



**KOLEJ YAYASAN PELAJARAN JOHOR
FINAL EXAMINATION**

COURSE NAME : INSTRUMENTATION
COURSE CODE : DKE 1033
EXAMINATION : OCTOBER 2018
DURATION : 2 HOURS 30 MINUTES

INSTRUCTION TO CANDIDATES

1. This examination paper consists of **FIVE (5)** questions. Answer **ALL** questions in the answer booklet provided.
2. Candidates are not allowed to bring any material to examination room except with the permission from the invigilator.
3. Please check to make sure that this examination pack consist of:
 - i. Question Paper
 - ii. Answer Booklet

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

This examination paper consists of 9 printed pages including front page

This paper contains of **FIVE(5)** questions. Answer **ALL** questions in the Answer Booklet.

*Kertas soalan ini mengandungi **LIMA (5)** soalan. Jawab **SEMUA** soalan di dalam buku jawapan yang disediakan.*

QUESTION 1 / SOALAN 1

- a. Systematic error is one of the types that frequently occur in any measurement. Explain briefly **two (2)** types of errors that are categorized as systematic error.

*Ralat sistematik merupakan salah satu jenis ralat yang sering berlaku di dalam sesuatu pengukuran. Terangkan dengan ringkas **dua (2)** jenis ralat yang dikategorikan sebagai ralat sistematik.*

(3 marks/ markah)

- b. A voltmeter and an ammeter having a scale of 5 V and 10 mA respectively are used to measure the voltage and the current across resistor, R_2 as shown in Figure Q1 (b). Both meters have an accuracy of $\pm 2\%$ full-scale deflection. The expected voltage across R_2 and the expected current through R_2 are 1.43 V and 7.14 mA respectively. However, during measurement, it is observed that the power dissipated by the resistor, R_2 is 9.8 mW. Calculate:

- the value of resistor, R_2 .
- the voltage reading across R_2 that will be obtained during measurement.
- the current reading that will be obtained during measurement.
- the percentage of the error that occurs for both readings.

Satu meter volt dan satu meter ampere masing-masing mempunyai skala 5 V dan 10 mA digunakan untuk mengukur voltan dan arus merintangi perintang R_2 seperti yang ditunjukkan dalam Rajah Q1 (b). Kedua-dua meter mempunyai kejituan $\pm 2\%$ pesongan skala penuh. Nilai voltan terjangka merintangi perintang R_2 dan arus terjangka melalui R_2 masing-masing ialah

1.43 V dan 7.14 mA. Namun semasa pengukuran didapati bahawa kuasa yang dilesapkan oleh perintang R_2 ialah 9.8 mW. Kirakan :

- i. nilai perintang, R_2 .
- ii. bacaan voltan merintang R_2 yang akan diperolehi semasa pengukuran.
- iii. Bacaan arus yang akan diperolehi semasa pengukuran.
- iv. Peratus ralat yang terhasil bagi kedua-dua bacaan tersebut.

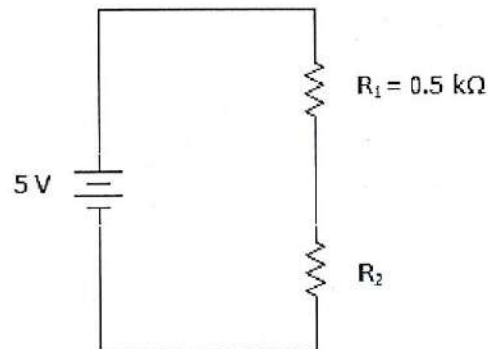


Figure Q1 (b) / Table Q1 (b)

(17 marks/ markah)

QUESTION 2 / SOALAN 2

- a. A 1 mA full scale deflection current meter movement is used in an ohmmeter circuit. The meter movement has an internal resistance, $R_m = 100 \Omega$ and a 3 V battery is used in the circuit. Determine:
 - i. the ohmmeter basic circuit.
 - ii. the value of the variable resistance, R_z .
 - iii. the value of R_x at 20%, 50% and 70% full-scale reflection.

Gerakan meter arus pesongan skala penuh 1 mA digunakan dalam litar meter ohm. Gerakan meter tersebut mempunyai rintangan dalam, $R_m = 100 \Omega$ dan sebuah bateri 3 V digunakan dalam litar tersebut. Tentukan :

- i. litar asas meter ohm.
- ii. nilai rintangan bolehubah, R_z .
- iii. nilai R_x pada 20%, 50% dan 70% pesongan skala penuh.

(8 marks/ markah)

b. Figure Q2 (b) shows a half-wave rectifier type ac meter with a range of 50 V. The diodes have a forward resistance of 100Ω while the parameters of the d'Arsonval movement are $50 \mu\text{A}$, 200Ω . It is required that $I_{sh} = I_m$.

