

國立臺北科技大學

九十四學年度電機工程系碩士班入學考試

通訊原理試題

填准考證號碼

第一頁 共二頁

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注意事項：

1. 本試題共八題，配分共 100 分。
2. 請按順序標明題號作答，不必抄題。
3. 全部答案均須答在答案卷之答案欄內，否則不予計分。

1. (10%) A stationary process $x(t) = A \cos(2\pi f_c t + \theta)$ is applied to a linear filter whose impulse response is defined by a truncated exponential:

$$h(t) = \begin{cases} ae^{-2at}, & 0 \leq t \leq T \\ 0, & \text{otherwise} \end{cases} \quad (a)$$

The θ is a uniformly distributed random variable over the interval $[-\pi, \pi]$. Please find the power spectral density $S_y(f)$ of the filter output $y(t)$.

2. (15%) Consider a linear prediction filter, the filter output $\hat{x}[n]$ is defined as below:

$$\hat{x}[n] = \sum_{k=1}^p w_k x[n-k]$$

The p is the prediction order. The w_k is the predictive coefficient. The mean square value J of prediction error is defined as below:

$$J = E[(x[n] - \hat{x}[n])^2]$$

Please derive and prove the following equations.

$$w_o = R_x^{-1} r_x$$

$$J_{\min} = \sigma_x^2 - r_x^T R_x^{-1} r_x$$

(The w_o is the optimum coefficient vector. The J_{\min} is the minimum mean square value of the prediction error. The r_x is p -by-1 autocorrelation vector. The R_x is p -by- p autocorrelation matrix.)

3. (15%) The properties of the Hilbert transform are listed as below. Please prove them.

(a). A signal $g(t)$ and its Hilbert transform $\hat{g}(t)$ have the same magnitude spectrum. (4%)

(b). If $\hat{g}(t)$ is the Hilbert transform of $g(t)$, then the Hilbert transform of $\hat{g}(t)$ is $-g(t)$. (4%)

(c). A signal $g(t)$ and its Hilbert transform $\hat{g}(t)$ are orthogonal over the entire time interval $(-\infty, \infty)$, as shown by (4%)

$$\int_{-\infty}^{\infty} g(t)\hat{g}(t)dt = 0$$

(d). The signals $\frac{g(t) + j\hat{g}(t)}{2}$ and $g(t)$ have the same spectrum at the positive frequency. (eq. $f > 0$). (3%)

4. (10%) The binary data stream 0110101011 is applied to the input of a modified duobinary system.

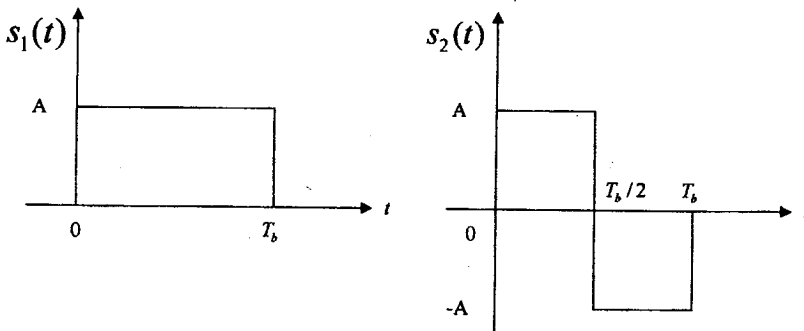
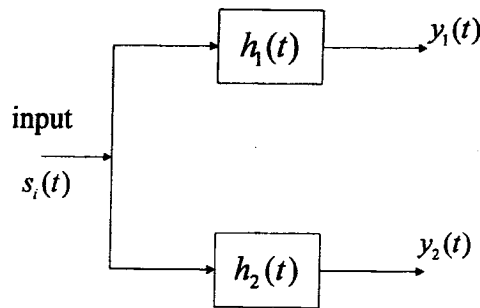
(a). Construct the modified duobinary coder output and corresponding receiver output, with a precoder. (5%)

