Y/K/TY

Reg. No: 23BCN0050

VIT
Vellore Institute of Technology

Final Assessment Test - November 2025

Course: BCHE305L - Process Dynamics and Control
Class NBR(s): 1248
Slot: D1+TD1
Time: Three Hours
Max. Marks: 100

- KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE
- DON'T WRITE ANYTHING ON THE QUESTION PAPER

COs	CO Statements
CO1	Understand process measuring instruments and their operating principles.
CO2	Apply the mathematical tools for modelling the dynamic behaviour of open loop process using different forcing functions.
CO3	Identify the modes of control action required for closed loop control system and its stability in time domain.
CO4	Analyse the stability of closed loop control system in frequency domain.
CO5	Discuss different advanced control schemes and various types of computer control in industries.

BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)

Answer ALL Questions
(10 X 10 = 100 Marks)

1. Design a fluid flow measurement system for a highly corrosive and viscous liquid chemical stream. The stream contains small solid particles that could interfere with certain types of flow meters. Compare and contrast the suitability of a magnetic flow meter and an orifice plate with a differential pressure transmitter for this application. **CO1 BL3**

2. *Two first order liquid level tank systems for which the time constants are equal ($\tau_1=\tau_2=\tau$) are connected in series as interacting manner. Assume that the tanks areas and resistance offered to flow are equal ($A_1=A_2$ and $R_1 = R_2$). Find the response of output flow rate of second tank for a unity step change in input flow rate of first tank.* **CO2 BL3**

3. *A step change of magnitude 0.1 is introduced in to a system having transfer function* $\frac{Y(s)}{X(s)} = \frac{8}{2S^2+3S+9}$. *Determine:* **CO2 BL3**

(i) Maximum value of Y(t) and the time at which it occurs.

(ii) Ultimate value of Y(t)

(iii) Period of oscillation

(iv) Rise time

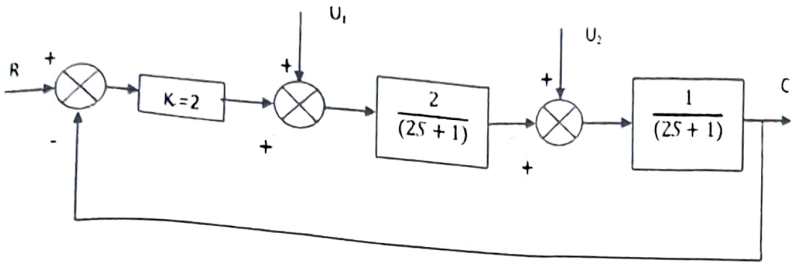
(v) Draw the sketch of Y(t) as a function of time.

List out components of closed loop control system and develop the closed loop block diagram for a stirred tank heater controlled by proportional integral controller. Note: Steam is used as heating medium. **CO3 BL3**

5. The location of a load change in a control loop may affect the system response. In the block diagram shown in Figure, a unit-step change is occurring in either U_1 or U_2. CO3 BL4

a) Find the overall transfer function C/U_1, C/U_2, natural frequency, damping coefficient and time constant of the closed loop system when the load enters at U_1 and U_2. Also comment on your result. [5]

b) What is the offset value at steady state condition when the load disturbance enters at U_1 and U_2? [5]



6. a) A PID controller is at steady state with an output pressure of 9 psi. The set point and pen point are initially together. At time t=0, the set point is moved away from the pen point at a rate of 0.5 inch/min. If the knob settings are Kc= 2 psi/inch, τ_I = 1.25 min and τ_D = 0.4 min. Plot the output pressure versus time. [7] CO3 BL3

b) A unit step change is given to PI controller. If the proportional sensitivity or gain Kc is 4, the integral time τ_I is 2, Obtain the response of the PI controller. [3]

7. A feedback control system has the following transfer functions; CO4 BL4

Process : $G_p(S) = \frac{5}{[(2s+1)(s+1)]}$

Measurement : $H(s) = \frac{1}{(0.5s+1)}$

Valve : $G_v(s) = \frac{0.2}{(0.1s+1)}$

Controller : $G_c(s) = K_c$

Using Routh's stability criterion, find characteristics equation and range of K_c value for which the system is stable.

8. A unity feedback system has open loop transfer function $G(S) = \frac{5(1+2S)}{(1+4S)(1+0.25S)}$. Determine Gain margin, Phase margin using Bode plot and find the stability. CO4 BL4

9.a) Describe any three processes that would benefit from feedforward control. In each process identify the controlled variable, the manipulated variable, and the key measurable disturbance. Also, explain the working mechanism of feedforward controller. CO5 BL3

OR

9.b)	Explain in detail with neat diagram about control of Distillation column using different control mechanism.	CO5	BL3
10.a)	Discuss in detail about overview of Distributed Control System (DCS) and compare its advantages over Programmable Logic Controller (PLC)	CO5	BL3
	OR		
10.b)	A blending process requires maintaining a constant ratio of 3:1 between two liquid streams, A (wild flow) and B (controlled flow). Draw a fully labelled block diagram for an indirect and direct ratio control system by indicating all components. Discuss the key limitations and potential sources of error for this control scheme, particularly concerning the behaviour of the flow transmitters at low flow rates.	CO5	BL3

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