

**ELECTRICAL AND ELECTRONIC MEASUREMENTS
(AEIE 2203)**

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) A voltmeter has a resistance of $2000\ \Omega$. When it is connected across a d.c. circuit its power consumption is $2\ mW$. Suppose this voltmeter is replaced by a voltmeter of $4000\ \Omega$ resistance, then what will be the power consumption when the circuit conditions remain undisturbed?
(a) $4\ mW$ (b) $1\ mW$ (c) $2\ mW$ (d) None of the above
- (ii) A $1\ mA$ ammeter has a resistance of $100\ \Omega$. It is to be converted to a $1\ A$ ammeter. The value of shunt resistance is
(a) $0.001\ \Omega$ (b) $0.1001\ \Omega$ (c) $100000\ \Omega$ (d) $100\ \Omega$.
- (iii) A meggar is used for measurement of
(a) Low valued resistances
(b) Medium valued resistances
(c) High valued resistances, particularly insulation resistance
(d) All the above
- (iv) Which instrument is the cheapest disregarding the accuracy?
(a) PMMC (b) Moving Iron (c) Electrodynamicometer (d) Rectifier.
- (v) In spring controlled moving iron instruments, the scale is
(a) Uniform
(b) Cramped at the lower end and expanded at the upper end
(c) Expanded at the lower end and cramped at the upper end
(d) Cramped both at the lower and the upper ends.
- (vi) The nominal ratio of a current transformer is
(a) primary winding current secondary winding current
(b) rated primary winding current/rated secondary winding current
(c) number of secondary winding turns/number of primary winding turns
(d) all the above.

- (vii) The braking torque provided by a permanent magnet in a single phase energy meter can be changed by
 (a) Providing a magnetic shunt and changing its position
 (b) Changing the distance of the permanent magnet from the centre of the revolving disc
 (c) Both (a) and (b)
 (d) None of the above
- (viii) Frequency can be measured by using
 (a) Maxwell's bridge (b) Schering bridge
 (c) Heaviside Campbell bridge (d) Wien's bridge.
- (ix) In a $3\frac{1}{2}$ digit 0 – 10 V digital meter, the most significant digit is
 (a) $\frac{1}{2}$ (b) 0 or 1 (c) 0 or 10 (d) 3.
- (x) In a digital frequency meter, the Schmitt trigger is used for,
 (a) Sinusoidal waveforms into rectangular pulses
 (b) Scaling of sinusoidal waveforms
 (c) Providing time base
 (d) None of the above.

Fill in the blanks with the correct word

- (xi) An _____ type of instruments are used as both standard and transfer instruments.
- (xii) In PMMC instruments, power consumption is _____.
- (xiii) The braking torque of induction type single-phase energy meter is directly proportional to the _____.
- (xiv) The type of damping uses for moving iron instrument is _____.
- (xv) The internal resistance of ammeter should be ____ .

Group - B

2. (a) Why electrodynamicometer type instrument used as transfer instruments?
[[CO2](Understand/LOCQ)]
- (b) Derive the torque equation of an electro dynamometer type instrument when alternating current is passing through the coils.
[[CO2](Analyze/IOCQ)]
- (c) A moving coil ammeter has a fixed shunt of $0.02\ \Omega$. With a coil resistance of $R = 1000\ \Omega$ and a potential difference of $500\ mV$ across it, full scale deflection is obtained:
 (i) To what shunted current does this correspond?
 (ii) Calculate the value of R to give full scale deflection when shunted current I is $10\ A$ & $75\ A$.
[[CO2](Apply/IOCQ)]

2 + 6 + (2 + 2) = 12

3. (a) Describe the construction of single phase induction type energy meter. [[CO2](Understand/LOCQ)]
 (b) Show that total number of revolutions of single phase induction type energy meter is proportional to energy supplied to meter only when the phase angle between the supply voltage and pressure coil flux is 90 degrees. [[CO2](Analyze/IOCQ)]
 (c) Differentiate between the terms “Scale Range” and “Scale Span” giving suitable examples. [[CO1](Understand/LOCQ)]
- 4 + 6 + 2 = 12**

