淡江大學97學年度碩士班招生考試試題

系別：機械與機電工程學系　　　　科目：自動控制

准帶項目請打「V」	
V	簡易型計算機

本試題共2頁　4大題

1. (20%) A spring-mass-damper system is shown in Figure 1. Find the transfer function $Y(s)/F(s)$.

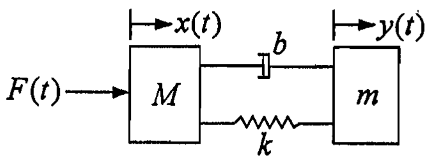

Figure 1　Spring-mass-damper system

本試題雙面印製

2. (20%) Consider the unity negative feedback control system of Figure 2, where the process transfer function is expressed as

$$G(s)=\frac{k}{s(s+\sqrt{3k})}$$

a. Determine the percent overshoot and settling time (using 2% settling criterion) due to a unit step input.

b. For what range of k is the settling time less than 1.2 sec?

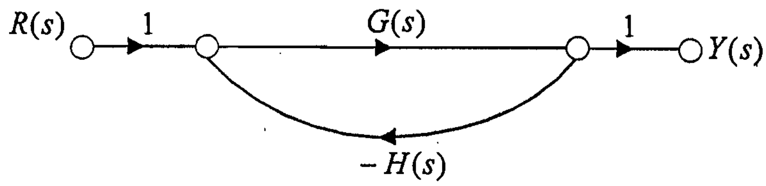

Figure 2 A feedback control system

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3. (30%) Consider the feedback control system of Figure 3, where the loop transfer function is

$$GH(s)=\frac{K}{s(s+2)}$$

   a. Sketch the root locus for the feedback control system.
   b. If we require the damping ratio of the dominant complex roots to be ζ=0.45, please determine the loop gain K to meet the requirement.
   c. If we require further that the system velocity error constant is K_v=20 (damping ratio is still ζ=0.45), please design a cascade phase-lag compensator $C(s)=\frac{(s+z)}{s+p}$ to meet the requirements.

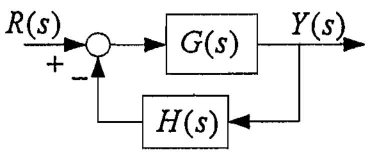

Figure 3 A feedback control system

4. (30%) Consider the feedback control system of Figure 3, where the loop transfer function is

$$GH(s)=\frac{K}{s(s+2)}, \qquad H(s)=1$$

   a. If the requirement of percent overshoot is less than 5% for this second-order system, determine the damping ratio ζ, the natural frequency ω_n, and the loop gain K for the system.
   b. Plot the Bode diagram for the loop transfer function in Question a.
   c. Design a cascade phase-lead compensator to meet the requirement of the percent overshoot to be less than 5% and a requirement of the system phase margin to be approximately 65°.

Note: For a phase-lead compensator $C(s)=\frac{K_c(s+z)}{s+p}$:

the magnitude and phase at the maximum phase angle are

$$|C(j\omega)|=\sqrt{\frac{p}{z}}$$

$$\angle C(j\omega)=\phi_m(\omega)=\sin^{-1}\left(\frac{p-z}{p+z}\right)$$

The frequency at the maximum phase lead is

$$\omega_m=\sqrt{zp}$$