UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2009/2010

SUBJECT NAME	:	ELECTRICAL INSTRUMENTATIONS AND MEASUREMENTS
SUBJECT CODE	:	BEE 2123
COURSE	:	2 BEE
EXAMINATION DATE	:	NOVEMBER 2009
DURATION	:	2 ½ HOURS
INSTRUCTION	:	ANSWER FOUR (4) QUESTIONS ONLY

THIS PAPER CONSISTS OF 6 PAGES

Q1 (a) A PMMC instrument with a 600Ω coil resistance gives full scale deflection (FSD) with a 450μA coil current. The instrument will be converted into a dc ammeter with a 11Ω shunt resistance.

(i) Draw the circuit.

(5 marks)

(ii) Derive the formula of the FSD current.

(5 marks)

(iii) Calculate the FSD current.

(5 marks)

(b) A dc ammeter is constructed of a PMMC instrument and shunt resistor. If the instrument has a 1.5kΩ coil resistance and 50μA FSD current, and the measured current at 0.25 FSD is 200μA.

(i) Derive the formula of the shunt resistor.

(5 marks)

(ii) Calculate the shunt resistance.

(5 marks)

Q2 (a) A PMMC instrument with a 1 kΩ coil resistance is to be used as a dc voltmeter. The sensitivity of the voltmeter is 12.5kΩ/V while its FSD is 50V.

(i) Draw the circuit.

(5 marks)

(ii) Derive the formula of the multiplier resistor.

(5 marks)

(iii) Calculate the multiplier resistance.

(5 marks)

(b) The voltages at opposite ends of a 100Ω ± 5% resistor are measured using the voltmeter as V_1 = 15V and V_2 = 5V. The measuring accuracies are ± 0.4V for V_1 and ± 3% for V_2.

(i) Calculate the power dissipated by the resistor.

(5 marks)

(ii) Specify its accuracy.

(5 marks)

Q3 (a) A half-wave rectifier is used with a PMMC instrument and a series resistor for ac voltage measurements. A shunt resistor is included to ensure a satisfactory rectifier forward current level. An additional diode minimizes reverse leakage current. The PMMC instrument has a 200Ω coil resistance and a 1mA FSD current. The ac voltmeter is required to give $10V_{rms}$ for FSD.

(i) Draw the circuit.

(5 marks)

(ii) Derive the equation of the multiplier resistor.

(5 marks)

(iii) Calculate the multiplier resistance.

(2.5 marks)

(b) A full-wave rectifier is used with a PMMC instrument and a series resistor for ac voltage measurements. The PMMC instrument has a 250Ω coil resistance and a 1mA full scale deflection current. The ac voltmeter is required to give $10V_{rms}$ for full scale deflection.

(i) Draw the circuit.

(5 marks)

(ii) Derive the equation of the multiplier resistor.

(5 marks)

(iii) Calculate the multiplier resistance.

(2.5 marks)

Q4 An ac bridge is balanced at a frequency of 1 kHz and has the following constants: arm AB (Z_1) is a 0.5μF capacitor in parallel with a 1kΩ resistor, arm AD (Z_2) is a 2kΩ pure variable resistance, arm BC (Z_3) is a 0.5μF pure capacitance and arm CD (Z_x) are an unknown capacitor C_x and a resistor R_x in series.

(a) Draw circuit of the bridge.

(10 marks)

(b) Derive the balance condition to obtain the equation of arm CD (Z_x).

(10 marks)

(c) Determine the values of the components in arm CD (Z_x).

(5 marks)

Q5 (a) Figure Q5(a) shows basic diagram of an oscilloscope.

(i) Identify numbered components in the figure.

(8 marks)

(ii) Explain the operation of the oscilloscope.

(7 marks)

(b) A Lissajous pattern as shown in Figure Q5(b) is displayed on the screen of the oscilloscope when the input of Channel 1 is a sinusoidal waveform from a signal generator with 3 kHz frequency. Calculate the frequency of the unknown sinusoidal waveform in Channel 2.

