台灣聯合大學系統99學年度碩士班考試命題紙

科目：控制系統(500D)

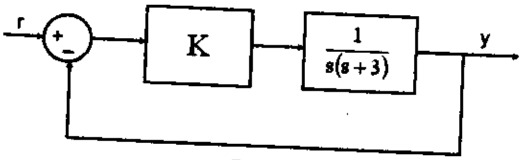
校系所組：中央大學電機工程學系（系統與生醫組）
交通大學電控工程研究所（甲組、丙組）
清華大學電機工程學系（甲組、丁組）

1. (25%) Suppose a physical system under input $r(t)$ can be modeled by the differential equation $\dddot{x}(t)+2\ddot{x}(t)+4\dot{x}(t)+Kx(t)=r(t)$ with zero initial conditions. Find out

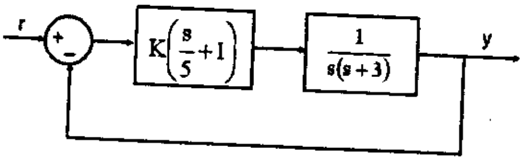
(a) the conditions on K such that the solutions of this physical system will be 0 asymptotically under bounded input, (12%)

(b) the value of K such that the steady state will have a pure oscillatory solution for unit step input. (13%)

2. (a) (12%) Please draw the root locus for the systems I and II as shown. You must explain how the root locus is constructed. Also, which system do you think has a smaller overshoot in its unit step response when K = 5? Please explain.

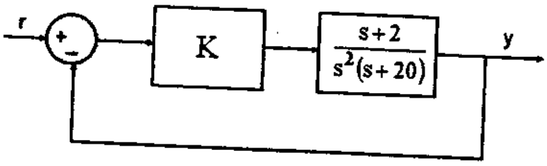


System I



System II

(b) (13%) Please draw the root locus for the system as shown below. You must explain how the root locus is constructed.



注意：背面有試題

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3. (25%) Consider the following system:

$$\frac{dx}{dt}=\begin{bmatrix}0&1&0&0\\0&0&-1&0\\0&0&0&1\\0&0&5&0\end{bmatrix}x+\begin{bmatrix}0\\1\\0\\-2\end{bmatrix}u,\quad y=\begin{bmatrix}1&0&0&0\end{bmatrix}x$$

(1) Prove and determine that this system is controllable or uncontrollable. (12%)

(2) The state feedback control $u=r+kx,\ k=\begin{bmatrix}k_1 & k_2 & k_3 & k_4\end{bmatrix}$ will be designed to let controlled system closed-loop poles be placed at -1, -2, -1±j, find k_1, k_2, k_3 and k_4. (13%)

4. (25%) For the given control system:

(1) Neglecting the feedforward controller G_{fc} and the disturbance F_L, derive the closed-loop tracking transfer function $H_{dx}(s)\triangleq x(s)/x^*(s)$, and find the stability ranges of the controller parameters K_x and K_v. (6%)

(2) Find K_x and K_v to let the controlled closed-loop transfer function $H_{dx}(s)$ possess damping ratio $\varsigma=1.25$ and natural frequency $\omega_n=10$. (8%)

(3) Find: (a) the value of output $x(t)$ at t=0.2s, $x(t=0.2)$ and the steady-state value $x(t=\infty)$ due to unit-step command input of x^*; (b) the steady-state value $x(t=\infty)$ due to unit-step disturbance input of F_L; (c) the steady-state value $x(t=\infty)$ due to unit-ramp command input of x^*. (6%)

(4) Applying the feedforward controller G_{fc} and neglecting the disturbance F_L, derive the transfer function $H_{dv}(s)\triangleq v(s)/v^*(s)$ and then find G_{fc} to yield the ideal position tracking control, i.e., $H_{dx}(s)\triangleq x(s)/x^*(s)$. (5%)