



UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION  
SEMESTER II  
SESSION 2023/2024**

- COURSE NAME : ELECTRICAL MEASUREMENT  
AND INSTRUMENTATION
- COURSE CODE : DAE 21403
- PROGRAMME CODE : DAE
- EXAMINATION DATE : JULY 2024
- DURATION : 2 HOURS 30 MINUTES
- INSTRUCTIONS :
1. ANSWER ALL QUESTIONS
  2. THIS FINAL EXAMINATION IS CONDUCTED VIA  
 Open book  
 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 **SIXTEEN (16)** PAGES

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**SECTION A (40 MARKS)**

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

- (a) Kilogram (kg)
- (b) Millimetre (mm)
- (c) Candela (cd)
- (d) Ampere (A)

**Q2** Select the **incorrect** statement.

- (a) Power (Watt) is a result from derivation of fundamental unit.
- (b) Measurement system must have the ability to record and display.
- (c) Measurement value is restricted to seven fundamental unit.
- (d) Physical quantity is changed to electrical signal in order for measurement to take place.

**Q3** 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.

**Q4** 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.

**Q5** In D'Arsonval ammeter configuration, a shunt resistor is connected parallel with PMMC. What is the main purpose of that shunt resistor?

- (a) To minimize current flow in meter coil, thus protecting the PMMC.
- (b) To maximize current flow in meter coil, resulting in full-scale deflection.
- (c) Acts as current divider, so equal current flow in meter coil and shunt resistor.
- (d) To ensure moving coil voltage ( $V_m$ ) has the same value as shunt resistor voltage ( $V_{sh}$ ).

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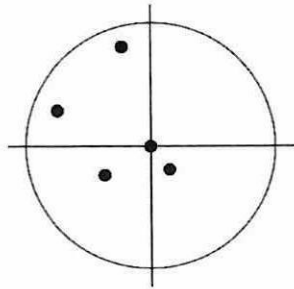
**Q6** The best description of parallax error is:

- (a) The positional degree of the observer eye.
- (b) The error of reading the measurement data.
- (c) The uncertain position of pointer sitting on the scale.
- (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 level of detail at which data is stored.
- (d) The extend to which a value approaches its true value.

**Q8** 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.

**Q9** A technician is using an instrument that has low quality of components. What is the most common error that the output will produce from this practice?

- (a) Gross error.
- (b) Systematic error.
- (c) Environmental error.
- (d) Random error.

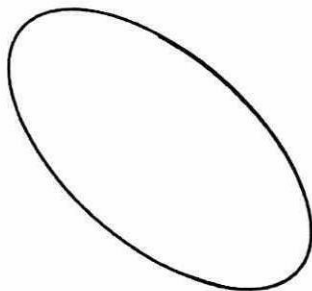
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- Q10** To increase the range of ammeter, connect:
- (a) a high value resistance in series with the ammeter coil.
  - (b) a high value resistance in parallel with the ammeter coil.
  - (c) a low value resistance in parallel with the ammeter coil.
  - (d) a low value resistance in series with the ammeter coil.
- Q11** A capacitance of a component is stated with a value of  $100 \mu\text{F} \pm 1 \mu\text{F}$ . Select the type of error it represents.
- (i) Absolute error.
  - (ii) Relative error.
  - (iii) Guaranteed error.
  - (iv) Limiting error.
- (a) i
  - (b) ii
  - (c) ii and iii
  - (d) i, iii and iv
- Q12** The number 0.007730 has \_\_\_ significant figures.
- (a) 3
  - (b) 5
  - (c) 6
  - (d) 7
- Q13** 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.
- Q14** 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.

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- Q15** 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.
- Q16** During current measurement of unknown value, the ammeter range is best positioned at the highest range. Why this procedure is crucial for an analogue 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.
- Q17** 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.
- Q18** Referring to the figure below, estimate the correct phase angle difference.



- (a) 45°.
- (b) 135°.
- (c) 175°.
- (d) 325°.

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**Q19** 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.

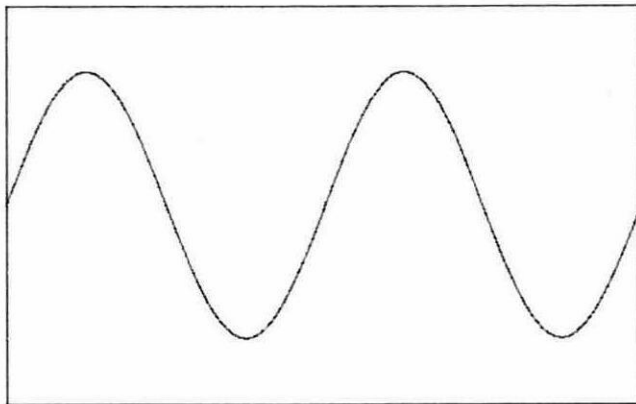
**Q20** What is a transducer?

