國立臺灣科技大學
九十一學年度博士班招生考試試題

系所組別：電機工程系乙組
科 目： 控制工程

總分 100 分

1. Given a discrete-time signal x[n]

(a) Express x[n] as a summation of weighted, shifted impulse train $\delta[n-k]$, $-\infty < k < \infty$. (5%)

(b) If x[n] is applied to a linear system, whose response to $\delta[n-k]$ is $h_k[n]$, then what is the corresponding output y[n]? (5%)

(c) What the output y[n] will be, if the same system is time invariant as well? (10%)

2. Consider a continuous-time LTI system whose frequency response is

$$H(j\omega) = \int_{-\infty}^{\infty} h(t)e^{-j\omega t}dt = \frac{\sin(4\omega)}{\omega}$$

If the input to this system is a periodic signal

$$x(t) = \begin{cases} 1, & 0 \le t < 4 \\ -1, & 4 \le t < 8 \end{cases}$$

with period T = 8, determine the corresponding system output y(t). (15%)

3. The following four facts are given about a real signal x[n] with Fourier transform $X(e^{j\omega})$

(a) x[n] = 0 for n>0

(b) x[0] > 0

(c) $\text{Im}\{X(e^{j\omega})\} = \sin\omega - \sin 2\omega$

(d) $\frac{1}{2\pi}\int_{-\pi}^{\pi} |X(e^{j\omega})|^2 d\omega = 3$

Determine x[n]. (15%)

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4. A system transfer function, $H(s)$, has three poles at $s = -1, -2, -2$, one zero at $s = -3$, and a dc gain $H(0) = 4$. Find its step response $y(t)$. (15%)

5. A unity-feedback system has the plant transfer function $G(s) = \dfrac{1}{s(s+1)}$. We wish to design a lead compensator $D(s) = K\dfrac{s+\sqrt{2}}{s+p}$, $p > \sqrt{2}$, so that one of the closed-loop pole is located at $s = -1 + j$. [Note: $\tan(22.5^\circ) = 0.4142$] (15%)

6. Consider a unity feedback system with the open-loop transfer function $G(s)$,

$$G(s) = \frac{10}{(s+1)(s+10)},$$

and a proportional control gain K as shown in Fig. P1.

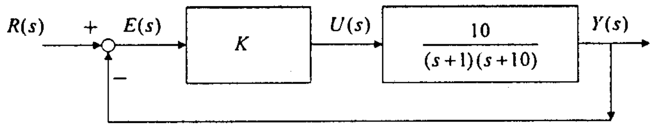

Figure. P1.

(1) Plot the root locus for the above unity feedback system with design gain K. (5%)

(2) Find the steady-state error e_{ss} in Fig. P1 for unit ramp input. (5%)

(3) Design the gain $K = K_1 = ?$ such that the above unity feedback system is stable and has damping ratio 0.707. (5%)

(4) Find the gain crossover frequency ω_g and phase margin PM of the above system when gain $K = K_1$. (5%)