國立彰化師範大學 97 學年度碩士班招生考試試題

系所：工業教育與技術學系碩士班　　組別：乙組　　科目：自動控制

☆☆請在答案紙上作答☆☆　　

1. A unity feedback control system is shown in Fig. 1, where $G(s)=\dfrac{100}{s(\frac{s}{10}+1)(\frac{s}{100}+1)}$ and K is the gain of proportional controller.

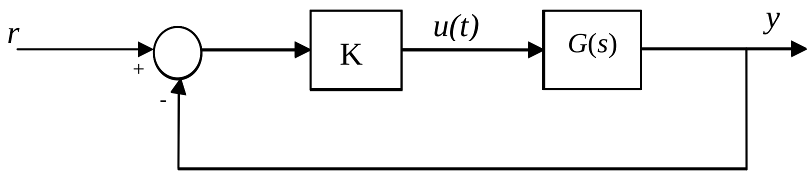

Fig. 1

(1) Draw the Bode plot for $G(jw)$ assuming $K=1$. (5%)

(2) Is the system stable for $K=1$? Why? (5%)

(3) Find GM(gain margin) and PM(phase margin) from the Bode plot in (1) (7%)

(4) Draw the Nyquist plot for $G(s)$ and determine the range of K to ensure the stability of system. (8%)

2. A control system is shown in Fig. 2. The moments of inertia of gears are lumped as J_1, J_2, and J_3. $T(t)$ is the applied torque; N_1,N_2, N_3, and N_4 are the number of gear teeth. Please find the following (assume rigid shafts):

(1) $G(s)=X(s)/T(s)$. (5%)

(2) Damping ratio ζ. (3%)

(3) Rising time. (3%)

(4) Peak time. (3%)

(5) Overshooting Max. (3%)

(6) Steady-state error for a unit-step function. (8%)

Where M =1kg, K=1N/m, B =1N-s/m (Columb friction coefficient), N_1=60, N_2=30, N_3=50, N_4=40 and $J=J_1=J_2=J_3=1$ kg-m^2.

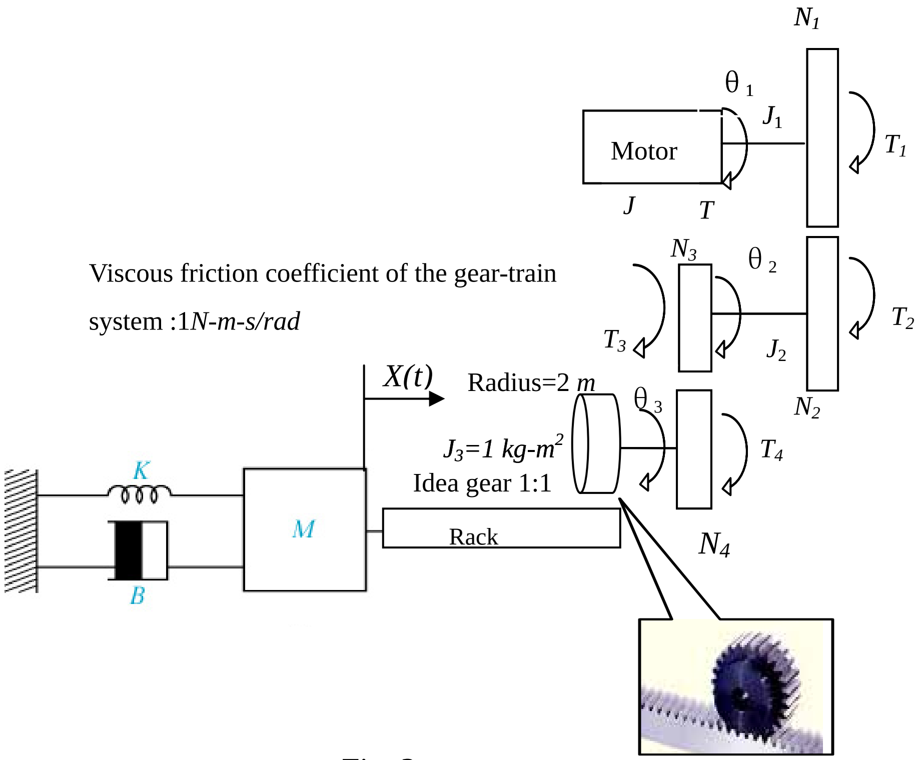

Fig. 2

3. Consider a system $\dot{x} = Ax + Bu$, $y = Cx$,

where $A = \begin{bmatrix} -\frac{3}{4} & -\frac{1}{4} \\ -\frac{1}{2} & -\frac{1}{2} \end{bmatrix}$, $B = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$, $C = \begin{bmatrix} 4 & 2 \end{bmatrix}$

(1) Find the eigenvalues of A. (3%)

(2) Find the eigenvectors of A. (3%)

(3) Find the state transition matrix. (4%)

(4) Is the system state controllable? (3%)

(5) Is the system observable? (3%)

(6) Find the transfer function $\frac{Y(s)}{U(s)}$. (4%)

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4. Consider a system

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & -3 \\ 8 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

The state feedback control is $u = -[k_1 \quad k_2] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$, where k_1 and k_2 are the real constants. Sketch and determine the region in the k_1 versus k_2 plane in which the overall system is stable. Please put k_1 as the x-axis and k_2 as the y-axis. (15%)

5. Consider a system

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ -1 & 1 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

The state feedback control is $u = -[k_1 \quad k_2] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + r$, where $r(t)$ is the unit step function. Determine the values of k_1 and k_2 such that the closed loop system has a damping ratio $\xi = 0.7071$ and the peak time $t_p = 3.1416$. (15%)