00163

The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Electrical and Computer Engineering

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: EEX3331**
	Electrical Measurement and Instrumentation
Academic Year	: 2019/20
Date	: 30th July 2020
Time	: 1330-1630hrs

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Six (6)** questions in **Six (6)** pages.
3. Answer any **Five (5)** questions only. All questions carry equal marks.
4. Answer for each question should commence from a new page.
5. This is a Closed Book Test **(CBT).**
6. Answers should be in clear hand writing.
7. Do not use red color pen.

Question 1

Figure 1 shows an experimental setup to be used in identifying the value of unknown resister, R. Internal resistance of Voltmeter is 0.5 kΩ. Observations are as follows,

Voltmeter Reading - 100 V
Ammeter Reading – 12 A

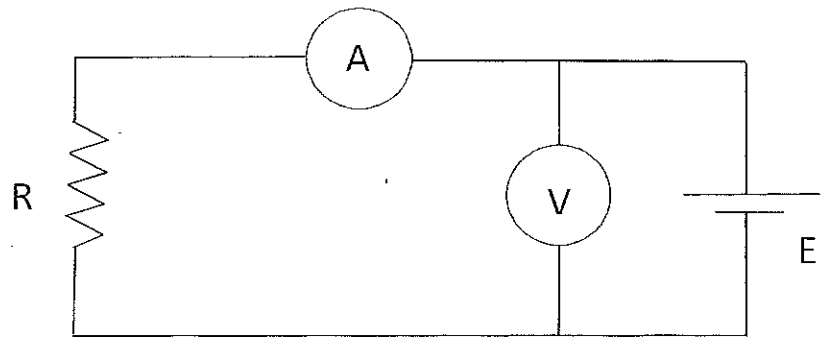


Figure 1

i. Calculate the resistance using meter readings.

(2-Marks)

ii. Calculate the percentage error of the above method if the exact value of the resistance is 4.5 Ω.

(2-Marks)

iii. Briefly describe the most probable reason for having such a value for error percentage.

(4-Marks)

iv. Suggest a modification to the above circuit to minimize the error percentage. Calculate the new value of error percentage for the circuit you have suggested.

(6-Marks)

v. Later, the unknown resistor, R was measured using a Kelvin Double Bridge circuit. Draw the circuit diagram and derive an expression to determine R, if the outer ratio and the inner ratio are equal. Calculate the unknown resistance if the standard resistance is 0.471 Ω and the outer ratio is 10.

(6-Marks)

Question 2

i. Define the meaning of "Sensitivity" and "Accuracy" of an AC bridge circuit.

(2-Marks)

ii. Derive an expression for the sensitivity of a general four arm AC bridge indicating the assumptions.

(4-Marks)

iii. Using the expression derived in (ii), obtain a condition for the maximum sensitivity of the four arm AC bridge circuit.

(3-Marks)

iv. Circuit diagram of Owen's Bridge is shown in Figure 2. Derive an expression for the out of balance voltage of Owen's Bridge.

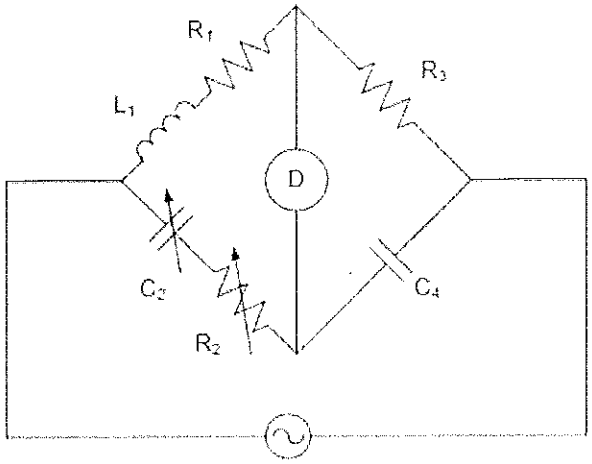


Figure 2

(3-Marks)

v. Draw sketches to illustrate the locus of variation when varying following parameter. (The notations have standard meanings)

a) C_2 and R_2
b) C_4 and R_3
c) R_2 and R_3

(6-Marks)

vi. Using (v), determine the most suitable pair to be used as variable component to achieve the balance condition.

