國立台灣科技大學九十八學年度碩士班招生試題

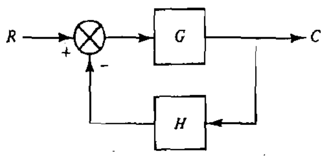
系所組別： 自動化及控制研究所碩士班乙組

科　　目： 控制系統

共六大題，總分 100 分；請於答案卷內依序作答。

1. For a fluid power position servo with loop gain function

$$GH = \frac{K}{s(s^2+6s+13)}$$



(a) Sketch the loci of the system poles for varying K. (6 %)

(b) Find K for a damping ratio 0.707 of the dominating poles. (7 %)

(c) Where is the third pole for this K? (7 %)

2. In the Figure shown, let G(s)=1/[(s+1)(s+4)] and let the compensator G_c have the form $G_c=K(T_1s+1)/(T_2s+1)$. This is called phase-lead compensation if $T_1>T_2$ and phase-lag compensation if $T_1<T_2$. Both are very common and their design will be discussed at length. One approach, considered here, is to choose the zero of G_c to cancel one of the plant poles. If the system is to be designed for a damping ratio 0.5 using

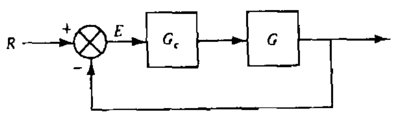
1. Proportional control $G_c = K$
2. Phase-lag compensation K(s+1)/(5s+1)
3. Phase-lead compensation K(0.25s+1)/(0.05s+1)

then:

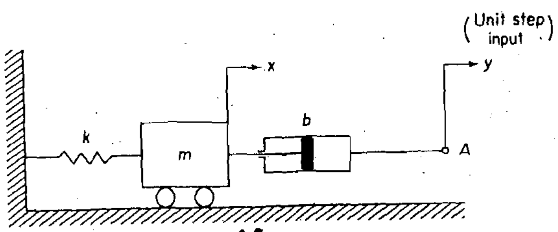
(a) Determine the values of K required. (5 %)

(b) Find and compare the steady-state errors following unit step inputs. (5 %)

(c) Determine the closed-loop system time constants and compare the speeds of response. (5 %)



3. In the Figure as shown below, the system is at rest initially. At t = 0 a unit-step displacement input is applied to point A. Assuming that the system remains linear throughout the response period and is underdamped, find the response x(t) as well as the values of x(0+), $\dot{x}(0+)$, and x(∞). (15 %)



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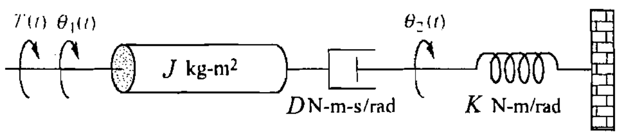
4. For the system shown below, a step torque *T(t)* is applied at $\theta_1(t)$ shaft.

(a) Find a state space representation of the system in vector-matrix form. (5%)

(b) If J=1kg-m^2, design *D* and *K* so that the percent overshoot is 16.3% and the peak time is 1.2092 sec. (5%)

(c) If it is also desired that the settling time is less than 2.5sec, can this design meet the requirement? If not, how would you change your design? (5%)

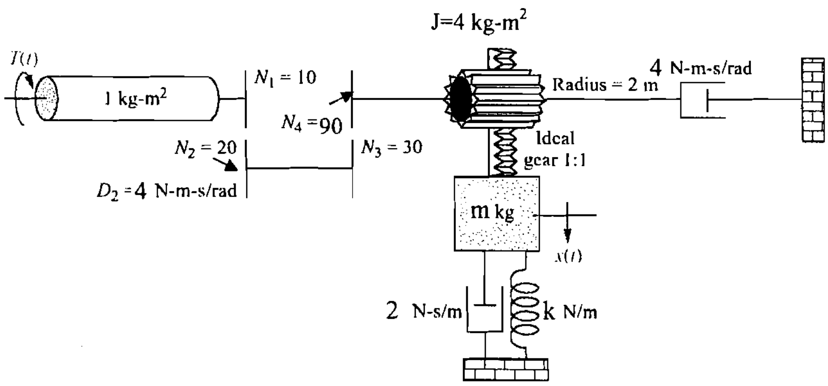
(d) Continued from (b), if it is desired to reduce the rise time by changing the values of *J* and *K* (with *D* fixed). How would you tune these two values, and which one is more effective? (5%)



$$T_p = \frac{\pi}{\omega_n\sqrt{1-\zeta^2}}, \quad T_s = \frac{4}{\zeta\omega_n}$$

$$\%OS = e^{-\frac{\zeta\pi}{\sqrt{1-\zeta^2}}} \times 100\%$$

5. Derive the transfer function $\frac{X(s)}{T(s)}$, and use it to design *m* and *k* such that the step response of this system has a rise time about 2sec and percent overshoot about 16.3%. What is the smallest rise time if the overshoot is to be kept within 16.3%? Without the requirement on the overshoot, what is the achievable range of the rise time? (15%)



6. Find the transfer function *T(s)=Y(s)/R(s),* determine the system type and find the steady state error with respect to an input *R(s)=10/s*. Is this system a minimum phase one? Stable? (15%)