

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☆☆

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

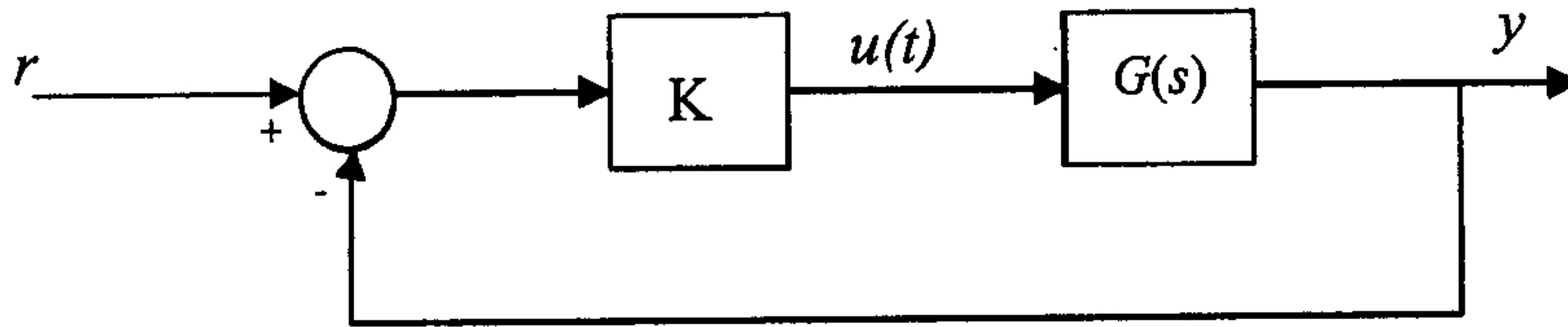


Fig. 1

- (1) Draw the Bode plot for $G(j\omega)$ 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 $M = 1\text{kg}$, $K = 1\text{N/m}$, $B = 1\text{N-s/m}$ (Columb friction coefficient), $N_1 = 60$, $N_2 = 30$, $N_3 = 50$, $N_4 = 40$ and $J = J_1 = J_2 = J_3 = 1\text{ kg-m}^2$.

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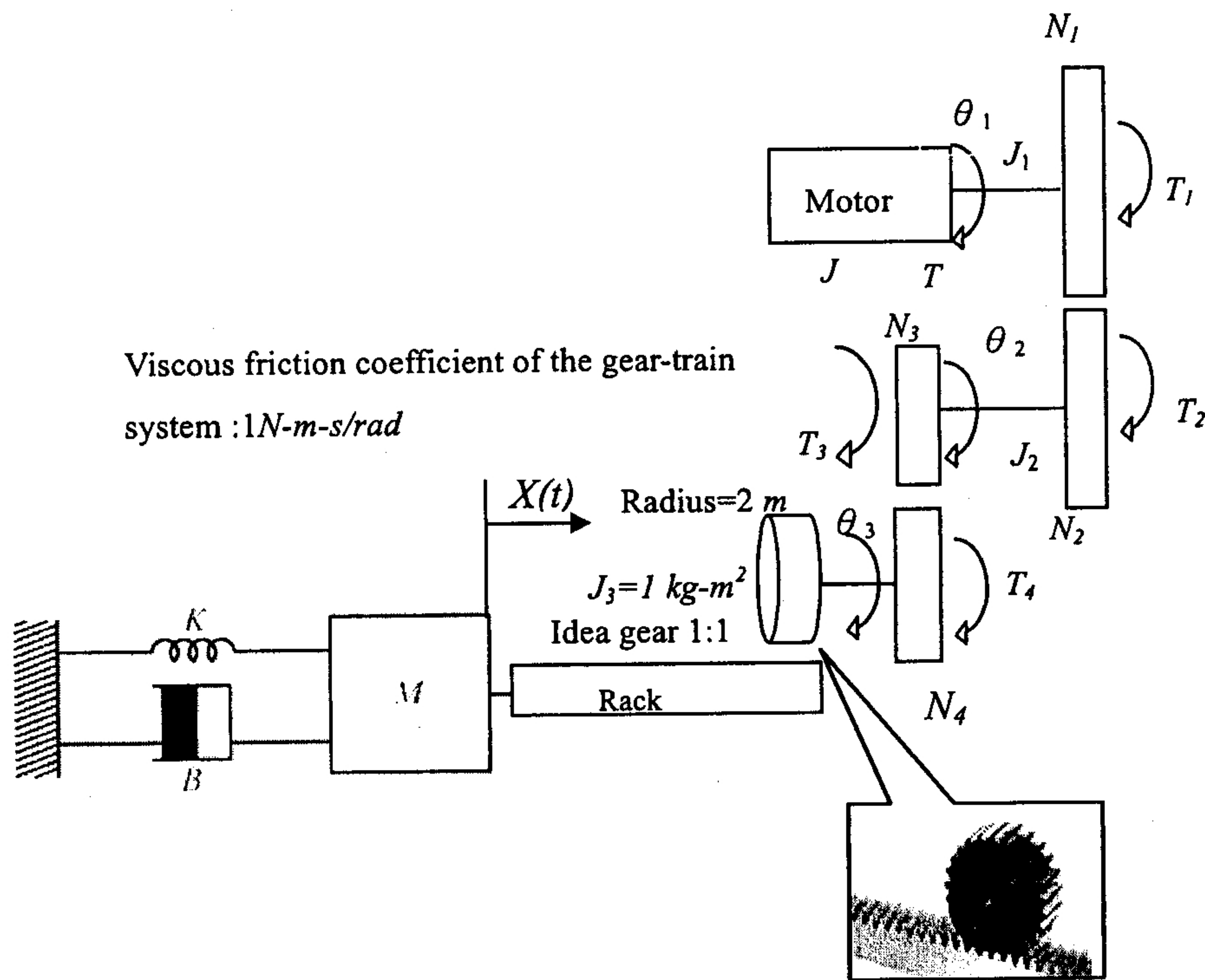


Fig. 2

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

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

- (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 $u = -[k_1 \ k_2] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$, 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 $u = -[k_1 \ k_2] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + r$, 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%)