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B. Tech
CPEN 5306

Fifth Semester Examination – 2008

INSTRUMENTATION AND MEASUREMENTS

Full Marks – 70

Time : 3 Hours

Answer Question No. 1 which is compulsory
and any **five** from the rest.

The figures in the right-hand margin
indicate marks.

Draw appropriate diagrams wherever necessary.

All the symbols carry their usual meaning

1. Answer the following questions : 2 × 10
- (a) A voltmeter having a range of 300V has
an error of $\pm 1\%$ of full scale deflection.
If the true voltage is 150V, what would be
the range of readings ?

P.T.O.

- (b) A voltmeter having a sensitivity of $1 \text{ K}\Omega/\text{V}$ reads 90V on its 120V scale when connected across an unknown resistor in series with a milli-ammeter. If the milli-ammeter reads 5mA , calculate the apparent resistance of the unknown resistor.
- (c) Give the expression for the critically damped motion of a d'Arsonval galvanometer.
- (d) Draw the equivalent circuit of a current transformer.
- (e) How the reading of a wattmeter is affected if pressure coil inductance is taken into consideration ?
- (f) Show how can you measure power in a three-phase balanced load using just one wattmeter.
- (g) For what condition the maximum torque is produced in an induction type of energy meter ?

- (h) State the principle of a vibrating reed type of frequency meter.
- (i) Which bridge(s) is (are) used for the measurement of self inductance ?
- (j) State two advantages of a digital meter over an analog meter of identical specifications.

2. An Owen's bridge is used to measure the properties of a sample of sheet steel at 2KHz . At balance, arm ab is test specimen; arm bc is 100Ω , arm cd is $0.1 \mu\text{F}$ and arm da is a resistor of 839Ω in series with a capacitor of $0.124 \mu\text{F}$. Calculate from the fundamentals the effective impedance of the specimen under test conditions. 10

3. A current transformer having a 1 turn primary is rated at $500/5\text{A}$, 50Hz with an output of 15VA . At rated load with non-inductive burden the inphase and quadrature components of the exciting mmf are 8 and 10A respectively. The

number of turns in the secondary is 98, and the resistance and leakage reactance of the secondary winding are 0.35Ω and 0.3Ω respectively. Calculate from the fundamentals the current and phase angle error. Draw the equivalent circuit diagram and phasor diagram.

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4. A voltage $100 \sin \omega t + 40 \cos(3\omega t - 30^\circ) + 50 \sin(5\omega t + 45^\circ)$ V is applied to the pressure circuit of a wattmeter and through the current coil is passed a current of $8 \sin \omega t + 6 \cos(5\omega t - 120^\circ)$ A.

(a) What will be the reading of the wattmeter?

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(b) What percentage of this power is due to fundamental?

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5. (a) A galvanometer has the following parameters : $B = 10 \times 10^{-3}$ Wb/m², $N = 200$ turns, $l = 16$ mm, $d = 16$ mm, $K = 10 \times 10^{-9}$ Nm/rad, $J = 50 \times 10^{-9}$ kg-m², $D = 5 \times 10^{-9}$ Nm/rad s⁻¹. The resistance of the coil is 120Ω . Calculate

(i) the deflection of the galvanometer in radian and in mm when a constant current of 1μ A flows through it, the scale being 1 m away,

(ii) the frequency of damped oscillations and

(iii) the first maximum deflection. 6

(b) Bring out the essential differences between a d Arsonval type galvanometer and ballistic galvanometer. 4

6. (a) In an electrical resonance deflectional type of frequency meter, there are two parallel circuits each consisting of an inductance and a capacitance in series. One circuit has $C_1 = 1\mu$ F and is tuned to a frequency $f_1 = 60$ Hz. The other has $C_2 = 1.5\mu$ F and is tuned to a frequency of f_2 , below 50 Hz. The resistance of

each circuit is $R_1 = R_2 = 100\Omega$. What must be the inductance of the second circuit and to what frequency must it be tuned, in order that the current in both the circuits are the same at 50Hz ?6

- (b) The meter constant of a 230V, 10A watt-hour meter is 1800 revolutions/KWh. The meter is tested at half load at rated voltage with unity power factor. The meter is found to make 80 revolutions in 138s. Determine the meter error at half load.

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7. (a) Discuss the working of a Drysdale polar type of potentiometer with the help of a neat diagram.
- (b) Discuss the working of a CRO with the help of an appropriate block schematic.

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8. Write short notes on any two : 5×2

- (a) Piezoelectric transducer
(b) Digital frequency meter
(c) Creep in energy meters
(d) Optical Transducers.