Department of Electrical Engineering, IIT Kanpur
EE250: Control Systems Analysis
Tutorial 2 03 Feb 2021

1. A Signal Flow Graph is shown in Figure 1. Find the transfer function between the input node and the output node, using Mason's gain formula.

2. A low-pass filter is shown in Figure 2. $R = 1k\Omega$, $C = 1\mu F$
   Construct a signal flow graph connecting input $V_1(s)$ and output $V_2(s)$ and showing internal signals $I_1(s)$, $I_2(s)$, and $V_2(s)$.
   Find $T(s) = \frac{V_3(s)}{V_1(s)}$

3. The block diagram of a feedback control system is shown in Fig. 3.

   (a) Apply the SFG formula to the block diagram to find the transfer functions

   $$\left.\frac{Y(s)}{R(s)}\right|_{N=0} \qquad \left.\frac{Y(s)}{N(s)}\right|_{R=0}$$

   Express $Y(s)$ in terms of $R(s)$ and $N(s)$ when both inputs are applied simultaneously.

   (b) Find the desired relation among the transfer functions $G_1(s)$, $G_2(s)$, $G_3(s)$, $G_4(s)$, $H_1(s)$ and $H_2(s)$ so that the output $Y(s)$ is not affected by the disturbance signal $N(s)$ at all.

4. The block diagram of the position-control system of the electronic word processor is shown in Fig. 4.

   (a) Find the loop transfer function $\frac{\Theta_0(s)}{\Theta_e(s)}$ through block diagram reduction (the outer feedback path is open)

   (b) Find the closed-loop transfer function $\frac{\Theta_o(s)}{\Theta_r(s)}$ through block diagram reduction.

