國立臺北科技大學 100 學年度碩士班招生考試

系所組別：2140 電機工程系碩士班丁組

第一節　通訊原理　試題

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%)

Assume $X(t)$ is a white random process with power spectrum $S_X(f)=1, \forall f$.

Suppose $X(t)$ is the input to the linear filter with impulse response

$$h(t)=\begin{cases} e^{-t}, & t\geq 0 \\ 0, & t<0 \end{cases}$$

(10%) (a) Determine the power spectrum $S_Y(f)$ of the filter output.

(15%) (b) Write a computer programming script (in one of the formats of MATLAB, C/C++/C#, Java, etc...) to compute and plot $S_Y(f)$ under the given $S_X(f)$ and $h(t)$.

2.(25%)

Assume a message signal is given by $m(t)=2\cos(2\pi f_m t)+\cos(4\pi f_m t)$.

Let $x_c(t)=2m(t)\cos(2\pi f_c t)+2\hat{m}(t)\sin(2\pi f_c t)$, where $\hat{m}(t)$ is the Hilbert Transform of $m(t)$.

(10%) (a) Derive $x_c(t)$

(15%) (b) Show that $x_c(t)$ is indeed a lower-sideband SSB signal of $m(t)$ based on your answer in (a).

3. (25%)

In a digital communication system, a root-raised cosine (RRC) filter is frequently used as the transmit and receiver filter. A RRC filter $H_{RRC}(f)$ is defined as

$$H_{RC}(f)=H_{RRC}(f)H_{RRC}(f),$$

where

$$H_{RC}(f)=\begin{cases} T, & 0\leq |f|\leq \dfrac{1-\alpha}{2T} \\ \dfrac{T}{2}\left[1+\cos\dfrac{\pi T}{\alpha}\left(|f|-\dfrac{1-\alpha}{2T}\right)\right], & \dfrac{1-\alpha}{2T}\leq |f|\leq \dfrac{1+\alpha}{2T} \\ 0, & |f|>\dfrac{1+\alpha}{2T} \end{cases}$$

is the raised cosine (RC) filter. Explain in details what rules the RRC filters play from the following aspects:

(10%) (a) Output signals of the receiver

(15%) (b) Bandlimited channel

4. (25%)

Suppose binary data are transmitted over an additive white Gaussian noise (AWGN) channel using BPSK signaling. Assume an optimal matched filter detection is used at the receiver, and hard-decision decoding is applied at the output of the matched filter detection.

(10%) (a) Derive (show details) the error probability of this BPSK system in terms of γ, where γ is defined as $\gamma=\dfrac{E_b}{N_0}$, in which E_b is the energy of each BPSK signal and $\dfrac{N_0}{2}$ is the noise power spectral density.

(15%) (b) Derive (show details) the channel capacity of this BPSK system based on the answer you derived in (a).