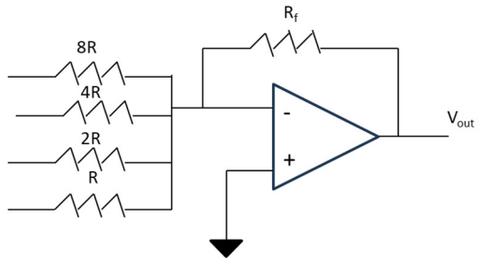
q.5	i.	A 4-bit Weighted Resistor DAC with resistor values of R, 2R, 4R, and 8R ohms, where R is a reference resistor value of 1 kΩ (1000 ohms) shown in figure below-  Calculate the analog output voltage for the binary input "1101."	**3**	3	4	2
	ii.	Explain the principles of operation of Digital to Analog Converters (DAC) with the help of the example. Explain the binary-weighted resistor and R-2R ladder type of DAC type with the help of a circuit diagram.	**7**	2	4	3
OR	iii.	Explain the principles of operation of Analog to Digital Converters (ADC) with the help of the example. Explain the successive approximation and sigma-delta type of ADC with the help of a circuit diagram.	**7**	2	4	3
Q.6		Attempt any two:				
	i.	Describe the concept of self-communication in smart sensors and give an example of its practical application.	**5**	2	5	1
	ii.	Discuss in detail the characteristics of smart sensors, including self-calibration, self-testing, and self-communication, and provide examples of how these characteristics improve sensor functionality.	**5**	2	5	1
	iii.	Write the applications of smart sensors in both automatic robot control and automobile engine control. Discuss the specific sensors used and the benefits they provide in these applications.	**5**	2	5	1

******

Total No. of Questions: 6 *Total No. of Printed Pages:4*

Enrollment No.....

Faculty of Engineering
End Sem Examination Dec 2024
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.

			Marks	BL	CO	PO	PSO
Q.1	i.	What is the primary function of the sensor? (a) To convert electric energy to physical quantity (b) To convert physical quantity to electric energy (c) To interchange electric energy to physical quantity (d) To store electric energy	**1**	1	1	1	
	ii.	In a potentiometer, how is the resistance varied to measure a physical quantity like displacement or position? (a) By changing the material of the potentiometer (b) By adjusting the input voltage (c) By positioning the slider along the resistive element (d) By altering the ambient temperature	**1**	1	1	1	
	iii.	What is the use of RTD? (a) Measuring density (b) Measuring viscosity (c) Measuring temperature (d) Measuring pressure	**1**	1	2	1	
	iv.	In which application is a laser flow sensor commonly used? (a) Monitoring fluid level in tanks (b) Measuring gas pressure (c) Measuring air temperature (d) Measuring fluid flow rates	**1**	1	2	1	

v.	In virtual instrumentation, what is meant by "Reconfigurability"? (a) The ability to replace virtual instruments with physical ones (b) The ability to adapt to changes in the physical environment (c) The capacity to switch between different operating systems (d) The process of converting analog signals to digital format	**1**	1	3	1
vi.	Which graphical programming language is commonly used for data analysis and visualization? (a) Python (b) C++ (c) Scratch (d) LabVIEW	**1**	1	3	1
vii.	What is the need for a quantizer in digital communications? (a) Break up a sampled signal to a finite dataset (b) Sample a pure analog signal (c) Sample a digital signal (d) Encode an analog signal	**1**	1	4	1
viii.	The resolution of the 3-bit DAC and the reference voltage is 5 V given by (a) 5/8 (b) 5/6 (c) 6/5 (d) None of these	**1**	1	4	2
ix.	Which component of smart sensor converts a physical parameter into an electrical signal? (a) Microcontroller (b) Transducer (c) Signal conditioner (d) Communication interface data	**1**	1	5	1
x.	The microcontroller in a smart sensor is primarily responsible for: (a) Communicating with other sensors (b) Storing historical sensor (c) Processing and decision-making based on sensor data (d) Calibrating the sensor periodically	**1**	1	5	1
Q.2 i.	Explain the working principle of the resistance strain gauge with the help of neat diagram.	**3**	2	1	1
ii.	Explain the factors and considerations involved in selecting a sensor or transducer. Why is it crucial to choose the right sensor?	**7**	2	1	1

