GATE.CH.61

EE23BTECH11062 - V MANAS

Question:
The outlet concentration C_A of a plug flow reactor (PFR) is controlled by manipulating the inlet concentration C_{A0}.The following transfer function describes the dynamics of this PFR.

$$\frac{C_A(s)}{C_{A0}(s)} = e^{-(\frac{V}{F})(k+s)}$$

In the above question, V=1m^3,F=0.1m^3min^{-1} and k=0.5min^{-1}.The measurement and valve transfer functions are both equal to 1.The ultimate gain, defined as the proportional controller gain that produces sustained oscillations, for this system is
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Solution:

Variable	Description	Values
G_o	overall transfer function	1
G_p	process transfer function	
G_c	proportional controller transfer function	
K_c	gain of the proportional controller	

TABLE I
VARIABLES USED

$$G(s) = \frac{CA(s)}{CA_0(s)} = e^{-(\frac{V}{F})(k+s)} \quad (1)$$

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

$$G(s) = e^{-(10s+5)} \quad (3)$$

The transfer function of a proportional controller is K_c so we can take,G_c=K_c
Given that the measurement and valve transfer functions are both equal to 1, we can take G_p=G(s)

$$G_o = G_p \times G_c \quad (4)$$

$$G_o = G(s) \times K_c \quad (5)$$

$$1 = e^{-(10s+5)} \times K_C \quad (6)$$

$$1 = 1 \times \frac{K_c}{e^5} \quad (7)$$

$\therefore K_c = e^5 = 148.11$