國立臺灣大學 105 學年度碩士班招生考試試題

1. Consider the unity feedback control problem of the mechanical system as shown in Fig.1. Please find the values of mass M and damper D to yield 20% overshoot and 2 seconds settling time. **(25%)**

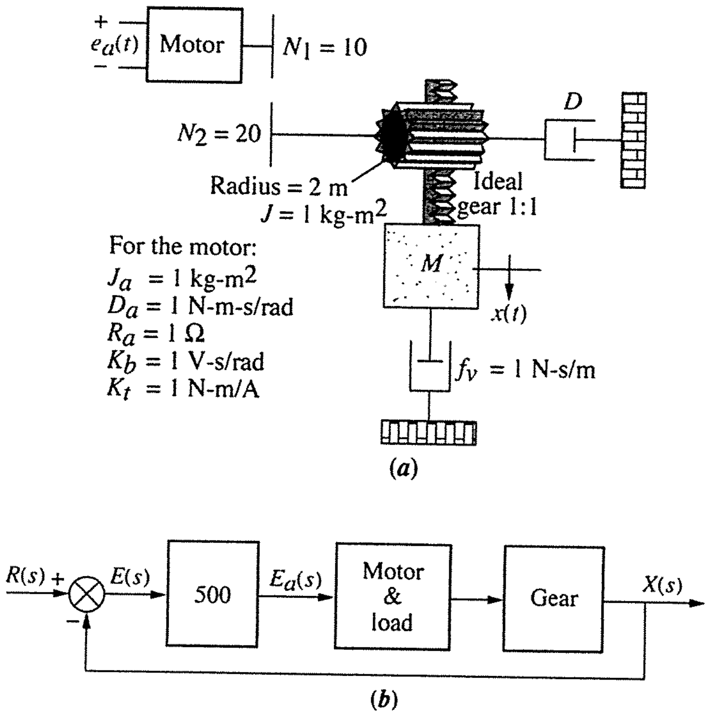

Fig. 1

2. Consider a control system in Fig.2 where $D(s) = K_p + \frac{K_I}{s}$ is the controller and

$$G(s) = \frac{100}{s^2 + 10s + 100}$$ is the plant.

(a) Please find K_I such that the velocity constant of ramp input steady state error K_v is 10. **(10%)**

(b) Sketch the root locus of the characteristic equation with the value of K_I determined in (a) and for $0 \le K_p < \infty$. **(15%)**

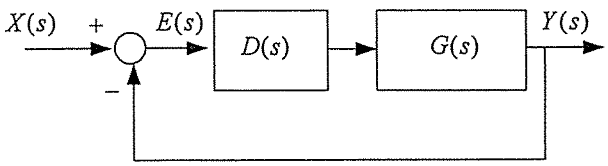

Fig. 2

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3. Consider a control system in Fig.3 where the controller K is a constant gain. All poles and zeros of the plant $G(s)$ are on the left half plane. The plant $G(s)$ has a gain of $20\log_{10}2$ dB at the only corner frequency $\omega = 1$ rad/sec. An asymptotic Bode gain plot of the plant $G(s)$ has only two segments, such as low frequency asymptote with a slope of -60 dB/decade and high frequency asymptote with a slope of -20 dB/decade.

(a) Please find the transfer function $G(s)$ according to the asymptotic Bode gain plot. **(10%)**

(b) Please sketch the Nyquist plot of the system and determine the range of K for the closed-loop system stability. **(15%)**

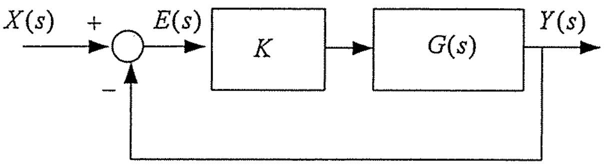

Fig. 3

4. Consider a state feedback control system as

$$\dot{\mathbf{x}}(t) = \mathbf{A}\mathbf{x}(t) + \mathbf{B}u(t) \qquad y(t) = \mathbf{C}\mathbf{x}(t)$$

where $\mathbf{A} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -2 & -3 \end{bmatrix}$, $\mathbf{B} = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$, $\mathbf{C} = \begin{bmatrix} 3 & 1 & 0 \end{bmatrix}$, $\mathbf{x} = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$

(a) Please find the gain matrix $\mathbf{K} = [k_1 \quad k_2 \quad k_3]$ of the state feedback controller $u = r - \mathbf{K}\mathbf{x}$ so that the closed-loop transfer function of the system is $\dfrac{Y(s)}{R(s)} = \dfrac{1}{s^2 + 3s + 2}$, where $R(s)$ and $Y(s)$ are Laplace transform of $r(t)$ and $y(t)$. **(15%)**

(b) Please discuss the controllability of the closed-loop control system. **(10%)**

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