NSPIRED BY LIFE

## INTERNATIONAL CENTRE FOR APPLIED SCIENCES (Manipal University) IV SEMESTER B.S. DEGREE EXAMINATION – OCT. / NOV. 2017 SUBJECT: MEASUREMENTS AND INSTRUMENTATION (MET 242) (BRANCH: MECHATRONICS ENGINEERING) Tuesday, 07 November 2017

## **Time: 3 Hours**

Max. Marks: 100

- ✓ Answer ANY FIVE full Questions.
- Missing data, if any, may be suitably assumed.
- **1A.** Prove that in a Permanent Magnet Moving Coil Mechanism (PMMC), the angular deflection is linearly proportional to the current flowing through it.
- **1B.** Explain the following Static Characteristics:
  - a. Repeatability and Reproducibility
  - b. Sensitivity of Measurement
  - c. Linearity
  - d. Hysteresis
- **1C.** Explain the different methods of measurement with examples.

(6+8+6)

(5+10+5)

- 2A. I. How does the sensing ability of a capacitive sensor varies with respect to the:
  - i. Target's Size
  - ii. Dielectric Constant
  - iii. Distance from the sensor

II. Capacitive Proximity Sensor generates an electrostatic field and reacts to change in capacitance caused when a target enters the electrostatic field. Show this phenomena with a neat diagram.

**2B.** The following measurements were taken with an analogue meter of the current flowing in a circuit (the circuit was in steady state and therefore, although the measurements varied due to random errors, the current flowing was constant):

21.5mA, 22.1mA, 21.3mA, 21.7mA, 22.0mA, 22.2mA, 21.8mA, 21.4mA, 21.9mA, 22.1mA

Calculate:

- i. The Mean Value
- ii. The Median Value, and
- iii. The Standard Deviation.
- **2C.** Derive the balanced condition of Wheatstone Bridge Circuit.

- **3A.** Determine the value of:
  - i. Shunt Resistance in a DC Ammeter (Shunt Resistor), and
  - ii. Multiplier Resistance in a DC Voltmeter (Multiplier Resistor).

Draw the circuit diagram for both.

**3B.** A Kelvin double bridge each of the ratio arms  $P = Q = p = q = 1000 \Omega$ . The emf of the (10+10) battery

is 100 V and a resistance of 5  $\Omega$  is included in the battery circuit. The galvanometer has a resistance of 500  $\Omega$  and the resistance of the link connecting the unknown resistance to the standard resistance may be neglected. The bridge is balanced when the standard resistance S = 0.001  $\Omega$ . (*Refer Figure 1 given below*)

- i. Determine the value of unknown resistance
- ii. Determine the current (approximate value) through the unknown resistance R, at balance.
- iii. Determine the deflection of galvanometer when the unknow resistance R is changed by 0.1 percent from its value at balance. The galvanometer has a sensitivity of 200 mm/ $\mu$ A.



- **4A.** Explain the construction and working principle of LVDT.
- **4B.** I. Define sensitivity drift and zero drift. What factors can cause sensitivity drift and zero drift in instrument characteristics?

II. An instrument is calibrated in an environment at a temperature of 20°C and the following output readings y are obtained for various input values x:

у	13.1	26.2	39.3	52.4	65.5	78.6
x	5	10	15	20	25	30

Determine the measurement of sensitivity of instrument in terms of y/x.

- **4C.** Define metrology. List the objectives of metrology.
- **5A.** Define the terms Limits and Fits. Explain the different types of fits with proper diagrams.
- **5B.** Define Seebeck Effect. Describe the three laws of thermocouple with diagram.

(8+8+4)

**5C.** The arms of an AC Maxwell's Bridge are as follows: AB is a non-inductive resistance of (8+8+4) 1000 $\Omega$  in parallel with a capacitor of capacitance 0.5 $\mu$ F, BC is a non-inductive resistance of 600 $\Omega$ . CD is an inductive impedance (unknown) and DA is a non-inductive resistance of 400 $\Omega$ . If a balance is obtained under these conditions, find the value of resistance and inductance of branch CD. (*Refer Figure 2 below*)



- **6A.** Cathode Ray Oscilloscope (CRO) is used to measure various parameters. Explain how it is used to measure the following parameters:
  - i. Voltage
  - ii. Current
  - iii. Time
- **6B.** Explain in brief the elements of a measurement system. Draw the block diagram also.
- **6C.** Discuss how the sensing capacity of an ultrasonic sensor varies with respect to:
  - a. Target Size
  - b. Target to sensor distance
  - c. Temperature of the surroundings
  - d. Type of target to be sensed

(8+8+4)

**7A.** For the bridge circuit shown in figure 3 below, derive the null condition.



Figure 3

- **7B.** Define a sensor and write its advantages with respect to manufacturing.
- **7C.** When an object carrying, current I is placed in a magnetic field B, then an electric field E (8+6+6) is induced in the object in direction perpendicular to both I and B.

Answer the following:

- i. What is the name of this phenomena?
- ii. On what principle does this phenomenon occurs?
- iii. Explain its working principle with a neat diagram.
- **8A.** Explain the construction and working of inductive sensor, with a neat sketch.
- **8B.** State the definition of a Random Error. How is the statistical analysis of measurements subjected to random errors are carried out?
- **8C.** Write a short note on Incremental Encoder. Also, list the applications of encoders. (8+6+6)

##