Total No. of Questions: 6 *Total No. of Printed Pages:3*

Enrollment No.....

Faculty of Engineering
End Sem Examination Dec-2023
RA3CO27 Sensors & Instrumentation

Programme: B.Tech. Branch/Specialisation: RA

Duration: 3 Hrs. **Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d. Assume suitable data if necessary. Notations and symbols have their usual meaning.

Q.1 i. How can sensors be classified based on their working principles? **1**
(a) Temperature sensors and humidity sensors
(b) Passive sensors and active sensors
(c) Mechanical sensors and electrical sensors
(d) Sensors and transducers

ii. A variable flow meter (rotameter) ranges 1-10 LPM with an accuracy of 10% of full scale. The percentage of error will be- **1**
(a) Increase from the minimum value to the maximum value
(b) Decrease from the minimum value to the maximum value
(c) Remains constant across the range
(d) May increase or decrease depending on temperature

iii. Infrared camera is used for- **1**
(a) Measurement of pressure (b) Measurement of viscosity
(c) Measurement of temperature (d) Measurement of velocity

iv. What is the primary principle of operation of an ultrasound-level sensor? **1**
(a) Measurement of sound wave propagation in air
(b) Measurement of the Doppler shift in ultrasound waves
(c) Measurement of fluid viscosity
(d) Measurement of time-of-flight of ultrasound waves

v. What is the key component of virtual instrumentation? **1**
(a) Physical instruments (b) Hardware only
(c) Software (d) Measurement units

vi. LabVIEW is- **1**
(a) Text-based programming technique
(b) Graphical programming technique
(c) High level programming technique
(d) None of these

vii. How is DAC resolution typically measured? **1**
(a) In hertz (Hz) (b) In ohms (Ω)
(c) In volts (V) (d) In bits (e.g., 8-bit, 12-bit)

viii. In an 8-bit ADC, what is the maximum number of discrete digital values it can represent? **1**
(a) 16 (b) 64 (c) 128 (d) 256

ix. Which of the following is not a common component of a smart sensor? **1**
(a) Actuator (b) Signal conditioner
(c) Transducer (d) Microcontroller

x. In the context of smart sensors, what does "self-calibration" mean? **1**
(a) The sensor can automatically adjust its accuracy
(b) The sensor can communicate its calibration data
(c) The sensor must be calibrated by an external device regularly
(d) The sensor can only be calibrated once during its lifetime

Q.2 i. What is the basic principle of operation of a potentiometer? **2**

ii. Explain the principle of operation of an LVDT, its construction, and the factors that affect its performance. What are the common applications where LVDTs are utilized? **8**

OR iii. Describe the classification of sensors based on their working principles and provide examples of each type. **8**

Q.3 i. Describe the principle of working of the Hall effect sensor with the help of diagram. **3**

ii. Describe the construction, theory and working of thermocouples. Explain how it is different from RTD. **7**

OR iii. Describe the methods of measurements of flow with the use of ultrasound flow sensor with the help of neat diagram. **7**

Q.4 i. Explain the architecture of Virtual Instruments with the help of a diagram. **3**

ii. Explain the "for loops" and "while loops" with the help of flow chart. When and how it can be used one over another? **7**

OR iii. Write the differences between the graphical programming technique and text-based programming technique **7**

Q.5 i. An 8-bit R2R ladder DAC with a reference voltage of 5 volts (V_{ref}). Calculate the analog output voltage for the digital input 11011010 (in binary). **2**

ii. Explain the binary-weighted resistor and R-2R ladder type of DAC with the help of a neat diagram. **8**

OR iii. Draw a basic block diagram of a data acquisition system. What are the main components and their interconnections in the diagram? Briefly explain the function of each component. **8**

Q.6 Attempt any two:

i. What is the general structure of a smart sensor? What are its main components? **5**

ii. Define "self-communicating" in the context of smart sensors and provide an example of its application. **5**

iii. How are smart sensors used in automatic robot control? What advantages do they offer in this application? **5**

