Printed pages: 03 **Sub Code: NCH603**

Paper Id: 151612 **Roll No.** [redacted]

B. TECH.
(SEM-VI) THEORY EXAMINATION 2017-2018
PROCESS DYNAMICS AND CONTROL

Time: 3 Hours **Max. Marks: 100**

Note: Attempt all sections. If require any missing data; then choose suitably.

SECTION – A

1. Attempt all questions in brief. 2 x 10 = 20

a. What are the design elements of control system? Explain with examples
b. A model equation developed using first principles contain the term $C_v h^{3/2}$ where C_v is a constant and h is a variable. Express the linearized form in terms of deviation variable h'.
c. Solve the following linear differential equation using Laplace transforms.

$$\frac{d^2y}{dt^2} + \frac{dy}{dt} = t^2 + 2t \quad \text{with } y(0) = 4 \qquad y'(0) = -2$$

d. Describe the Nyquist stability criteria with important properties.
e. Define in physical terms the servo and regulator control problems.
f. Draw the flowchart of hierarchy of process control activities.
g. What are the difference between negative feedback and positive feedback system? Explain with the help of example.
h. What conclusion can be drawn if two elements in the first column of the Routh array are negative? Explain with the help of example.
i. Discuss the advantages and disadvantages of Cascade control.
j. Discuss the major steps involved in designing and installing a control system using the Model based approach.

SECTION - B

2. Attempt any **three** of the following. 10 x 3 = 30

a. Derive transfer function of single tank liquid level system. Draw a suitable figure.
b. A unit-step change in error is introduced into a PID controller. If $K_c = 10$, $\tau_I = 1$, and $\tau_D = 0.5$, plot the response of the controller, $P(t)$.
c. Discuss the characteristics of under damped response and plot the graph of overshoot and decay versus damping factor.
d. Discuss the graphical rules for Bode diagrams.
e. Explain with a neat sketch Feed-forward control action.

SECTION - C

3. Attempt any ***one*** of the following: 10 x 1 = 10

a. A thermometer having a time constant of 1 min is initially at 50 ˚C. It is immersed in a bath maintained at 100 ˚C at t = 0. Determine the temperature reading at t = 1.2 min.

b. Develop the mathematical model for the system shown in figure 1. What are the state variables for this system and what type of balance equations have you used? All the flow rates are volumetric, and the cross-sectional areas of the three tanks are A_1, A_2 and A_3 (ft^2), respectively. The flow rate F_5 is constant and does not depend on h_3, while all other effluent flow rates are proportional to the corresponding hydrostatic liquid pressures that cause the flow.

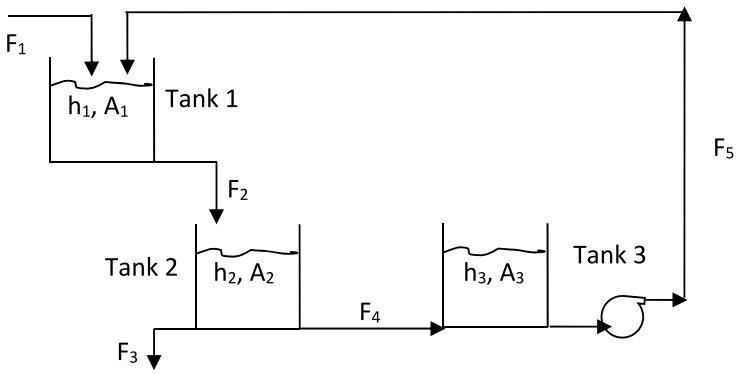


Figure 1

4. Attempt any one part of the following: 10 x 1 = 10

a. A step change of magnitude 4 is introduced into a system having the transfer function

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

Determine:

1) Percent overshoot
2) Rise Time
3) Maximum value of Y(t)
4) Ultimate value of Y(t)
5) Period of oscillation

b. A pneumatic PI controller has an output pressure of 10 psi when the set point and pen point are together. The set point and pen point are suddenly displaced by 0.5 in. (i.e., a step change in error is introduced) and the following data are obtained:

Time, sec	psig
0-	10
0+	8
20	7
60	5
90	3.5

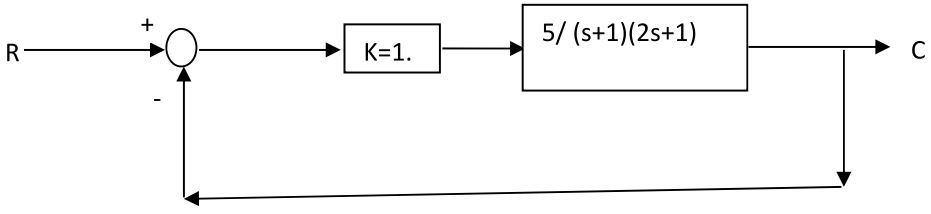
Determine the actual gain(psig per inch displacement) and the integral time.

5. Attempt any ***one*** of the following: 10 x 1 = 10

a. The set point of the control system shown in Figure is given a step change of 0.1 units. Determine

1) The maximum value of C and the time at which it occurs
2) The offset.
3) The period of oscillation

Draw a sketch of *C*(t) as a function of time.



b. Discuss the three types of disturbances in feedback loop system.

6. Attempt any ***one*** of the following: 10 x 1 = 10

a. Explain the Routh test for stability of a control system? Check the stability of system described by following equation.

$$S^4 + 3S^3 + 5S^2 + 4S + 2 = 0$$

b. Draw the Bode plot for the transfer function

$$G(s) = \frac{10(1+0.5s)e^{-s/10}}{(s+1)^2(0.1s+1)}$$

From the graph determine

1) Gain crossover frequency 2) Phase crossover frequency

3) Gain margin & Phase margin 4) Stability of the system

7. Attempt any ***one*** of the following: 10 x 1 = 10

a. Explain predictive control multivariable model.

b. Why is cascade controller called distributed decision – maker?