Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2022/2023

COURSE NAME	:	ELECTRICAL INSTRUMENTATION AND MEASUREMENT
COURSE CODE	:	DAE 21403
PROGRAMME CODE	:	DAE
EXAMINATION DATE	:	FEBRUARY 2023
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWER **ALL** QUESTIONS. 2. THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK.** 3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK.

THIS QUESTION PAPER CONSISTS OF **ELEVEN (11)** PAGES

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SECTION A (40 MARKS)

Q1 Select the **non-fundamental** unit of International Standard.

A. Kilogram (kg)
B. Millimeter (mm)
C. Candela (cd)
D. Ampere (A)

Q2 Physical quantity of measurement system is best described as:

A. Properties of material or system that can be express as value.
B. Data that represent the fundamental value of SI unit.
C. Measurable data attained from instrumentation.
D. Representation of measured data.

Q3 Resistance colour code depicted in the resistance band is a method of describing the resistance value and its tolerance. The range of resistance value is also known as:

A. Relative Error.
B. Absolute Error.
C. Guaranteed Error.
D. Random Error.

Q4 Zero-ohm adjustment in a multimeter is to:

A. reduce gross error.
B. eliminate error due to battery variation.
C. adjust the sensitivity of the coil due to variation of range selected.
D. ensure the continuity test measures the lowest resistance possible.

Q5 Which of the listed statement in **incorrect**?

A. Full-scale deflection reading has the least error.
B. Full-scale current at moving coil is direct proportional to percentage of deflection.
C. Full-scale deflection is always referred to maximum range of the measurement scale.
D. Full-scale deflection resulted from maximum current flowing thru moving coil.

Q6 The **best** description of parallax error is:

A. The error of reading the measurement data.
B. The uncertain position of pointer sitting on the scale.
C. The positional degree of the observer eye.
D. The uncertainty about the eye of the observer being directly in line with the end of the pointer.

Q7 What is meant by the term precision?

A. The overall quality of data.
B. The lack of bias in the data.
C. The extent to which a value approaches its true value.
D. The level of detail at which data is stored.

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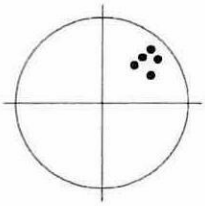
Q8 What is meant by the term accuracy?

A. The lack of bias in the data.
B. The overall quality of the data.
C. The level of detail at which data is stored.
D. The extent to which a value approaches its true value.

Q9 Looking at the rifle target below, how would you describe the shooting of this contestant?



A. Inaccurate and imprecise.
B. Accurate and imprecise.
C. Accurate and precise.
D. Inaccurate and precise.

Q10 The difference between the measured value and true value is described as:

A. Relative error.
B. Absolute error.
C. Gross error.
D. Probable error.

Q11 Systematic error can be defined as:

A. Instrumental error.
B. Environmental error.
C. Random error.
D. Instrumental and environmental error.

Q12 Relative error can be defined as:

A. Difference of the measured value and the true value.
B. Ratio of absolute error to the measured value of the quantity under measurement.
C. Ratio of absolute error to the true value of the quantity under measurement.
D. Ratio pf the probable error to the true value of quantity under measurement.

Q13 To increase the range of ammeter, connect:

A. a high value resistance in series with the ammeter coil.
B. a high value resistance in parallel with the ammeter coil.
C. a low value resistance in parallel with the ammeter coil.
D. a low value resistance in series with the ammeter coil.

Q14 The number 0.032040 has ___ significant figures.

A. 3
B. 5
C. 6
D. 7

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Q15 The function of shunt in an ammeter is to:
A. Bypass the current.
B. Increase the sensitivity of the ammeter.
C. Increase the resistance of the ammeter.
D. None of the above.

Q16 What are the main criteria of a balanced Wheatstone bridge?
A. Resistance across each arm must be equal.
B. No current flow through the null detector.
C. Measured resistance must be lower than 1 ohm.
D. Voltage in each resistor must be equal.