- (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.

**Q21** What is volt meter loading effect?

- (a) Effect of connecting two resistances together.
- (b) Condition where voltage at measured component is less whenever a voltmeter is connected.
- (c) Effect due to voltmeter error.
- (d) None of the above.

**Q22** The diagram in figure below shows the trace obtained on the screen of oscilloscope. The time base of the oscilloscope is set at 10 ms per division and the voltage sensitivity at 15 V per division. Determine  $V_{rms}$ .



- (a) 19.1V
- (b) 21.21V
- (c) 30V
- (d) 60V

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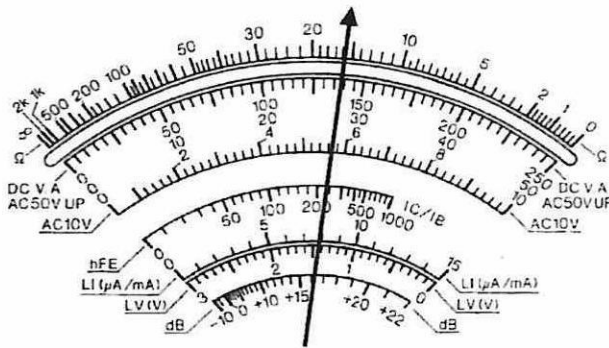
**Q23** A balance condition in an AC bridge should have this condition, **except**:

- (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.

**Q24** A transducer should have this following requirement, **except** for:

- (a) Ruggedness.
- (b) High output of signal quality.
- (c) Precise.
- (d) None of the above.

**Q25** A measurement of is made using analogue multimeter. The measurement is shown as in the given figure. If the mode is selected to resistance measurement with X10 multiplier, select the correct resistance value measured.



- (a) 16Ω.
- (b) 28Ω.
- (c) 140Ω.
- (d) 160Ω.

**Q26** All of this sensor is categorised as a light sensor, **except**:

- (a) Photovoltaic cell.
- (b) Light dependent resistor.
- (c) Infrared sensor.
- (d) Photodiode.

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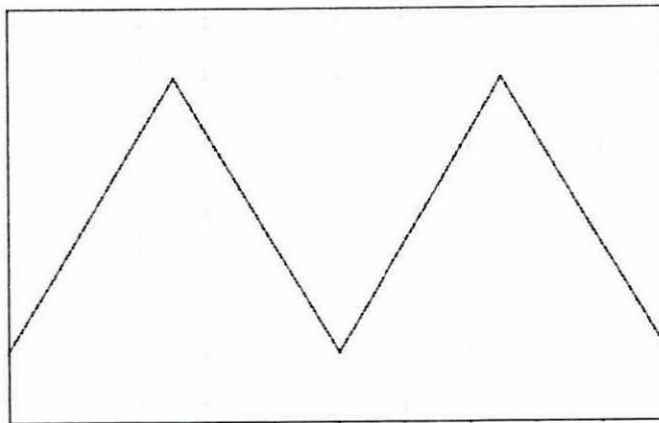
**Q27** All of this criterion is the beneficial contribution of sensor to human in improving their quality of life, **except**:

- (a) Accelerate process.
- (b) Data collection.
- (c) Increase productivity.
- (d) Lower energy usage.

**Q28** 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.

**Q29** The diagram in figure below shows the trace obtained on the screen of oscilloscope. The time base of the oscilloscope is set at 10 ms per division and the voltage sensitivity at 15 V per division. Determine the frequency of the signal.



- (a) 10Hz
- (b) 20Hz
- (c) 75Hz
- (d) 150Hz

**Q30** An engineer is designing a system to monitor temperatures in a chemical reactor and convert this information into an electrical signal for analysis. Which type of transducer should they incorporate into their design?

- (a) A pressure transducer.
- (b) A temperature transducer.
- (c) A motion transducer.
- (d) A light transducer.

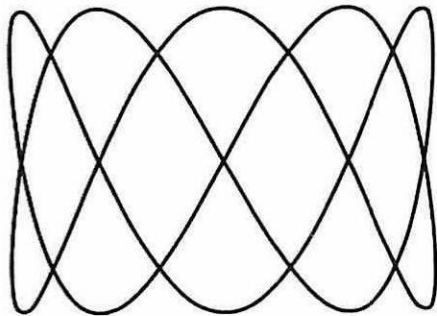
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**Q31** Which of the listed device is **not** categorised as sound transducer?

