國立臺灣師範大學 100 學年度碩士班招生考試試題

科目：通訊原理 　　　　　　　　　　適用系所：應用電子科技學系

注意：1.本試題共 3 頁，請依序在答案卷上作答，並標明題號，不必抄題。2.答案必須寫在指定作答區內，否則不予計分。

1. A random process is defined by $X(t)=A\cos(2\pi f_0 t+\Theta)$ where Θ is a random variable uniformly distributed on $[0,2\pi)$.

   (a) Find the autocorrelation function of X(t), $R_X(\tau)$.(10 分)

   (b) Find the power-spectral density of X(t), $S_X(f)$. (10 分)

   (c) If X(t) passes through a differentiator, find the power-spectral density of the output, $S_Y(f)$. (10 分)

2. Consider the three waveforms $\psi_n(t)$ shown in Fig. 1.

   (a) Show that these waveforms are orthonormal. (10 分)

   (b) Express the waveform x(t) as a weighted linear combination of $\psi_n(t)$, n=1, 2, 3, if

$$x(t) = \begin{cases} -1, & 0 \le t \le 1 \\ 1, & 1 < t \le 3 \\ -1, & 3 < t \le 4 \end{cases}$$
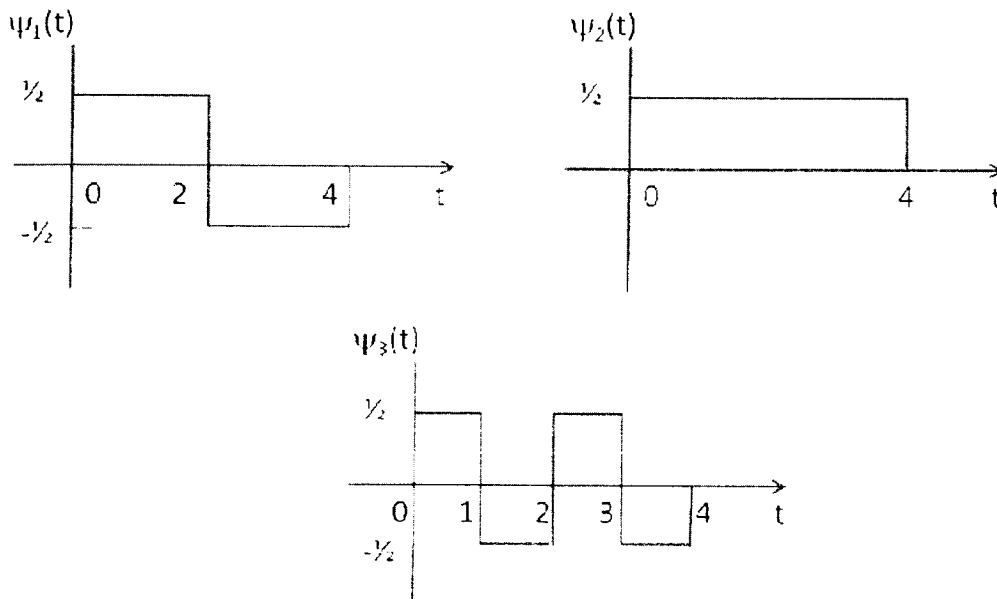
   and determine the weighting coefficients. (10 分)

Fig.1

3. To communicate one bit of information reliably, a system transmit the same binary symbol five times. Thus, the information "zero" is transmitted as 00000 and "one" is 11111. The receiver detects the correct information if three or more binary symbols are received correctly. What is the information error probability P[E], if the binary symbol error probability is $q=0.1$? (10 分)

4. We assume that the message is a wide-sense stationary random process $M(t)$ with the autocorrelation function $R_M(\tau) = 16 \text{ sinc}^2(10000\tau)$. We also know that all the realizations of the message process satisfy the condition max $|m(t)| = 6$. We want to transmit this message to a destination via a channel with a 50 dB attenuation and additive white noise with the power spectral density $S_n(f) = N_0/2 = 10^{-12}$ W/Hz. We also want to achieve an SNR at the modulator output of at least 50 dB. What is the required transmitter power and channel bandwidth if we employ the following modulation schemes?

    (a) DSB AM (5 分)

    (b) SSB AM (5 分)

    (c) Conventional AM with a modulation index equal to 0.8 (5 分)

5. a) Find the Fourier transform of the following signals.

    a. $x_1(t) = \Pi(t-1)\exp[j4\pi(t-1)]$ (4 分)

    b. $x_2(t) = \Pi(t+1)\exp[j4\pi(t+1)]$ (4 分)

    b) By applying appropriate theorems and using the signals defined in a), find Fourier transforms of the following signals.

    a. $x_a(t) = \frac{1}{2}x_1(t) + \frac{1}{2}x_1(-t)$ (4 分)

    b. $x_b(t) = \frac{1}{2}x_2(t) + \frac{1}{2}x_2(-t)$ (4 分)

6. Find the power spectral densities and average power of the following signals.

    a. $x_1(t) = 2\cos\left(20\pi t + \frac{\pi}{3}\right)$ (3 分)

    b. $x_2(t) = 3\sin(30\pi t)$ (3 分)

    c. $x_3(t) = 5\sin\left(10\pi t - \frac{\pi}{6}\right)$ (3 分)