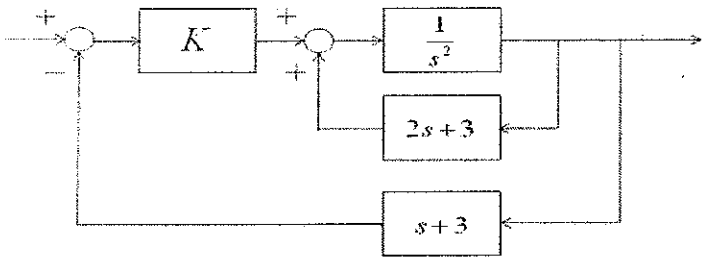
國立臺灣海洋大學101學年度研究所碩士班暨碩士在職專班入學考試試題

考試科目： 控制系統（含線性系統理論）

系所名稱： 電機工程學系碩士班控制組

1.答案以橫式由左至右書寫。2.請依題號順序作答。

1. (15%) Consider the following system



   (a) Plot its root locus for $K > 0$. (Please compute and specify break points.)

   (b) Compute the K values which correspond to the break points.

2. (15%) Consider a system with characteristic equation

$$s^3 + 5s^2 - 6s + K(s+1) = 0.$$

   (a) Explain the Nyquist stability criterion.

   (b) Apply the Nyquist stability criterion to determine the value of K for system stability.

3. (20%) Consider a unity-feedback system with $G_p(s) = \frac{1}{s(s+1)}$ and $G_c(s) = K_p + K_i\frac{1}{s} + K_d s$ in cascade in forward path.

   (a) Design the PID controller parameters K_p, K_i, K_d such that closed-loop system has a real pole at -10 and another two dominant poles achieving damping ratio $\zeta = 0.5$ and natural frequency $\omega_n = 4$.

   (b) Compute the steady-state errors when tracking unit step, ramp (t), and parabola $(\frac{t^2}{2})$ inputs.

4. (10 %) State and prove the separation principle.

5. (20 %) Consider a linear, time-varying system $\dot{x}(t) = A(t)x(t)$, $, y(t) = C(t)x(t)$, where

$$A(t) = \begin{bmatrix} -1 & e^{2t} \\ 0 & -1 \end{bmatrix}, \quad C(t) = \begin{bmatrix} 0 & e^{-t} \end{bmatrix}.$$

   (a) Find the state transition matrix of the system.

   (b) Find the observability Gramian of the system. Is the system observable?

6. (20 %) Consider a linear, time-invariant system $\dot{x}(t) = Ax(t) + Bu(t)$, where

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 2 & -1 \end{bmatrix}, \quad B = \begin{bmatrix} 0 & 1 \\ 1 & 1 \\ 0 & 0 \end{bmatrix}.$$

(a) Is this system controllable? Justify your answer.

(b) Find a static state feedback $u(t) = Fx(t)$ so that the poles of the closed-loop system are located at -2 and $-1 \pm j$.

(c) In part (b), is the feedback gain matrix F unique? Justify your answer.