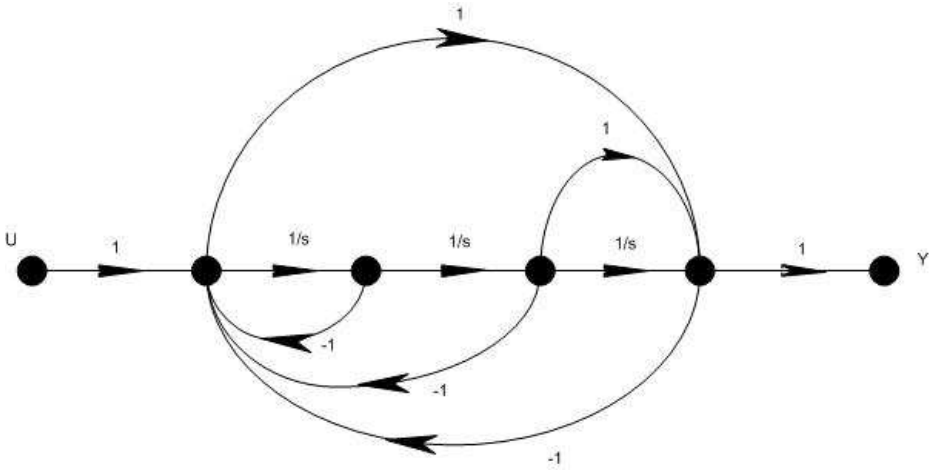

Figure 1: Problem 1

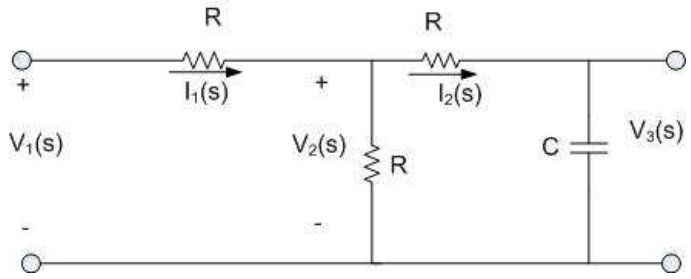

Figure 2: Problem 2

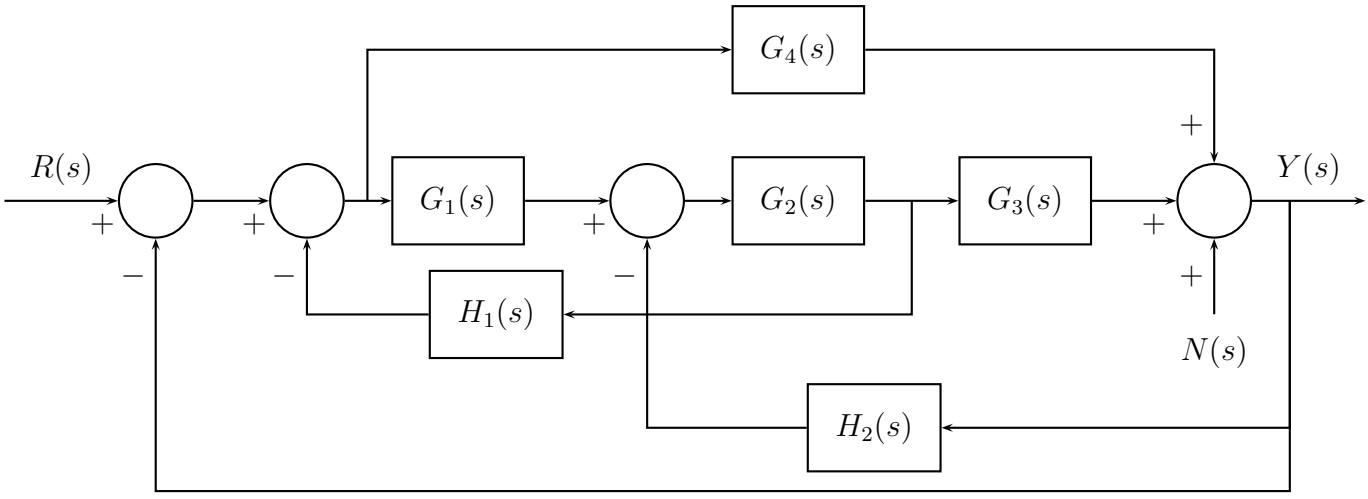

Figure 3: Problem 3

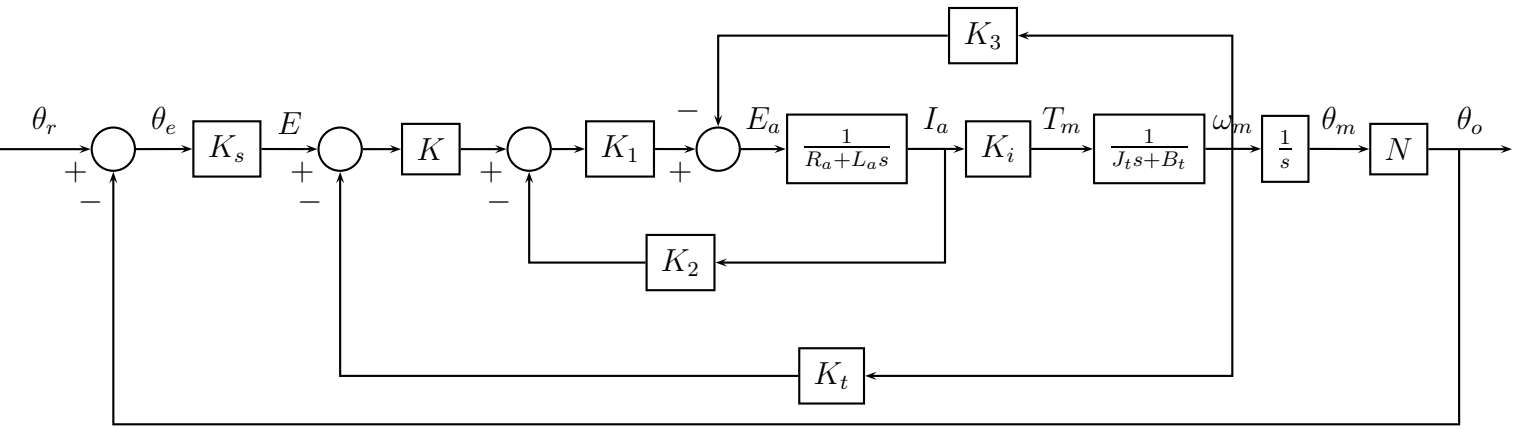

Figure 4: Problem 4