ELECTRICAL AND ELECTRONIC MEASUREMENTS
(AEIE 2203)

Time Allotted : 3 hrs   **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and
<u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> from each group.

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

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

    (i)   The smallest change in a measured variable to which an instrument will respond is
            (a) resolution   (b) precision   (c) sensitivity   (d) accuracy.

    (ii)   A pressure measurement instrument is calibrated between 10 bar and 260 bar. The scale span of the instrument is
            (a) 10 bar   (b) 260 bar   (c) 250 bar   (d) 270 bar.

    (iii)   The disadvantages of using shunts for high current measurements are
            (a) power consumption by the shunts themselves is high
            (b) it is difficult to achieve good accuracy with shunts at high currents
            (c) the metering circuit is not electrically isolated from the power circuit
            (d) all of the above.

    (iv)   DeSauty's bridge is used for measurement of
            (a) high Q inductances   (b) low Q inductances
            (c) loss less capacitors   (d) capacitors with dielectric losses.

    (v)   A megger is used for the measurement of
            (a) low valued resistance   (b) medium valued resistance
            (c) high valued resistance   (d) all of (a), (b) & (c).

    (vi)   A sine wave having time period 4ms and $V_{pp} = \pm 2$volt is applied to the vertical deflecting plates of a CRT. If the vertical deflection sensitivity is 2 cm/volt, then at 1.5 ms the vertical deflection of the electron beam in cm will be
            (a) 4.8 cm   (b) 4 cm   (c) 2 cm   (d) 2.8 cm.

    (vii)   In dual trace oscilloscope for measuring the low frequency signal the best selected mode is
            (a) alternate mode   (b) chop mode
            (c) x-y mode   (d) sweep mode.

(viii)   High range can be obtained in a basic D.C. electronic voltmeter by
(a) a transformer   (b) an attenuator
(c) a transducer   (d) a resistor.

(ix)   For a digital voltmeter having 4-1/2 digit display, the input voltage of 0.8654 V on 10 V range will be displayed as
(a) 0.865 V   (b) 0.86 V
(c) 0.8654 V   (d) 0.8 V.

(x)   The time base error in digital frequency meter is generated by
(a) flip-flop   (b) wave shaping circuit
(c) AND gate   (d) crystal oscillator.

Group - B

2.   (a)   List 3 advantages and 3 disadvantages of electrodynamometer type instruments.
[(CO2)(Remember/LOCQ)]

(b)   A PMMC voltmeter with a resistance of 20 Ω gives a full-scale deflection of 1200 when a potential difference of 100 mV is applied across it. The moving coil has dimensions of 30 mm × 25 mm and is wound with 100 turns. The control spring constant is 0.375 × 10^{-6} N-m/degree. Find the flux density in the air gap. Find also the dimension of copper wire of coil winding if 30% of the instrument resistance is due to coil winding. The specific resistance of copper is 1.7 × 10^{-8} Ω m.   *[(CO2)(Analyse/IOCQ)]*

(c)   A single-phase induction type energy meter is tested for 30 minutes run at a supply voltage of 230 V and a load current of 10 A at 0.8 lagging power factor. The dial reading at start was 57.35 and at the end of test was 58.25. The meter constant is 1200 revolutions/kWh. The meter made 890 revolutions during this period. Find out the (i) error in registration and (ii) error in rpm of the meter.
[(CO2)(Analyse/IOCQ)]
3 + 5 + (2 + 2) = 12

3.   (a)   Define threshold. A moving coil ammeter has a uniform scale with 50 divisions and gives a full-scale reading of 5 A. The instrument can read up to ¼th of a scale division with a fair degree of certainty. Determine the resolution of the instrument in mA.   *[(CO1)(Remember/LOCQ)/(Analyze/IOCQ)]*

(b)   State the sources of error in a current transformer? 'The secondary of current transformer is never kept open' – explain.
[(CO2)(Remember/LOCQ)/(Understand/LOCQ)]

(c)   A correctly adjusted single phase 240 V watt-hour meter has a meter constant of 600 revolutions per kWh. Determine the speed of the disc for a current of 8 A at a lagging power factor of 0.6.   *[(CO2)(Analyze/IOCQ)]*
(2 + 2) + (3 + 2) + 3 = 12

Group – C

4.   (a)   Why Wheatstone bridge is not used for the measurement of low resistances below 1 Ω? What are the difficulties in the measurement of high resistances?
[(CO3)(Understand/LOCQ)]

