國立彰化師範大學 101 學年度碩士班招生考試試題

系所： 工業教育與技術學系　　組別： 乙組　　科目： 自動控制

☆☆請在答案卷上作答☆☆　　

1. A first-order system is given by the state equations

$$\frac{dx}{dt} = -4\,x(t) + 5\,u(t)$$

$$y(t) = x(t)$$

(Hint : *Convolution solution* $\mathbf{x}(t) = \Phi(t)\mathbf{x}(0) + \int_0^t \Phi(\tau)\,\boldsymbol{Bu}\,(t-\tau)\,d\tau$)

(1) Determine the Laplace transform of the state transition matrix. (3%)
(2) Determine the state transition matrix. (3%)
(3) If the input $u(t)$ is a unit step function, with $x(0) = 0$, find $y(t)$, $t > 0$, using the *convolution solution*. (5%)
(4) If the input $u(t)$ is a unit step function, with $x(0) = -2$, find $y(t)$, $t > 0$, using the *convolution solution*. The results of (2) and (3) are useful. (5%)
(5) Verify the results of (3), using the transfer function approach. (7%)
(6) Verify the results of (4), using the Laplace transform of the state equation. (7%)

2. Consider the system shown in Fig. 1,

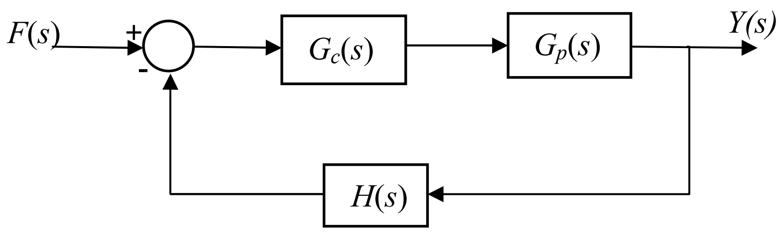

Fig. 1

where $G_c(s) = 2$, $G_p(s) = \dfrac{K(s+5)}{s(s-2)}$, and $H(s) = 0.5$

(1) Determine the root locus of the system. (5%)
(2) Find any points at which the locus crosses the $j\omega$ axis. (5%)
(3) From (1) and (2), find the range of K for which the system is stable. (5%)
(4) From (1) and (2), find the range of K for which the system is stable and the closed-loop transfer function poles are real. (5%)

注意：第 2 頁仍有試題

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3. Consider a linear system with the Bode plot of magnitude shown in Fig. 2. Assume this system is minimum phase.
   (1) Estimate the transfer function. (5%)
   (2) Sketch the Bode plot of phase. (5%)
   (3) Is the unity feedback of control system stable? (5%)

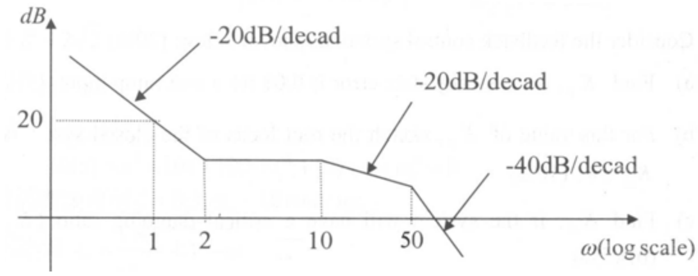

Fig. 2

4. For the control system shown in Fig. 3.
   (1) Determine the range of K and the range of K_f for a stable system. (10%)
   (2) Find the values of K and K_f so that the maximum overshoot is 10% and the rise time t_r is 0.2 sec. (10%)

   (Hint： $t_r \cong \dfrac{0.8+2.5\zeta}{\omega_n}$)

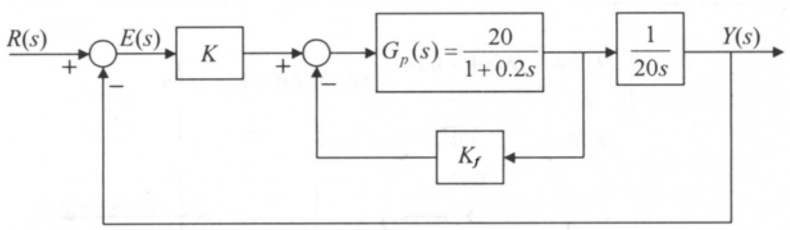

Fig. 3

5. Consider the following state-variables system

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

$$y(t)=\begin{bmatrix}1 & 0\end{bmatrix}x(t)$$

   (1) Is this system controllable? (5%)
   (2) Is this system observable? (5%)
   (3) Is this system stable? (5%)