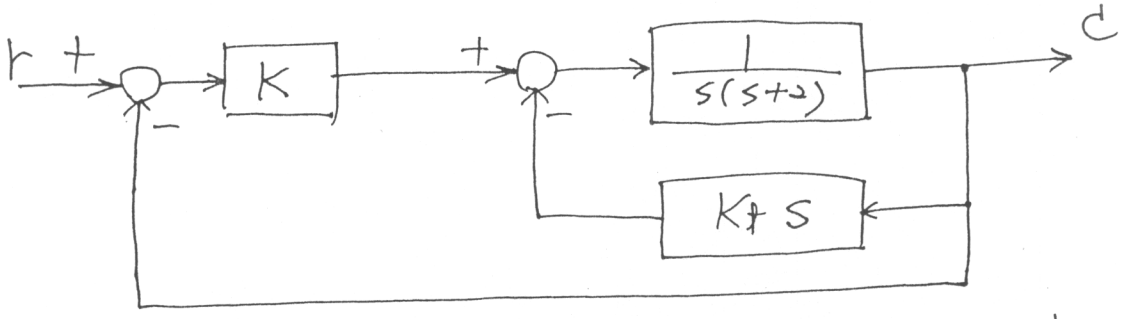
1. A control system with tachometer feedback is shown below:




(a) With $K=10$ and $K_t=0$, determine the system undamped natural frequency ($\omega_n$) and damping ratio ($\zeta$). Also, determine the steady-state error of unit-ramp input. (10%)

(b) With $K=10$, and the desired damping ratio ($\zeta$) increases to 0.6, what value of $K_t$ shall be assigned? In this case, what is the steady-state error of unit-ramp input? (10%)

(c) Determine the values of $K$ and $K_t$ so that the steady-state error of unit-ramp input is the same as that of case (a) and the damping ratio ($\zeta$) is equal to 0.6. (10%)

2. The open loop transfer function of a unity-feedback system is:

$$G(s)=\frac{K}{s(1+0.2s)(1+0.05s)}$$

(a) find the value of $K$ if the system gain margin is 20 dB. (10%)

(b) find the value of $K$ is the system phase margin is 40°. (10%)

(背面仍有題目,請繼續作答)

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3. A system is described by

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\\ \dot{x}_3\end{bmatrix}=\begin{bmatrix}-2 & -2 & 0\\ 0 & 0 & 1\\ 0 & -3 & -4\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}+\begin{bmatrix}1 & 0\\ 0 & 1\\ 1 & 1\end{bmatrix}\begin{bmatrix}u_1(t)\\ u_2(t)\end{bmatrix}$$

(a) Find the change of variables

$$\mathbf{x}=M\mathbf{q} \quad (M \text{ is the modal matrix})$$

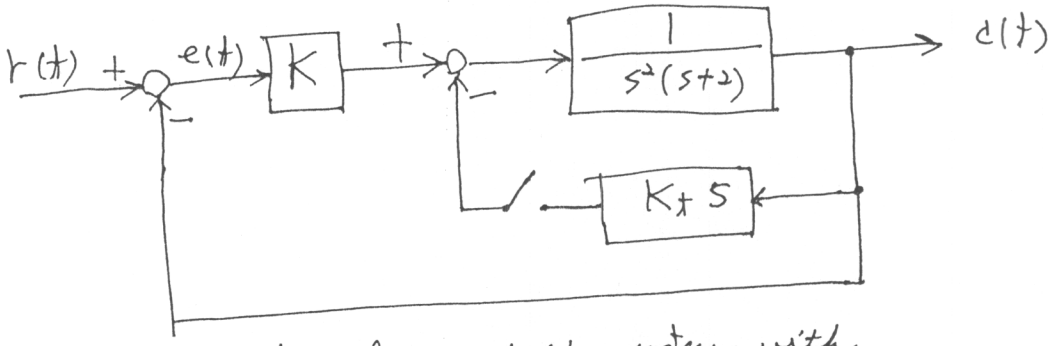
which uncouples this system. (10%)

(b) If $\mathbf{x}(0)=\begin{bmatrix}10\\ 5\\ 2\end{bmatrix}$ and $\mathbf{u}(t)=\begin{bmatrix}t\\ 1\end{bmatrix}$

find $\mathbf{x}(t)$. (10%)

(c) Prove that the system is completely controllable. (10%)

4. A feedback control system is shown as follows:




(a) Plot the loop locus of the system with the switch open and $K \geq 0$; also investigate the system stability with $K \geq 0$. (10%)

(b) Plot the loop locus of the system with the switch closed, $K=1$, and $K_t \geq 0$; also determine the range of $K_t$ so that the system is stable. (10%)