

B. Power Engg. 3<sup>rd</sup> Year 1<sup>st</sup> Semester Examination, 2019

Transducers and Measurement

Time 3 Hr.

Full Marks: 100

1. Answer any three questions 3×5
  - (a) Derive the expression for steady state deflection of PMMC instruments. How the effect of temperature changes is adjusted using voltmeter-multipliers?
  - (b) Derive the general equation for deflection of a spring controlled repulsion type moving iron instrument. Comment on the shape of the scale.
  - (c) What is creeping? How can it be prevented in a single phase induction type energy meter?
  - (d) Describe the constructional details of electro-dynamometer type instruments.
  
2. Answer any two questions 2×8
  - (a) Explain how an inductance may be measured by comparison with a standard capacitor in an alternating current bridge. What are the modification and additional features incorporated in a low voltage Schering bridge for it to be used on high voltage?
  - (b) Draw the equivalent circuit and phasor diagram of a current transformer. Derive the expression for ratio and phase angle error.
  - (c) Describe with the help of a suitable diagram, how a dc potentiometer can be used to calibrate a voltmeter? What are the functions of the transfer instrument and the phase shifting transformer? Explain with suitable diagram.
  
3. Answer any five questions 5×8
  - (a) A current transformer, of nominal ratio 1000/5 A, is operating with total secondary impedance of  $(0.4 + j0.2) \Omega$ . At rated current, the components of the primary current associated with the core-magnetizing and core-loss effects are respectively, 5 A and 1.5 A, while the primary has 4 turns. Calculate the ratio error and phase angle error at rated primary current, if the secondary has 800 turns.
  - (b) A moving coil galvanometer has a coil wound upon a former of non-conducting material. The current sensitivity of the instrument is  $0.001 \mu\text{A/mm}$  at 1m and the undamped periodic time is 5 sec. If the torque is  $0.07 \text{ Nm/A}$ , calculate the control torque of the suspension, the moment of inertia of the moving system and the total circuit resistance which critically damps the instrument. The effect of air damping is neglected.
  - (c) The inductance of a MI ammeter is  $7 + 3\theta - \frac{1}{2}\theta^2 \mu\text{H}$ , where  $\theta$  is the deflection in radian from zero position. The control spring torque is  $15 \times 10^{-6} \text{ Nm/rad}$ . Calculate the scale position in radian and in degree for current of 5 A and discuss the scale shape.
  - (d) In an Anderson Bridge for measurement of inductance the arm AB consists of unknown impedance with inductance L and R, a known variable resistance in arms DE and BC, fixed resistance of  $600\Omega$  each in arms CD and DA and a condenser with fixed capacitance of  $1\mu\text{F}$  in arm CE. The ac supply of 100 V is connected across A and C, the detector is connected between B and E. If the balance is obtained with a resistance of  $400 \Omega$  in the arm DE and a resistance of  $800\Omega$  in the arm BC, calculate the value of unknown R and L.
  - (e) Four arms of a Wheatstone bridge are as follows:  
 $AB = 100 \Omega$ ,  $BC = 1000 \Omega$ ,  $CD = 4000 \Omega$ , and  $DA = 400 \Omega$ .  
 The galvanometer has a resistance of  $150 \Omega$ , a sensitivity of  $100 \text{ mm}/\mu\text{A}$  and is connected across AC. A source of 5 V DC is connected across BD. Calculate the current through the galvanometer and its deflection if the resistance of the arm DA is changed from  $400 \Omega$  to  $402\Omega$ .
  - (f) A moving coil instrument whose resistance is 30 ohm gives a full scale deflection with a current of 1mA. This instrument is to be used with a manganin shunt to extend its range to 100 mA. Calculate the error caused by  $15^\circ\text{C}$  rise in temperature when;
    - (i) Copper moving coil is connected directly across the manganin shunt
    - (ii) A 75 ohm manganin resistance is used in series with the instrument moving coil
 The temperature co-efficient of copper is  $0.004/^\circ\text{C}$  and that of the manganin  $0.00015/^\circ\text{C}$ .

4. Answer any three questions

3×8

- (a) Describe the working principle of the resistance thermometers. Name the materials used for RTDs along with their properties.
- (b) What are thermistors? Discuss the resistance-temperature characteristics of thermistors and the method of measurement of temperature with the use of thermistors.
- (c) Describe the methods of pressure measurement using embedded and unbonded strain gage pressure transducers and also using variable capacitance transducer.
- (d) Define the following transducer characteristics: Accuracy, Calibration, Repeatability and Noise  
How does a pH meter work?

5. Answer any one:

1×5

- (a) Discuss with a neat diagram the application of Hall effect transducer for measurement of magnetic field.
- (b) Enumerate five functions of a signal conditioning system. Draw the block diagram of an A.C. signal conditioning system. Draw the circuit diagram of an Optoisolator circuit used in signal conditioning system.