

國立成功大學

111學年度碩士班招生考試試題

編 號：182

系 所：電腦與通信工程研究所

科 目：通信系統

日 期：0219

節 次：第 2 節

備 註：可使用計算機

※ 考生請注意：本試題可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. (10%) Consider a linear time-invariant (LTI) channel whose unit impulse response is denoted as  $g[n]$ . Suppose that we know that  $g[n]=0$  if  $n < 0$  or  $n > 1$ . Let  $x[n]$  and  $y[n]$  denote the input and output of the channel, respectively. Suppose that we feed the channel with an input with  $x[n]=0$  if  $n < 0$  or  $n > 1$ . Determine  $g[n]$  based on  $x[0], x[1], y[0]$ , and  $y[1]$ .
  
2. (40%) Consider the following DSB-SC signal:  $x_c(t) = A_c m(t) \sin(2\pi f_c t + \theta)$  where  $m(t)$  is the real-valued message signal that satisfies  $\int_{-\infty}^{\infty} m(t) dt = 0$  (i.e.,  $m(t)$  does not have the DC component),  $A_c > 0$  is a constant,  $f_c > 0$  is the carrier frequency in Hertz (Hz),  $\theta$  is a constant phase, and  $x_c(t)$  is the transmitted DSB-SC signal. Let  $x_r(t)$  denote the received signal where we assume that  $x_r(t) = x_c(t)$ . Assume that the message bandwidth is  $W$  Hz. Suppose that, at the receiver, you first multiply the received signal with the local carrier  $c(t) = -\sin(2\pi f_c t)$ . The resulting signal is passed through the ideal lowpass filter (LPF) with a passband gain of 2 and a cutoff frequency of  $B$  Hz (where  $2f_c - W > B > W$ ).
  - (a) From a time-domain perspective, find the expression of the output signal of the LPF. [10 points]  
**Hint:** 寫出 receiver 中各個訊號點的 time-domain expression.
  - (b) From a frequency-domain perspective, find the expression of the output signal of the LPF. [Let us define  $M(f)$  as the continuous-time Fourier transform of  $m(t)$ .] [20 points]  
**Hint:** 寫出 receiver 中各個訊號點的 frequency-domain expression (in terms of continuous-time Fourier transform.) You could use the Euler's formula.  
**● Please note:** 本題並無假設  $m(t)$  的頻譜是呈某特定形狀，故請勿使用圖解畫頻譜之方式作答。
  - (c) Determine the expression of the local carrier  $c(t)$  such that the output of the ideal LPF at the receiver is exactly  $m(t)$ . 並由此推導過程寫出你設計的 **local carrier** 其 **phase** 所須滿足之條件。 [10 points = 5+5]  
**[Note]** 此題假設在接收端有辦法產生任何你想產生的 sinusoidal 波形 當 local carrier。請寫出 local carrier 的數學式。
  
3. (25%) Please answer the following questions
  - (a) Can we apply spread spectrum system to improve BER performance in the pure AWGN environment? why? [5+5 points]
  - (b) Why can the multi-carrier system eliminate the effects of multipath interference, i.e. ISI? [5 points]
  - (c) What cause its power amplifier operate in the lower efficient region? What is the name of this effect we usually call? [5+5 points]

4. (25%) Please answer the following questions related to M-ary phase modulation.

- (a) Drive the exact expression of the symbol error rate for M-ary phase modulation scheme, i.e. [20 points]

$$P_E = \frac{1}{\pi} \int_0^{\pi - \frac{\pi}{M}} \exp\left(-\frac{\left(\frac{E_s}{N_0}\right) \sin^2(\pi/M)}{\sin^2(\phi)}\right) d\phi$$

Where  $E_s$  and  $N_0/2$  denote the symbol energy and double-side band power spectrum density of AWGN.

- (b) It is known that we can use source coding to reduce the bit error rate. Could you write down the name of a source doing? [5 points]