

[This question paper contains 6 printed pages.]

Your Roll No.

3211

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MEE

Paper – EE.552

Process Instrumentation and Control

Time : 3 Hours

Maximum Marks : 100

*(Write your Roll No. on the top immediately
on receipt of this question paper.)*

Question No. 1 is compulsory.

Answer any four from the remaining.

1. Answer the following questions in brief :
 - (a) What are two different types of input variables and output variables ? 2
 - (b) Distinguish between continuous and semi-continuous processes. 3
 - (c) Draw a feed-forward/feedback control strategy for liquid level control in a tank. Assume inlet flow rate in tank has small disturbance and outlet flow rate is manipulated variable. Also, draw the block diagram of scheme. 5
 - (d) Fig. 1 shows a heat exchanger control diagram. The objective is to maintain a desired cold stream outlet temperature.

[P. T. O.]

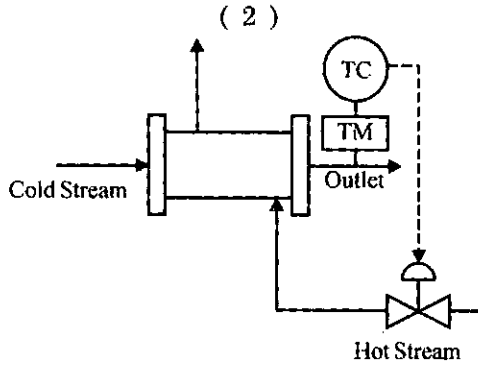


Fig. 1

Is the process gain relating the manipulated flow rate to the measured temperature positive or negative? Should the control valve be fail-open or fail-closed? Why?

- (e) The step response of a first order process is shown in Fig. 2.

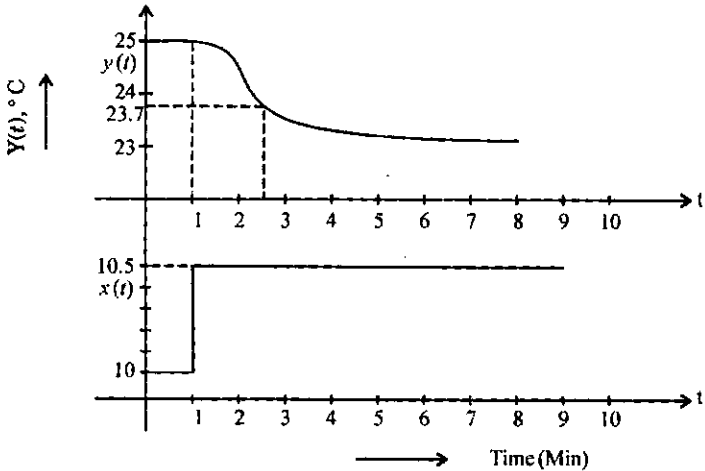


Fig. 2

Determine steady-state gain time constant and transfer function of this process. 5

2:1 (a) What is a cascade control ? Draw a control block diagram of cascade control and derive the closed loop transfer function relating a secondary disturbance to primary output for a cascade control. 10

(b) Draw a feedforward/feedback control of outlet temperature, where a fired furnace is used to heat a process fluid stream. The purpose of feedforward control is to immediately change the fuel gas flow rate, when a change in the process flow rate is sensed. Feedback controller manipulate the outlet temperature by manipulating the valve position of the fuel gas control valve. Fig. 3 shows the fired furnace without feedback/feedforward controllers. Draw a control block diagram of this process also. 10

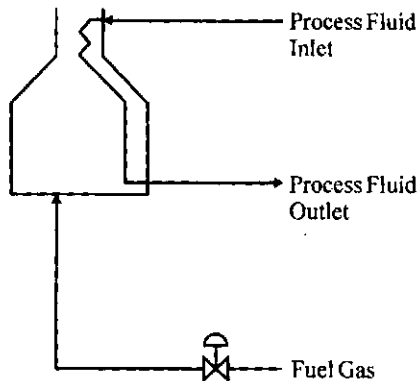


Fig. 3

3. (a) What is ratio control ? Give few processes name, where ratio control is used. Also, draw block diagrams for direct and indirect approach for ratio control. 10
- (b) Fig. 4 shows a block diagram, representing two first order processes in opposing modes :

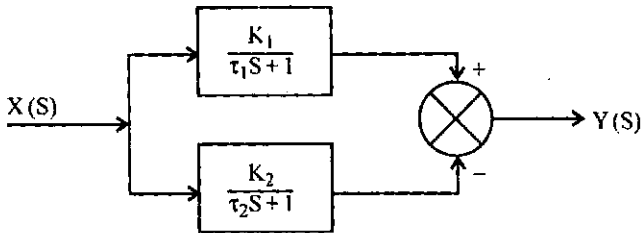


Fig. 4

Derive conditions for which, this system shows the inverse response. 10

4. (a) Draw a schematic diagram for two interacting processes and derive their overall transfer function. Comment on the nature of transfer function. 10
- (b) Fig. 5 shows the block diagram of two non-interacting processes. Determine the unit step response of the overall process.

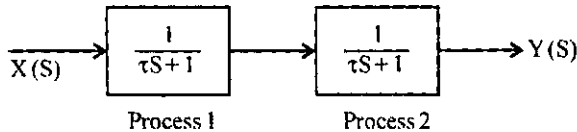


Fig. 5

Distinguish, the dynamic behaviour of this process from that of the interacting process. 10

5. (a) Fig. 6 shows a schematic diagram of a pneumatic controller, where bellow I is connected to the control pressure, p_c without any restriction and bellow II connected through a restriction. Assuming small deviation in error, e as input variable and change in control pressure p_c as output, show that the controller gives an integral control action. 10

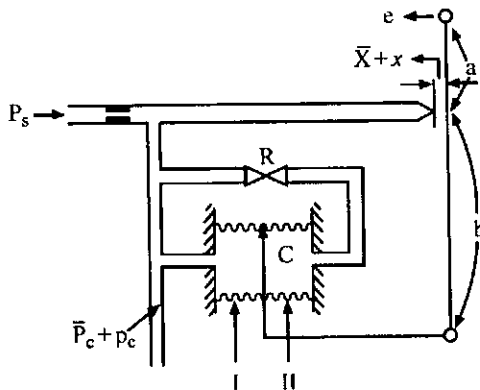


Fig. 6

- (b) Give a comparison between pneumatic and hydraulic systems. 10
6. (a) Distinguish between a metal strain gauge and semiconductor strain gauge and derive a relation for gauge factor in case of resistance strain gauge. 10
- (b) Under what conditions is a "dummy" strain gauge used, and what is the function of that gauge.

- The unstrained resistance of each of the four elements of the unbounded strain gauge in a wheatstone bridge is 120Ω . The strain gauge has a gauge factor of 3 and is subjected to a strain of 0.0001.
- Assuming, input voltage of bridge 10 V, calculate the output voltage of bridge. 10
7. (a) What are the materials used for manufacturing thermistors ? Describe the resistance-temperature, voltage-current and current time characteristics of a thermistor. 10
- (b) Discuss, whether a voltage transmitter or current transmitter is used in process industries. What is the standard range for the industrial transmitters ? Give a block diagram of closed loop differential pressure transmitters and explain its operating principle. 10
8. Write short notes on *any four* of the following :
- 4 × 5
- (i) Pressure transducer.
 - (ii) Flow transducer.
 - (iii) Controllers Tuning methods.
 - (iv) LVDT.
 - (v) Open loop transmitters.
 - (vi) Piezoelectric sensors.