

Code : 041706

B.Tech 7th Semester Exam., 2020

INTELLIGENT INSTRUMENTATION

Time : 3 hours

Full Marks : 70

Instructions :

- (i) The marks are indicated in the right-hand margin.
- (ii) There are **SEVEN** questions in this paper.
- (iii) Attempt **FIVE** questions in all.
- (iv) Question No. 1 is compulsory.

1. Choose the correct option (any seven) : 2×7=14

(a) Which of the following statements is correct?

- (i) Sensors and actuators are both examples of transducers
- (ii) Actuators and transducers are both examples of sensors
- (iii) Sensors and transducers are both examples of actuators
- (iv) All of the above

(b) A piezo-electrical crystal generates voltage when subjected to ____ force.

- (i) electrical
- (ii) mechanical
- (iii) gravitational
- (iv) All of the above

(c) What happens to the density of air with increase in humidity?

- (i) Increases
- (ii) Decreases
- (iii) No effect
- (iv) Density is linked to many other parameters and cannot be predicted

(d) The sensors are classified on the basis of

- (i) functions
- (ii) performance
- (iii) output
- (iv) All of the above

(e) Input signal to smart sensor is fed from

- (i) power supply
- (ii) transducer
- (iii) voltmeter
- (iv) All of the above

- (f) _____ handle mathematical operations necessary to deliver the output signal.
- (i) Small sensors
 - (ii) Mat sensors
 - (iii) Soft sensors
 - (iv) Super sensors
- (g) CMRR is more in
- (i) single-ended amplifier
 - (ii) differential amplifier
 - (iii) inverting operational amplifier
 - (iv) chopper amplifier
- (h) _____ is the ability of the sensor to indicate the same output over a period of time for a constant input.
- (i) Stability
 - (ii) Resolution
 - (iii) Error
 - (iv) Impedance
- (i) Which of the following statements is correct?
- (i) Velocity can be determined using a position transducer by integrating its output signal

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- (ii) Velocity can be determined using a position transducer by differentiating its output signal
 - (iii) Integration tends to amplify high-frequency noise present in a signal
 - (iv) None of the above
- (j) Output of smart sensors will be
- (i) analog
 - (ii) digital
 - (iii) analog and digital
 - (iv) None of the above
2. (a) What are the main components of intelligent instrumentation? Draw the block diagram of intelligent instrumentation and briefly explain its blocks.
- (b) Define sensitivity drift and zero drift. What factors can cause sensitivity drift and zero drift in instrument characteristics?
- An instrument is calibrated in an environment at a temperature of 20 °C and the following output

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(5)

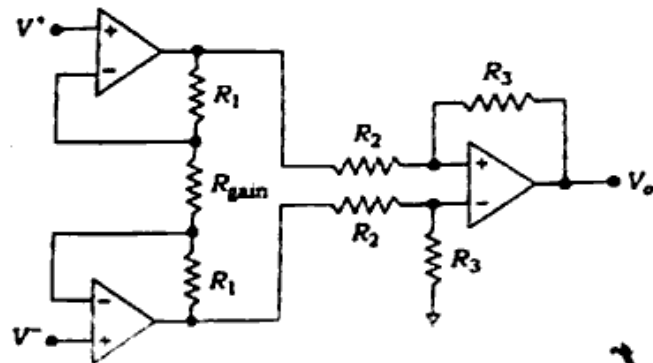
readings y are obtained for various input values x :

y	13.1	26.2	39.3	52.4	65.5	78.6
x	5	10	15	20	25	30

Determine the measurement sensitivity, expressed as the ratio y/x . 6+8

3. (a) What do you mean by segment-wise linearization? List the limitation of the segment-wise linearization technique. Discuss the point-to-point linearization technique with suitable diagram.