Q17 What are the criteria for a balanced Kelvin bridge?
A. Resistance across each arm must be equal.
B. No current flow through the null detector.
C. Measured resistance must be higher than 1 ohm.
D. Voltage in each resistor must be equal.

Q18 What is the significant difference between Wheatstone and Kelvin bridge?
A. Wheatstone bridge able to measure much lower resistance in contrast with Kelvin bridge.
B. Wheatstone bridge has higher accuracy compared to Kelvin bridge.
C. Wheatstone bridge can be implemented to more measurement application.
D. Kelvin bridge is having higher error margin.

Q19 Which is the following standard is used as the main reference in controlling the quality of manufacturing goods for the industry.
A. International Standard.
B. Primary Standard.
C. Secondary Standard.
D. Working Standard.

Q20 The significant of Working Standard as the main reference in industry is as follows **except** for:
A. Easier for employee training.
B. Reduce variability in the output.
C. Less requirement needed for calibration.
D. Continuous improvement of the standard.

Q21 Measurement is best recorded at nearly full-scale deflection. Select the **best** reason why this practice is necessary.
A. To protect the instrument.
B. To get the least measurement error possible.
C. The scale is more precise at near full scale.
D. To ensure maximum current is applied during measurement.

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Q22 During current measurement of unknown value, the ammeter range is best positioned at the highest range. Why this procedure is crucial for an analog ammeter?

A. To protect the ammeter.
B. To get full-scale deflection.
C. To get the least measurement error possible.
D. To reduce insertion effect.

Q23 Select the statement which in **incorrect** regarding AC bridge.

A. The measurement can be carried out by AC bridge is more diverse compared to DC bridge.
B. Require warner earth device to ensure measurement is accurate.
C. Balancing time is comparatively high due to the complexity of the circuitry.
D. Element in the bridge arms can be either resistive or reactive.

Q24 A balance condition in an AC bridge should have this condition, **except**:

A. Product of the magnitudes of the opposite arms are equal.
B. Product of phase angles of the opposite arms are equal.
C. Sum of phase angles of the opposite arms equal.
D. AC current across the bridge is null.

Q25 Select the control panel in an oscilloscope that control the graticule (horizontal and vertical lines).

A. Display Control.
B. Vertical Control.
C. Horizontal Control.
D. Trigger Control.

Q26 Which of this control panel controls the time base of graph plotted on the oscilloscope?

A. Display Control.
B. Vertical Control.
C. Horizontal Control.
D. Trigger Control.

Q27 Which of this control panel controls the voltage amplitude of graph plotted on the oscilloscope?

A. Display Control.
B. Vertical Control.
C. Horizontal Control.
D. Trigger Control.

Q28 Oscilloscope can be used to measure all the items below, **except**:

A. AC voltage.
B. DC current.
C. Time period.
D. Phase shift.

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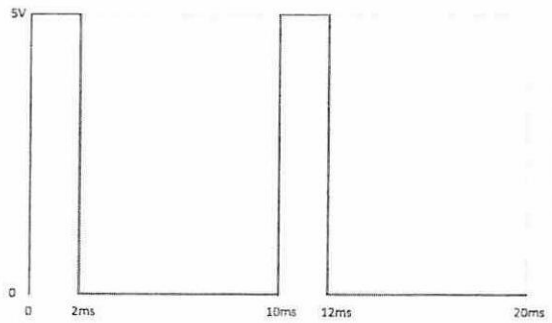
Q29 Why probe of the oscilloscope needs to be calibrated?

A. To acquire accurate time measurement.
B. To acquire accurate voltage measurement.
C. To eliminate waveform distortion at higher frequencies.
D. To eliminate waveform distortion at lower frequencies.

Q30 Referring to the figure below, calculate the duty cycle of the waveform.



A. 12%
B. 16.67%
C. 20%
D. 80%

Q31 What is a periodic signal?

A. A repetitive signal overtime.
B. A signal that displayed the same shape.
C. A measurable signal.
D. None of the above.

Q32 Select the **incorrect** statement.