OR	iii.	Describe the construction, principle of working and application of the Linear Variable Differential Transformer (LVDT). What are the key advantages and disadvantages of using this type of displacement sensor in various engineering and industrial applications?	**7**	2	1	1
Q.3	i.	A spring balance is calibrated in an environment at a temperature of 20 ºC shown in Table 1 and then used in an environment at a temperature of 30 ºC shown in Table 2-	**2**	3	2	2

Table 1

Load (kg)	0	1	2	3	
Deflection (mm)	0	20	40	60	

Table 2

Load kg	0	1	2	3
Deflection (mm)	5	27	49	71

Determine zero drift and sensitivity drift per degree C change in ambient temperature.

	ii.	Explain the principle and working of the ultrasound flow sensor based on the transit time and the doppler effect. Also, write its applications.	**8**	2	2	1
OR	iii.	Explain the concept of thermal imaging. What is the role of emissivity in thermal imaging and how the measurement by infrared (IR) camera is different from the thermocouples?	**8**	4	2	1
Q.4	i.	What is Virtual Instrumentation (VI)? Write the advantages of Virtual Instrumentation (VI) over traditional instrumentation.	**4**	4	3	1
	ii.	Explain the use of "for loops" in the context of virtual instrumentation. Provide examples of how these loops can be employed to control and automate data acquisition and processing in virtual instrument applications.	**6**	2	3	5
OR	iii.	Explain the use of "While loops" in the context of virtual instrumentation. Provide examples of how these loops can be employed to control and automate data acquisition and processing in virtual instrument applications.	**6**	2	3	5

Marking Scheme
RA3CO27 (T) Sensors & Instrumentation (T)

Q.1 i) (a) To convert electric energy to physical quantity **1**

ii) (c) By positioning the slider along the resistive element. **1**

iii) (c) measuring temperature **1**

iv) (d) Measuring fluid flow rates. **1**

v) (b) The ability to adapt to changes in the physical environment **1**

vi) (d) LabVIEW **1**

vii) (a) Break up a sampled signal to a finite dataset **1**

viii) (a) 5/8 **1**

ix) (b) Transducer **1**

x) (c) Processing and decision-making based on sensor data **1**

Q.2 i. Explain the working principle of the resistance strain gauge with the help of neat diagram. **3**

Diagram -1 Mark

Description -2 Marks

ii. Explain the factors and considerations involved in selecting a sensor or transducer. Why is it crucial to choose the right sensor? **7**

Description: factors and considerations - 5 Marks

Reasoning: Why is it crucial to choose the right sensor -2 Marks

OR iii. Describe the construction, principle of working and application of the Linear Variable Differential Transformer (LVDT). what are the key advantages and disadvantages of using this type of displacement sensor in various engineering and industrial applications? **7**

Construction (diagram) - 1 Mark

Principle of working - 2 Marks

Application - 2 Marks

Advantage and disadvantage - 2 Marks

Q.3 i. A spring balance is calibrated in an environment at a temperature of 20 ^{0}C shown in Table 1 and then used in an environment at a temperature of 30 ^{0}C shown in Table 2 **2**

Table 1

Load kg	0	1	2	3
Deflection mm	0	20	40	60

Table 2

Load kg	0	1	2	3
Deflection mm	5	27	49	71

Determine zero drift and sensitivity drift per ^{0}C change in ambient temperature.