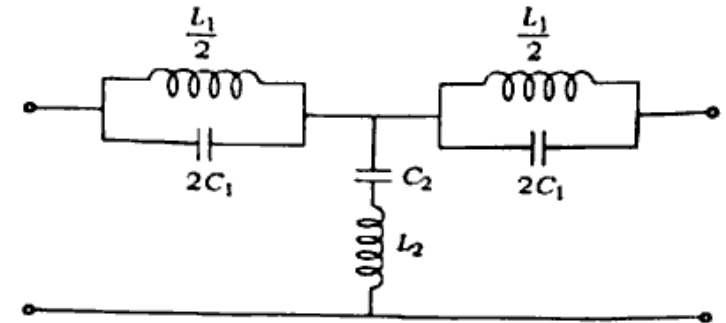
(b) Find out the expression for the differential gain of the instrumentation amplifier shown in the figure below :



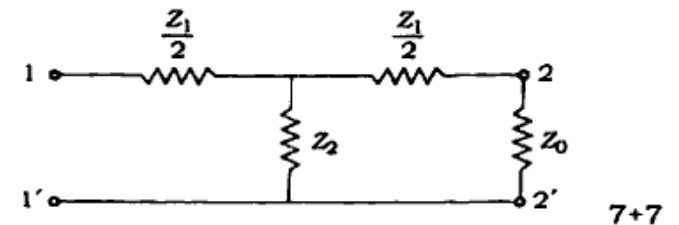
If $R_1 = 10 \text{ k}\Omega$, $R_2 = 5 \text{ k}\Omega$, $R_3 = 10 \text{ k}\Omega$ and $R_{\text{gain}} = 5 \text{ k}\Omega$, what is the gain of the instrumentation amplifier? 7+7

(6)

4. (a) What is a constant K filter? What type of filter is represented by following network? State the condition to make it work like a constant K filter :
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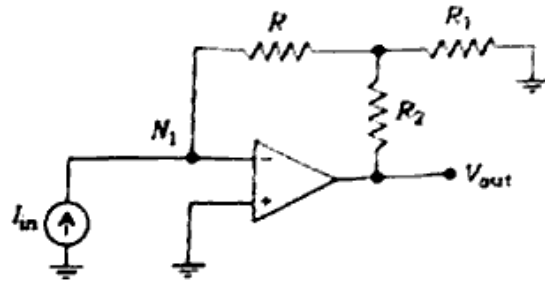


(b) Show that the characteristic impedance of following symmetrical T-section is given by $Z_0 = \sqrt{\frac{Z_1^2}{4} + Z_1 Z_0}$:

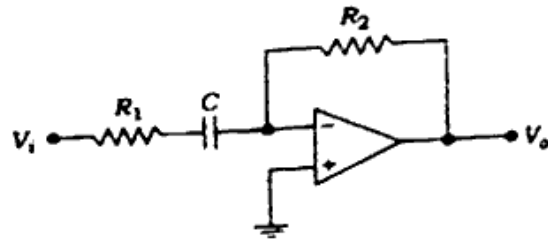


(7)

5. (a) Find the output voltage of the following OPAMP circuit :



- (b) The following circuit is a high-pass filter :



- (i) Derive the voltage transfer function V_o / V_i .
- (ii) What is the voltage gain at low and at high frequencies? 6+8
6. (a) Draw the basic structure of a digital to analogue converter and explain its working. Discuss the adder converter circuit and state the advantages and disadvantages of the same.

(Turn Over)

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(8)

- (b) Explain the working principle of a counter A/D converter with suitable block diagram. If a 1 MHz clock is connected to a 10 bit counter-type ADC operating in the range ± 10 V, what is (i) the maximum conversion time and (ii) the time to convert $+ 5.1$ V?

- (c) What do you understand by aperture or window time? Suggest a method to overcome the problem of ADC input signal uncertainty and explain its working principle with the help of a suitable diagram. 4+5+5

7. (a) In interfacing of sensor with computer clearly state the roles of (i) address decoding and (ii) data transfer control. Explain the BUSY, READY, ENABLE and ERROR control signals.
- (b) The binary code representation of a number is 110100011000. The first and last binary digits are sign and parity bits respectively, so only the middle ten digits are data bits. What are (i) the octal, (ii) the hexadecimal and (iii) the decimal data values?
- (c) Describe the basic issues of interfacing. Explain the RS-232 serial interface. How does the communication take place between two nodes with RS-232? 6+4+4

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