Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Sixth Semester B.Tech Degree Regular and Supplementary Examination July 2021

Course Code: CH302
Course Name: PROCESS DYNAMICS AND CONTROL

Max. Marks: 100 Duration: 3 Hours

Require normal & semilog graph sheet

PART A

Answer any two full questions, each carries 15 marks. Marks

1 a) Consider an exothermic first reaction occurring in a CSTR and reactor is provided with cooling jacket. Explain the concept of stable and unstable systems and the need of controller to stabilize the process. (8)

b) Solve $\frac{d^2x}{dt^2} + 2\frac{dx}{dt} + 2x = 2$ x(0)=x^1(0)=0 (7)

2 a) Sketch the function (8)

$$f(t) = (t-1)U(t-1) + 2\,U(t-1) - (t-3)U(t-3) - 4U(t-4)$$

and express the function the in s-domain.

b) A liquid level system has an external area of 5 m^2. The valve characteristic, flow –head relation is $= 10\sqrt{h}$. where q is the flow rate in m^3/min and h is the level in m. Calculate the time constant of this system if the operating level is (7)

a. 5 m b. 10 m.

3 a) i) Consider a mercury manometer with tube diameter 0.63 cm. Assuming the flow in the manometer to be laminar and steady. Determine a transfer function in standard second-order form between the applied pressure P_1 and manometer reading h. (15)

List a. Steady state gain

b. Time constant, τ

c. Damping factor, Ɛ (8)

ii) For this mercury manometer if the steady state pressure reading is 15.25cm and the applied pressure is suddenly increased to 20.32 cm. Length of the mercury column is 122 cm. What is the peak reading and at what time does it pass first 20.32 cm. The value of density and viscosity are 13.5 g/cm^3 and 0.016 g/cm. sec. (7)

PART B

Answer any two full questions, each carries 15 marks.

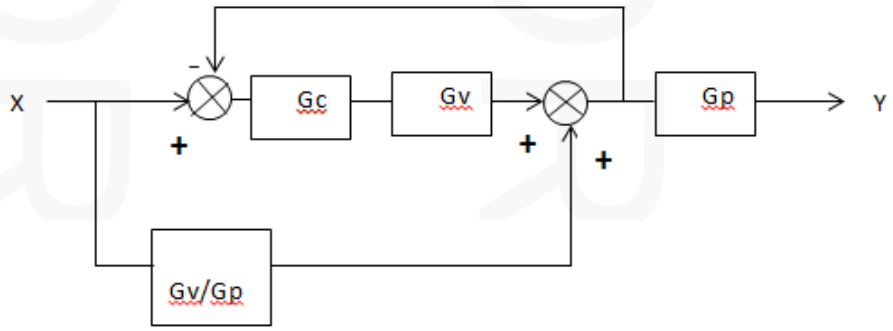
4 a) What are the different types of controllers used in the chemical industry to control the controlled variable. Obtain its transfer functions. (8)

Compare the response of a typical control system while using different mode of controllers. (5)

(3)

b) Obtain the response of unity feedback servo type system whose open loop transfer function is $G(s) = \frac{4}{s(s+5)}$ and when the input is unit step. (7)

5 a) (7)



Determine the transfer function Y(s)/X(s) for the block diagrams shown above. Express the result in terms of Gc, Gv and Gp.

b) Describe on the following (3)

i. Stability of the system

ii. Characterestic equation

iii. Routh stability criterion

c) Construct Routh array and determine the stability of the system represented by the characteristic equation, $9s^5 - 20s^4 + 10s^3 - s^2 - 9s - 10 = 0$. Comment on the location of roots of characteristic equation. (5)

6 a) A unity feedback control system has an open loop transfer function $G = \frac{K(s+2)}{s^2+2s+2}$. Sketch the root locus. (12)

b) Write the transfer function of transportation lag and discuss its effect on root locus diagram. (3)

PART C

Answer any two full questions, each carries 20 marks.

7 a) The open loop transfer function of a feedback system is given by $G(s) = \frac{(0.5s+1)e^{-0.1s}}{s(5s+1)}$. (15)

Sketch the Bode plot and using Bode stability criterion find the limiting value of K for stability. Also determine gain margin and phase margin.

b) Find out amplitude ratio and phase lag of dead time process by substitution rule. (5)

8 a) Sketch the Nyquist plot for the system whose open loop transfer function is (13)

$G(s) = \frac{K}{s(s+1)(s+2)}$. Find the range of K for stability.

b) Explain the process reaction curve method to determine the controller parameters of a feedback control system. (7)

9 a) Using Ziegler-Nichols tuning rules, determine the settings of PID controllers for a process whose open loop transfer function is given by (12)

$$G(s) = \frac{5\ e^{-0.2s}}{(s+1)(0.5s+1)}$$

b) Describe on Distributed Control System(DCS) and supervisory control and data acquisition (SCADA). (8)

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