CHUKA  **UNIVERSITY**

UNIVERSITY EXAMINATIONS

EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING

EENG 571: INSTRUMENTATION AND MEASUREMENT

STREAMS: BSc. EENG **TIME: 2 HOURS**

DAY/DATE: TUESDAY 09/04/2024 **11.30 A.M. – 1.30 P.M.**

INSTRUCTIONS

- **Answer question ONE and any other TWO questions**
- **Do not write on the question paper**

QUESTION ONE (30 MARKS)

a) Define Measurement [2 marks]

b) Give the classification of instruments [2 marks]

c) What are absolute instruments? [2 marks]

d) Compare null type and deflection type instruments. [4 marks]

e) What is meant by calibration? [2 marks]

f) How can the range of an instrument be extended in PMMC instruments? [4 marks]

g) Distinguish between Current Transformer and Potential Transformer. [4 marks]

h) Name the bridge circuits used for the m/s of self-inductance. [4 marks]

i) How are leakage errors minimized in ac bridge circuits? [2 marks]

j) How is resistance measured in direct deflection method? [2 marks]

k) Explain the concepts of Disk Storage. [2 marks]

QUESTION TWO (20 MARKS)

a) A moving coil voltmeter with a resistance of 20Ω gives a full-scale deflection of 120^0, when a potential difference of 100mV is applied across it. The moving coil has dimension of 30mm*25mm and is wound with 100 turns. The control spring constant is $0.375\ x\ 10^{-6} N - m/degree$. Find the flux density, in the air gap. Find also the diameter of copper wire of coil winding if 30% of instrument resistance is due to coil winding. The specific resistance for copper = $1.7\ x\ 10^{-8} \Omega m$.

[6 marks]

b) Draw a schematic diagram of voltmeter and ammeter with a simple circuit. **[3 marks]**

c) What is duty cycle? **[2 marks]**

d) Derive the equation of torque developed by a PMMC instrument **[3 marks]**

e) What are the disadvantages of a PMMC? **[2 marks]**

f) A specimen of iron stamping weighting 10 kg and having an area of 16.8 cm^2 is tested by an episten square. Each of the two winding S_1 and S_2 have 515 turns. A.C. voltage of 50 HZ frequency is given to the primary. The current in the primary is 0.35 A. A voltmeter connected to S_2 indicates 250 V. Resistance of S_1 and S_2 each equal to 40 Ω. Resistance of pressure coil is 80 kΩ. Calculate maximum flux density in the specimen and iron loss/kg if the wattmeter indicates 80 watt? **[4 marks]**

QUESTION THREE (20 MARKS)

a) A PMMC ammeter has the following specification. Coil dimension are 1cm x 1cm. Spring constant is $0.15x10^{-6} N - m/rad$, Flux density is $1.5\ x\ 10^{-3}$ wb/m^2. Determine the no. of turns required to produce a deflection of 90^0 when a current 2mA flows through the coil. **[4 marks]**

b) The pointer of a moving coil instrument gives full scale deflection of 20mA. The potential difference across the meter when carrying 20mA is 400mV.The instrument to be used is 200A for full scale deflection. Find the shunt resistance required to achieve this, if the instrument to be used as a voltmeter for full scale reading with 1000V. Find the series resistance to be connected to it? **[8 marks]**

c) What is the value of series resistance to be used to extent '0'to 200V range of 20,000Ω/volt voltmeter to 0 to 2000 volt? **[4 marks]**

d) For a certain dynamometer ammeter the mutual inductance 'M' varies with deflection θ as $M = -6cos(\theta + 30^0) mH$. Find the deflecting torque produced by a direct current of 50mA corresponding to a deflection of 60^0. **[4 marks]**

QUESTION FOUR (20 MARKS)

a) With the use of a diagram, discuss the Multi range D.C. voltmeter. **[5 marks]**

b) Using a diagram, show the working of Owen's bridge. **[4 marks]**

c) In a low- Voltage Schering bridge designed for the measurement of permittivity, the branch 'ab' consists of two electrodes between which the specimen under test may be inserted, arm 'bc' is a non-reactive resistor R3 in parallel with a standard capacitor C3, arm CD is a non-reactive resistor R4 in parallel with a standard capacitor C4, arm 'da' is a standard air capacitor of capacitance C2. Without the specimen between the electrode, balance is obtained with following values, C3=C4=120 pF, C2=150 pF, R3=R4=5000Ω.With the specimen inserted, these values become C3=200 pF,C4=1000 pF,C2=900 pF and R3=R4=5000Ω. In such test w=5000 rad/sec. Find the relative permittivity of the specimen? **[7 marks]**

d) Design a multi range d.c. mille ammeter using a basic movement with an internal resistance Rm = 50W and a full scale deflection current I_m =1mA . The ranges required are 0-10mA; 0-50mA; **[4 marks]**

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