(b) The four arms of a bridge are connected as follows:
Arm AB: A choke coil L_1 with an equivalent series resistance r_1
Arm BC: A noninductive resistance R_3
Arm CD: A mica capacitor C_4 in series a noninductive resistance R_4
Arm DA: A noninductive resistance R_2
When the bridge is supplied from a source of 450 Hz is given between terminals A and C and the detector is connected between nodes B and D, balance is obtained the following conditions: R_2 = 2400 Ω, R_3 = 600 Ω, C_4 = 0.3 μF and R_4 = 55.4 Ω. Series resistance of the capacitor is 0.5 Ω. Calculate the resistance and inductance of the choke coil. Hence determine the quality factor of the coil.

[(CO3)(Analyse/IOCQ)]
(2 + 3) + 7 = 12

5. (a) Discuss the role of loop test methods for localizing ground fault and short circuit fault in low voltage cable. *[(CO3)(Evaluate/HOCQ)]*

(b) A low resistance of approximately 150 Ω was measured by Kelvin's double bridge. The bridge has the following resistance components: Standard resistance = 100 μΩ, inner ratio arms = 15 Ω and 30 Ω, outer ratio arms = 40 Ω and 60 Ω. If the resistance of the connecting leads from standard to unknown resistance is 800μΩ, calculate the unknown the resistance under this condition.

[(CO3)(Analyze/IOCQ)]

(c) Calculate the value of self capacitance of a coil when the following measurements are made:
At 4 MHz frequency the tuning capacitor is set to 400 pF and at 6 MHz frequency the capacitor is tuned to 50 pF to achieve resonance. *[(CO3)(Analyse/IOCQ)]*
4 + 4 + 4 = 12

Group - D

6. (a) With neat sketch describe the operation of practical emitter-follower voltmeter circuit using two transistors. Identify its advantage over simple emitter-follower voltmeter? *[(CO4)(Understand/LOCQ)/(Remember /LOCQ)]*

(b) An op-amp voltmeter circuit is required to measure a maximum input of 20 mV. The op- amp input current is 0.2 μA and the meter circuit has I_m = 100 μA at FSD and R_m = 10 kΩ. Determine suitable resistance values for voltage divider section. With the same voltage divider section setting, if R_s = 40 kΩ is added with Rm, then calculate the maximum input voltage to be measured by this circuit.

[(CO4)(Analyse/IOCQ)]
(5 + 1) + (4 + 2) = 12

7. (a) Explain the operation of 10:1 attenuation probe used for CRO?
[(CO5)(Understand/LOCQ)]

(b) With a neat block diagram explain how PLL is used as FM demodulator.
[(CO4)(Apply/IOCQ)]

(c) List the advantage of thermocouple type true rms voltmeter over conventional ac electronic voltmeter. *[(CO4)(Remember/LOCQ)]*
5 + 5 + 2 = 12

Group - E

8. (a) Design a digital frequency meter circuit for the signal frequency less than or equal to 100 Hz.   *[(CO6)(Create/HOCQ)]*
    (b) For a 4 ½ digit seven segment LED display and 4 ½ digit LCD display, examine the required supply currents. It is provided that for each segment the current required for LED to give reasonable brightness is 20 mA and for LCD is 300 μA.
                                                                           [(CO6)(Analyse/IOCQ)]
                                                                           6 + (3 + 3) = 12

9. (a) Design a 4-bit successive approximation type digital voltmeter for measurement of an input analog dc voltage of 4.3 volt.   *[(CO6)(Create/HOCQ)]*
    (b) What are the errors in measuring frequency by digital frequency meter? Calculate the percentage error in measuring frequency of the signals having frequencies 1 MHz.   *[(CO6)(Remember/LOCQ)]/[(CO6)(Analyse/IOCQ)]*
                                                                           8 + (2 + 2) = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	29.17	52.08	18.75

Course Outcome (CO):

After the completion of the course students will be able to
1. Define and understand the static and dynamic characteristics of measuring instruments.
2. Compare among the operation of measuring instruments and choose the suitable one for measurement of electrical quantities.
3. Apply appropriate method/instrument for measurement of resistance, capacitance, inductance and quality factor of coil & capacitor.
4. Recognize suitable electronic instrument for measurement of voltage, current, frequency/phase.
5. Explain the construction and working principle of cathode ray tube, oscilloscope time base, CRO probes & dual trace oscilloscope and describe their applications.
6. Analyze the working principles of digital voltmeters, digital frequency meter and digital display units.

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