Systems Control I Exam. (2019-Fall Semester) 1/27/2020 (2nd period, 10:30-12:00)

(1) Answer the following questions for the system in Fig. 1.

1. Describe two motion of equations at point A and B using the variable x, y, u (and their derivatives) and the parameters d, k_1, k_2.
2. Using the two differential equations, derive one differential equation on the variable y, u (x should not be included), where y is the output and u is the input.
3. Find the transfer function $G(s) = \frac{Y}{U}$, where $Y = \mathcal{L}[y], U = \mathcal{L}[u]$.

(2) For the system in Fig. 2, answer the following questions.

1. Show the closed loop transfer function $G_{cl}(s) = \frac{Y}{U}$.
2. Calculate $y(t)$, when $u(t) = 1$ $(t \geq 0)$ and $K = 1$, where $y = \mathcal{L}^{-1}[Y], u = \mathcal{L}^{-1}[U]$.

(3) Answer the following questions for the system in Fig. 3 where K is a gain.

1. Show the closed loop transfer function $G_{cl}(s) = \frac{Y}{R}$.
2. Show the stable condition on K for the closed loop system.
3. Show the condition on K when the steady state error $e(\infty) < 1$, where $R = \frac{1}{s^2}$ and $e(t) = \mathcal{L}^{-1}[E(s)]$.

(4) Answer the following questions in Fig. 3 and Fig. 4 where K is a same gain.

1. Find N, D in the Fig. 4 when both characteristic equations are equivalent for the systems in Fig. 3 and Fig. 4.
2. Draw the root locus for the system in Fig. 3.

(5) Answer the following questions.

1. Draw the Bode chart (only gain chart by straight lines approximation) for $G(s) = \frac{s+10}{s(s+0.1)}$ using a given semi-log sheet. Note that write your name on it and use a ruler for each line).
2. Draw the vector locus and Nyquist locus for the system in Fig. 5, then discuss the stability of the closed loop system by Nyquist stability theorem.

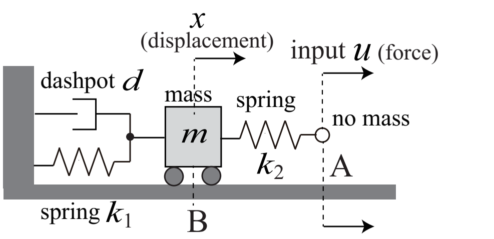

Fig. 1

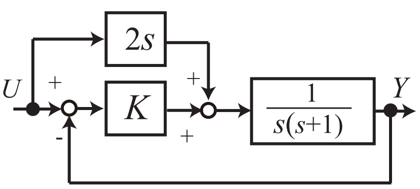

Fig. 2

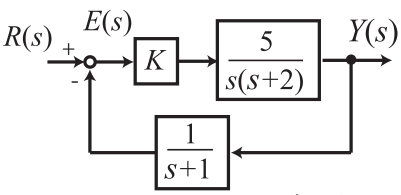

Fig. 3

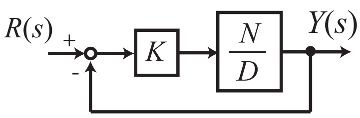

Fig. 4

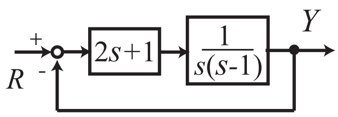

Fig. 5