REG.NO:

VIT
Vellore Institute of Technology

SCHOOL OF CHEMICAL ENGINEERING
CONTINUOUS ASSESSMENT TEST -II
FALL SEMESTER 2025-2026

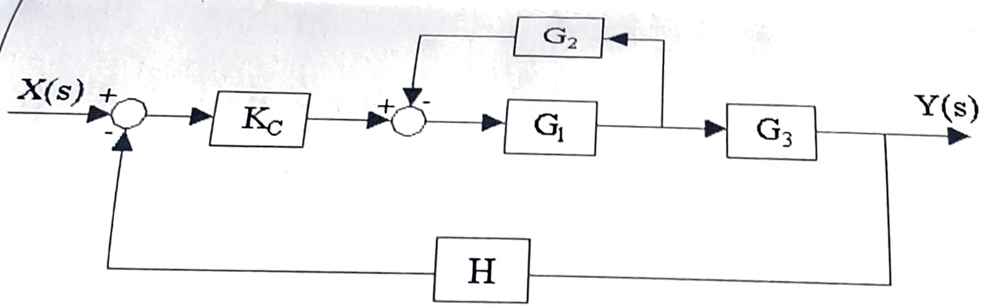
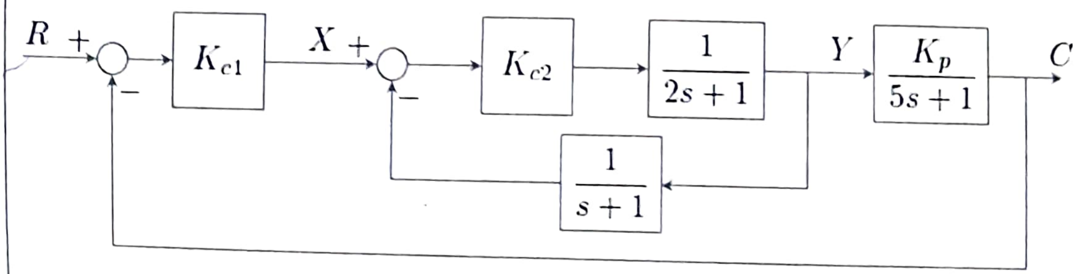
SLOT: D2+TD2

Programme Name & Branch	: B.Tech Chemical Engineering
Course Code	: BCHE305L
Course Name	: Process Dynamics and Control
Faculty Name(s)	: Dr.Pandurangan K
Class Number(s)	: VL2025260101249
Slot	: D2 +TD2
Date of Examination	: 08-10-2025
Exam Duration	: 90 minutes

Maximum Marks: 50

General instruction(s):

- **Answer All Questions**
- **M - Max mark; CO – Course Outcome; BL – Blooms Taxonomy Level**
- **CO3. Identify the modes of control action required for closed loop control system and its stability in time domain.**

Q. No	Question	Marks	(CO)	(BL)
1.	The block diagram of a control system is shown in Fig.1 (a & b). Using the method of "reduction of block diagram", find the transfer function (i) $\frac{Y(s)}{X(s)}$ for Fig.1 (a) and (ii) $\frac{C(s)}{R(s)}$ for Fig.1 (b).  Fig.1(a) **(5M)**  Fig.1 (b). **(5M)**	10	3	3

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2. Deduce the transfer function in simpler form

$$\frac{C(S)}{R(S)} = \frac{\dfrac{200K_pG_p(S)}{(S+1)(S+2)}}{1+\dfrac{200K_pG_p(S)}{(S+1)(S+2)}}$$

And calculate the offset of C due to a unit step change in the reference signal $R(S)$ for different $G_p(S)$. Take $K_p = 0.02$ — 10 — 3 — 3

(i) $G_p(S) = 1$ **(4M)**

(ii) $G_p(S) = \frac{S+0.1}{S}$ and **(3M)**

(iii) $G_p(S) = 1 + 0.3S$. **(3M)**

3. (a). A PI controller indicates an output of 12 mA when the error is zero. The set point is suddenly increased to 14 mA and the controller output is recorded and is given below. — 10 — 3 — 3

Time (t), sec	0	10	20	30
output, mA	0	16	18	20

Find the value of K_p and τ_I

(5M)

(b). The response for the proportional controller is given by

$$\tau_p \frac{dy}{dt} + y = K_pK_c\,(y_{set} - y)$$

Using steady state approach and setting $y \rightarrow y_{ss}$ (steady state value of the out-put). Show that

$$\text{offset} = \frac{y_{set}}{1+K_pK_c}$$

Following the same logic, what would the offset be for a Proportional Integral controller?

(5M)

4. (a). A control valve has an equal percentage characteristic with a rangeability R=30. The maximum flow rate is 120 L/min at full opening. Calculate the flow rate and pressure drop at 30%, 50%, and 70% valve openings. Assume the pressure drop at full opening is 25 psi, and flow follows the square law. — 10 — 3 — 3

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Use the equal percentage valve:

$$Q = Q_{max}\left(\frac{R^{x} - 1}{R - 1}\right)$$

Where x is the fractional valve opening. And the pressure drop across the valve: $\Delta P = \Delta P_{max}\left(\frac{Q}{Q_{max}}\right)^2$

(6M)

(b). Flow through constant sensitivity(S) Characteristic valve is given by

$$Q = \frac{Q_{max}}{R}\left[1 + (R-1)\frac{X}{X_{max}}\right]$$

The valve passes a maximum flow (Q_{max}) of 100 m^3/min at a maximum lift (X_{max}) of 5 cm. If the valve sensitivity(S) is known to be 18 m^3/min per cm of lift(X), determine the rangeability R of the valve.

(4M)

5. *(a).Determine K value by Routh stability test for the closed loop control system with unity feedback (H =1). Transfer function for the closed loop control block is given by*

$$\frac{G}{1+GH} = \frac{\frac{2.5K}{S(S+5)}}{1 + \frac{2.5K}{S(S+5)(0.1S+1)}}$$

(6M)

(b). Determine the stability of closed loop control system whose characteristic equation is

$$S^4 + 2S^3 + 6S^2 + 4S + 1 = 0$$

(4M)

10 3 3

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