大同大學 99 學年度研究所碩士班入學考試試題

考試科目:控制系統　　所別:電機工程研究所　　

註:本次考試 不可以參考自己的書籍及筆記； 不可以使用字典； 不可以使用計算器。

1. Sketch the Bode plot for the followings:

(a) (5%) lead compensator $D(s) = \dfrac{Ts+1}{\alpha Ts+1}$, where $\alpha = 0.1$ and $T = 1$.

(b) (5%) lag compensator $D(s) = \dfrac{Ts+1}{\alpha Ts+1}$, where $\alpha = 10$ and $T = 1$.

2. The hanging crane is shown schematically in Figure 1. Let the coefficients required be $m_t = 2$ kg, $m_p = 0.2$ kg, $\ell = 1$ m, the acceleration of gravity g = 9.8 m/sec^2, and the moment of inertia I = 0.8 kg·m^2. Assume that the pendulum rod and the cart can only move in either clockwise/counter-clockwise direction or back and forth direction, respectively, the center of gravity of the pendulum is at its geometric ceneter, and no friction is considered.

(a) (8%) Please derive the accelerations in the directions of a_1, a_2, a_3, and a_4, respectively.

(b) (12%) Please derive the dynamical equations of the hanging crane system.

(c) (5%) The dynamical equation in (b) is supposedly nonlinear. Please linearize the equations about $\theta = \pi$.

(d) (5%) Let the output variable be θ and the input variable be the control force u. Please find the transfer function $G(s) = \theta(s)/u(s)$.

(e) (5%) From (d), is $G(s)$ BIBO stable ? Explain your answer and simple YES and NO will not be granted any point.

(f) (5%) From (d) and Figure 2, please find the PD controller gains (K, K_D) so that the closed-loop system poles are located at $s = -1 \pm j\sqrt{3}$.

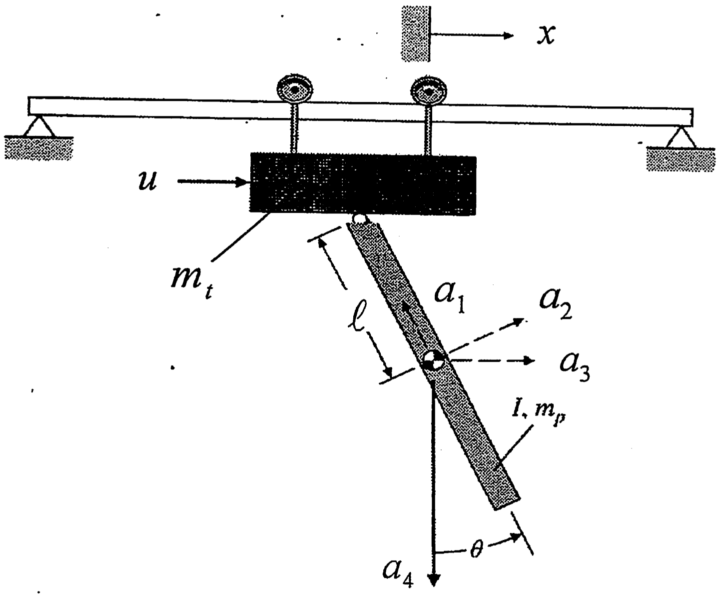

Figure 1.

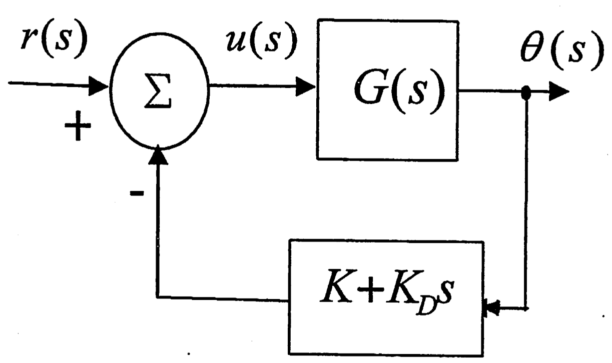

Figure 2.

<背面繼續>

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3. (24%) Consider the subsystems shown in Figure 3 and connected to form a feedback system, where $G(s)$ is represented in state space as

$$\dot{x}_1 = A_1 x_1 + B_1 e$$
$$y = C_1 x_1$$

and $H(s)$ is represented in state space as

$$\dot{x}_2 = A_2 x_2 + B_2 y$$
$$p = C_2 x_2$$

If the closed-loop system can be represented in state space as

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} T_1 & T_2 \\ T_3 & T_4 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} Q_1 \\ Q_2 \end{bmatrix} r$$
$$y = \begin{bmatrix} S_1 & S_2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

then determine $\boldsymbol{T}_1, \boldsymbol{T}_2, \boldsymbol{T}_3, \boldsymbol{T}_4, \boldsymbol{Q}_1, \boldsymbol{Q}_2, \boldsymbol{S}_1$, and $\boldsymbol{S}_2$ in terms of $\boldsymbol{A}_1, \boldsymbol{A}_2, \boldsymbol{B}_1, \boldsymbol{B}_2, \boldsymbol{C}_1$, and $\boldsymbol{C}_2$.

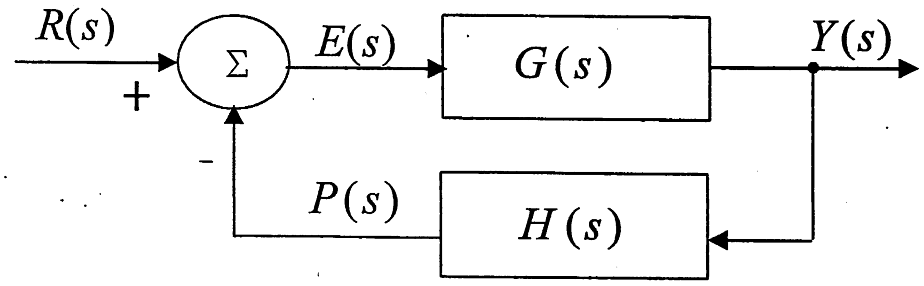

Figure 3.

4. Consider the discrete-time system

$$x(k+1) = \begin{bmatrix} 0.25 & 0.5 \\ 1 & 2 \end{bmatrix} x(k) + \begin{bmatrix} 1 \\ 4 \end{bmatrix} u(k)$$
$$y(k) = \begin{bmatrix} 1 & 0 \end{bmatrix} x(k)$$

(a) (13%) Determine the state feedback controller $u(k) = \begin{bmatrix} L_1 & L_2 \end{bmatrix} \mathbf{x}(k)$ such that the states are brought to the origin in two sampling intervals.

(b) (13%) Is it possible to determine a state-feedback controller that can take the system from the origin to $\mathbf{x}(k) = \begin{bmatrix} 2 & 8 \end{bmatrix}^T$?