The Open University of Sri Lanka
Department of Electrical and Computer Engineering
Diploma in Technology/Bachelor of Technology - Level 03

**ECD1203 - Electrical Measurements**
Final Examination 2005

Duration: 3 hours

| Date: 04-04-2006 | Time: 0930-1230 |
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Answer *five* questions.
All questions carry equal marks

Q1

(a) Show how the range of an ammeter can be extend with help of set of resistors.

(b) Internal resistance of a voltmeter is $R_V$ and series resistor used to multiply the range is $R_S$. Show that

$$\frac{V'}{V} = \left(1 + \frac{R_S}{R_I}\right)$$

where **V** is the potential difference across voltmeter at full scale deflection and **V'** is the voltage range that can be measured after extending the range

(c) Winding of a moving coil meter is 4cm X 3cm wide and has 100 turns. Estimate the measured current if control spring exerts a torque of $2.5 \times 10^{-4}$ Nm at equilibrium and flux density of the magnetic field in the air gap is 1 Wb/m$^2$.

Q2

(a) Describe the basic operation of the moving iron meter with help of the appropriate sketches. Hence derive the following expression for the deflection torque ($\iota$).

$$\iota = \frac{1}{2} i^2 \left(\frac{dL}{d\theta}\right)$$

where **L** is the inductance of the moving iron meter, $\theta$ is the deflection from zero position, and **i** is the measured current.

(b) The voltage coil of a dynamometer wattmeter has a resistance of 8K$\Omega$ and an inductance of 63.6mH. A load connected to the wattmeter carrying 8A at 0.1 power factor and measured voltage across the load is 240V. Estimate percentage error in the wattmeter that caused by the loading and inductance of the voltage coil by assuming supply frequency as 50Hz.

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Q3

(a) Describe the advantages of using instrument transformers to extend ranges of AC meters.

(b) An ammeter. which is connected across a current transformer, has an impedance of 2+j0.3 ohms and the turns ratio is 198. Loss and magnetisation components of the no load current are 46A and 107A respectively. The impedance of secondary coil is 0.3+j0.5 ohms. Find the ratio error and phase angle error of the current transformer if the ammeter reading is 5A.

Q4

(a) Prove that two wattcmeters can be used to measure power in a three-phase three-wire system.

(b) Explain the operation of an A/C wattmeter

(c) A three phase delta connected induction motor outputs 15 kW when the line voltage is 440V. Calculate the reading on each wattmeter connected to measure the input power of the motor, if the efficiency of the motor is 90% and the power factor is 0.8.

Q5

(a) Figure Q5 shows a Maxwell's Wien bridge used to measure the self-inductance and equivalent series resistance of inductors. Derive expressions for $L_1$ and $R_1$ in terms of bridge components at balance condition.
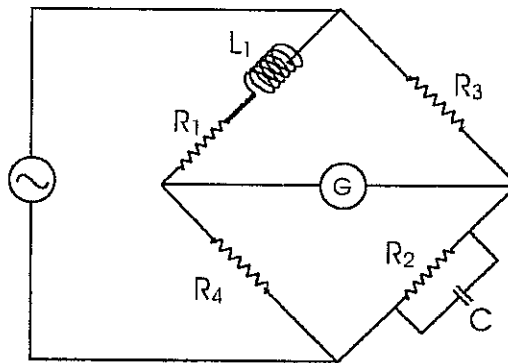


Figure Q5

(b) Calculate $L_1$ and $R_1$, if values of bridge components are $R_2$= 12KΩ, $R_3$=1.2KΩ, $R_4$= 800Ω, and C=0.2uF.

(c) Draw the phasor diagram that indicating the voltages across each element at balance.

Q6

(a) State 3 electrically measurable magnetic properties of materials

(b) Explain how the iron loss of a ring specimen can be measured using Maxwell's Bridge

(c) The measured iron loss of a specimen was 4.8W at 40Hz and 12.7W at 60Hz. Determine eddy current loss per unit weight at 50 Hz, if weight of the concerned specimen is 2 Kg.

Q7    Write short notes on four of following topics

(a) Levels of standards in terms of availability, cost, and accuracy

(b) Sources of errors when using analogue voltmeters

(c) Megger insulation tester

(d) Applications of potentiometers

(e) Performance of analogue to digital converters used in electronic voltmeters

Q8

(a) Explain the advantages of electronic meters when compared with its electrical counterpart.

(b) Briefly explain the operation of successive approximation type analogue to digital converters

(c) Draw a scaled analogue computer flow diagram to study the system described by the following equation.

$$6\ddot{Y} + \dot{Y} + X = 10$$

$$\dot{X} + 5Y = 0.5$$

Where Y(0)=0, $\dot{Y}(0) = 8$, and X(0)=1.5