# MACHAKOS UNIVERSITY

**University Examination 2018/2019**

**SCHOOL OF ENGINEERING AND TECHNOLOGY**

**DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING**

**SECOND/THIRD YEAR SECOND SEMESTER EXAMINATION FOR**

**BACHELOR OF SCIENCE (ELECTRICAL AND ELECTRONICS ENGINEERING)**

**EEE 208: ELECTRICAL MEASUREMENTS**

**DATE: 17/5/2019** **TIME: 8.30-10.30 AM**

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**INSTRUCTIONS**

**Answer Question ONE and any other TWO Questions.**

**QUESTION ONE (30 MARKS) (COMPULSORY)**

a) State any three classes of fundamental units. (3 marks)

b) Use dimensional notation to derive the following parameters in electromagnetic system of units.

i. Potential difference

ii. Capacitance

iii. Inductance (9 marks)

c) Show that the gauge factor of a resistance strain gauge is given by;

$$G = 1 + 2\mu + \frac{\Delta\rho/\rho}{\Delta L/L}$$

Where $\mu$ = poisons constant

$\frac{\Delta\rho/\rho}{\Delta L/L}$ = change in resistance due to piezo resistive effect (10 marks)

d) The output of LVDT transducer is connected to a 20volts voltmeter through an amplifier whose amplification factor is 100. An output of 4mvolts appears across the terminals of

the LVDT when the plugger moves through 0.8mm. the voltmeter has 50 divisions and scale reads $\frac{1}{10}$ of a division. Determine:

i. Sensitivity of the LVDT

ii. The sensitivity of the entire system

iii. Final output voltmeter reading

iv. Resolution of the system (8 marks)

**QUESTION TWO (20 MARKS)**

a) Fig Q2(a) is a hay A.C bridge. Use it to derive the expression of $L_x$ and $R_x$ in terms of the known component values at balance. (12 marks)

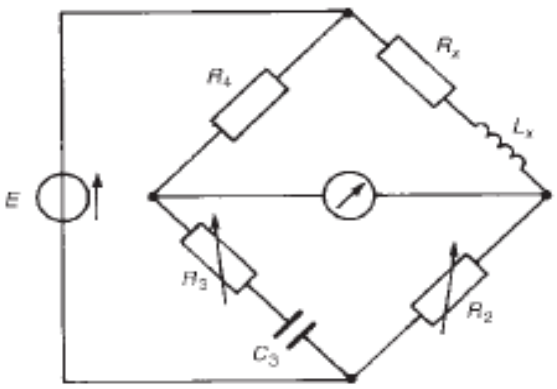


Fig Q2(a)

b) With an aid of an ammeter/voltmeter method, show that the inductance of a coil is given by;

$$L = \frac{1}{2\pi f}\sqrt{Z^2 - R^2}$$ (8 marks)

**QUESTION THREE (20 MARKS)**

a) With an aid of a diagram, show that the resistance measurement using ammeter-voltmeter method is given by;

$$R_x = \frac{R_m R_v}{R_v - R_m}$$ (6 marks)

b) The A.C bridge shown in Fig Q3(b) is used to measure the capacitance $C_x$ and resistance $R_x$.

i. Derive the balance equation of the bridge

ii. Given that $R_3 = R_4$, $C_2 = 0.2\mu F$, $R_2 = 2.5k\Omega$ and the frequency of the supply is 1kHZ. Determine the values of $R_x$ and $C_x$ at balance. (14 marks)

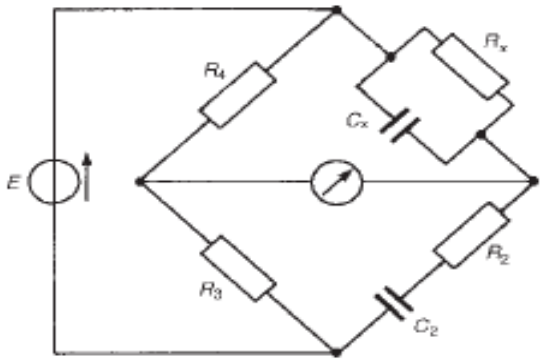


Fig Q3(b)

**QUESTION FOUR (20 MARKS)**

a) With an aid of a circuit diagram, show that the power factor determined using a two wattmeter method for power measurement is given by:

$$\text{P.F} = \text{COS}\ \{tan^{-1}\sqrt{3}\ (\frac{P_1 - P_2}{P_1 + P_2})\}$$ (12 marks)

b) Two watt meters connected to a three phase motor indicate the total power input to be 12kw. The power factor is 0.6. Determine the reading of each watt meter. (8 marks)

**QUESTION FIVE (20 MARKS)**

a) A barium titanate piezo electric pick up has a dimensions of 6mm × 6mm × 1.5mm and a voltage sensitivity 0.012 V/N. relative permittivity of barium titanate is 1400 and modulus of elasticity of the barium titanate is $12\times 10^{10}$ N/$m^2$. Determine;

i. The output voltage

ii. Charge sensitivity

iii. Strain

iv. Charge generated

v. Capacitance of the pick up if the force applied to the pickup is 10N. (10 marks)

b) With the aid of a diagram, describe the operation of ballistic galvanometer as used in magnetic flux measurement. (10 marks)