- i. Calculate the shunt resistor R_{sh} .
- ii. Calculate the multiplier resistor R_s .
- iii. Calculate the dc sensitivity of the meter.
- iv. Calculate the ac sensitivity of the meter.

Rajah Q2 (b) menunjukkan meter au jenis penerus separuh-gelombang ber julat 50 V. Diod mempunyai rintangan ke depan 100Ω sementara parameter gerakan d'Arsonval ialah $50 \mu\text{A}$, 200Ω . Dikehendaki supaya $I_{sh} = I_m$.

- i. Kirakan rintangan pirau R_{sh} .
- ii. Kirakan rintangan pendarab R_s .
- iii. Kirakan kepekaan at meter.
- iv. Kirakan kepekaan au meter.

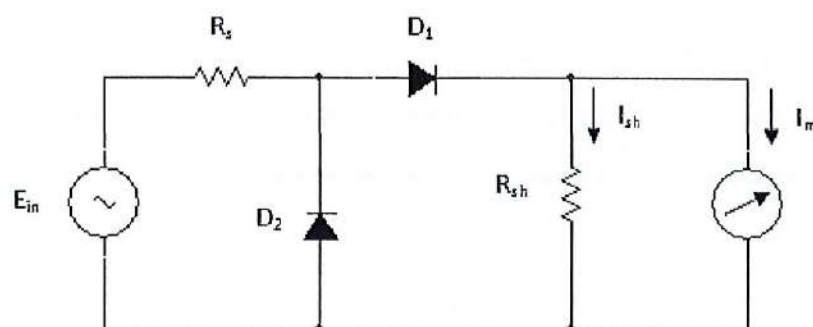


Figure Q2 (b) / Rajah Q2 (b)

(12 marks/ markah)

QUESTION 3 / SOALAN 3

- a. Briefly explain **three (3)** the difference between a digital instrument and a digital display instrument.

*Terangkan dengan ringkas **tiga (3)** perbezaan antara alatan digital dan alatan paparan digital.*

(6 marks/ markah)

- b. The 805A model digital multimeter is a 4½ digit instrument. The dc current measuring specifications are as follows:

5 ranges from 2 mA to 20 A

Accuracy: $\pm (1\% + 10d)$

Calculate the limiting error percentage when measuring a current of 250 mA.

Meter pelbagai digit model 805A ialah alatan 4½ digit. Penentuan ukuran arus at ialah seperti berikut:

5 julat dari 2 mA ke 20 A

Kejituan: $\pm (1\% + 10d)$

Kirakan peratus ralat mengehend ketika mengukur arus 250 mA.

(6 marks/ markah)

- c. A digital voltmeter as shown in Figure Q3 (c) utilizes a voltage-to-frequency converter as its analogue-to-digital converter. The relationship between the input V_i and the output frequency f is given as

$$V_i = \frac{f}{100}$$

If 130 pulses are sent to the AND gate in 0.5 s, calculate the amplitude of the input voltage V_i .

Sebuah meter volt digit seperti dalam Rajah Q3 (c) menggunakan penukar voltan-ke-frekuensi sebagai penukar analog-ke-digit. Hubungan antara V_i dan frekuensi keluaran f diberikan sebagai

$$V_i = \frac{f}{100}$$

Jika 130 denyutan dihantar ke get DAN dalam masa 0.5 saat, kirakan amplitud voltan masukan V_i .

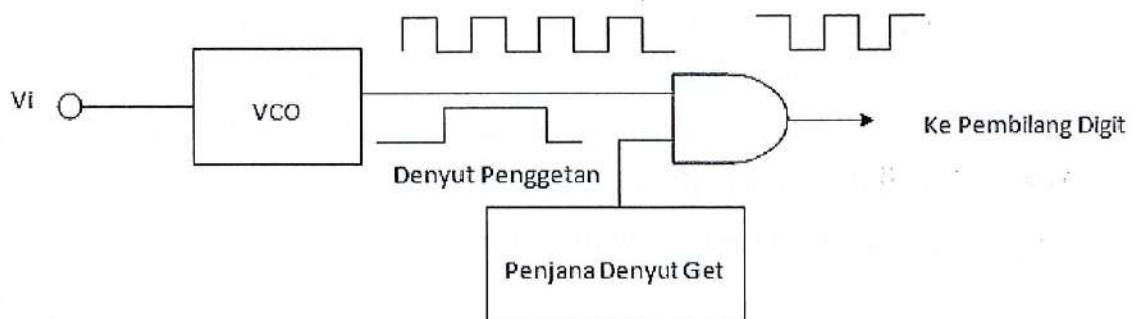


Figure Q3 (c) / Rajah Q3 (c)

(8 marks/ markah)

QUESTION 4 / SOALAN 4

- a. State **three (3)** main factors to be considered in choosing a suitable transducer for an instrumentation system.

