Ref No: EX / PG/ EE/T/ 127 B / 2025

M.E. ELECTRICAL ENGINEERING FIRST YEAR SECOND SEMESTER EXAMINATION, 2025

TRANSDUCER TECHNOLOGY (MS)

Full Marks 100

Time: Three hours

Answer any FOUR questions

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

(b) Why is a manganin resistor connected across an RTD, in the ohmmeter method of measurement? Will the purpose be served for all types of RTD? 5

(c) In the charge amplifier circuit used with piezoelectric sensors, what purpose is served by opting for a large value of the feedback resistance? What are the constraints on the upper limit of the resistance that can be used? 5

(d) Why is electrostatic shielding provided in the Rogowski coil current transducer? Elucidate. 6

(e) Why does an open-loop Hall-effect current transducer require a field-enhancing ferromagnetic toroid ? What other advantage and disadvantage does the use of this toroid have? 5

2. A piezoelectric transducer consists of a rectangular slab held between two metal electrodes placed on the opposite surfaces. The charge sensitivity of the sensor material is 10 pC/N. The capacitance and the leakage resistance of the sensor are 17.6 pF and 2.5×10^{10} Ω respectively. Connections from the transducer are taken to a voltage measuring device through a coaxial cable having a shunt capacitance of 10 pF. The input resistance and the input capacitance of the measuring device are 100 MΩ and 20 pF respectively. Calculate the sinusoidal steady state gain of the system in mV/N at 450 Hz.

At the lower frequency limit of the arrangement, the gain of the system saturates to within 5% of the maximum gain. In what

manner, and what value of a capacitance can be inserted into the arrangement to make the lower frequency limit one-hundredth of its present value? To what extent the voltage sensitivity is sacrificed? 18+7
Derive the expressions used.

3. (a) With reference to any appropriate transducer, bring out clearly the implication of using synchronous demodulation arrangement for transducers. Give suitable illustrations and explanations. 10

(b) 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

(c) Indicate clearly the advantages of Rogowski coil (with integrator) over conventional CTs with ferromagnetic core. 7

4. (a) Explain with neat sketch the principle of non-destructive eddy current testing method. What are the different types of sensors used in this testing? Point out the limitations of the eddy current testing method. 10

(b) Explain the effect of orientation of defects in magnetic particle testing. 5

(c) How is the angle beam ultrasonic transducer used to detect flaw in the test object? 5

(d) What are prods, and where are they used? 5

5. (a) Explain the differences between the step-index and the graded-index optical fibres. Bring out clearly the meaning and the significance of absorption and bending losses related to optical fibres. What is wave division multiplexing? 5+8+5

(b) What is 'MODBUS' ? point out the Query and Response message format of MODBUS. 7

6. Write short notes on any TWO of the following. 12 ½ +12 ½

(a) Liquid Inspection Testing
(b) Radiographic testing
(c) Shunt linearization arrangement for NTC thermistor