Ref. No.: Ex/IEE/PC/B/T/313/2024

B.I.E.E Third Year First Semester Examination 2024

Time: **3 hours** Subject: **Process Instrumentation** Full Marks: **100**

- Each module is associated with a course outcome.
- Answer all modules.
- Choices if provided, are limited to questions within a module.

Module A: Answer Question 1 and any TWO from the rest.
Coverage: Course Outcome 1

Question	Marks
1a. State two applications of level measurement.	5
1b. Distinguish between: • Direct and Inferential level measurement techniques. • Level and Interface measurement.	3 + 3
2. Describe the construction and operating principle of a magnetostrictive level sensor. Do changes in liquid density affect the measurement accuracy of this sensor?	7
3. Explain the principle of operation of an Ultrasonic level sensor. What are the main sources of error associated with this sensor?	7
4. Describe a capacitive level sensor, designed to measure the level of a conducting liquid within a spherical metallic tank and produce an output that varies linearly with the liquid level. Derive a mathematical equation that relates the sensor output to the tank level. What is the primary source of error of this sensor?	7

Module B: Answer all questions. Coverage: Course Outcome 2

5. Describe the necessity of cold junction compensation in a thermocouple-based temperature measurement system. How can it be implemented by software-based techniques?	4 + 5

Question	Marks
6. Draw and explain circuit configurations that use a voltage source excitation, and produce an output that varies linearly with changes in the resistance of a **a.** 3-wire RTD. **b.** 4-wire RTD. Examine the comparative merits and drawbacks of these circuit configurations.	7 3
7. Why are temperature sensors commonly placed within a thermowell? What are the drawbacks associated with the use of thermowells?	5
Module C: Answer Question 8 and any TWO from the rest. Coverage: Course Outcome 3	
8a. Define flowmeter Rangeability / Turndown. **b.** Explain the necessity of a specified length of straight pipe upstream and downstream of some volumetric flowmeters. **c.** Distinguish between cavitation and flashing phenomena in the context of liquid flow through a constriction.	2 3 5
9. Describe the operating principle of a transit-time ultrasonic flowmeter. Explain how the output can be made independent of the velocity of sound in the flowing medium.	8
10. Explain the principle of operation of a vortex-shedding flowmeter. What is the K Factor of a vortex flowmeter?	8
11. Describe how the various noise voltages (non-flow related voltages) detected by the electrodes of an electromagnetic flowmeter are effectively rejected.	8

Question	Marks
Module D: Answer any FIVE questions. Coverage: Course Outcome 4	
12. State if the following statements are true or false. Justify your answer. a. Smart transmitters are more accurate than analog electronic transmitters. b. Re-ranging analog transmitters is much easier than re-ranging smart transmitters. c. Indicators on analog transmitters can display the value of the measured variable in the desired engineering units. d. In the HART protocol, the digital transmission provides faster updates of the measured variable than the analog transmission. e. HART protocol allows multiple transmitters to be connected to the host system with a much lesser length of cable. f. In HART protocol the same pair of cables are used for digital and analog communication and also for carrying the transmitter power supply. g. HART protocol uses all the layers of the ISO, OSI reference model.	$5 \times 5 = 25$