



**KOLEJ YAYASAN PELAJARAN JOHOR
FINAL EXAMINATION**

COURSE NAME : INSTRUMENTATION AND MEASUREMENT
COURSE CODE : DEE 1053
EXAMINATION : JUNE 2023
DURATION : 2 HOURS 30 MINUTES

**INSTRUCTION TO CANDIDATES /
ARAHAN KEPADA CALON**

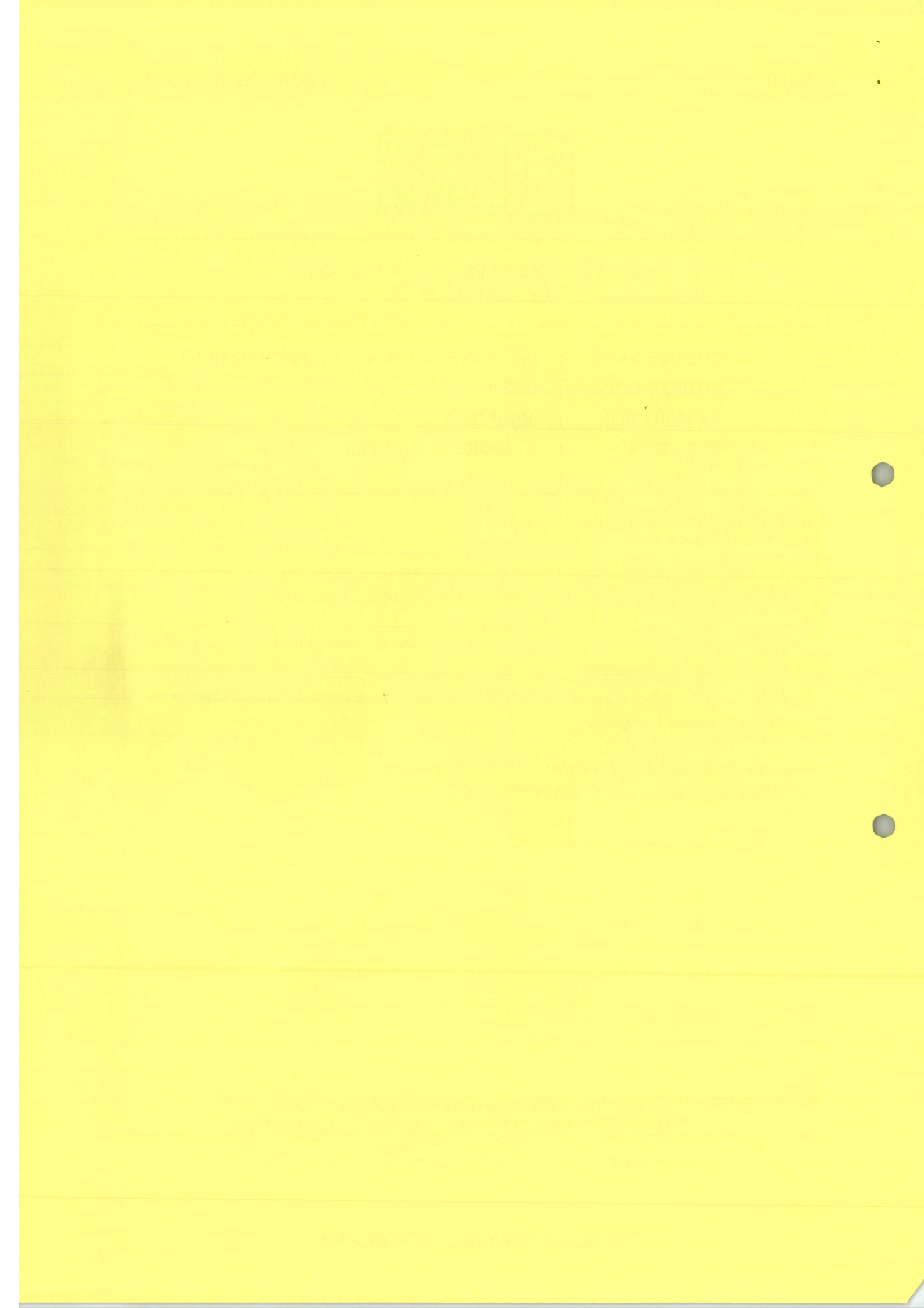
1. This examination paper consists of **FIVE (5)** questions. Answer **ALL** questions. /
Kertas soalan ini mengandungi LIMA (5) soalan. Jawab SEMUA soalan.

