國立臺北科技大學九十五學年度碩士班招生考試

系所組別：1112 機電整合研究所甲組

第二節 自動控制（選考）試題

填 准 考 證 號 碼

注意事項：

1. 本試題共 4 題，配分共 100 分。
2. 請標明大題、子題編號作答，不必抄題。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

1. (25%) The loop transfer function of a single-loop feedback control system is given as $G(s)H(s)=\dfrac{K(s+5)}{s(s+2)(1+Ts)}$, Determine the regions in the T-versus-K parameter plane (T horizontal, K vertical) where the closed-loop system is asymptotically stable, marginally stable, and unstable.

2. (25%) Consider the loop transfer function of a single-loop feedback control system $G(s)H(s)=\dfrac{K}{s(1+Ts)(s^2+2s+2)}$, Construct the root contours of the characteristic equation with K and T as variable parameters.
   (1) First, setting T=0, plot root locus for $K\geqq 0$ (10%)
   (2) Then, letting K=4, plot root locus for $T\geqq 0$ (15%)

3. (25%) A dynamic equation of a plant is given as

$$\dot{X}=\begin{bmatrix}1 & 1 & -1\\ 0 & 1 & 1\\ 0 & 0 & 1\end{bmatrix}X+\begin{bmatrix}1\\ 0\\ 1\end{bmatrix}u,\quad y=[1\quad 0\quad 0]X$$

   (1) Find transfer function $G(s)=\dfrac{Y(s)}{U(s)}$ (5%)
   (2) Determine the controllability and observability (5%)
   (3) Determine the stability of the plant (5%)
   (4) Let control law be $u(t)=pr(t)-KX(t)$, find the feedforward gain p and state feedback gain matrix K so that the closed loop system has poles at -4, $-1\pm j1$ and can track asymptotically any step reference input $r(t)$. (10%)

4. (25%) The Nichols chart of a forward-path transfer function *G(s)* of a unity-feedback system is shown below. The value of the frequency (in rad/sec) at points indicated is given as: $\omega_1 = 3, \omega_2 = 6, \omega_3 = 10, \omega_4 = 20, \omega_5 = 50, \omega_6 = 70$ · find (estimate as best as you can)

(1) resonant peak ($M_{p\omega}$) in dB and resonant frequency (ω_r) (4%)

(2) gain margin (gm) and phase margin (pm) (4%)

(3) gain crossover frequency (ω_g), phase crossover frequency (ω_p), and bandwidth (ω_B) (4%)

(4) damping ratio (ξ) based on the phase margin (4%)

(5) Suppose the forward-path transfer function becomes *KG(s)*, find the maximum value of *K* so that the system will remain stable. (4%)

(6) Suppose the forward-path transfer function becomes $e^{-Ts}G(s)$, find the maximum value of *T* so that the system will remain stable. (5%)