A. Lissajous pattern can be used to measure frequency.
B. Lissajous pattern can be used to compare two frequencies of the same waveform.
C. Lissajous pattern can be used to calculate phase different between two signals of the same frequency.
D. Lissajous pattern can be used to calculate phase different between two signals of the different frequency.

Q33 What is a transducer?

A. Convert electrical signal into a displacement.
B. Convert one form of energy into electrical signal.
C. A movement of signal that can be measured.
D. A form of sensor.

Q34 A transducer should have this following requirement, **except** for:

A. Ruggedness.
B. High output of signal quality.
C. Precise.
D. None of the above.

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Q35 What is an actuator?
A. Convert electrical signal into a displacement.
B. Convert one form of energy into electrical signal.
C. A linear mechanical motion device.
D. A form of sensor.

Q36 All of this sensor is categorised as a light sensor, **except**:
A. Photovoltaic cell.
B. Light dependent resistor.
C. Infrared sensor.
D. Photodiode.

Q37 A thermal sensor which is constructed using two different metal is called:
A. PTC.
B. NTC.
C. Thermocouple.
D. RTD.

Q38 A type of resistor whose electrical resistance varies with changes in temperature is known as:
A. RTD.
B. Thermistor.
C. NTC.
D. PTC.

Q39 Which of the listed device is **not** categorised as sound transducer?
A. Microphone.
B. Loudspeaker.
C. Ultrasonic sensor.
D. Walkie talkie.

Q40 All of this criterion is the beneficial contribution of sensor to human in improving their quality of life, **except**:
A. Accelerate process.
B. Data collection.
C. Increase productivity.
D. Lower energy usage.

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SECTION B (60 MARKS)

Q1 (a) List **four (4)** precaution procedures of handling and taking measurement data from a multirange ammeter.

(4 marks)

(b) Based on the **Figure Q1(b)**, a PMMC instruments has three Ayrton shunt resistors connected across it to make an ammeter. The meter has $R_m = 250\ \Omega$, $FSD = 25\ \mu A$ and ammeter ranges of $1.5\ A$, $1.0\ A$ and $0.5\ A$.

(i) Calculate the required values of multiplier resistors (R_1, R_2, R_3) for the given circuit configuration.

(6 marks)

(ii) Determine which selector position is to be place for each ammeter range.

(3 marks)

(iii) Discuss the reason why the selector is placed as such condition in **Q1(b)(ii)**.

(3 marks)

(c) The ohm meter circuit in **Figure Q1(c)** has $E_b = 3\ V$, $R_1 = 1.5\ k\Omega$, $R_2 = 25\ \Omega$, $R_m = 25\ \Omega$ and meter FSD, $I_m = 1\ mA$. Determine:

(i) The ohm meter scale reading (value of R_x) at $0.5\ FSD$.

(3 marks)

(ii) The new resistance value of R_2 that must be adjusted to when E_b falls by 10%.

(6 marks)

(iii) The ohm meter scale reading (value of R_x) at $0.5\ FSD$ with new value of R_2 as in **Q1(c)(ii)**.

(3 marks)

(iv) The percentage difference on the scale reading at **Q1(c)(i)** and **Q1(c)(iii)**.

(2 marks)

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Q2 (a) A transducer needs to be with a high reliability and stability. Discuss why this criterion is important in a transducer.

(5 marks)

(b) Explain **two (2)** significant difference between input and output of sound transducer.

(6 marks)

(c) Based on Wheatstone bridge in **Figure Q2(c)**, the resistive components have following nominal values: $E = 5\ V$, $R_1 = 1\ k\Omega$, $R_2 = 1\ k\Omega$, $R_3 = 2.5\ k\Omega$ and $R_g = 10\ \Omega$.

(i) Calculate the value of R_X when $V_{TH} = 25\ mV$ and $I_g = 15\ \mu A$.

(8 marks)

(ii) The galvanometer has a sensitivity of $2.0\ mm/\mu A$. Determine the galvanometer deflection for the condition in **Q2(c)(i)**.

(2 marks)

(d) Lissajous pattern can be used to estimate phase or frequency different in an electrical circuit. Complete the measurement and estimation given by the Lissajous pattern in **Figure Q2(d)**.