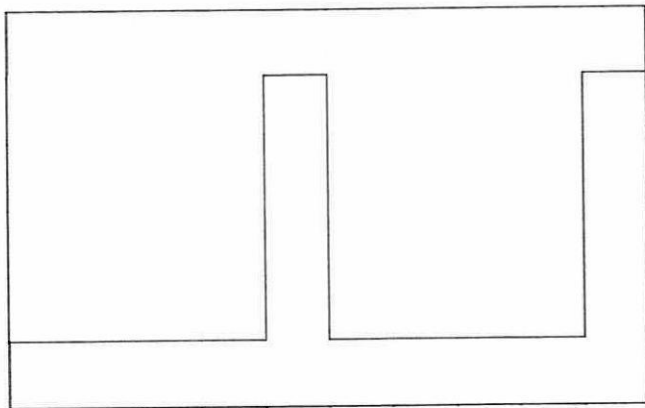
- (a) Microphone.
- (b) Loudspeaker.
- (c) Ultrasonic sensor.
- (d) Walkie talkie.

**Q32** Referring to the figure below, determine correct notation that represent the frequency ratio of the signal.



- (a) 2.5:1
- (b) 2:5
- (c) 5:2
- (d) 10:4

**Q33** Referring to the figure below, calculate the duty cycle of the waveform.



- (a) 12%
- (b) 16.67%
- (c) 20%
- (d) 80%

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- Q34** A thermal sensor which is constructed using two different metal is called:
- (a) PTC.
  - (b) NTC.
  - (c) Thermocouple.
  - (d) RTD.
- Q35** An engineer is required to measure very low resistances with high accuracy. Which type of bridge should they use?
- (a) Wheatstone Bridge
  - (b) Kelvin Bridge
  - (c) Wien Bridge
  - (d) AC Bridge
- Q36** What is the primary use of an oscilloscope in electronic measurements?
- (a) To generate a range of audio frequencies.
  - (b) To count the frequency of an electronic signal.
  - (c) To measure voltage, duration, frequency, phase, and pulse of a waveform.
  - (d) To generate electrical signals of various shapes.
- Q37** An engineer needs to analyse the harmonics of an electrical signal. Which instrument would be most appropriate for this task?
- (a) Frequency Counter
  - (b) Audio Generator
  - (c) Signal Generator
  - (d) Oscilloscope
- Q38** 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.

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- Q39** Oscilloscope can be used to measure all the items below, **except**:
- (a) AC voltage.
  - (b) DC current.
  - (c) Time period.
  - (d) Phase shift.
- Q40** 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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**SECTION B**

**Q41** PMMC is a universal device that allows different measurements to be carried out such as current, voltage and resistance.

(a) DC ammeters, voltmeters and ohm meters is a current-sensing device. The D'Arsonval movement is a DC moving coil-type movement in which an electromagnetic core is suspended between the poles of a permanent magnet.

(i) Sketch the multi range circuit for measuring current using D'Arsonval meter configuration. (3 marks)

(ii) Sketch the multi range circuit for voltage measurement using D'Arsonval meter configuration. (3 marks)

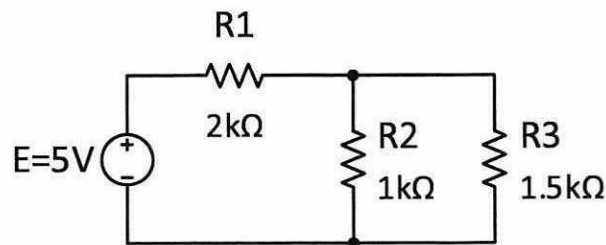
(iii) State **two (2)** advantages of D'Arsonval meter movement. (4 marks)

(b) A current meter has internal resistance of  $75\Omega$  is used to measure the current through resistor R1 as illustrated in **Figure Q41(b)**. Determine:

(i) equivalent resistance connected to the ammeter,  $R_{TH}$ . (4 marks)

(ii) ratio of moving coil current to current error,  $I_m/I_e$ . (2 marks)

(iii) the percentage of error of the reading due to ammeter insertion. (2 marks)



**Figure Q41(b)**

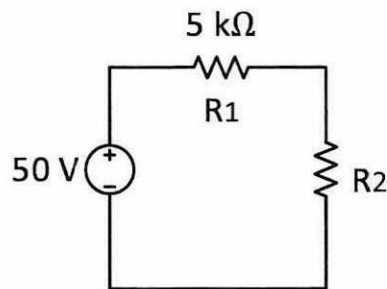
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- (c) Two different voltmeters are used to measure voltage across resistor R1 and R2 in the circuit in **Figure Q41(c)**. The meter specifications are as follows:

Voltmeter: Sensitivity =  $0.25 \text{ k}\Omega/\text{V}$ , Range = 20 V.

