Exam Date & Time: 03-Jul-2023 (02:30 PM - 05:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

B. Tech in Chemical Engineering
VI Semester External Examination (Make Up)
June/July 2023

PROCESS DYNAMICS AND CONTROL [CHE 3252]

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

Descriptive Questions

Answer all the questions. Section Duration: 180 mins

1) List the objectives of Process Control in Chemical Industries. (2)

A)

B) Solve and find y(t) for the following equation

$$\frac{dy}{dt} + 2y = 12e^{3t}$$; given the initial condition $y(0) = 3.$ (4)

C) Why do we need mathematical modelling for a process control? (4)

2) Write short note on process gain and time constant of a process. (2)

A)

B) A thermometer showing steady state temperature of 37°C is suddenly immersed into a hot water bath at 120°C which follows first order dynamics (τ_P = 0.7 sec & K_P = 1). Determine the following (4)

a. Thermometer reading after 0.5 sec

b. Thermometer reading after 1.5 sec

C) Consider a second order system with the following transfer function

$$G(s) = \frac{10}{s^2+1.6s+4}$$ (4)

Find

a) overshoot percentage

b) rise time

c) period of oscillation

d) response time (±2 %)

3) Define Proportional Band and Reset time. (2)

A)

B) Discuss how the stability is affected for integral and derivative control? (4)

C) A closed loop control system has two first order systems in series with time constants of 1 and 2 min and gains of 3 and 5 respectively. Proportional control is used. For a servo problem determine, what value of K_c gives a damping coefficient of 0.707 for closed loop response? (4)

4) Brief about stability based on the roots of characteristic equation. (2)

A)

B) Check for stability by using Routh Hurwitz method for the following equation.

$$s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 10s + 16 = 0$$ (4)

C) What is meant by controller tuning in process control? (4)

5) Mention the importance of gain margin and phase margin in frequency response analysis. (2)

A)

B) Find the amplitude ratio and phase lag for different values of frequency to the transfer function $G(s) = \frac{5}{(s+1)(2s+1)(3s+1)}$ (4)

C) Briefly discuss about the cascade control system with a neat example. (4)

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