碩士班入學考題

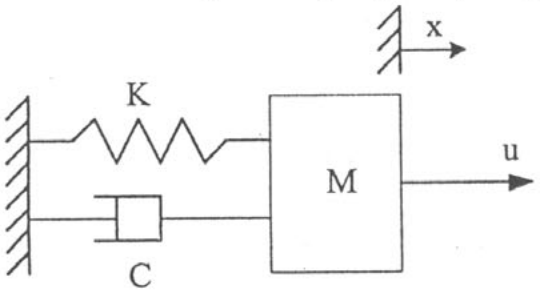
1. (20%) (i) Find the final value, if it exists, of each signal according to its Laplace transform shown below.

(a) $F_1(s)=\dfrac{3s+2}{s^2+2.5s+3}$ (b) $F_2(s)=\dfrac{2s+4}{s^3+2s^2-s+5}$

(c) $F_3(s)=\dfrac{5s^2+4}{2s^3+3s^2+4s}$ (d) $F_4(s)=\dfrac{s-5}{s^3+0.7s^2}$ (e) $F_5(s)=\dfrac{s+4}{s+2}$

(ii) Suppose F_1 to F_5 in part (i) are the impulse responses of some linear systems. Find the dc gain, if it exists, of each system.

2. (10%) Consider the following mass-spring-damper system



where M=1 Kg, K=1 N/m and C=1 N/m/s.

(i) What is the natural frequency of the system?
(ii) What is the damped natural frequency of the system?
(iii) What is the bandwidth of the system?
(iv) What is the settling time of the system?
(v) What is the dc-gain of the system?

3. (20%) Continue the discussion of the system shown in Prob. 2.

(i) (8%) If $x(0)=0\,\text{m}$, $\dot{x}(0)=1\,\text{m/s}$. Suppose $x(t)=x_1(t)$, when $u(t)=u_1(t)$. What is x(t) when $u(t)=2u_1(t)$?

(ii) (4%) Is the system stable at $x=0\,\text{m}$ if u=1N?

(iii) (4%) If $u=\sin(20t)\,\text{N}$, what is x(t) as $t\to\infty$?

(iv) (4%) Is the system controllable? Is it possible to "hold" the system at any point in the state space?

(背面仍有題目,請繼續作答)

4. (20%)

Plot the Bode plot and the Nyquist plot of the system $G = \dfrac{k(s-1)}{(s+1)(s+5)}$ with $k = 1$, and determine the range of k such that the closed-loop system, as shown in Figure 4, will be stable.

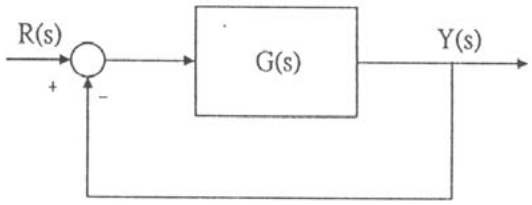


Figure 4.

5. (20%)

Consider the system described in problem 4. Plot the closed-loop root locus plot and determine the value of k such that the resulting closed-loop system has two multiple roots.

6.

(a). (3%) What are the major objectives of introducing lead and lag controllers?

(b). (2%) Give three advantages and three disadvantages of using feedback control.

(c). (3%) Why do we need to know before hand the number of open-loop unstable poles in order to tell closed-loop system stability from Nyquist plot?

(d). (2%) Define the gain crossover frequency and the phase crossover frequency.