Group - C

4. (a) Derive the equation of balance for modified DeSauty's bridge. Also draw the phasor diagram for balance condition. [[CO3](Understand/LOCQ)]
 (b) The arms of a five node bridge are as follows:
 arm ab : Unknown impedance (R_1, L_1) in series with a non-inductive variable resistor r_1 ,
 arm bc : A non-inductive resistor $R_3 = 100 \Omega$,
 arm cd : A non-inductive resistor $R_4 = 200 \Omega$,
 arm da : A non-inductive resistor $R_2 = 250 \Omega$,
 arm de : A non-inductive variable resistor r
 arm ec : A loss-less capacitor $C = 1 \mu F$, and
 arm be : A detector.
 An a.c. supply is connected between a and c .
 Calculate the resistance and inductance R_1, L_1 when under balance conditions $r_1 = 43.1 \Omega$ and $r = 229.7 \Omega$? [[CO4](Apply/IOCQ)]
 (c) What is Q-factor of a coil? For high Q-factor of a coil which type of bridge circuit is used for inductance measurement and why? [[CO2](Understand/LOCQ)]
- (3 + 2) + 4 + (1 + 1 + 1) = 12**

5. (a) Derive the equations of balance for an Anderson's bridge. Draw the phasor diagram for conditions under balance. [[CO3](Analyse/IOCQ)]
 (b) A Maxwell's capacitance bridge is used to measure an unknown inductance in comparison with capacitance. The various values at balance,
 $R_2 = 400 \Omega$; $R_3 = 600 \Omega$; $R_4 = 1000 \Omega$; $C_4 = 0.5 \mu F$.
 Calculate the values of R_1 and L_1 . Calculate also the value of storage (Q) factor of coil if frequency is 1000 Hz ? [[CO3](Apply/IOCQ)]
 (c) Discuss the advantages and disadvantages of Maxwell's bridge for measurement of unknown inductance. [[CO3](Understand/LOCQ)]
- (3 + 2) + 4 + 3 = 12**

Group - D

6. (a) Draw the block diagram of PLL and explain its operation. [[CO4](Remember/LOCQ)]
 (b) What are lock range and capture range of PLL? Derive the expression for lock range of PLL. [[CO4](Understand/LOCQ)]
- 5 + (2 + 5) = 12**

7. (a) Draw the block diagram of automatic time base of CRO. If the input to the vertical deflection amplifier is a sine wave then draw the outputs at each stages of the time base. [[CO5](Understand/LOCQ)]
- (b) The simple emitter-follower voltmeter circuit has $V_{cc} = 20\text{ V}$, $R_s + R_m = 9.3\text{ k}\Omega$, $I_m = 1\text{ mA}$ at full scale and transistor $h_{FE} = 100$.
 (i) Calculate the meter current when $E = 10\text{ V}$.
 (ii) Determine the voltmeter input resistance with and without the transistor. [[CO4](Apply/IOCQ)]
- (c) What is the significance of the term TIMES/DIV regarding time-base of CRO? [[CO5](Remember/LOCQ)]
- 6 + (2 + 2) + 2 = 12**

Group - E

8. (a) Briefly explain the operation of ramp type digital voltmeter. [[CO6](Understand/LOCQ)]
- (b) Calculate the maximum time t_1 for the ramp type digital voltmeter if the clock generator frequency is 1.5 MHz . Also, suggest a suitable frequency for the ramp generator. [[CO6](Apply/IOCQ)]
- (c) What is the use of time base in electronic measurement system? What is the role of divider in time base generator? [[CO6](Understand/LOCQ)]
- 5 + (3 + 2) + (1 + 1) = 12**
9. (a) Sketch the cross section of a liquid crystal cell and explain its operation. [[CO6](Analyse/IOCQ)]
- (b) What are common cathode and common anode seven segment display? [[CO6](Understand/LOCQ)]
- (c) How time period and pulse width of a signal can be measured by digital frequency meter? [[CO6](Understand/LOCQ)]
- 4 + 4 + 4 = 12**

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	56.25	43.75	0

Course Outcome (CO):

After the completion of the course students will be able to

- Define and understand the static and dynamic characteristics of measuring instruments.
- Compare among the operation of measuring instruments and choose the suitable one for measurement of electrical quantities.
- Apply appropriate method/instrument for measurement of resistance, capacitance, inductance and quality factor of coil & capacitor.
- Recognize suitable electronic instrument for measurement of voltage, current, frequency/phase.
- Explain the construction and working principle of cathode ray tube, oscilloscope time base, CRO probes & dual trace oscilloscope and describe their applications.
- 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.