(b). Suppose that due to error during transmission, the level produced by the second digit is reduced to zero. Construct the new receiver output. (5%)

注意：背面尚有試題

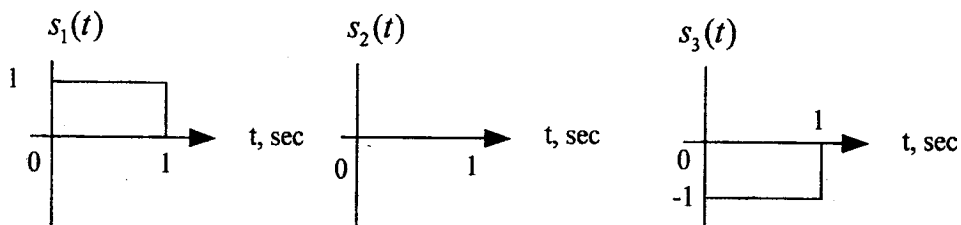
5. (10%) A system for detecting signals $s_1(t)$ and $s_2(t)$ is shown below, where $h_1(t)$ and $h_2(t)$ are filters matched to $s_1(t)$ and $s_2(t)$, respectively.

- (a) Sketch the impulse responses of the filters $h_1(t)$ and $h_2(t)$. (4%)
- (b) Sketch the waveforms of $y_1(t)$ and $y_2(t)$ when $s_1(t)$ is transmitted. (6%)

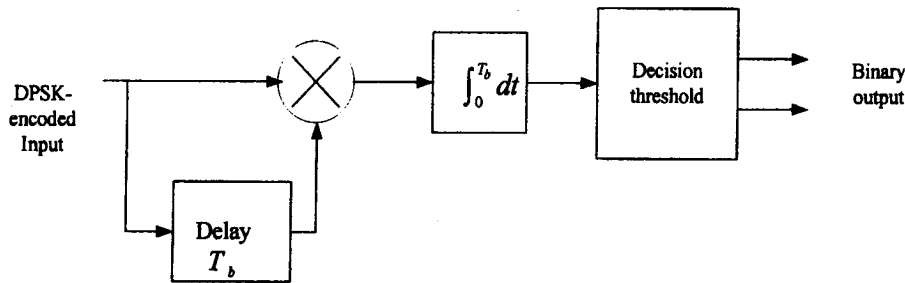


6. (10%) Three signals to be detected are shown below and it is assumed that they are equally likely. The received signal is $x(t) = s_i(t) + w(t)$, $i=1,2,3$, $0 \leq t \leq 1$, where $w(t)$ is AWGN.

- (a) Plot the corresponding signal-space diagram (signal constellation) and indicate the decision regions for optimum detection in the signal space. (4%)
- (b) Plot the block diagram of the optimum correlation receiver for detecting these three signals. Note that the optimum receiver consists of two subsystems, which include the detector part for producing the observation vector \mathbf{x} , and the signal transmission decoder implemented in the form of a maximum-likelihood decoder. (6%)



7. (12%) The bit stream 101101001 is to be transmitted using DPSK modulation scheme.
- (a) Determine the encoded sequence. Assume a '1' as the extra starting (preamble) digit.(4%)
 - (b) Now the receiver shown below is used to demodulate the DPSK-encoded signal. Determine the detection result if an error in the fourth digit (not include the preamble digit) in the DPSK-encoded bit stream in part (a) is introduced. Explain your result.(4%)
 - (c) Describe the advantage(s) and disadvantage(s) of DPSK scheme.(4%)



8. (18%) Answer the following questions.
- (a) What modulation scheme is employed in the GSM system? What advantages does this scheme have?(5%)
 - (b) What are the advantage(s) and disadvantage(s) of using coherent M -ary PSK with large M ? (5%)
 - (c) A discrete memoryless source has its output from alphabet set $\{A, B, C, D\}$ with probability $P(A)=1/2, P(B)=1/4, P(C)=1/8,$ and $P(D)=1/8,$ respectively. Calculate the coding efficiency if Huffman coding scheme is applied. (8%)