Ref: Ex/PE/PC/B/T/315/2025

**Jadavpur University**

**BE(Power Engg.) 3rd Year First Semester Examination 2025**

**Control Systems**

**Time 3hrs** **Full Marks 100**

**Group A (Answer Any Two)**

1. Consider a unity-feedback closed-loop plant $G(s)H(s)$ where the controller $H(s)$ is in the forward path. Derive the characteristics of $G(jw)H(jw)$ as a filter for (i) good tracking and (ii) good output disturbance rejection.
   If $G(s) = \frac{0.5}{(2s+1)}$ and $H(s) = 5.0$ express the closed-loop system in State-Variable form.
   **CO1(10)+ CO2(10)**
2. Reduce the block diagram shown in Fig. 1 to obtain the transfer function between the input and the output

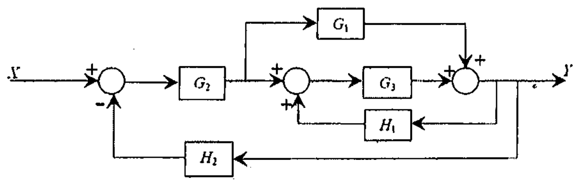


Fig 1 (Refer Q2.)

Check the result using a Signal Flow Graph and Mason's Gain formula **CO1 (10)+ CO2(10)**

3. A pulse train of height 1V ,frequency 1Hz and duty cycle 0.5 is applied to a circuit whose transfer function $G(s) = \frac{2}{(10s+1)}$. Model the pulse train and derive the output.
   Show that the peak overshoot of a second order system with complex poles depends on its damping only. **CO1 (10)+ CO2(10)**

**Group B (Answer Q7 or Q8 and Any Two )**

4. Represent the Pole-Zero map of the system $G(s) = \frac{4e^{-0.2s}}{s^2+2.4s+4}$ in the complex plane with suitable approximation. Deduce the approximation.
   If the system is controlled by a controller K , with a unity feedback, what is the maximum value of K for which the closed loop system is stale. **CO3(10) + CO4(10)**
5. For the system with characteristic equation defined by $Q(s) = s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16$ use Routh-Hurwitz stability criterion to determine the imaginary roots, if any , of the system. Now, if the constant term (i.e. coefficient of $s^0$ is replaced by a variable gain $K$ , determine the range of $K$ for the roots of the system to have real parts more negative than $s = -1$. **CO3(10) + CO4(10)**
6. Use Nyquist criterion to estimate the stability of **a unity feedback closed loop system** corresponding **to the open-loop system** defined by $G(s) = \frac{10}{(2s-1)(s+1)}$ and interpret the stability of the closed-loop system. **CO3(10) + CO4(10)**
7. Draw the asymptotic Bode plot for the system defined by $G(s) = \frac{10}{(0.1s+1)(s+1)(2s+1)}$ identify the corner frequency, the asymptotes and sketch a rough Bode Plot. Calculate the Gain Margin and Phase Margin- either analytically or using a Graph Paper .Using the Bode Plot, calculate how much delay the system can tolerate. **CO5(20)**
8. Construct the root locus diagram for the system $G(s)H(s) = \left(2 + \frac{4.0}{s}\right)\left(\frac{2.5}{2s+1}\right)$ .From the RL plot deduce what you should be doing to produce two complex-conjugate RL poles. **CO5(20)**