國立成功大學 79 學年度 電機工程研究所入學考試( 控制工程 試題) 

1. (a) Draw the Nyquist diagram for the system shown in Fig. 1.
   (b) Estimate the range of K based on the Nyquist stability analysis for which the system is stable, and vertify with a root locus plot.

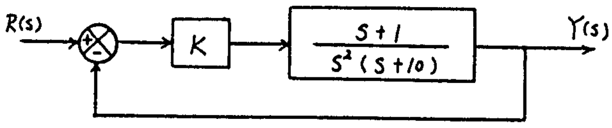


Fig. 1

2. Design the system shown in Fig. 2 (i.e., find $K_p$, J, D) that satisfies the following specifications:
   (a) The steady-state error $e_{ss} \leqslant 0.05$ rad for step input $\theta_{in}=1.0$ rad (with $T_d=0$).
   (b) $e_{ss} \leqslant 0.05$ rad for ramp input $\theta_{in}=75$ rad/sec (with $T_d=0$).
   (c) $e_{ss} \leqslant 0.05$ rad for step disturbance $T_d=50$ N·m (with $\theta_{in}=0$).
   (d) Setting time $T_s=0.1$ sec for 5% transient residue. (Hint: $T_s=3/\zeta\omega_n$)
   (e) Phase margin PM=45°.

   The margins of stability are shown in the Table 1.
   (Hint: $\dfrac{\theta_{out}(s)}{\theta_{in}(s)} = \dfrac{K_p}{Js^2+Ds+K_p} = \dfrac{\omega_n^2}{s^2+2\zeta\omega_n s+\omega_n^2}$ when $T_d(s)=0$ )

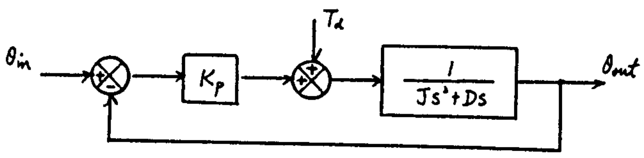


Fig. 2

| $\zeta$ | PM | GM |
|---|---|---|
| 0 | 0° | 0 |
| 0.125 | 20° | 6.3 |
| 0.25 | 30° | 25 |
| 0.5 | * 45° | 100 |
| 0.707 | 60° | 200 |
| 1.0 | 90° | 400 |

Table 1

3. Let

$$A=\begin{pmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ -3 & 1 & 2 & 3 \\ 2 & 1 & 0 & 0 \end{pmatrix} \qquad B=\begin{pmatrix} 0 & 0 \\ 0 & 0 \\ 1 & 2 \\ 0 & 2 \end{pmatrix}$$

   Find two different real constant 2×4 matrices K such that the matrix (A+BK) has eigenvalues $-4\pm 3j$ and $-5\pm 4j$.

4. Consider the system defined by the equations

$$x_1(k+1)=2x_1(k)+0.5x_2(k)-5$$
$$x_2(k+1)=0.8x_2(k)+2$$

   Determine the stability of the equilibrium state.

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