(2-Marks)

Question 3

An experiment was conducted to calculate the earth resistance using Wenner and Schlumberger methods. The readings are as follows,

Electrode spacing – 5 m

Electrode depth – 0.5 m

Measured Voltage – 105.5 V

Measured Current – 2.3 A

i. Find the earth resistance using,
   a) Wenner's full equation.
   b) Wenner's approximated equation by neglecting parameters appropriately.

(4-Marks)

ii. Describe three (3) advantages of using Schlumberger method over Wenner Method.

(6-Marks)

iii. List four (4) factors that affect earth resistivity. Briefly describe one of them.

(6-Marks)

iv. Describe 'Dead Earth Method' to measure the soil resistance. What has the higher accuracy between 'Dead Earth Method' and 'Fall of Potential Method'? Explain.

(4-Marks)

Question 4

i. Draw the electrical circuit which is used to measure the flux density using Hall Effect technique and derive the expression for flux density.

(4-Marks)

ii. Figure 3 shows the circuit diagram of the experimental method to observe the hysteresis loop from the oscilloscope. Derive equations for voltages across X and Y plates of the oscilloscope.

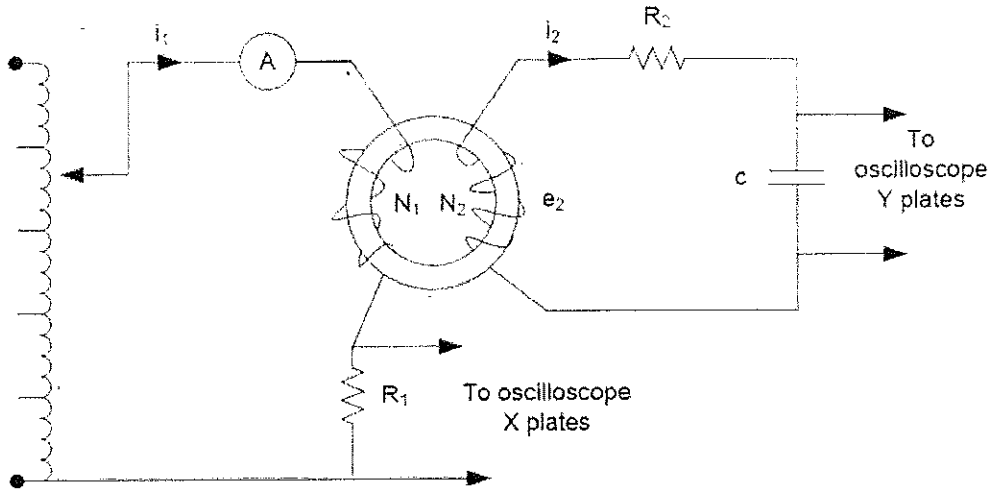


Figure 3

(6-Marks)

iii. Derive equations for determining the permeability and iron loss for ring specimen which is connected to Maxwell's bridge.

(6-Marks)

iv. The iron loss of a 10 kg specimen was measured to be 20 W at 45 Hz and 33 at 55 Hz. Determine the iron loss of the specimen when the frequency is 50 Hz when operating at the same value of peak flux density.
(Hint, the iron loss of a magnetic material, $\Delta P_{Loss} = K_h f B_m^n + K_e f^2 B_m^2$)

(4-Marks)

Question 5

i. Draw the circuit diagram of Wien Bridge. Use standard notations to name the components. Derive an expression for frequency using the equation for the general balanced condition.

(6-Marks)

ii. Is it possible to measure the frequency of a pulse train using Wien Bridge? Justify your answer.

(4-Marks)

iii. What is the 'Equivalent Series Resistance (ESR)' regarding capacitor modelling?

(2-Marks)

iv. Draw the circuit diagram of 'Modified De Sauty's Bridge' and derive an expression for the unknown capacitor and resistance.

(6-Marks)

v. Explain why De Sauty's bridge needs a modification to measure capacitors with losses.

(2-Marks)

Question 6

Briefly explain the following. (You may use circuit diagrams and equations where applicable)

i. Use of AC potentiometer to measure unknown impedance.

(4-Marks)

ii. Suitability of current transformer operation with an open circuit secondary side while primary circuit is energized.

(4-Marks)

iii. Use of Guard Terminal in high resistance measurements.

(4-Marks)

iv. Use of Single Ratio Arm Transformer Bridges to measure unknown impedance.

(4-Marks)

v. Advantages of Null Methods over Deflection Methods.

(4-Marks)