

**ELECTRICAL & ELECTRONIC MEASUREMENTS
(ELE2103)**

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) Which of the following is an example of an integrating instrument?
(a) Voltmeter (b) Watt-hour meter
(c) Ammeter (d) Wattmeter.
- (ii) For measurement of high voltage which type of instrument is suitable
(a) PMMC instrument (b) Electrostatic instrument
(c) Induction type instrument (d) Moving iron type instrument
- (iii) 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%
- (iv) In an electrodynamicometer type of wattmeter
(a) the current coil is made fixed (b) the pressure coil is made fixed
(c) any of the two coils can be made fixed (d) both the coils should be movable
- (v) The burden of current transformer is expressed in terms of
(a) secondary winding current (b) VA rating of transformer
(c) power factor of load (d) none of the above
- (vi) The Maxwell's Inductance-Capacitance bridge is not suitable for the measurement inductance of coil if the Q factor is
(a) less than 1 only (b) between 1 to 10
(c) greater than 10 only (d) less than 1 and greater than 10 both
- (vii) Megger' is a
(a) PMMC type instrument and measure low resistance
(b) PMMC type instrument and measure high resistance
(c) moving iron type instrument and measure low resistance
(d) moving iron type instrument and measure high resistance

- (viii) Kelvin double bridge is used to measure
 (a) very low resistance (b) medium resistance
 (c) high resistance (d) very high resistance
- (ix) A true RMS reading voltmeter uses two thermocouples in order to
 (a) increase sensitivity
 (b) cancel out the non linear effect of first thermocouple
 (c) prevent drift in dc amplifier
 (d) all of these.
- (x) Varley loop tests are performed over Murray loop test because
 (a) the sensitivity of the Murray loop test gets reduced when the fault resistance is high
 (b) Varley loop test can locate open circuit fault
 (c) Varley loop test can locate earth fault
 (d) Varley loop test can locate short circuit fault.

Fill in the blanks with the correct word

- (xi) The resolution for 10 bit, 10V D/A converter is _____.
- (xii) A PMMC meter has an internal resistance of 500Ω and the current required for its full scale deflection is $100\mu\text{A}$. The power consumed by the meter is _____.
- (xiii) The ratio error of a CT is negative when the secondary side power factor is _____.
- (xiv) Horizontally mounted moving iron instrument use _____ damping.
- (xv) The most suitable material to make spring for spring control mechanism is _____.

Group - B

2. (a) Why is a controlling torque necessary in an analog indicating instrument? What would happen in the absence of a controlling torque? [[CO1](Remember/LOCQ)]
- (b) Explain how an electro-dynamometer type instrument is able to measure the true r.m.s. value of a voltage or current irrespective of its waveforms. [[CO2](Analyze/IOCQ)]
- (c) A wattmeter having a range of 1000W has an error of $\pm 1\%$ of full scale deflection. If the true power is 100W, what would be the range of readings? [[CO2](Analyze/IOCQ)]
- 3 + 5 + 4 = 12**
3. (a) Derive the equation for deflection of a moving iron instrument if the instrument is spring controlled. [[CO1](Analyze/IOCQ)]
- (b) A moving coil voltmeter with a resistance of 20Ω gives a full scale deflection of 120° when a potential difference of 100mV is applied across it. The moving coil has dimensions of $30\text{mm} \times 25\text{mm}$ and is wound with 100 turns. The control spring constant is $0.375 \times 10^{-6} \text{ Nm/deg}$. Find the flux density in the air gap. Also find the diameter of the copper wire of coil winding if 30% of instrument resistance is due to coil winding. The specific resistance of copper is $1.7 \times 10^{-8} \Omega\text{m}$.

[[CO4] (Evaluate/HOCQ)]

- (c) Explain the phenomenon of hysteresis in the measurement system.

[[C02](Understand/LOCQ)]

4 + 5 + 3 = 12

Group - C

4. (a) A wattmeter is rated at 10A and 25V. The current coil has a resistance of 0.06Ω and a reactance of 0.02Ω . The potential coil circuit may be assumed to be purely resistive having a resistance of 6250Ω . 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 10A at a power factor of 0.174 lagging. The voltage across the load is 25V.
- [[C03](Analyze/IOCQ)]
- (b) Describe the functions of the following in a single phase induction type energy meter:
- (i) Shading bands, (ii) holes in the disc.
- [[C03](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 40A at 230V and 0.4 power factor for an hour. If it actually makes 360 revolutions, find the percentage error.
- [[C03](Analyze/IOCQ)]

5 + 4 + 3 = 12

5. (a) How do you use instrument transformers for Power measurement?
- [[C04](Apply/IOCQ)]
- (b) What happens if the secondary side of a current transformer is opened when the primary winding is energized?
- [[C04](Analyze/HOCQ)]
- (c) A 1000/5A, 50 Hz current transformer has a secondary burden comprising a non-inductive impedance of 2.8Ω . 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 100A.
- [[C04](Evaluate/HOCQ)]

4 + 2 + 6 = 12

Group - D

6. (a) Derive the equation of balance for an Anderson bridge with diagram
- [[C05](Remember/LOCQ)]
- (b) Discuss advantages and disadvantages of Maxwell inductance Capacitance Bridge.
- [[C05](Apply/IOCQ)]
- (c) With suitable diagram and phasor diagram explain how quadrature adjustment of current in AC potentiometer can be carried out by phase splitting circuit.
- [[C04](Analyze/HOCQ)]

4 + 3 + 5 = 12

7. (a) How is the Wien Bridge used to measure unknown frequency? Deduce the condition for balance of the bridge and find frequency in terms of bridge parameters.
- [[C05](Remember/LOCQ)]
- (b) Show the phasor diagram for De Sauty Bridge.
- [[C05](Analyze/HOCQ)]

- (c) Explain how standardization is done in a Crompton's DC potentiometer.

[[CO4](Remember/LOCQ)]

4 + 2 + 6 = 12

Group - E

8. (a) A Wheastone bridge is connected for a Varley Loop test. When the switch is in position 1 the bridge is balanced with $R_1=1000\Omega$, $R_2= 2000\Omega$, $R_3= 100\Omega$. When switch is in position 2 the bridge is balanced with $R_1=1000\Omega$, $R_2= 2000\Omega$, $R_3= 99\Omega$. If the resistance of the earthed wire is $0.15\Omega/\text{Km}$ at how many metres from the bridge has the ground fault occurred. [[CO5](Analyse/HOCQ)]
- (b) The reference voltage of a dual slope ADC is 10 V. The integrator has a capacitor of 1 μF and resistance of 200 $\text{k}\Omega$. The time taken to read an unknown voltage V_x is 0.5 seconds. Find V_x . [[CO6](Analyse/HOCQ)]
- 6 + 6 = 12**
9. (a) Explain with a diagram the working principle of a True reading voltmeter. [[CO6](Remember/LOCQ)]
- (b) A sawtooth voltage has a peak value of 200 V and a time period of 4 seconds. Calculate the error when measuring this voltage with an average reading voltmeter calibrated in terms of rms value of a sinusoidal wave. [[CO6](Apply/IOCQ)]
- (c) Compare the maximum conversion type of an 8 bit digital ramp ADC with that of a successive approximation ADC both using clock of 100 kHz. [[CO6](Analyse/HOCQ)]
- 4 + 4 + 4 = 12**

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	29.17	33.33	37.5