(10 marks)

Q6 (a) Explain the difference between sensor and transducer?

(5 marks)

(b) Describe the passive and active transducers. Give two examples for each of them.

(5 marks)

(c) A resistive position transducer with a resistance of 10 kΩ and a 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 Q6(c). The initial position to be used as a reference point is when the shaft is at midstroke like in the figure.

(i) Draw the equivalent circuit of the system.

(5 marks)

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

(4 marks)

(iii) What is the value of V_{out} when the shaft of the transducer is at initial position?

(2 marks)

(iv) What will the value of V_{out} be if the shaft has reached point A?

(4 marks)

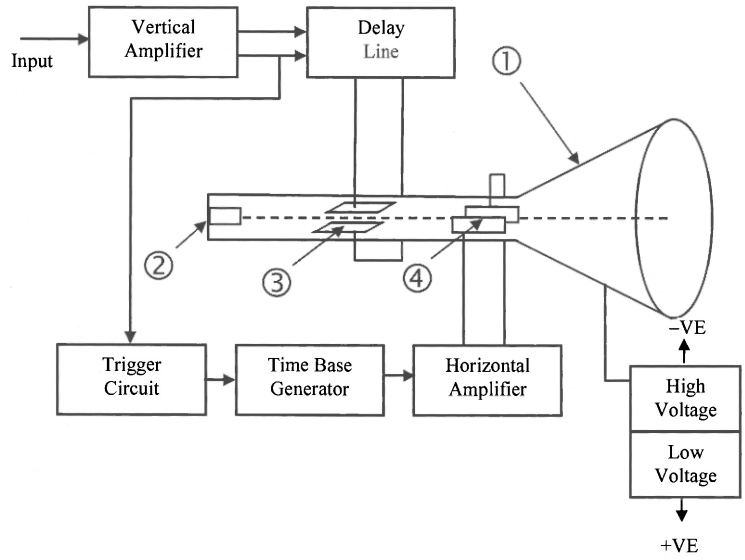

Figure O5(a)

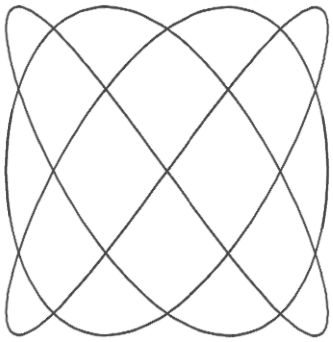

Figure O5(b)

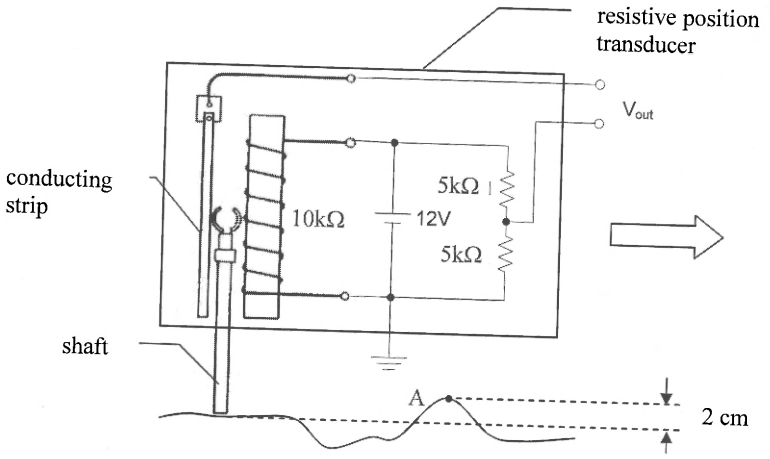
resistive position transducer
V_{out}
conducting strip
10kΩ
5kΩ
12V
5kΩ
shaft
A
2 cm

Figure O6(c)