國立成功大學 105 學年度碩士班招生考試試題

系　　所：電腦與通信工程研究所

考試科目：通信系統

考試日期：0228，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. (10%) In order to determine the impulse response of an unknown causal, linear time-invariant (LTI) system, Tang feeds the following input $x[n]$ to the system:

$$x[n]=0, \text{ if } n<0;\ x[n]=1, \text{ if } n\geq 0.$$

The corresponding output $y[n]$ is given by the following: $y[n]=0$, if $n<0$; $y[n]=8,\ 12,\ 14,\ 15,\ 15.5$, for $n=0,\ 1,\ 2,\ 3,\ 4$, respectively; $y[n]=15.75$, if $n\geq 5$.

(a) Find the impulse response of this system.

(b) Let $\mathbf{y}=[y[0],\cdots,y[5]]^T$ and $\mathbf{x}=[x[0],\cdots,x[5]]^T$. The input-output relationship of this system can be written as $\mathbf{y}=\mathbf{H}\mathbf{x}$. Determine the matrix $\mathbf{H}$.

2. (14%) Consider the following two-path channel:

$$y(t)=\frac{1}{\sqrt{2}}s(t)-\frac{1}{\sqrt{2}}s(t-\tau_0)$$

where $s(t)$ and $y(t)$ represent the channel input and output, respectively, and τ_0 is a constant that represents the propagation delay. It can be shown that the channel is an LTI system; the impulse response is denoted as $h(t)$.

(a) Determine $h(t)$.

(b) For an input signal $s(t)=\cos(2\pi f_0 t)$ with $f_0=\frac{1}{6}\times 10^6$ Hz, determine $y(t)$. Assume that the propagation delay is $\tau_0=1\times 10^{-6}$ sec. (Note: 答案必須是 $A\cos(2\pi ft+\theta)$ 的型式。)

(c) Suppose that the spectrum of the input $s(t)$ is centered at 1.5×10^6 Hz and has a bandwidth of 100 kHz. If you are asked to design an LTI system (i.e., a linear equalizer) at the receiver that processes $y(t)$ properly to recover $s(t)$. Determine the frequency response of the equalizer. Again, assume that $\tau_0=1\times 10^{-6}$ sec.

3. (5%) Consider a transmission scheme based on pulse-code modulation (PCM). The message signal is bandlimited by an anti-aliasing filter such that components above 3400 Hz are eliminated. The resulting signal is sampled at a rate of 8 kHz. A uniform quantizer with 256 levels is used to quantize the samples before encoding to binary digits (bits). Each bit is transmitted using a baseband rectangular pulse. Let us assume that the bandwidth occupied by such a pulse of width T sec is approximately $\frac{1}{T}$ Hz. Determine the transmission bandwidth of such a scheme.

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4. (21%)簡答、填充、選擇題

(a) [選擇題] Gaussian noise 是指 noise 的何種特性呈高斯分布: (A)取樣值。(B)瞬間功率。(C)功率頻譜密度(power spectral density)。(D)頻譜。(E)振幅頻譜(magnitude spectrum)。

(b) [選擇題] 訊雜比(SNR, signal-to-noise ratio)為 20 dB 表示: (A)訊號電壓之絕對值是雜訊電壓之絕對值的 20 倍。(B)訊號電壓之絕對值是雜訊電壓之絕對值的 100 倍。(C)訊號功率是雜訊功率的 10 倍。(D)訊號功率是雜訊功率的 100 倍。(E)以上皆非。

(c) 在 AWGN (additive white Gaussian noise) channel 中,將接收訊號放大 m 倍,則 SNR 會變為放大前之 ___ 倍. (填空)

(d) Is $x[n]=cos(0.4n)$ a periodic signal ? Justify your answer. (簡答)

(e) Determine the fundamental period of $x[n]=cos\left(\frac{4\pi n}{25}\right)$. (簡答)

(f) 解釋為何在 FDM (frequency-division multiplexing) 系統中需使用 guard band。 (簡答)

(g) 解釋為何 message signal 在調變過程中常被乘上高頻的載波(如 $\cos(2\pi f_c t)$)? (簡答)

5. (22%) Given the following signals:

$$S_A(t) = A\cos\left(\frac{\pi(t-T/2)}{T}\right)\prod\left(\frac{t-T/2}{T}\right)$$

and

$$S_B(t) = \frac{B}{2}\left\{1+\cos\left(\frac{2\pi(t-T/2)}{T}\right)\right\}\prod\left(\frac{t-T/2}{T}\right)$$

Assume that they are used in a binary digital data transmission system under the impact of AWGN. The priori-probabilities of $S_A(t)$ and $S_B(t)$ are equal. Note that the optimal receiver is the match filter.

(1) (15%) Derive the error probability P_E.

(2) (7%) Write down the optimum detection threshold.

6. (10%) Consider the marker code 10111000. Find the Hamming distance h between all possible shifts of it and the received sequence 10110 10110 00011 10101. Is there a unique match to within $h = 1$ and this received sequence? If so, at what delay does it occur?

7. (18%) On the basis of null-to-null bandwidths, given the required transmission bandwidth to achieve a bit rate of 10 Kbps under the AWGN channel using the following modulation scheme:

(1) (4%) 16-QAM

(2) (4%) 32-PSK

(3) (5%) 8-FSK, coherent

(4) (5%) 16-FSK, noncoherent