

**ELECTRICAL & ELECTRONIC MEASUREMENT  
(ELEC 2103)**

**Time Allotted : 2½ hrs**

**Full Marks : 60**

*Figures out of the right margin indicate full marks.*

*Candidates are required to answer Group A and  
any 4 (four) from Group B to E, taking one from each group.*

*Candidates are required to give answer in their own words as far as practicable.*

**Group – A**

1. Answer any twelve:

**12 × 1 = 12**

*Choose the correct alternative for the following*

- (i) Electrostatic type instruments are primarily used as  
(a) ammeters      (b) wattmeters      (c) voltmeters      (d) ohmmeters.
- (ii) Horizontally mounted moving iron instruments use  
(a) Eddy current damping      (b) Electromagnetic damping  
(c) Fluid Friction damping      (d) Air Friction damping.
- (iii) The power in a 3 phase circuit is measured with the help of 2 wattmeters. The reading of one of the wattmeters is positive and that of the other is negative. The magnitudes of readings are different It can be concluded that the power factor of the circuit is  
(a) unity      (b) zero  
(c) 0.5 (lagging)      (d) less than 0.5 (lagging).
- (iv) Creeping in a single phase induction type energy meter may occur due to  
(a) Overcompensation for friction      (b) Overvoltage  
(c) Vibrations      (d) All of (a), (b) & (c).
- (v) A wattmeter has a full scale range of 2500W; it has an error of  $\pm 1\%$  of true value. What would be the range of reading if true power is 1250W?  
(a) 1225W-1275W      (b) 1245W-1255W  
(c) 1200W-1300W      (d) 1237.5W-1262.5W.
- (vi) In a single phase induction type energy meter, in order to measure true value of energy, the shunt magnet flux should lag behind the applied voltage by  
(a)  $0^\circ$       (b)  $45^\circ$       (c)  $60^\circ$       (d)  $90^\circ$ .
- (vii) 'Megger' is a  
(a) PMMC type instrument and measures low resistance  
(b) PMMC type instrument and measures high resistance  
(c) Moving iron type instrument and measures low resistance  
(d) Moving iron type instrument and measures high resistance.

- (viii) A 0-10A ammeter has a guaranteed accuracy of 1% of full scale deflection. The limiting error while reading 2.5A is  
 (a) 1% (b) 2%  
 (c) 4% (d) 5%.
- (ix) Murray loop test is used for  
 (a) detection of fault location  
 (b) measuring the unknown capacitance of the circuit  
 (c) measuring the unknown frequency of the circuit  
 (d) all of the above.
- (x) An rms reading voltmeter can accurately measure voltages of  
 (a) sine waveforms (b) square waveforms  
 (c) sawtooth waveforms (d) all of (a), (b) & (c).

*Fill in the blanks with the correct word*

- (xi) The most suitable material to make spring for spring control mechanism is \_\_\_\_\_.
- (xii) \_\_\_\_\_ type of instrument is suitable for very high voltage measurement.
- (xiii) The number of electromagnets used in an induction type energy meter is \_\_\_\_\_.
- (xiv) The resolution for 8 bit, 5 V D/A converter is \_\_\_\_\_.
- (xv) The ratio error of a CT is negative when the secondary side power factor is \_\_\_\_\_.

### **Group - B**

2. (a) Why is controlling torque necessary in an analog indicating instrument? What would happen in the absence of controlling torque? [[CO1](Analyse/IOCQ)]
- (b) In a permanent magnet moving coil type voltmeter the deflecting torque is proportional to the applied voltage. If the deflection is  $90^\circ$  at a full scale value of 100 V what would be the angle of deflection for a voltage of 50 V, if the instrument is (i) spring controlled, (ii) gravity controlled? [[CO1](Analyse/IOCQ)]
- (c) Explain with a suitable figure the method of producing oil friction damping. [[CO1](Remember/IOCQ)]  
**4 + 4 + 4 = 12**
3. (a) Derive the equation for deflection of an electro-dynamometer type instrument under ac operation with spring control mechanism. [[CO1](Evaluate/HOCQ)]
- (b) For a certain dynamometer ammeter the mutual inductance  $M$  varies with deflection  $\theta$  (expressed in degrees) as  $M = -6\cos(\theta + 30^\circ)$  mH. Find the deflecting torque produced by a direct current of 50 mA corresponding to a deflection of  $60^\circ$ . [[CO1](Evaluate/HOCQ)]
- (c) Explain the phenomenon of hysteresis in the measurement system. [[CO2](Understand/LOCQ)]  
**5 + 4 + 3 = 12**