2. Candidates are not allowed to bring any material/note to the examination hall/room except with the permission from the invigilator. /
Calon tidak dibenarkan untuk membawa sebarang bahan/nota ke dewan/bilik peperiksaan tanpa kebenaran daripada pengawas.

3. Please check to make sure that this examination pack consist of: /
Pastikan kertas soalan peperiksaan ini mengandungi:
 - i. The Question Paper /
Kertas Soalan
 - ii. An Answering Booklet /
Buku Jawapan

**DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO /
JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIBERITAHU**

This examination paper consists of **8** printed pages including front page
Kertas soalan ini mengandungi 8 muka surat termasuk kulit hadapan



This part contains **FIVE (5)** questions. Answer **ALL** questions in the Answering Booklet.

Kertas soalan ini mengandungi LIMA (5) soalan. Jawab SEMUA soalan di dalam Kertas Jawapan.

QUESTION 1 / SOALAN 1

a) Explain **two (2)** suitable times to calibrate the equipment.

(4 marks/ markah)

b) Systematic error is one of the type that frequently occur in any measurement. Briefly explain **two (2)** types of errors that are categorized as systematic error.

(4 marks/ markah)

c) Refer to **Table 1**, calculate:

- i. the average value of the readings.
- ii. the deviation.
- iii. algebraic sum of all deviations.
- iv. the standard deviation.

(12 marks/ markah)

a) Terangkan **dua (2)** masa yang sesuai bagi mententukur sesuatu peralatan.

b) 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.

- c) Merujuk pada **Jadual 1**, kirakan:
- nilai purata bacaan.
 - sisihan.
 - hasil tambah aljabar kesemua sisihan.
 - sisihan piawaian.

Data/ <i>Data</i>	1	2	3	4	5
Readings/ <i>Bacaan</i>	4.5	4.7	5.0	5.2	4.6

Table 1 / Jadual 1

QUESTION 2 / SOALAN 2

- a) Briefly explain the operating principle of the d'Arsonval movement with its diagram.

(4 marks/ markah)

- b) 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:

- the ohmmeter basic circuit.
- the value of the variable resistance, R_z .
- the value of R_x at 20%, 50% and 70% full-scale reflection.

(8 marks/ markah)

- c) **Figure 1** 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 $I_{sh} = I_m$.

- Calculate the shunt resistor, R_{sh} .
- Calculate the multiplier resistor, R_s .
- Calculate the DC sensitivity of the meter, S_{dc} .

(8 marks/ markah)

- a) Terangkan dengan ringkas prinsip pengendalian gerakan d'Arsonval berserta gambar rajahnya.
- b) 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:
- litar asas meter ohm.
 - nilai rintangan bolehubah, R_z .
 - nilai R_x pada 20%, 50% dan 70% pesongan skala penuh.
- c) **Rajah 1** menunjukkan meter AU jenis penerus separuh-gelombang berjulat 50 V. Diod mempunyai rintangan ke depan 100Ω sementara parameter gerakan d'Arsonval ialah $50 \mu\text{A}$, 200Ω . Dikehendaki supaya $I_{sh} = I_m$.
- Kirakan rintangan pirau, R_{sh} .
 - Kirakan rintangan pendarab, R_s .
 - Kirakan kepekaan AT meter, S_{at} .

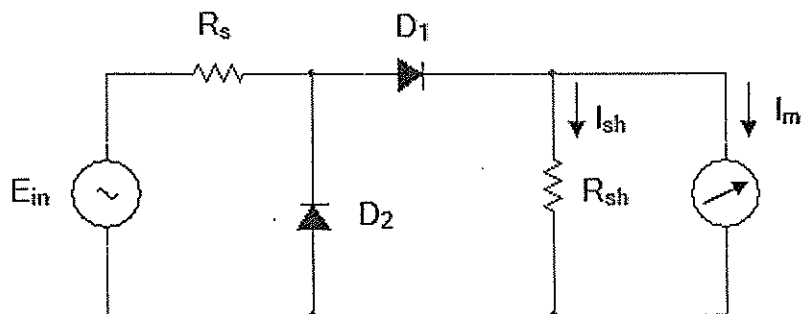


Figure 1 / Rajah 1

QUESTION 3 / SOALAN 3

- a) With the aid of diagrams, explain **three (3)** differences between a digital instrument and a digital display instrument.

