國立成功大學 104 學年度碩士班招生考試試題

系所組別：電腦與通信工程研究所乙組

考試科目：通信系統

考試日期：0211，節次：2

※ 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. (33%) Consider the following signal model.

$$x_c(t) = A[m_1(t)\cos(2\pi f_c t) + m_2(t)\sin(2\pi f_c t)] \ .$$

(a) (4%) Determine $m_1(t)$ and $m_2(t)$ for QPSK.

(b) (4%) Determine $m_1(t)$ and $m_2(t)$ for MSK.

(c) (10%) Derive the error probability of QPSK.

(d) (5%) Explain what is OQPSK and what is its purpose?

(e) (5%) Also, what is the difference between OQPSK and MSK in terms of the envelope deviation characteristics?

(f) (5%) Compare the error rate performance between QPSK, OQPSK and MSK.

2. (17%) A source output consists of four messages $[m_1, m_2, m_3, m_4]$ with respective probabilities [0.35, 0.3, 0.2, 0.15]. Determine the binary code words for the second-order source extension using Huffman coding technique. Determine the efficiency of the resulting codes.

3. (25%=5%*5) Consider a discrete-time linear time-invariant (LTI) system described by the following difference equation:

$$y(n) = \frac{1}{2}[x(n) - x(n-1)]$$

where $x(n)$ denotes the system's input, and $y(n)$ the output. (We assume that the condition of initial rest is satisfied. Therefore, the system is an LTI system.)

(a) Plot the magnitude response of the system, denoted as $|H(\omega)|$. [頻率(ω)軸請畫出 -2π~2π 的範圍。]

(b) Plot the phase response of the system, denoted as $\angle H(\omega)$. [頻率(ω)軸請畫出 -2π~2π 的範圍。]

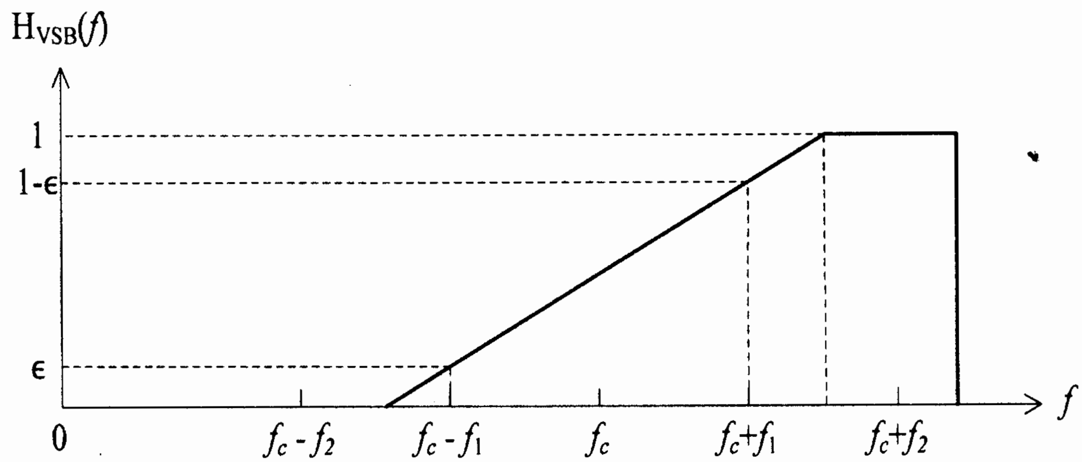
(c) Is this system a lowpass filter or a highpass filter? Justify your answer.

(d) If $x(n) = \left[\dfrac{(-1)^n \cdot \sin\left(\frac{\pi}{4}n\right)}{\pi n}\right]$, plot the magnitude spectrum of output $y(n)$. [頻率(ω)軸請畫出 -2π~2π 的範圍。]

(e) Determine the difference equation that describes the inverse system of $H(\omega)$. Note: Please denote the input and output of the inverse system as $x'(n)$ and $y'(n)$, respectively.

[There are problems on the next page.]

4. (25%) Consider the following vestigial sideband (VSB) system. The message signal is given by $m(t) = A\cos(2\pi f_1 t) + B\cos(2\pi f_2 t)$ where $A>0$, $B>0$, and $f_2 > f_1$. The message signal is first multiplied by $A_c\cos(2\pi f_c t)$ where f_c is the carrier frequency (in Hz), before passing through the VSB sideband filter to generate the VSB signal $x_{\text{VSB}}(t)$. The frequency response of the VSB sideband filter, denoted as $H_{\text{VSB}}(f)$, is shown below.



Note in the figure that $H_{\text{VSB}}(f)$ is plotted for $f \geq 0$ only; for $f < 0$, we have $H_{\text{VSB}}(f) = H_{\text{VSB}}(-f)$. In other words, $H_{\text{VSB}}(f)$ is real-valued and even. We assume that the propagation channel is ideal, i.e., the channel gain is 1 and there is no noise. Therefore, the received signal is equal to the transmitted signal.

(a) (5%) Plot the spectrum of $x_{\text{VSB}}(t)$, which is $X_{\text{VSB}}(f)$, the continuous-time Fourier transform (CTFT) of $x_{\text{VSB}}(t)$.

(b) (5%) From the frequency-domain perspective, demonstrate how the VSB signal can be coherently demodulated. [That is, show how $M(f)$, the CTFT of $m(t)$, can be recovered from $X_{\text{VSB}}(f)$.] You need to draw the block diagram of the demodulator.

(c) (5%) Determine the expression of $x_{\text{VSB}}(t)$. Note: You need to express $x_{\text{VSB}}(t)$ in the form of $a(t)\cos(2\pi f_c t) + b(t)\sin(2\pi f_c t)$.

(d) (10%) To enable non-coherent demodulation, we need to insert the carrier signal before transmission. In other words, the transmitted signal is given by $y_{\text{VSB}}(t) = x_{\text{VSB}}(t) + C\cos(2\pi f_c t)$ where $C>0$. Demonstrate how the VSB signal can be demodulated in a non-coherent manner. You need to draw the block diagram of the demodulator. You also need to clearly specify the conditions (on C) on which non-coherent demodulation recovers $m(t)$.