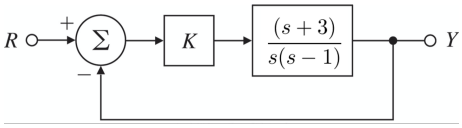
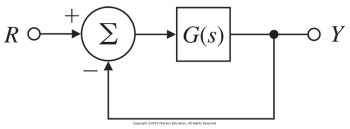
Midterm Exam

Subject : Control System Engineering 2, Lecturer : Prof. Youngjin Choi,
Date : Oct. 27, 2020 (Contact e-mail : cyj@hanyang.ac.kr)

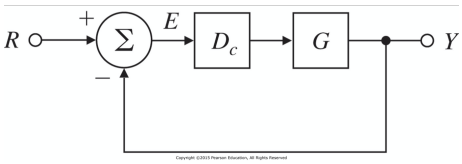
Problem 1 (20pt) Determine the stability properties of the following closed-loop system using Nyquist criterion? where it is noted that $K > 0$.



Problem 2 (20pt) Find the phase crossover frequency ω_p, the gain margin GM, the gain crossover frequency ω_g, and the phase margin PM of the following closed-loop system? where $G(s) = \frac{1-s}{s(s+3)}$



Problem 3 (20pt) For given system $G(s) = \frac{1}{s(s+2)}$, we wish to meet a steady-state error requirement for a unit-ramp input ($K_v = 10$), furthermore, to assure the phase margin of $PM = 40°$. Design the lag compensation $D_c(s) = K\beta\frac{Ts+1}{\beta Ts+1}$ satisfying two specifications? where $\beta > 1$.



Problem 4 (20pt) Find the state description matrices in the control canonical form and the modal canonical form of the following transfer function, respectively?

$$G(s) = \frac{s+7}{s(s^2+2s+2)}$$

Problem 5 (20pt) For given system

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

$$y = \begin{bmatrix} 0 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + [0]u$$

1. Find the control law that places the closed-loop poles of the system so that they are both at -2 ?
2. Find the output $y(t)$ of the closed-loop control system with initial conditions $x_1(0) = 1$ and $x_2(0) = 0$?