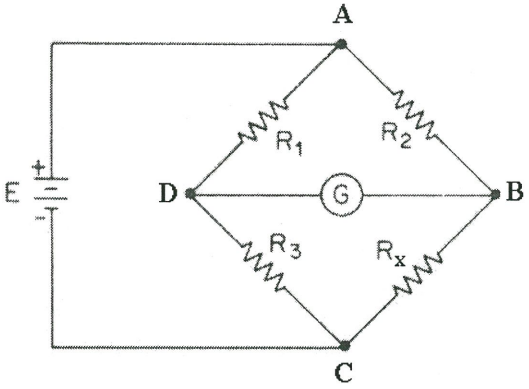

FIGURE Q2(a)

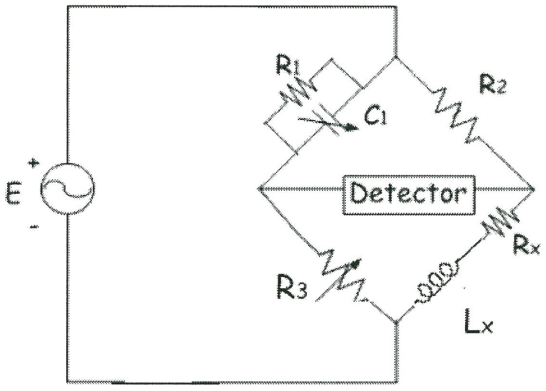

FIGURE Q2(b)

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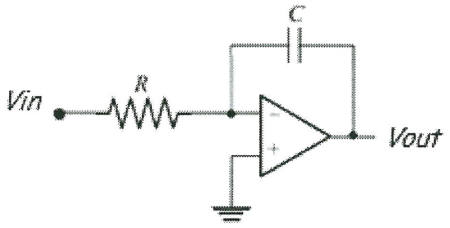

FIGURE Q3(a)

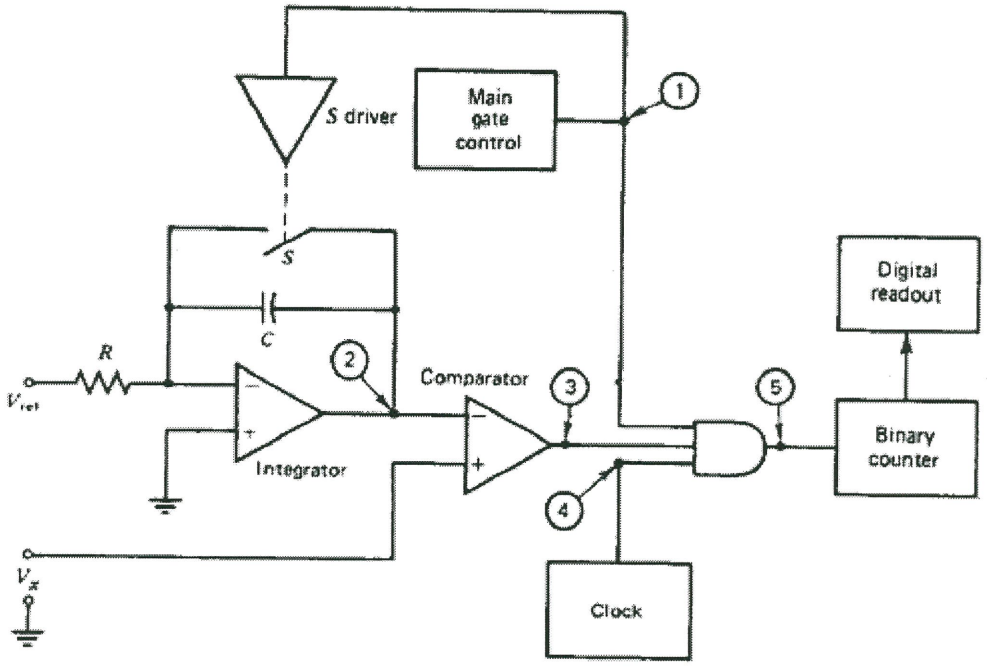

FIGURE Q3(b)