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Marking Scheme

RA3CO27 (T)- Sensors & Instrumentation

Q.1	i)	How can sensors be classified based on their working principles? b) Passive sensors and active sensors.	**1**
	ii)	A variable flow meter (rotameter) ranges 1-10 lpm with an accuracy of 10% of full scale. The percentage of error will be b) decrease from the minimum value to the maximum value	**1**
	iii)	Infrared camera is used for (c) measurement of temperature	**1**
	iv)	What is the primary principle of operation of an ultrasound-level sensor? d) Measurement of time-of-flight of ultrasound waves.	**1**
	v)	What is the key component of virtual instrumentation? c) Software	**1**
	vi)	LabVIEW is (b) graphical programming technique	**1**
	vii)	How is DAC resolution typically measured? d) In bits (e.g., 8-bit, 12-bit)	**1**
	viii)	In an 8-bit ADC, what is the maximum number of discrete digital values it can represent? d) 256	**1**
	ix)	Which of the following is not a common component of a smart sensor? a) Actuator	**1**
	x)	In the context of smart sensors, what does "self-calibration" mean? a) The sensor can automatically adjust its accuracy.	**1**
Q.2	i.	What is the basic principle of operation of a potentiometer? Description -2	**2**
	ii.	Explain the principle of operation of an LVDT, its construction, and the factors that affect its performance. What are the common applications where LVDTs are utilized? Principle of working -2 Construction (diagram) - Factors -2 Application -2	**8**
OR	iii.	Describe the classification of sensors based on their working principles and provide examples of each type. classification of sensors (each 1 mark) - 4 examples (each 1 mark) - 4	**8**
Q.3	i.	Describe the principle of working of the Hall effect sensor with the help of diagram. Principle of working -2 Diagram -1	**3**
	ii.	Describe the construction, theory and working of thermocouples. Explain how it is different from RTD. Construction (diagram) -1 Principle of working -2 Theory -2 Differences over RTD -2	**7**
OR	iii.	Describe the methods of measurements of flow with the use of ultrasound flow sensor with the help of neat diagram. Each Method (Transit time & Doppler effect) Principle -1 Working -2 Diagram -2 Application -2	**7**
Q.4	i.	Explain the architecture of Virtual Instruments with the help of a diagram. Diagram -1 Description -2	**3**
	ii.	Explain the "for loops" and "while loops" with the help of flow chart. When and how it can be used one over another? Description (each 1 mark) -2 Explanation with Flow chart (each 2 mark) -4 Advantages -1	**7**
OR	iii.	Write the differences between the graphical programming technique and text-based programming technique Differences with examples (1 mark each) -7	**7**
Q.5	i.	An 8-bit R2R ladder DAC with a reference voltage of 5 volts (V_{ref}). Calculate the analog output voltage for the digital input 11011010 (in binary). Formula -1 Calculation -1	**2**
	ii.	Explain the binary-weighted resistor and R-2R ladder type of DAC with the help of a neat diagram. Binary-weighted resistor: Circuit diagram -2 Method -2 R-2R ladder: Circuit diagram -2 Method -2	**8**

OR	iii.	Draw a basic block diagram of a data acquisition system. What are the main components and their interconnections in the diagram? Briefly explain the function of each component. Diagram -2 Component (each 1 mark) -6	**8**
Q.6		Attempt any two:	
	i.	What is the general structure of a smart sensor, and what are its main components? Description with block diagram -2 Components (each 1 mark) -3	**5**
	ii.	Define "self-communicating" in the context of smart sensors and provide an example of its application. Description with diagram -2 Examples (each 1 mark) -3	**5**
OR	iii.	How are smart sensors used in automatic robot control, and what advantages do they offer in this application? Uses in automatic robot control -3 Advantages -2	**5**

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