ELECTRICAL MEASUREMENT AND INSTRUMENTS
(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 any 5 (five) from Group B to E, taking at least one 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 shunt resistance in an ammeter is usually
(a) less than meter resistance (b) equal to meter resistance
(c) more than meter resistance (d) of any value.

(ii) Wheatstone bridge is not preferred for precision measurements because of errors due to
(a) resistance of connecting leads (b) resistance of contacts
(c) thermo-electric emf (d) all of these.

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

(iv) The high torque/weight ratio in an analog indicating instrument indicates
(a) high friction loss (b) fast response
(c) low friction loss (d) slow response.

(v) Creeping is observed in
(a) voltmeter (b) ammeter
(c) wattmeter (d) energy meter.

(vi) De Sauty's bridge is used for measurement of
(a) high Q inductances
(b) low Q inductances
(c) lossless capacitors
(d) capacitors with dielectric losses.

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

(viii) In a PMMC instrument, the torque/ weight ratio is
(a) high (b) low (c) zero (d) infinity.

(ix) The bridge used for measurement of mutual inductance is
(a) Anderson bridge (b) Heaviside bridge
(c) Schering bridge (d) Wien's bridge.

(x) The Murray loop test is used to locate
(a) short circuit fault on a cable
(b) ground fault on a cable
(c) both short circuit fault and ground fault
(d) open circuit fault.

Group – B

2. (a) Name and explain how the different torques are produced in a permanent magnet moving coil instrument.

(b) State 2 merits and 2 demerits of permanent magnet moving coil instrument over moving iron instruments.

(c) A moving coil ammeter has a shunt of 0.02 Ω with a coil resistance of R = 1000 Ω and a potential difference of 500 mV across it. Full scale deflection is obtained.
(i) To what shunted current does it correspond?
(ii) Calculate the value of R to give full scale deflection when shunted current I is 20 A.
(iii) With what value of R, 45% deflection is obtained with I = 100 A?
(iv) With what value of shunt resistance, 60% deflection is obtained with R = 1000 Ω?

4 + 2 (1 + 1 + 2 + 2) = 12

3. (a) With neat diagram briefly explain the working principle of attracted disc type electrostatic voltmeter and derive the expression for the force of attraction between the discs.

(b) An electrostatic voltmeter has two flat parallel plates, each 10 cm^2 in area. If these plates are 6 mm apart from each other, estimate the force of attraction when there is potential difference of 2000 volts between them.

(5 + 4) + 3 = 12

Group – C

4. (a) Explain with neat diagram the working principle of Gall-Tinsley coordinate type potentiometer.

   (b) Measurements for the determination of the impedance of a coil are made on a coordinate type potentiometer. The results are:
   Voltage across 1 Ω standard resistance in series with the coil = +0.952 V on inphase dial and -0.340 V on quadrature dial. Voltage across 10:1 potential divider connected to the terminals of the coil = +1.35 V on inphase dial and +1.28 V on quadrature dial. Calculate the resistance and reactance of the coil.

7 + 5 = 12

5. (a) Draw the equivalent circuit of the potential transformer. Hence draw and explain the phasor diagram of it.

   (b) A potential transformer with nominal ratio 1100/110 V has the following parameters:
   Primary resistance = 82 Ω, Secondary resistance = 0.9 Ω, Primary reactance = 76 Ω, Secondary reactance = 0.72 Ω, no load current = 0.02A at 0.4 power factor. Calculate (i) phase angle error at no load and (ii) burden in VA at unity power at which phase angle error will be zero.

(2 + 5) + 5 = 12

Group – D

6. (a) With neat diagram, explain the loss of charge method for measurement of high resistance.

   (b) The following results were obtained by loss of charge method of testing a cable:
   (i) discharged immediately after charging, the deflection = 200 division
   (ii) discharged 30 seconds after charging, the deflection = 125 division
   (iii) discharged 30 seconds after charging, when in parallel with a resistance of 10 MΩ, the deflection = 125 division
   Calculate the insulation resistance of the cable.

   (c) List the sources of errors in a Wheatstone bridge and mention the possible remedies to minimize/eliminate these.

5 + 4 + 3 = 12

7. (a) Draw a neat schematic diagram and phasor diagram of the Heaviside bridge. Derive the expression for the unknown mutual inductance in terms of known components.

   (b) The four arms of a bridge are connected as follows:
   Arm AB: A 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
   Arm DA: A capacitor C_2 with an equivalent series resistance r_2 in series with a resistance R_2
   A supply of 50 Hz is given between terminals A and C and the detector is connected between nodes B and D. at balance R_2 = 5 Ω, R_3 = 1000 Ω, R_4 = 3000 Ω, C_2 = 0.3 μF and r_2 = 0.25 Ω. Calculate the values of C_1, r_1 and also the dissipation factor of the capacitor C_1.

(2 + 2 + 4) + 4 = 12

Group – E

8. (a) How can we differentiate between the Murray and the Varley loop test? Describe with suitable schematic diagram the Murray loop test for localizing ground fault and short circuit fault in low voltage cable.

   (b) A short circuit fault is located by Murray loop test. The faulty cable has a length of 6.8 km and is looped with a sound (healthy) cable of the same length and cross section. Resistances of the ratio arms of the measuring bridge circuit are 200 Ω and 444 Ω at balance. Calculate the distance of fault point from the testing terminal.

(2 + 5) + 5 = 12

9. (a) In a higher educational institution, 25 students were appeared in the applied mathematics exam. the results of which are as follows: 22, 21, 25, 18, 17, 23, 24, 15, 29, 10, 19, 23, 26, 27, 25, 20, 24, 16, 14, 21, 26, 18, 19, 20, 28.
   Find, (i) mean, (ii) median, (iii) mean deviation and (iv) standard deviation.

   (b) Distinguish between the method of sequential differences and the method of extended differences. What is MTTR? How it is related to MTBF?

(1 + 1 + 2 + 2) + (3 + 2 + 1) = 12