(7 marks)

(e) List **two (2)** application of Kelvin bridge as a measurement device in the industry.

(2 marks)

-END OF QUESTIONS –

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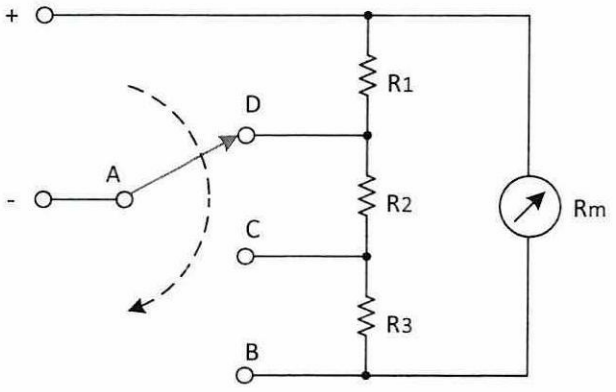

Figure Q1(b)

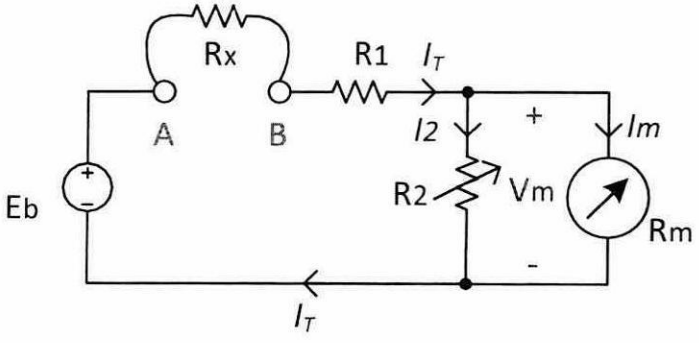

Figure Q1(c)

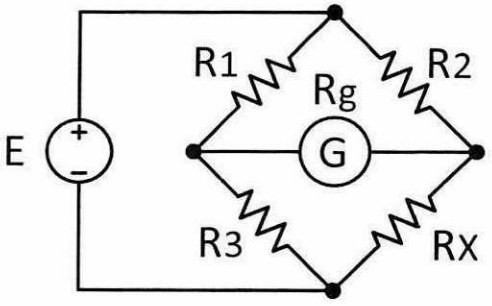

Figure Q2(c)

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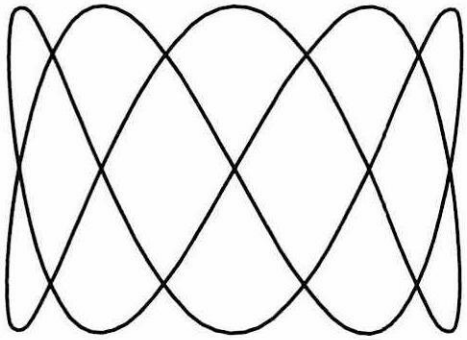
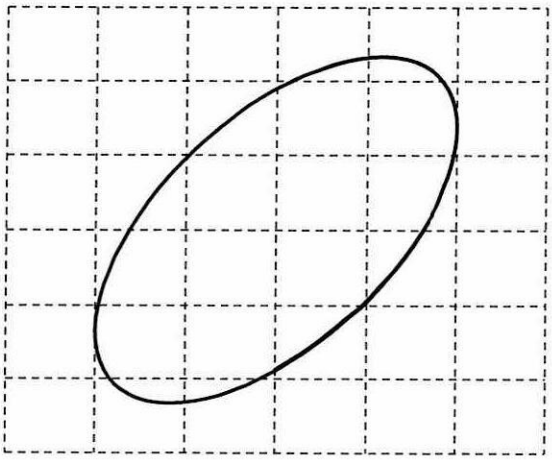


No. of Horizontal tangencies (nH):	
No. of Vertical tangencies (nV):	
Frequency ratio:	
Frequency CH1:	*2.0 kHz*
Frequency CH2:	



Horizontal Reading	
Vertical Reading	
Phase difference,ϕ (°)	

Figure Q2(d)

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