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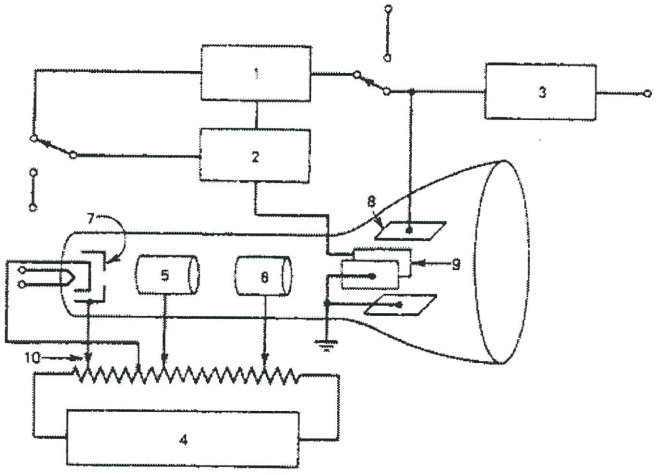

FIGURE Q4(a)

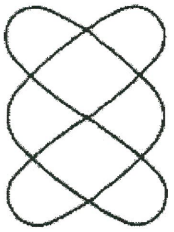

FIGURE Q4(b)

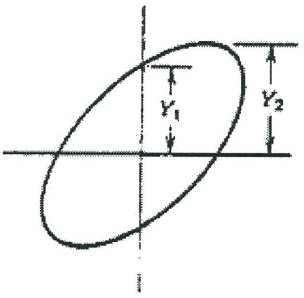

FIGURE Q4(c)

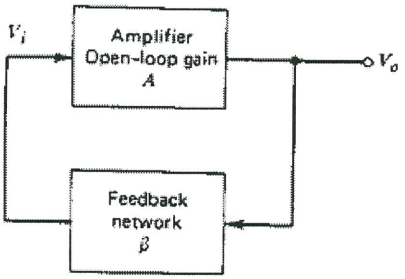

FIGURE Q5(a)

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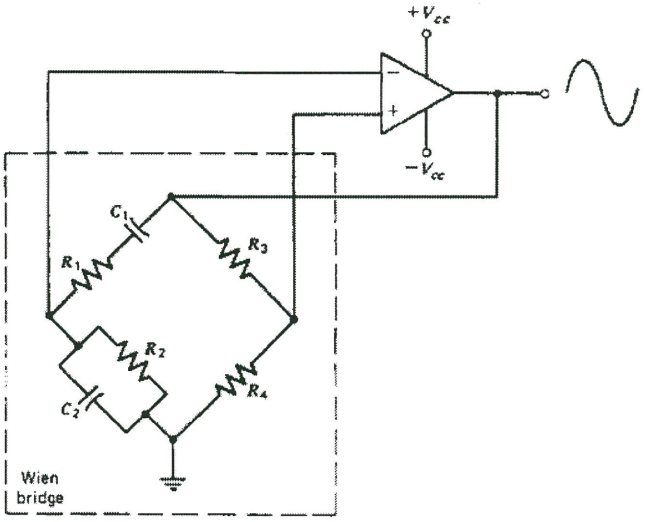

FIGURE Q5(b)

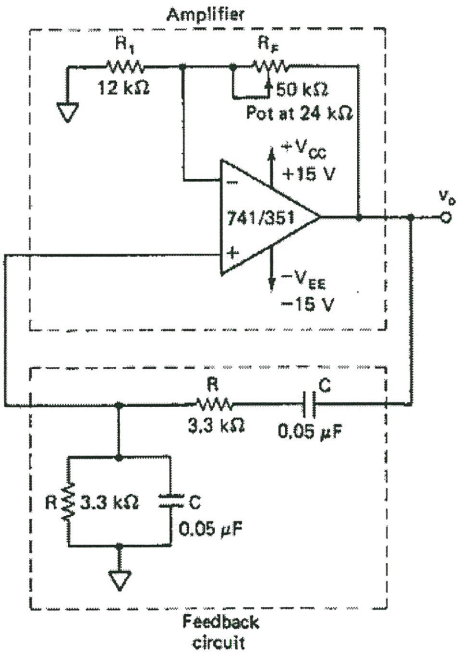

FIGURE Q5(c)