Calculation (Zero drift) - 1 Mark

Calculation (sensitivity drift) - 1 Mark

ii. Explain the principle and working of the ultrasound flow sensor based on the Transit time and the Doppler effect Also, write its applications **8**

Transit time:

Principle - 1 Mark

Working - 1 Mark

Diagram - 1 Mark

Application - 1 Mark

Doppler effect:

Principle - 1 Mark

Working - 1 Mark

Diagram - 1 Mark

Application - 1 Mark

OR iii. Explain the concept of thermal imaging. What is the role of emissivity in thermal imaging and how the measurement by infrared (IR) camera is different from the thermocouples? **8**

Description: concept of thermal imaging - 3 Marks

Role of emissivity - 2 Marks

Differences IR camera and thermocouples (each 1 marks) -3 Marks

Q.4 i. What is Virtual Instrumentation? Write the advantages of Virtual Instrumentation (VI) over Traditional instrumentation. **4**

Description of VI - 1 Mark
Advantages of VI - 3 Marks

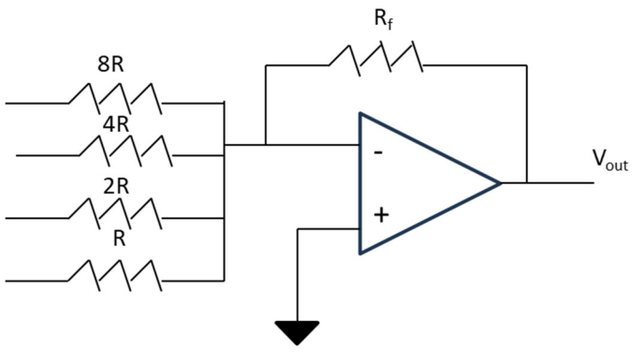
ii. Explain the use of "for loops" in the context of virtual instrumentation. Provide examples of how these loops can be employed to control and automate data acquisition and processing in virtual instrument applications **6**

Description - 1 Mark
Explanation with Flow chart - 3 Marks
Examples - 2 Marks

OR iii. Explain the use of "while loops" in the context of virtual instrumentation. Provide examples of how these loops can be employed to control and automate data acquisition and processing in virtual instrument applications **6**

Description - 1 Mark
Explanation with Flow chart - 3 Marks
Examples - 2 Marks

Q.5 i. A 4-bit Weighted Resistor DAC with resistor values of R, 2R, 4R, and 8R ohms, where R is a reference resistor value of 1 kΩ (1000 ohms) shown in figure below. **3**



Calculate the analog output voltage for the binary input "1101."

Method (formula) - 1 Mark
Calculation - 2 Marks

ii. Explain the principles of operation of Digital to Analog Converters (DAC) with the help of the example. Explain the binary-weighted resistor and R-2R ladder type of DAC type with the help of a circuit diagram. **7**

Short description with example - 1 Mark
Binary-weighted resistor:
Circuit diagram - 1 Mark
Method - 2 Marks
R-2R ladder:
Circuit diagram - 1 Mark
Method - 2 Marks

OR iii. Explain the principles of operation of Analog to Digital Converters (ADC) with the help of the example. Explain the successive approximation and sigma-delta type of ADC with the help of a circuit diagram. **7**

Short description with example - 1 Mark
Successive approximation:
Circuit diagram - 1 Mark
Method - 2 Marks
Sigma-delta:
Circuit diagram - 1 Mark
Method - 2 Marks

Q.6 Attempt any two:

i. Describe the concept of self-communication in smart sensors and give an example of its practical application. **5**

Description with block diagram - 2 Marks
Examples (each 1 mark) - 3 Marks

ii. Discuss in detail the characteristics of smart sensors, including self-calibration, self-testing, and self-communication, and provide examples of how these characteristics improve sensor functionality. **5**

self-calibration - 1 Mark
self-testing - 1 Mark
self-communication - 1 Mark
examples - 2 Marks

iii. Write the applications of smart sensors in both automatic robot control and automobile engine control. Discuss the specific sensors used and the benefits they provide in these applications. **5**

automatic robot control - 1.5 Mark
automobile engine control - 1.5 Mark
sensor used in both the application - 2 Marks

[2]

******

[3]

P.T.O.