

B.E. / B.Tech. - DEGREE EXAMINATIONS, NOV / DEC 2025

Third Semester

Instrumentation and Control Engineering

24IXPC301 - SENSORS TRANSDUCERS AND ACTUATORS

Regulations - 2024

Duration: 3 Hours

Max. Marks: 100

PART - A (MCQ) (10 × 1 = 10 Marks)

Answer ALL Questions

	<i>Marks</i>	<i>K- Level</i>	<i>CO</i>
1. A parallax error in reading an analog scale is an example of: (a) Instrumental Error (b) Observational Error (c) Environmental Error (d) Gross Error	1	K1	CO1
2. Which of the following is not typically a function of a transmitter in industrial measurement systems? (a) Amplifying signals (b) Converting signals to standard formats (c) Detecting physical parameters directly (d) Filtering and linearization	1	K1	CO1
3. In an RTD-based temperature measurement chain, the RTD acts as: (a) A transmitter only (b) A sensor alone or as part of a transducer (c) A transducer only (d) A wireless communication device	1	K1	CO2
4. Which method provides the most accurate evaluation of a transducer's linearity by minimizing bias from local variations? (a) End-point method (b) Best-fit straight line method (c) Zero adjustment method (d) Two-point calibration method	1	K1	CO2
5. The main advantage of Constant Temperature Anemometer (CTA) over CCA is: (a) Simpler circuit (b) Lower cost (c) Faster response and higher accuracy (d) Independence from calibration	1	K1	CO3
6. The resistance of a strain gauge changes mainly due to: (a) Temperature only (b) Change in length and area under strain (c) Magnetic field effect (d) Chemical reaction on the wire	1	K1	CO3
7. Which of the following is a limitation of Variable Reluctance devices? (a) High cost due to permanent magnets (b) Sensitive to dust and temperature (c) Non-linear characteristics and signal distortion at high frequencies (d) Inability to detect ferromagnetic objects	1	K1	CO4
8. The sliding contact and calibrated dial in an induction potentiometer are used to: (a) Adjust resistance of the circuit (b) Vary magnitude and phase of induced e.m.f. (c) Control excitation frequency (d) Reduce stray magnetic effects	1	K1	CO4
9. Output impedance of capacitive transducers is generally: (a) Very low (b) Moderate (c) Very high (10 ⁶ -10 ⁸ Ω) (d) Zero	1	K1	CO5
10. Hydraulic actuators are based on: (a) Gas laws (b) Ohm's law (c) Pascal's law (d) Faraday law	1	K1	CO6

PART - B (12 × 2 = 24 Marks)

Answer ALL Questions

11. Illustrate an environmental error affecting sensor performance.	2	K2	CO1
12. Develop a flow chart to organize different causes of gross errors in instrumentation.	2	K2	CO1
13. A displacement sensor with sensitivity 0.5 V/mm shows a reading of 3.5 V. Determine the measured displacement.	2	K2	CO2
14. Demonstrate the relationship between column height and applied pressure in a U-tube manometer using the hydrostatic principle.	2	K2	CO2

- | | | | |
|--|---|----|-----|
| 15. A resistive potentiometer of total resistance 10 k Ω and track length 50 mm is used as a displacement transducer. If a slider moves by 20 mm from one end and the supply voltage is 10 V, calculate the output voltage across the slider. | 2 | K2 | CO3 |
| 16. Illustrate one reason why platinum is widely used in RTDs. | 2 | K2 | CO3 |
| 17. Explain the key advantages of using an LVDT for precise linear position sensing. | 2 | K2 | CO4 |
| 18. Explain how the induced e.m.f. in an induction potentiometer is proportional to the dial angle. | 2 | K2 | CO4 |
| 19. Illustrate scenarios where capacitive proximity sensors outperform others. | 2 | K2 | CO5 |
| 20. Demonstrate how touch-mode improves sensor linearity & robustness. | 2 | K2 | CO5 |
| 21. Construct practical examples to show how logical and continuous actuators operate under different control conditions. | 2 | K2 | CO6 |
| 22. Illustrate two real-time industrial applications where pneumatic actuators are preferred. | 2 | K2 | CO6 |

PART - C (6 \times 11 = 66 Marks)

Answer ALL Questions

- | | | | |
|--|----|----|-----|
| 23. a) Apply the concept of standardization to demonstrate how international standards ensure measurement consistency across industries. | 11 | K3 | CO1 |
|--|----|----|-----|

OR

- | | | | |
|---|----|----|-----|
| b) Construct the procedure of static calibration and justify its role in maintaining precision in high-accuracy industries. | 11 | K3 | CO1 |
|---|----|----|-----|

- | | | | |
|---|---|----|-----|
| 24. a) (i) A load cell is tested by applying 50 N repeatedly under identical conditions. The recorded outputs are: 1.502 V, 1.498 V, 1.501 V, 1.499 V, 1.500 V. | 6 | K3 | CO2 |
|---|---|----|-----|

Tasks:

(a) Calculate the mean output voltage.

(b) Determine the repeatability index using the range method.

(c) Comment on whether the instrument meets the manufacturer's specification of ≤ 0.005 V repeatability deviation.

- | | | | |
|--|---|----|-----|
| (ii) Organize the components of an instrumentation system to differentiate between the functions of a sensor, transducer, and transmitter. | 5 | K3 | CO2 |
|--|---|----|-----|

OR

- | | | | |
|---|---|----|-----|
| b) (i) Apply the concept of second-order system dynamics to show how damping ratio (ζ) and natural frequency (ω_n) affect peak time, overshoot, and settling time. | 6 | K3 | CO2 |
|---|---|----|-----|

- | | | | |
|--|---|----|-----|
| (ii) Make use of real-world measurement scenarios to explain the influence of environmental and system parameters on accuracy. | 5 | K3 | CO2 |
|--|---|----|-----|

- | | | | |
|--|----|----|-----|
| 25. a) Utilize circuit analysis methods to explain the loading effect in potentiometer transducers and construct a plot showing the relationship between Rp/Rm ratio and percentage error. | 11 | K3 | CO3 |
|--|----|----|-----|

OR

- | | | | |
|--|----|----|-----|
| b) Develop a labeled diagram to illustrate the components of a hot-wire anemometer and interpret the role of each part—sensing wire, probe setup, and Wheatstone bridge in determining air velocity. | 11 | K3 | CO3 |
|--|----|----|-----|

- | | | | |
|--|----|----|-----|
| 26. a) Relate the operating principles of variable reluctance devices to their practical applications, and analyze their current advantages and limitations with future prospects. | 11 | K2 | CO4 |
|--|----|----|-----|

OR

- | | | | |
|---|----|----|-----|
| b) Infer the functional role of various constructional elements of an LVDT when employed as a secondary transducer. | 11 | K2 | CO4 |
|---|----|----|-----|

27. a) Utilize the capacitance formula to analyze the influence of distance variation on sensor output characteristics. 11 K3 CO5
- OR**
- b) Apply knowledge of pressure measurement principles to identify industrial processes where capacitive pressure sensors can enhance performance and accuracy. 11 K3 CO5
28. a) Develop a case-based explanation to show the integration of electro-pneumatic actuators in industrial control systems. 11 K3 CO6
- OR**
- b) Apply Pascal's law to explain how double-acting hydraulic cylinders achieve high force output during both extension and retraction. 11 K3 CO6