Exam Date & Time: 04-May-2024 (02:30 PM - 05:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

MIT MPL - BTech VI Semester Chemical Engineering - End Semester Examination - Apr/May 2024

PROCESS DYNAMICS AND CONTROL [CHE 3252]

Marks: 50 **Duration: 180 mins.**

Descriptive

Answer all the questions.

* Answer all questions.
* Assume the missing data suitably.
* Write neatly and legibly.
* Give suitable examples wherever necessary.

1) List the selection criteria required for a sensor used in a process control loop. (2)

2) Brief about the properties of a transfer function. (3)

3) Solve and find y(t) for the following equation. (5)

$$\frac{d^2y}{dt^2} + 4y = 0$$

$$y(0) = 1,\ y'(0) = 3$$

4) Establish the time response for unit step change in input for a first order process described by the transfer function. (2)

$$G(s) = \frac{1}{\tau_p s + 1}$$

5) A thermometer is placed in a water bath kept at 50 °C and allowed to reach equilibrium. At time t = 0, it is quickly transferred to another bath kept at 60 °C, kept there for 12 seconds and returned to the bath at 50 °C. What will be the temperature indicated in thermometer at 5 seconds, 10 seconds and 15 seconds? The time constant is 7.5 seconds. (3)

6) Discuss the characteristics of underdamped response and plot the graph of overshoot % versus damping factor. (5)

7) State the need of valve positioner in a control valve. (2)

8) Compare proportional, integral and derivative action of a controller. (3)

9) Consider the general closed-loop block diagram with

$$G_c(s) = 1.6;\ G_p(s) = \frac{5}{(s+1)(2s+1)}\ ;\ G_f(s) = G_m(s) = 1$$

Suppose that the system is subject to a step change in set point with the input of magnitude 0.1. Determine: (5)

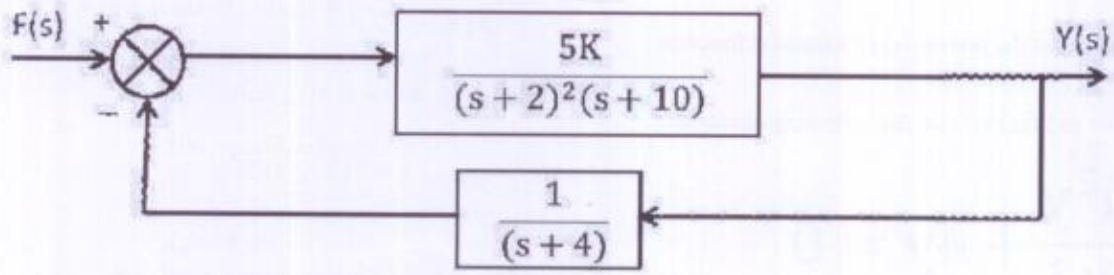
a) The maximum value of the response.

b) The period of the oscillation.

10) What conclusion can be drawn if two elements in the first column of the Routh array are negative? Explain with an example. (2)

11) Write the design procedure for tuning of a controller by process reaction curve method. (3)

12) Find value of K for the closed loop system to have a stable response.



(5)

13) Write a short note on feedforward control system. (2)

14) Discuss the advantages and disadvantages of a cascade control system. (3)

15)

$$G_{OL}(s) = \frac{K_c}{(5s+1)} e^{-2s}$$

For the given open loop transfer function

Calculate the following for a stable closed loop response, (5)

a. Maximum controller gain

b. Controller gain, if gain margin of 1.75 is used

c. Controller gain, if phase margin of 45 ° is used

If the dead time increases by 50 %, comment on the stability with controller gain obtained using gain margin and phase margin.

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