- (i) Compute Voltmeter resistance,  $R_T$ . (2 marks)
- (ii) Compute the R2 resistor value when the voltage measured across R2 is 10 V. (6 marks)
- (iii) Using R2 resistance value from (ii), compute the voltage value across resistor R2 when no voltmeter is connected. (2 marks)
- (iv) Compute the percentage of error. (2 marks)



**Figure Q41(c)**

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**Q42** Instruments and sensors play a vital role for an effective measurement thus gives more accurate data in developing a reliable system.

- (a) Produce a table of **two (2)** types of signal generator commonly used in audio manufacturing and describe its differences.

(10 marks)

- (b) List **two (2)** examples of applications for each of the following sensor or transducer:

(i) Light sensor.

(2 marks)

(ii) Velocity sensor.

(2 marks)

(iii) Pressure sensor.

(2 marks)

- (c) Maxwell bridge as illustrated in **Figure Q42(c)** has the value of  $R_1 = 1.2 \text{ k}\Omega$ ,  $R_2 = 2 \text{ k}\Omega$ ,  $R_3 = 470 \Omega$ ,  $C_1 = 1 \mu\text{F}$  and frequency,  $f = 50 \text{ Hz}$ .

- (i) Relate the expression of  $R_X$  and  $L_X$ , thus prove that

$$R_X = \frac{R_2 R_3}{R_1}, \text{ and } L_X = C_1 R_2 R_3$$

(5 marks)

- (ii) Compute  $R_X$ .

(2 marks)

- (iii) Compute  $L_X$ .

(2 marks)

- (iv) Compute the Q-factor of the inductor.

(2 marks)

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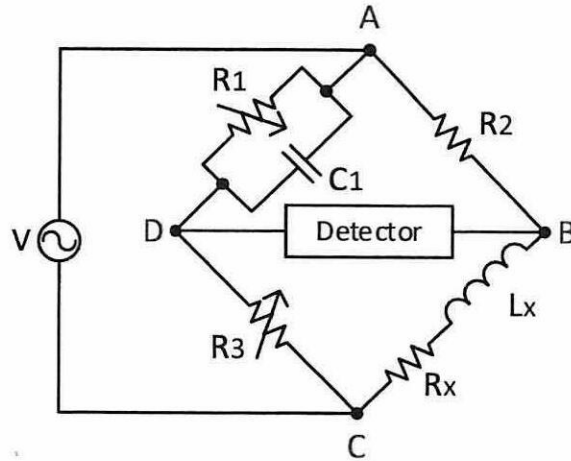


Figure Q42(c)

(d) Define the expression of bridge null or balance.

(3 marks)

- END OF QUESTIONS -

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## APPENDIX A

## List of Relevant Formula

$$\%Error = \left| \frac{\text{practical value} - \text{theoretical value}}{\text{theoretical value}} \right| \times 100\%$$

$$\bar{x} = \frac{1}{n} \sum_{n=1}^n x_n$$

$$d_n = x_n - \bar{x}$$

$$D_{av} = \frac{1}{n} \sum |d_n|$$

$$\sigma = \sqrt{\frac{d_n^2}{n}}$$

$$\text{Precision of } n\text{th Measurement} = 1 - \left| \frac{x_n - \bar{x}}{\bar{x}} \right|$$

$$V_{shunt} = V_{movement/coil}$$

$$I_{sh}R_{sh} = I_m R_m$$

$$\frac{I_m}{I_e} = \frac{R_{TH}}{R_{TH} + R_m}$$

$$\text{Insertion error} = \left( 1 - \frac{I_m}{I_e} \right) \times 100\%$$

$$V_{fsd} = I_m R_s + I_m R_m$$

$$R_T = \text{Sensitivity} \times \text{Range}$$

$$\phi = \frac{1}{I_{FSD}} = \frac{R_T}{V_{FSD}}$$

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

$$L_X = C_1 R_2 R_3$$

$$Q = \omega R_1 C_1$$

$$\phi = \sin^{-1} \left( \frac{x_1}{x_2} \right) = \sin^{-1} \left( \frac{y_1}{y_2} \right)$$

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