M.E. ELECTRICAL ENGINEERING FIRST YEAR SECOND SEMESTER EXAMINATION, 2019

TRANSDUCER TECHNOLOGY (MS)

Full Marks 100

Time: Three hours (50 marks for each part)

Use a separate Answer-Script for each part

PART I

Answer any *TWO* questions

1. (a) What role do the guard electrodes play in capacitive sensors? Elucidate. **4**

   (b) Does the velocity of ultrasound in a liquid depend on its temperature? If so, how does this fact affect the performance of ultrasonic transit time flowmeter? What is the remedy? *Explain clearly.* **5**

   (c) Enumerate, with explanations, the points in favour of having linear static transfer characteristics for transducers. **5**

   (d) How can an analog multiplier be used to counteract the nonlinearity introduced by the Wheatstone bridge circuit used for resistive strain gauges? Does it guarantee a linear relation between the output voltage and the mechanical strain ? Explain. **5**

   (e) Consider a processor-based data acquisition system used in conjunction with resistive sensors. What type of interfacing do you propose, to have a measurement independent of variation in the excitation voltage/ current? How is the unknown value of the physical variable obtained deploying a look-up table? Suggest any method for enhancing the accuracy of measurement. Give illustrations, and explanations. **6**

2. (a) Connections from a piezoelectric sensor are taken to a voltmeter via a coaxial cable 20 m long. Capacitance of the sensor is 1000 pF. Input capacitance of the voltmeter is 20 pF. The variety of the coaxial cable available has a shunt capacitance of 10 pF/m. If the distance between the location of the sensor and the control room **9**

increases such that the length of the cable has to be increased to 50 m, quantify the changes in the performance of the complete arrangement. Draw the equivalent circuit of the arrangement and analyze it to derive the expressions used.

(b) With reference to any appropriate transducer, bring out clearly the implication of using synchronous demodulation arrangement for transducers. Give suitable illustrations and explanations. 8

(c) Give an example of a transducer in which a *phase advancing network and voltage-controlled current source combine* is used. Give any appropriate circuit diagram for such a combination, and explain its functioning with the relevant derivations. 8

OR

(c) In a two-current sensing method for monitoring the temperatures of processors, the current levels are 500 µA and 200 µA. If the resistance in the series path is 5 kΩ and the non-ideality factor for the transistor sensor is 1.1, determine the temperature error in °C introduced by the series resistance. Consider Boltzmann constant as 1.38×10^{-23} J/K, and the magnitude of electronic charge as 1.6×10^{-19} C. Derive the expression used. *State clearly any assumption made.* 8

3. (a) Bring out clearly the principle of Rogowski coil current transducer. Comment with relevant explanations, on the susceptibility of the transducer to the effect of stray time-varying magnetic fields. 4+4

Why is electrostatic shielding necessary in such a transducer? How is such a shielding implemented effectively? 3

Enumerate the merits of the Rogowski coil, compared to other current transducers. 4

(b) Why is a closed loop Hall effect current transducer known as zero-flux transducer? Elucidate with necessary figures and mathematical expressions. What are its advantages over the open-loop counterpart. Also point out its demerits. 7+3

4. Write short notes on any *two* of the following.

(a) Capacitive liquid level gauges.

(b) Force balance accelerometer.

(c) Multivibrator circuits for capacitive sensors..

(d) Shunt linearization arrangement for   thermistor with negative
     temperature coefficient (NTC) of resistance.

12 ½
+
12 ½

Master of Electrical Engineering Second Semester Examination, 2019

Transducer Technology

Time: Three Hours   Full Marks: 100

(50 Marks for each part)

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PART-II

Answer *Any Two* Questions

Q1a) Briefly explain the principle of radiographic non- destructive testing method. Also mention the different types of sensors used in ultrasonic testing and their characteristic features. Why continuous magnetization technique is advantageous over residual magnetization technique?

4+4+2

Q1b) What is meant by acoustic emission technique? Define amplitude, rise time, Marse and count of acoustic emission signal and state their significances with respect to the testing method. Explain AE linear source location technique and also advantages of AE testing method.   2+4+4

Q.1c) Briefly discuss the characteristics of penetrant materials used in liquid inspection testing .   5

Q.2a) Explain the process steps involved in the fabrication of microsystems using LIGA. What are the main differences of this approach with silicon micromachining. Mention the key advantages and limitations of this approach.   12+3+5

Q.2b) Explain the principle of thermal evaporation process. List the materials for which this approach is practical.   3+2

Q.3a) Explain the differences between a step-index fiber and graded-index fiber.

What do you mean by absorption and bending loss related to optical fiber?

What is wave division multiplexing?   **5+8+5**

Q.3b) What is HART? Mention HART message format?   7

Q4. Write short notes on:

i) CAN Bus and its protocol.

ii) Bulk Micromachining and Surface Micromachining.   (12.5x2)