Strathmore
UNIVERSITY

**SCHOOL OF COMPUTING AND ENGINEERING SCIENCES**
**BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING**
**END OF SEMESTER EXAMINATION**

**BEE3203: ELECTRICAL MEASUREMENT AND INSTRUMENTATION**

**QUESTION PAPER**

**DATE: 19th December, 2023** **Time: 10:30-12:30 Hours**

**Instructions**

1. This examination consists of **FIVE** questions.
2. Answer **Question ONE (COMPULSORY)** and any other **TWO** questions.

**QUESTION ONE** **(Total: 30 Marks)**

a) Explain the meaning of the following terms as pertaining to taking of measurements:
   i. Accuracy 1 mark
   ii. Precision 1 mark
   iii. Sensitivity 1 mark

b) A basic D'arsenal movement with full scale deflection of 50μA and internal resistance of 1.8kΩ is to be converted into a multirange dc voltmeter with voltage ranges of 0-1V, 0-10V, 0-30V and 0-250V
   i. Design the multirange voltmeter 4 Marks
   ii. Sketch the circuit arrangement of the DC voltmeter. 3 Marks

c) In designing a measuring instrument, you are required to select a specific transducer. Explain in detail any five (5) selection criteria to consider in selecting a specific transducer. 5 Marks

d) Figure 1 shows the Schematic diagram of a Wheatstone bridge with values of the bridge elements. The battery voltage is 5V and its internal resistance is negligible. The galvanometer has a current sensitivity of 10mm/μA and internal resistance of 100 Ω. Calculate the deflection of the galvanometer caused by 5 Ω unbalanced in arm BC. 5 Marks

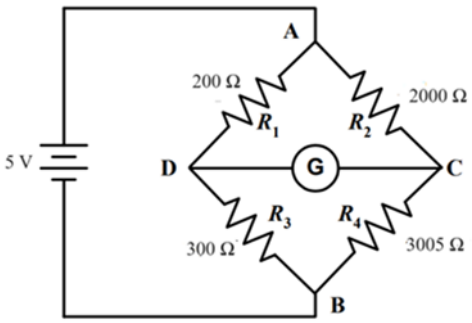



Figure 1

e) Draw a generalized block diagram of data acquisition system and describe the function of each component. 5 Marks

f) In a given laboratory session, you are required to obtained measurement of a signal magnitude and frequency.
   i. Mention the instrument to use and outline the procedure for obtaining the measurement 3 Marks
   ii. Discuss the errors that might be associated with the instrument in question f(i) above. 2 Marks

**QUESTION TWO** **(Total: 15 Marks)**

a) Distinguish a standardization from calibration. 2 Marks

b) Draw and describe the construction and working principle of single-phase induction type energy meter. 5 Marks

c) A PMMC ammeter has the following specification; Coil dimension are 1cm x 1cm. spring constant is 0.15x10-6N-m/rad, flux density is 1.5x10-3wb/m2. Determine the number turns required to produce a deflection of 900 when a current of 2 mA flows through the coil. 3 Marks

d) Explain with neat diagram the working principle of LVDT. Give its applications. 5 Marks

**QUESTION THREE** **(Total: 15 Marks)**

a) State four characteristics of virtual instrumentation 2 Marks

b) Explain the working principle of PMMC type equipment using torque equation. 6 Marks

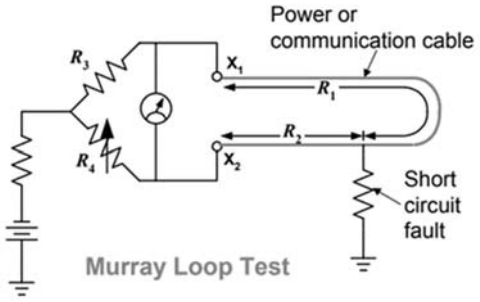
c) Describe the Hall-effect transducers with their application. 4 Marks

d) With the help of neat sketch describe the method of measurement of earth resistance. 3 Marks

**QUESTION FOUR** **(Total: 15 Marks)**

a) Explain the classification of analogue instruments and state one example of each 4 Marks

b) Murray loop test is used to locate ground fault in a telephone system. The total resistance, R = R1+ R2 is measured by Wheatstone bridge, and its value is 300 Ω. The conditions for Murray loop test are as follows: R3 = 1000 Ω and R4 = 500 Ω Find the location of the fault in meter, if the length per Ohm is 36.67 m. 5 Marks




c) Explain the dual slope integrator digital voltmeters system with proper diagram and waveform. 6 Marks

**QUESTION FIVE** **(Total: 15 Marks)**

a) With the aid of a well labelled diagram, explain the operation of flash type ADC as used in measuring instruments. 5 Marks

b) Explain the working principle of PMMC type equipment using torque equation. 5 Marks

c) (i) Derive the equation for Maxwell bridge and solve a Maxwell inductance bridge uses a standard capacitor $C_3$ = 0.1 μF and operate at a supply frequency of 100 Hz. Balance is achieved when $R_1$ = 1.26 kΩ, $R_3$ =470 Ω, and $R_4$ = 500 Ω. 3 Marks
(ii) Calculate the inductance and resistance of the measured inductor, and determine its Q factor. 2 Marks