*Nyatakan **tiga (3)** faktor utama yang perlu dipertimbangkan ketika memilih transduser yang sesuai dalam sistem pengalatan.*

(3 marks/ markah)

- b. A strain gauge with gauge factor 10 and unstrained resistance 100Ω is attached to a steel beam with Young's modulus $E = 2.0 \times 10^6 \text{ N/m}^2$. The beam changes in length from 100 mm to 100.4 mm.
- Calculate the strain G experienced by the beam.
 - Calculate the resistance of the gauge after the strain has been applied.
 - State the type of stress applied to the beam.
 - Calculate the magnitude of the stress.

Sebuah tolok terikan dengan faktor tolok 10 dan rintangan tak terterik 100Ω dilekatkan pada alur keluli dengan modulus Young $E = 2.0 \times 10^6 \text{ N/m}^2$. Alur tersebut berubah panjang dari 100 mm ke 100.4 mm.

- Kirakan terikan G yang dialami oleh alur tersebut.*
- Kirakan rintangan tolok setelah terikan dikenakan.*
- Nyatakan jenis tegasan yang dikenakan pada alur tersebut.*
- Kirakan jumlah magnitud bagi tegasan.*

(17 marks/ markah)

QUESTION 5 / SOALAN 5

- a. A full-bridge Wheatstone has resistance values $R_1 = R_4 = R + \Delta R$ and $R_2 = R_3 = R - \Delta R$. Show that the output of the bridge is

$$V_o = \frac{\Delta R}{R} E$$

Sebuah titi penuh Wheatstone mempunyai nilai-nilai rintangan $R_1 = R_4 = R + \Delta R$ and $R_2 = R_3 = R - \Delta R$. Tunjukkan bahawa keluaran titi tersebut ialah

$$V_o = \frac{\Delta R}{R} E$$

(5 marks/ markah)

- b. The Wheatstone bridge in Figure Q5 (b) is used as quarter-bridge where R_4 is connected to a strain gauge. Given that $R_1 = R_2 = R_3 = R$ where R is the initial resistance of the strain gauge. The strain gauge with gauge factor $K = 2.0$ and initial resistance 350Ω is used. The voltage supply 10 V . The gauge experiences a strain of $1450 \mu\text{m/m}$.

- i. Show that the output of the bridge is

$$V_o = \frac{\Delta R}{4R} E$$

- ii. Find the change in resistance of the strain gauge, ΔR .
iii. Calculate the output voltage.

Titi Wheatstone dalam Rajah Q5 (b) digunakan sebagai titi suku di mana R_4 disambungkan kepada tolok terikan. Diberi bahawa $R_1 = R_2 = R_3 = R$ dimana R ialah rintangan awal tolok terikan. Tolok terikan dengan faktor $K = 2.0$ dan rintangan awal 350Ω digunakan. Voltan bekalan ialah 10 V . Tolok tersebut mengalami terikan $1450 \mu\text{m/m}$.

- i. *Tunjukkan bahawa keluaran titi tersebut ialah*

$$V_o = \frac{\Delta R}{4R} E$$

- ii. *Dapatkan perubahan rintangan tolok terikan, ΔR .*
iii. *Kirakan voltan keluaran.*

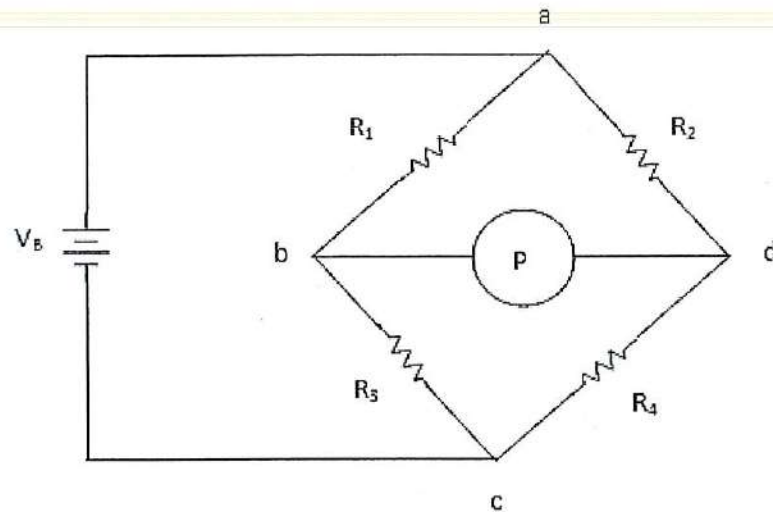


Figure Q5 (b) / Rajah Q5 (b)

(15 marks/ markah)

[100 MARKS / 100 MARKAH]**END OF QUESTION PAPER / KERTAS SOALAN TAMAT**