國立臺灣科技大學102學年度碩士班招生試題

系所組別： 自動化及控制研究所碩士班乙組

科　　目： 控制系統

（總分為100分）

1. An electromechanical system shown in Figure 1 represents a moveable-plate capacity. Assume that the plate a of the parallel capacitor is fixed and the plate b with mass M is moved by force f. If the capacitor $C(d)=\frac{\varepsilon A}{d}$, where ε is the dielectric constant, A is the surface of the plates, and d is the separation distance of the plates, then the electric field produces a force opposing the motion of the plates, and it is related to the charge q across the plates: $f_e=\frac{q^2}{2\varepsilon A}$.

   (a) Find the differential equations of this system. (10%)

   (b) Find the Laplace transforms of the differential equations in part (a). (10%)

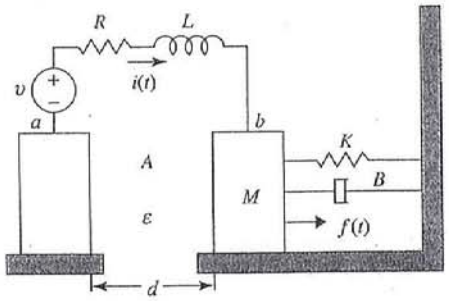

Figure 1

2. A unity feedback control system shown in Figure 2(a) is designed so that its closed-loop poles lie within the region shown in Figure 2(b).

   (a) Find the natural frequency ω_n and the damping ratio ς. (5%)

   (b) If $K_p=2$ and $p=2$, then find the values for K and K_I. (5%)

   (c) Show that, regardless of values K_p and p, the controller can be designed to place the poles anywhere in the left side of the s-plane. (5%)

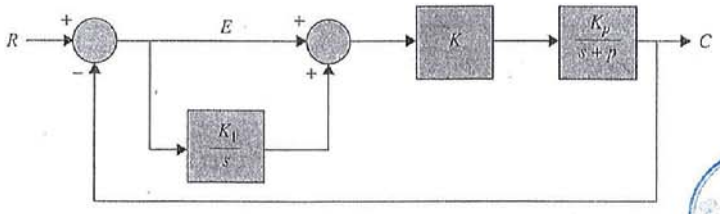

Figure 2(a)

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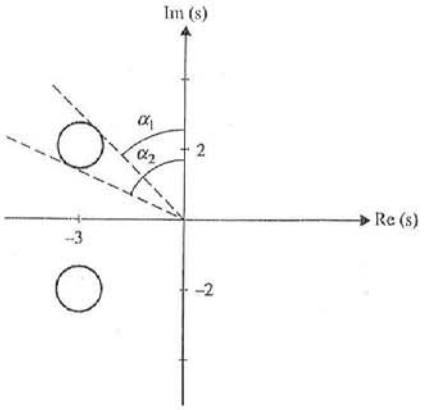

Figure 2(b)

3. Figure 3 shows a block diagram, where $G_p(s)=\dfrac{1000K}{s(s+a)}$. Design $G_{cf}(s)$ and $G_c(s)$ so that the following performance specifications are satisfied.

Ramp-error constant $K_v=100$ when $a=100$

Rise time $T_r<0.3$ sec

Maximum overshoot $<8\%$

Dominant characteristic equation roots $=-5\pm5j$

System must be robust when a varies between 8 and 12 (15%)

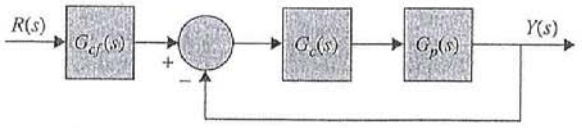

Figure 3

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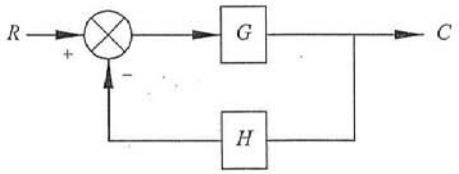
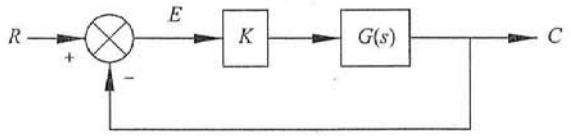
(總分為100分)

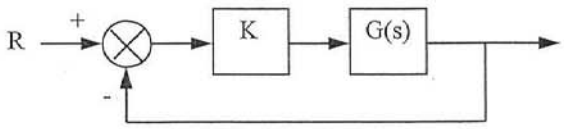
4. The feedback $H = (1 + K_t s)$ as shown below can represent a parallel combination of direct feedback and minor loop rate feedback. If $G(s) = K/(s^2 + 2s + 3.25)$ represents a spring-mass-damper system with a position output and a force input:
   (a) Find the constraints on K and/or K_t for a steady-state error of 10% following step inputs. (8%)
   (b) Calculate the value of K_t for a damping ratio 0.707 from the quadratic characteristic equation, and use the corresponding roots in sketching the loci for varying K_t. (7%)



5. For the system shown below with $G(s) = (s+1)/(s+2)$:
   (a) Find the value of K required for a system time constant $T = 0.667$ sec. (8%)
   (b) Calculate the corresponding unit step response. (7%)



6. For the system shown below with G(s)=1/[s(s+1)(s+4)]:
   (a) Find the limit on K for stability. At this limit, determine the position of the system poles on the imaginary axis of the s-plane. (10%)



   (b) Determine the limit on the value of K for stability if the amplifier K of part (a) is replaced by a dynamic compensator

$$\frac{K(0.5s+1)}{0.1s+1}$$

   Where on the imaginary axis is a root pair located at this limit? (10%)