國立中正大學
112學年度碩士班招生考試
試 題

[第1節]

科目名稱	通訊原理
系所組別	通訊工程學系-通訊甲組

－作答注意事項－

※作答前請先核對「試題」、「試卷」與「准考證」之系所組別、科目名稱是否相符。

1. 預備鈴響時即可入場，但至考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。
2. 考試開始鈴響時，即可開始作答；考試結束鈴響畢，應即停止作答。
3. 入場後於考試開始40分鐘內不得離場。
4. 全部答題均須在試卷（答案卷）作答區內完成。
5. 試卷作答限用藍色或黑色筆（含鉛筆）書寫。
6. 試題須隨試卷繳還。

國立中正大學 112 學年度碩士班招生考試試題

科目名稱：通訊原理　　本科目共 2 頁　第 1 頁

系所組別：通訊工程學系-通訊甲組

1. (20 %) A single sideband (SSB) signal can be expressed as

$$s(t) = m(t)\cos(2\pi f_c t) + \hat{m}(t)\sin(2\pi f_c t)$$

where $m(t)$ is the message signal, $\hat{m}(t)$ is the Hilbert transform of $m(t)$, and f_c is the carrier frequency. Let $M(f)$ be the Fourier transform of $m(t)$.

(a) (10%) Determine the Fourier transform of $s(t)$.

(b) (10%) Sketch a block diagram of the demodulator. Show that the message signal can be recovered using the demodulator.

2. (20 %) A DSB-SC signal is represented by

$$s(t) = Am(t)\cos(2\pi f_c t)$$

where $m(t)$ is the message signal and f_c is the carrier frequency. Let $M(f)$ and $S_m(f)$ be respectively the Fourier transform of $m(t)$ and the power spectral density of $m(t)$.

(a) (5 %) Determine the Fourier transform of $s(t)$.

(b) (5 %) Determine the power spectral density of $s(t)$.

(c) (10 %) How to demodulate the DSB-SC signal? Sketch the block diagram of the demodulator.

3. (20 %) The received signal in a binary communication system that employs antipodal signals is

$$r(t) = As(t) + n(t)$$

where $s(t)$ is shown in Figure 1 and $n(t)$ is AWGN with power spectral density of $N_0/2$. The value of A is given by

$$A = \begin{cases} \sqrt{E_s} & \text{if 1 is transmitted} \\ -\sqrt{E_s} & \text{if 0 is transmitted} \end{cases}$$

(a) (5 %) Sketch the impulse response of the filter matched to $s(t)$.

(b) (5 %) Sketch the output of the matched filter to the input $s(t)$.

(c) (5 %) Determine the variance of the noise output of the matched filter at $t = 1$.

(d) (5 %) Assume that $A = \sqrt{E_s}$ and $A = -\sqrt{E_s}$ occur with equal probability. Determine the probability of error as a function of E_s and N_0.

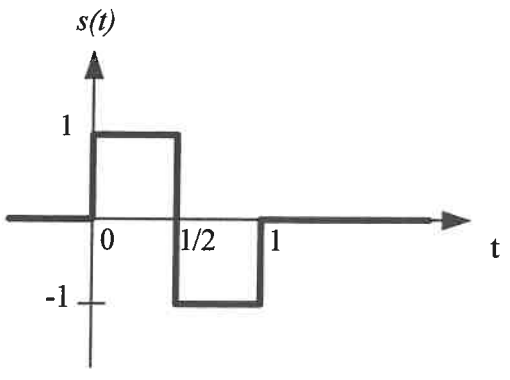

Figure 1

4. (20 %) Three modulation schemes, the binary phase-shift keying (BPSK), the binary frequency-shift keying (BFSK), and the on-off keying (OOK) are considered as candidates for a digital communication system. Let E_s be the average transmit energy per symbol.
   (a) (15 %) Determine the bit error rates for BPSK, BFSK, and OOK over the AWGN channel with power spectral density of $N_0/2$.
   (b) (5 %) Which one should be selected to achieve the lowest bit error rate? Explain why?

5. (20 %) A binary communication system uses two signals $s_1(t)$ and $s_2(t)$, for $0 \le t < T$, to represent equal probable information bit "0" and "1", respectively. The energies for both signals are equal with $E = \int_0^T |s_1(t)|\,dt = \int_0^T |s_2(t)|\,dt$. Let the received signal be $r(t) = s_i(t) + n(t)$, where $n(t)$ is a zero-mean white Gaussian noise with power spectral density of $N_0/2$.
   (a) (10 %) Design an optimal receiver for the system.
   (b) (5 %) Determine the bit error rate for the optimal receiver.
   (c) (5 %) Given E and N_0, under what conditions, the receiver has the best performance.