Contents

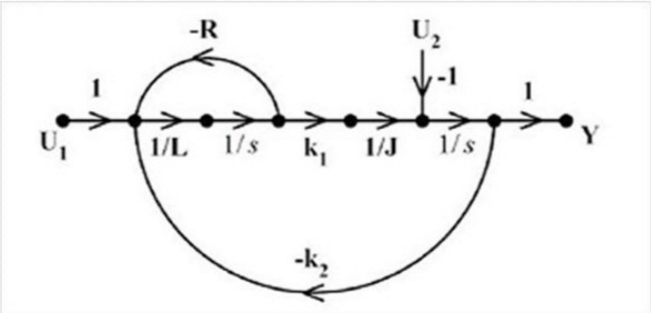
***Abstract*—This manual is an introduction to control systems based on GATE problems.Links to sample Python codes are available in the text.**

Download python codes using

1 Stability

2 Routh Hurwitz Criterion

2.1. In a system whose signal flow graph is shown in the figure, $U_1(s)$ and $U_2(s)$ are inputs. The transfer function $\frac{Y(s)}{U_1(s)}$ is



Solution:

Masons Gain Formula:

$T = \frac{C(s)}{R(s)} = \frac{\sum_{i=1}^{N} P_i \Delta_i}{\Delta}$

where,

- T is the transfer function or the gain between R(s) and C(s)
- C(s) is the output node
- R(s) is the input node
- P_i is the ith forward path gain
- Δ = 1−(sum of all individual loop gains)+(sum of gain products of all possible two non touching loops)-(sum of gain products of all possible three non touching loops)+....
- Δ_i is obtained from Δ by removing the loops which are touching the ith forward path

$$\left.\frac{Y(s)}{U_1(s)}\right|_{U_2(s)=0} \tag{2.1.1}$$

$$P_1 = 1 \cdot \frac{1}{L} \cdot \frac{1}{s} \cdot k_1 \cdot \frac{1}{J} \cdot \frac{1}{s} \cdot 1 = \frac{k_1}{LJs^2} \tag{2.1.2}$$

After removing the loops that are touching the forward path, the system will have no loops .Therefore,

$$\Delta_1 = 1 \tag{2.1.3}$$

Δ = 1−(sum of all individual loop gains) as in this system there are no non touching loops. Let L_1 and L_2 be the individual loops.

$$\Delta = 1 - (L_1 + L_2)$$

$$L_1 = \frac{1}{L} \cdot \frac{1}{s} \cdot (-R) = \frac{-R}{Ls} \tag{2.1.4}$$

$$L_2 = \frac{1}{L} \cdot \frac{1}{s} \cdot k_1 \cdot \frac{1}{J} \cdot \frac{1}{s} \cdot -(k_2) = \frac{-k_2 k_1}{LJs^2} \tag{2.1.5}$$

$$\frac{Y(s)}{U_1(s)} = \frac{P_1\Delta_1}{1-(L_1+L_2)} = \frac{\frac{k_1}{s^2LJ}}{1 + \frac{R}{Ls} + \frac{k_2k_1}{LJs^2}} \tag{2.1.6}$$

$$\frac{Y(s)}{U_1(s)} = \frac{k_1}{s^2LJ + sRJ + K_1k_2} \tag{2.1.7}$$

3 Compensators

4 Nyquist Plot