## Group - C

4. (a) A wattmeter is rated at 10 A and 25 V. The current coil has a resistance of  $0.06 \Omega$  and a reactance of  $0.02 \Omega$ . The potential coil circuit may be assumed to be purely resistive having a resistance of  $6250 \Omega$ . Find the error if the wattmeter is so connected that, (i) the current coil is on the load side, (ii) the pressure coil is on the load side. The load is 10 A at a power factor of 0.174 lagging. The voltage across the load is 25 V. [[CO3](Analyse/IOCQ)]
- (b) Describe the functions of the following in a single phase induction type Energy Meter: (i) Shading bands, (ii) holes in the disc. [[CO3](Understand/LOCQ)]
- (c) An energy meter is designed to make 100 revolutions of disc for one unit of energy. Calculate the number of revolutions made by it when connected to a load carrying 40 A at 230 V and 0.4 power factor for an hour. If it actually makes 360 revolutions, find the percentage error. [[CO3](Analyse/IOCQ)]
- 5 + 4 + 3 = 12**
5. (a) How do you use instrument transformers for power measurement? [[CO4](Apply/IOCQ)]
- (b) What happens if the secondary side of a current transformer is opened when the primary winding is energized? [[CO4](Analyse/IOCQ)]
- (c) A 1000/5 A, 50 Hz current transformer has a secondary burden comprising a non-inductive impedance of  $2.8 \Omega$ . The primary winding has one turn. Calculate the flux in the core and ratio error at full load. Neglect leakage reactance and assume the iron loss in the core to be 1.3 watt at full load. The magnetizing mmf is 100 A. [[CO4](Evaluate/HOCQ)]
- 4 + 2 + 6 = 12**

## Group - D

6. (a) The four arms of a bridge are :  
arm ab : an imperfect capacitor  $C_1$  with an equivalent series resistance  $r_1$   
arm bc : a non-inductive resistance  $R_3$ ,  
arm cd : a non inductive resistance  $R_4$  and  
arm da : an imperfect capacitor  $C_2$  with its internal resistance of  $r_2$  is in series with a resistance  $R_2$   
A supply of 450 Hz is given between terminals a and c and the detector is connected between b and d. At balance,  $R_2 = 4.8 \Omega$ ,  $R_3 = 2000 \Omega$ ,  $R_4 = 2850 \Omega$ , and  $C_2 = 0.5 \mu\text{F}$ ,  $r_2 = 0.4 \Omega$ .  
Calculate the value of  $C_1$  and  $r_1$  and its dissipation factor. [[CO3](Apply/IOCQ)]
- (b) Draw the circuit diagram and explain working of Crompton's DC potentiometer. [[CO4](Remember/LOCQ)]
- 6 + 6 = 12**
7. (a) Draw the circuit of a Kelvin's Double bridge and derive the condition for balance. [[CO4](Remember/LOCQ)]
- (b) A basic potentiometer has 200 cm slide wire with a resistance of 100 ohm. A 4 V battery in series with a variable resistance  $R_1$  provides current through the slide wire. The standard cell potential is 1.018 V and the potentiometer is calibrated

when the sliding contact is set to 101.8cm from the zero voltage end of the slide wire.

- (i) Calculate R1 and the current through R1
- (ii) Determine the measured voltage when zero galvanometer deflection is obtained with the slide rule at 94.3 cm from the zero voltage end.

[[CO4](Evaluate/HOCQ)]

**6 + 6 = 12**

### Group - E

8. (a) A Wheatstone bridge is connected for a Varley Loop test. When the switch is in position 1, the bridge is balanced with  $R_1 = 1000 \Omega$ ,  $R_2 = 2000 \Omega$  and  $R_3 = 100 \Omega$ . When the switch is in position 2, the bridge is balanced with  $R_1 = 1000 \Omega$ ,  $R_2 = 2000 \Omega$  and  $R_3 = 99 \Omega$ . If the resistance of the earthed wire is  $0.15 \Omega/\text{km}$ , how many metres from the bridge has the ground fault occurred. [[CO5](Analyse/IOCQ)]

- (b) Explain the working principle of a true RMS voltmeter. [[CO6](Remember/LOCQ)]

**6 + 6 = 12**

9. (a) A sawtooth voltage has a peak value of 200 V and a time period of 4 s. Calculate the error when measuring this voltage with an average reading voltmeter calibrated in terms of rms value of a sinusoidal wave. [[CO3](Analyse/IOCQ)]

- (b) Explain the working principle of a peak reading voltmeter. [[CO4](Remember/LOCQ)]

- (c) What is the function of the thermocouples in true rms reading voltmeter?

[[CO2](Apply/IOCQ)]

**5 + 4 + 3 = 12**

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	30.21	47.92	21.87

#### Course Outcome (CO):

After the completion of the course students will be able to

- Understand the mechanism of various deflecting type measuring instruments and extension of their ranges
- Define and classify various errors in measurement
- Acquire knowledge of various power and energy measuring devices
- Understand the operating principles and applications of instrument transformers and potentiometers
- Acquire knowledge about and analyze various ac and dc bridges for measuring different electrical parameters and their applications.
- Acquire knowledge about various electronic and digital instruments like average reading AC voltmeters, peak reading AC voltmeters, true RMS voltmeter, electronic multi-meter, digital voltmeters.

\*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.