16 Ω for position 1 and 7 Ω for position 2. The sound and faulty cables are identical and have a resistance of 0.4 Ω/km. Determine the length of each cable and the distance of fault from the test end.

(b) A batch of 100 identical thermocouples was tested over 12-week period. Twenty failures were recorded and mean down time is 6.2 hours. Calculate:
(i) mean time between failures
(ii) mean failure rate
(iii) availability.

$$(3 + 3) + (2 + 2 + 2) = 12$$

9. (a) The following set of data has been obtained by measurement:

X	1	2	3	4	5	6	7	8	9	10	11
Y	0	0.85	2.02	2.92	4.1	5.05	5.95	6.89	8.02	9.10	9.92

Obtain the slope of the best-fit straight line using
(i) method of sequential differences
(ii) method of extended differences.

(b) What is MTTF?

$$(5 + 5) + 2 = 12$$

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) A moving coil voltmeter has a uniform scale with 100 divisions, the full scale reading is 200V and 1/10 of a scale division can be estimated with a fair degree of certainty. The resolution of the instrument is
(a) 20V   (b) 2V   (c) 0.2V   (d) 0.1V.

(ii) Ammeter-voltmeter method is used for the measurement of
(a) high resistance   (b) low resistance
(c) medium resistance   (d) none of these.

(iii) Which of the following is the desirable dynamic characteristics of a measurement system?
(a) Fast response, fidelity and measuring lag
(b) Fast response and measuring lag
(c) Fidelity and measuring lag
(d) Fast response and fidelity.

(iv) A Ballistic galvanometer should be designed with
(a) a large period of natural oscillations and a negligible damping constant
(b) a small period of natural oscillations and a high damping constant
(c) a large period of natural oscillations and a high damping factor
(d) a small period of natural oscillations and a low damping factor.

(v) The condition for maximum sensitivity of Wheatstone bridge with arms P, Q, R and S is
(a) P/Q = R/S = 1   (b) P/Q = R/S = 100
(c) P/Q = R/S = 2   (d) P/Q = R/S = 50.

(vi) Unknown frequency is measured by using
(a) Maxwell's bridge
(b) Schering bridge
(c) Heaviside Campbell bridge
(d) Wien's bridge.

(vii) A quadrant type electrostatic instrument uses two types of connections. An external battery is used for
(a) idiostatic connection
(b) heterostatic connection
(c) both idiostatic and heterostatic connection
(d) none of these.

(viii) Measurement of unknown inductance of a low Q coil is done by
(a) Maxwell's bridge
(b) Schering bridge
(c) Anderson's bridge
(d) Hay's bridge.

(ix) The instrumental error of an instrument is classified as
(a) gross error
(b) systematic error
(c) random error
(d) indefinite error.

(x) A pressure measurement instrument is calibrated between 10 bar and 250 bar. The scale span of the instrument is
(a) 10 bar
(b) 250 bar
(c) 240 bar
(d) 260 bar.

Group – B

2. (a) State the operating torques necessary for proper operation of an analog indicating instrument and explain.

(b) A moving coil instrument gives a full scale deflection of 10 mA when the potential difference across its terminals is 100 mV.
(i) Calculate the shunt resistance for a full scale deflection corresponding to 100 A.
(ii) Calculate the series resistance for full scale reading with 1000 V.

(c) What are the main sources of errors in moving coil instruments?

6 + (2 + 2) + 2 = 12

3. (a) The inductance of a moving iron ammeter with a full scale deflection of 90° at 1.5 A, is given by the expression $L = (200 + 40\theta - 4\theta^2 - \theta^3)$ µH, where θ is the deflection in radian from the zero position. Estimate the angular deflection of the pointer for a current of 1 A.

(b) Derive the torque equation of an electro dynamometer type instrument when an alternating current is passing through the coils.

5 + 7 = 12

Group – C

4. (a) Draw the construction and phasor diagram of a single phase induction type energy meter mentioning all the parameters. A 230 V single phase energy meter records a constant load of 10 A for 4 hours at unity power factor. If the meter disc makes 2760 revolutions during this period, what is the meter constant in terms of revolutions per unit?

(b) With a neat diagram explain the working of Drysdale polar potentiometer.

(4 + 2) + 6 = 12

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

(b) What are the possible errors in current transformer? Why the secondary of current transformer is never kept open?

(2 + 4) + (3 + 3) = 12

Group – D

6. (a) Derive the expression for the unknown inductance of a high Q coil by Hay's bridge. Draw the phasor diagram of this bridge.

(b) In a Schering bridge a capacitance C_1 without dielectric specimen is connected in series in arm ab. Arm bc has resistance R_3, arm cd has resistance R_4 in parallel with a capacitance C_4. Arm da has a standard capacitor C_2. At balance $C_2 = 150$ pF, $C_4 = 120$ pF, $R_3 = R_4 = 5000$ Ω. When the same capacitance with dielectric specimen is connected in arm ab, balance of the bridge is obtained for $C_2 = 900$ pF and $R_3 = R_4 = 5000$ Ω. Calculate the relative permittivity of the dielectric specimen.

(6 + 3) + 3 = 12

7. (a) What are the difficulties in the measurement of high resistances? Explain the operation of a megger for the measurement of high resistance.

(b) Find the expression of the unknown frequency of ac supply by Wien's bridge.

(2 + 6) + 4 = 12

Group – E

8. (a) A short circuit fault is located by Varley loop test. The ratio arms are set at P = 5 Ω and Q = 10 Ω and the values of variable resistance S are