00128

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

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: EEX3331 Electrical Measurements and Instrumentation**
Academic Year	: 2021/2022
Date	: 03rd February 2023
Time	: 14:00 – 17:00 hrs.
Duration	: **3 hours**

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Six (6)** questions in **Four (4)** pages.
3. Answer any **Five (5)** questions. 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 handwriting.
7. Do not use Red colour pen.

Question 01

Part A

Figure 01 shows an experimental setup used to measure an unknown resistor (R). The internal resistance of the voltmeter is 2 MΩ. The readings of the two meters are as follows.

Voltmeter reading –: 56 V

Ammeter reading –: 8 A

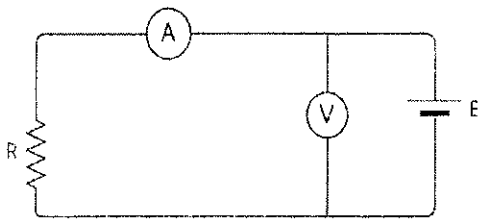


Figure 01

I. Calculate resistance of the unknown resister (R) using the meter readings. State the assumption you made. *(02 marks)*

II. Calculate the percentage error of the above measurement if the exact value of the resistance (R) is 4.5 Ω. *(02 marks)*

III. Suggest a modification to the circuit shown in Figure 01 to reduce the error in measurement. Draw the modified circuit and justify your answer. *(03 marks)*

Part B

Later, the unknown resistor (R) was measured using a Kelvin Double Bridge circuit. A circuit diagram of the complete Kelvin Double Bridge is shown in Figure 02.

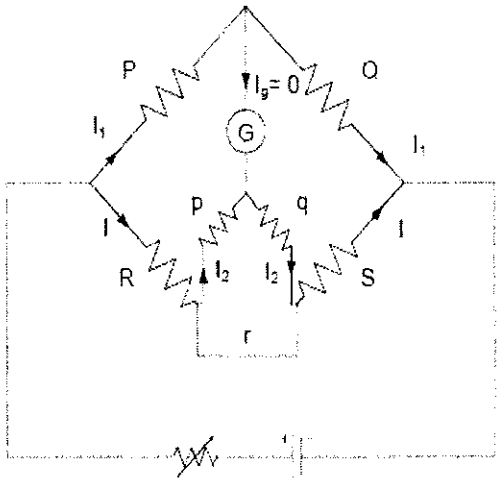


Figure 02

I. Derive an expression to determine R. Assume that the outer ratio and the inner ratio of the bridge are equal. *(09 marks)*

II. Calculate the unknown resistance, if the standard resistance (S) is 0.461 Ω and the outer ratio is 10. *(04 marks)*

Question 02

Part A

I. Write the applications of the following measuring methods. *(04 marks)*

a. Loss of Charge method
b. De Sauty's bridge
c. Wien bridge
d. Owen's bridge

Part B

I. List down two restrictions of Wein Bridge method. *(02 marks)*

Part C

The circuit shown in Figure 03 is a Schering Bridge used to measure the permittivity of a specimen. A parallel plate capacitor C_1 has a specimen with thickness of 4.0 mm and the plate area is 400 cm^2. The remaining arms in conventional notation have, R_3 =2.5 kΩ, R_4 = 4 kΩ, in parallel with a fixed capacitor C_4 of value 540 pF and C_2 a fixed capacitor of 220 pF. The frequency of the supply is 300 rad/s. Permittivity of vacuum is $8.854 \times 10^{-12}\ F/m$

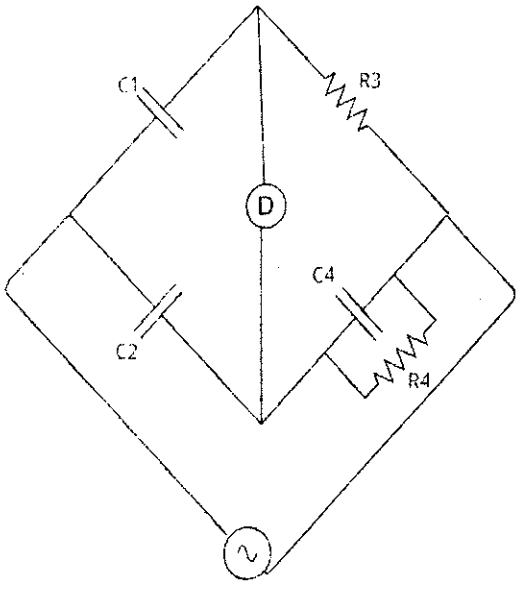


Figure 03

I. Derive the equation for ESR of the circuit. *(06 marks)*

II. With derivation of required equations, determine the relative permittivity of the dielectric and the loss angle. *(08 marks)*

Question 03

I. Draw a sketch of the Electrode Placement configurations of Wenner and Schlumberger methods and compare their two differences. *(04 marks)*

II. State four (04) factors affecting the earth's resistivity *(02 marks)*

III. In an earth resistivity measuring experiment, the following parameters were recorded.

- Electrode spacing a = 6 m
- Electrode depth b = 0.25 m
- Measured voltage V = 100 V
- Measured current I = 2 A

Use both approximated and original equations of the Wenner method and calculate the earth resistivity. *(06 marks)*

IV. In an earth resistivity measuring experiment, the following parameters were recorded.

- Electrode spacing (voltage probes) a = 1.5 m
- Electrode spacing (voltage and current probes) c = 6 m
- Electrode depth b = 0.2 m
- Measured voltage V = 100 V
- Measured current I = 850 mA

Calculate the earth resistivity using the Schlumberger method. *(04 marks)*

V. Write two methods of earth resistance measurements and explain one of them briefly. *(04 marks)*

Question 04

I. Explain the factors affecting behavior of a practical inductor and draw the model of non-ideal inductor indicating all the components. *(04 marks)*

II. Briefly explain Self and Mutual Inductance. *(04 marks)*

III. Draw Wien Bridge and derive an expression for frequency measurement. *(08 marks)*

IV. What are mechanical ganged variable components? And why are they important in constructing Wien Bridge? *(04 marks)*

Question 05

I. Describe the method of increasing the voltage measuring range of a DC potentiometer using volt-ratio box. *(06 marks)*

II. Write two main types of AC potentiometers. *(02 marks)*

III. Illustrate the principle of accuracy increasing of an AC potentiometer using Kelvin - Varley slide wire. *(06 marks)*

IV. Describe the use of X-Y mode of the oscilloscope to plot the Hysteresis (B-H loop) of a magnetic specimen. *(06 marks)*

Question 06

I. Define the terms 'Sensitivity' of a bridge circuit. *(01 marks)*

II. Derive an expression for the sensitivity of a general four-arm AC bridge circuit indicating the assumptions. *(07 marks)*

III. Using the expression derived in 'II', obtain a condition for the maximum sensitivity of the four-arm bridge circuit. *(02 marks)*

IV. Mention three factor causing errors in AC bridges and three methods to reduce the errors. *(06 marks)*

V. What is electrostatic shielding? *(04 marks)*

- End of the Paper -

Important equations

$$\rho = \frac{4\pi aR}{1 + \frac{2a}{\sqrt{a^2 + 4b^2}} - \frac{2a}{\sqrt{4a^2 + 4b^2}}}$$

$$\rho = \pi \frac{c.(c+a)}{a} R$$