(12 marks/ markah)

- b) A digital voltmeter as shown in **Figure 2** utilizes a voltage-to-frequency converter as its analogue-to-digital converter. The relationship between the input voltage 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 seconds, calculate the amplitude of the input voltage V_i .

(8 marks/ markah)

- a) Dengan bantuan gambar rajah, terangkan **tiga (3)** perbezaan di antara alatan digital dan alatan paparan digital.
- b) Sebuah meter volt digital seperti dalam **Rajah 2** menggunakan penukar voltan-ke-frekuensi sebagai penukar analog-ke-digital. Hubungan antara voltan masukan 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 .

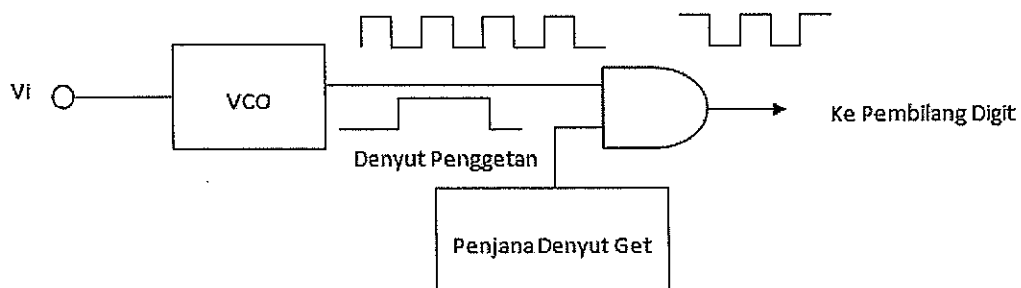


Figure 2 / Rajah 2

QUESTION 4 / SOALAN 4

- a) There are eight (8) main factors to be considered when choosing a suitable transducer. Explain any **three (3)** of these factors.

(6 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.

- i. Explain the relationship between the strain and the resistance of the strain gauge.
- ii. Calculate the strain G experienced by the beam.
- iii. Calculate the resistance of the gauge after the strain has been applied.
- iv. Calculate the magnitude of the stress.
- v. State **two (2)** main problems in the use of strain gauge.

(14 marks/ markah)

- a) Terdapat lapan (8) faktor utama yang perlu dipertimbangkan ketika memilih transduser yang sesuai. Terangkan mana-mana **tiga (3)** dari faktor tersebut.

- b) 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.

- i. Terangkan hubungan antara terikan dan rintangan bagi tolok terikan.
- ii. Kirakan terikan G yang dialami oleh alur tersebut.
- iii. Kirakan rintangan tolok setelah terikan dikenakan.
- iv. Kirakan jumlah magnitud bagi tegasan.
- v. Nyatakan **dua (2)** masalah utama di dalam penggunaan tolok terikan.

QUESTION 5 / SOALAN 5

- a) State **three (3)** characteristics of the operational amplifier.

(3 marks/ markah)

- b) The Wheatstone Bridge in **Figure 3** 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. Prove 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.

(14 marks/ markah)

- c) List down **three (3)** advantages of IEEE488 compared to RS232.

(3 marks/ markah)

- a) Nyatakan **tiga (3)** ciri penguat kendalian.

- b) Titi Wheatstone dalam **Rajah 3** 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. Buktikan bahawa keluaran titi tersebut ialah

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

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

- c) Senaraikan **tiga (3)** kebaikan IEEE488 berbanding dengan RS232.

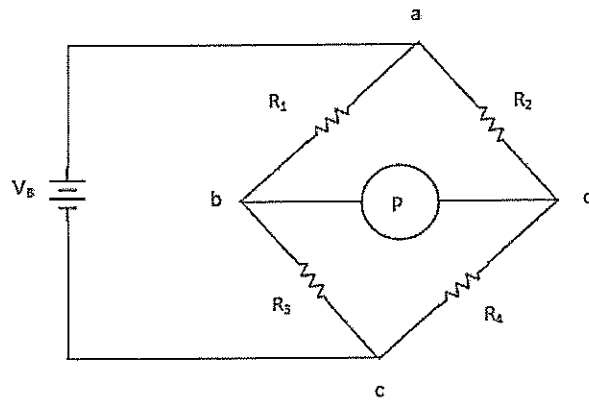


Figure 3 / Rajah 3

[100 MARKS / 100 MARKAH]

END OF QUESTION PAPER / KERTAS SOALAN TAMAT

