國立臺北科技大學九十九學年度碩士班招生考試

系所組別：2220 電腦與通訊研究所乙組

第二節　通訊系統　試題

注意事項：

1. 本試題共 6 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. (16%) A random signal has the autocorrelation function
   $R(\tau) = 20 + 5\Lambda(\tau/10)$
   where $\Lambda(x)$ is the unit-area triangular function. Determine the following:
   (1). The power spectral density of the random signal. (4%)
   (2). The total power contained in the random signal. (4%)
   (3). The DC power contained in the random signal. (4%)
   (4). The AC power contained in the random signal. (4%)

2. (20%) A zero-mean white Gaussian noise with power spectral density $N_o/2$ is connected to the input of the RC filter shown in Figure 1.

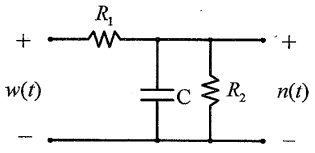

Figure 1

   (1). Find the power spectral density and autocorrelation function of the random process at the output of the filter. (10%)
   (2). What are the mean and variance of this output? (10%)

3. (16%) An AM modulator has output
   $s(t) = 50\cos(11000\pi t) + 20\cos(12000\pi t) + 20\cos(10000\pi t)$
   (1). Determine the modulation index and the efficiency of the modulator. (8%)
   (2). Determine the carrier power and side-band power for R = 1 ohm. (8%)

4. (16%) On the basis of null-to-null bandwidths, find the required transmission bandwidth to achieve a bit rate of 100 kbps for the following:
   (1). 16-PSK (4%)
   (2). 16-QAM (4%)
   (3). 16-FSK, coherent (tone spacing $=\frac{1}{2T_s}$ Hz) (4%)
   (4). 16-FSK, noncoherent (tone spacing $=\frac{2}{T_s}$ Hz) (4%)

5. (14%) Figure 2 shows a pair of signals $s_1(t)$ and $s_2(t)$ that are orthogonal to each other over the observation interval $0 \le t \le 2T$. The received signal is defined by
   $$x(t) = s_i(t) + n(t), \quad 0 \le t \le 2T, \quad i = 1, 2$$
   where $n(t)$ is a zero-mean white Gaussian noise with power spectral density $N_o/2$.
   (1). Design a receiver that decides in favor of signals $s_1(t)$ or $s_2(t)$, assuming that these two signals are equiprobable. (7%)
   (2). Find the average probability of symbol error incurred by this receiver for $\frac{E_s}{N_o} = 8$, where E_s is the signal energy. (7%)

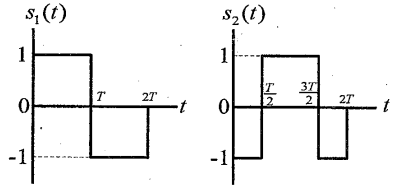

Figure 2

6. (18%) A digital communication system transmits binary data at the rate of 4 Mbps. During the course of transmission, Gaussian noise of zero mean and power spectral density 10^{-13} w/Hz is added to the signal. In the absence of noise, the amplitude of the received sinusoidal wave for digit 1 or 0 is 4 mV. Determine the average probability of symbol error for the following system configurations:
   (1). Coherent MSK (6%)
   (2). Coherent BFSK (6%)
   (3). Noncoherent BFSK (6%)

Note: If necessary, express your answer in terms of the complementary error function defined by $erfc(x) = \frac{2}{\sqrt{\pi}} \int_x^\infty \exp(-z^2)dz$.