大同大學 100 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. (a) (6%) Sketch the Bode plot for $D(s) = \dfrac{s+1}{10s+1}$. (b) (6%) From (a), is $D(s)$ the lead or lag compensator ? Explain your answer and simple lead and lag will not be granted any point.
2. Consider the PI feedback system shown in Fig. P-2, where $Y(s)$ is the output and $R(s)$ is the input.
   (a) (6%) Please find the transfer function $G(s)= Y(s)/R(s)$.
   (b) (10%) Use Routh's criterion to determine the region in the K_P versus K_I plane for which the system is stable (Use K_P as the horizontal axis and K_I as the vertical axis.)
   (c) (6%) From (b), what conditions must PI controller gains (K_P , K_I) satisfy so that the system is BIBO stable ?
   (d) (10%) From (a) and (b), what conditions must PI controller gains (K_P , K_I) satisfy so that the system is stable and its output can track a step reference input with constant steady-state error ?
   (e) (6%) From (a), please find the PI controller gains (K_P , K_I) so that the closed-loop system poles are located at $s = -1 \pm j\sqrt{3}$.

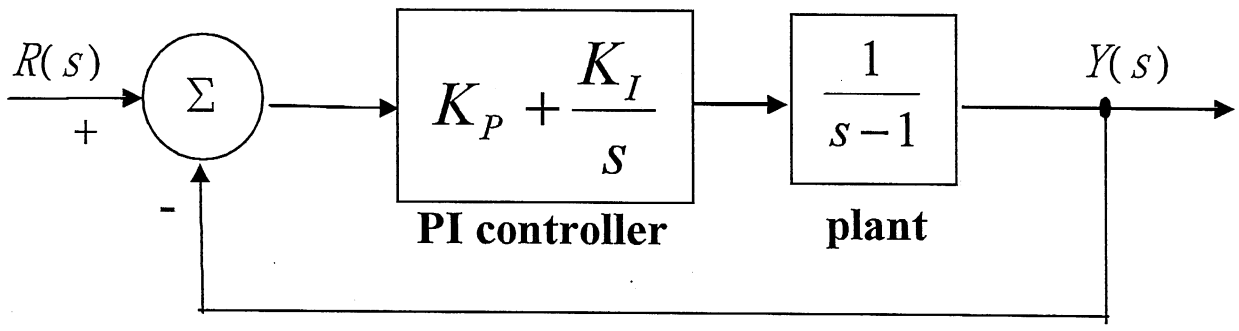

Fig. P-2

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3. Consider a nonsingular change of state variables

$$\mathbf{z} = \mathbf{P}\mathbf{x} \text{ and } \mathbf{x} = \mathbf{P}^{-1}\mathbf{z}$$

in a state-space representation for an original system

$$\dot{\mathbf{x}} = \begin{bmatrix} -1 & -2 & 0 \\ 1 & 2 & 0 \\ -2 & -1 & -3 \end{bmatrix}\mathbf{x} + \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}\mathbf{u} = \mathbf{A}\mathbf{x} + \mathbf{B}\mathbf{u}$$

$$\mathbf{y} = \begin{bmatrix} 1 & 0 & 1 \\ 1 & -1 & 0 \end{bmatrix}\mathbf{x} = \mathbf{C}\mathbf{x}$$

Then the state-space representation of the new state variable **z** can be written as

$$\dot{\mathbf{z}} = \bar{\mathbf{A}}\mathbf{z} + \bar{\mathbf{B}}\mathbf{u}$$

$$\mathbf{y} = \bar{\mathbf{C}}\mathbf{z}$$

(a) (15%) Determine $\bar{\mathbf{A}}$, $\bar{\mathbf{B}}$, and $\bar{\mathbf{C}}$ in terms of **A**, **B**, **C**, **P**, and $\mathbf{P}^{-1}$.

(b) (15%) Find a similarity transformation **P** such that $\bar{\mathbf{A}}$ is diagonal.

4. Consider the discrete-time system

$$y(k+2) + 0.4y(k+1) = u(k)$$

(a) (10%) For which values of L in the proportional controller

$$u(k) = L(r(k) - y(k))$$

is the closed-loop system stable?

(b) (10%) Determine the stationary error $r(k)$ - $y(k)$ when $r(k)$ is a step and when L=0.5 in the controller as shown in (a).