國立臺北科技大學

九十七學年第一學期電機系博士班資格考試

數位通訊理論

填學生證號碼

注意事項：

1. 本試題共【6】題，配分共 100 分。
2. 請按順序標明題號作答，不必抄題，可用計算器。
3. 全部答案均須答在試卷答案欄內，否則不予計分。
4. 考試時間:二小時。

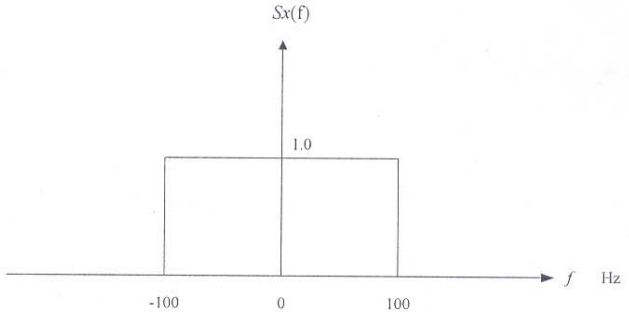
1. Briefly answer the following questions.

(a) List the advantage(s) and disadvantage(s) of duobinary signaling scheme (correlative-level coding) with and without precoding. (8%)

(b) What is the advantage of QPSK compared to BPSK? (4%)

(c) Describe the major disadvantage of QPSK. How to improve it? (6%)

2. Given that $Y(t) = X(t)\cos(2\pi 10^4 t + \Theta)$ where $X(t)$ is a WSS random process with PSD shown below, and Θ is a random variables that is uniformly distributed over the interval $[0, 2\pi]$. The signal $X(t)$ and Θ come from physically independent sources. Calculate the power of $Y(t)$ delivered to a $1-\Omega$ resistor. (18%) (Note: Complete process must be given)



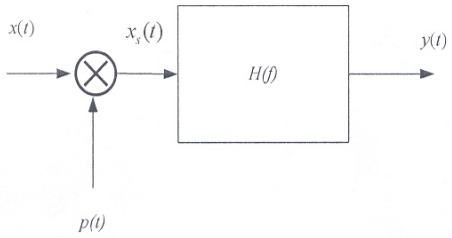
3. Briefly compare the different among TDMA, FDMA, and CDMA. Also describe their applications. (15%)

4. An ideal sampling system is shown below where $p(t) = \sum_{n=-\infty}^{\infty} \delta(t - nT_s)$ with sampling frequency $f_s = 1/T_s$.

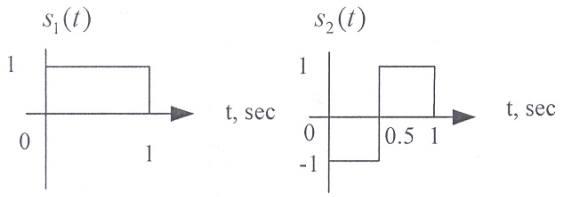
(a) Derive $X_s(f)$, the Fourier transform of $x_s(t)$. (8%)

(b) Sketch $X_s(f)$ if $x(t) = \sin c(2Wt)$ and $f_s = 3W$. (6%)

(c) Specify $H(f)$ for perfect reconstruction of $x(t)$. (3%)



5. Two signals $s_1(t)$ and $s_2(t)$ are transmitted over an AWGN channel and the correlation receiver shown below is used for detection. It is assumed that they are equally likely. The received signal is $x(t) = s_i(t) + w(t)$, $0 \le t \le 1$, where $w(t)$ is an AWGN of zero mean and with PSD of $\frac{N_0}{2}$ and E_j is the energy of $s_j(t)$. Answer the following problems.



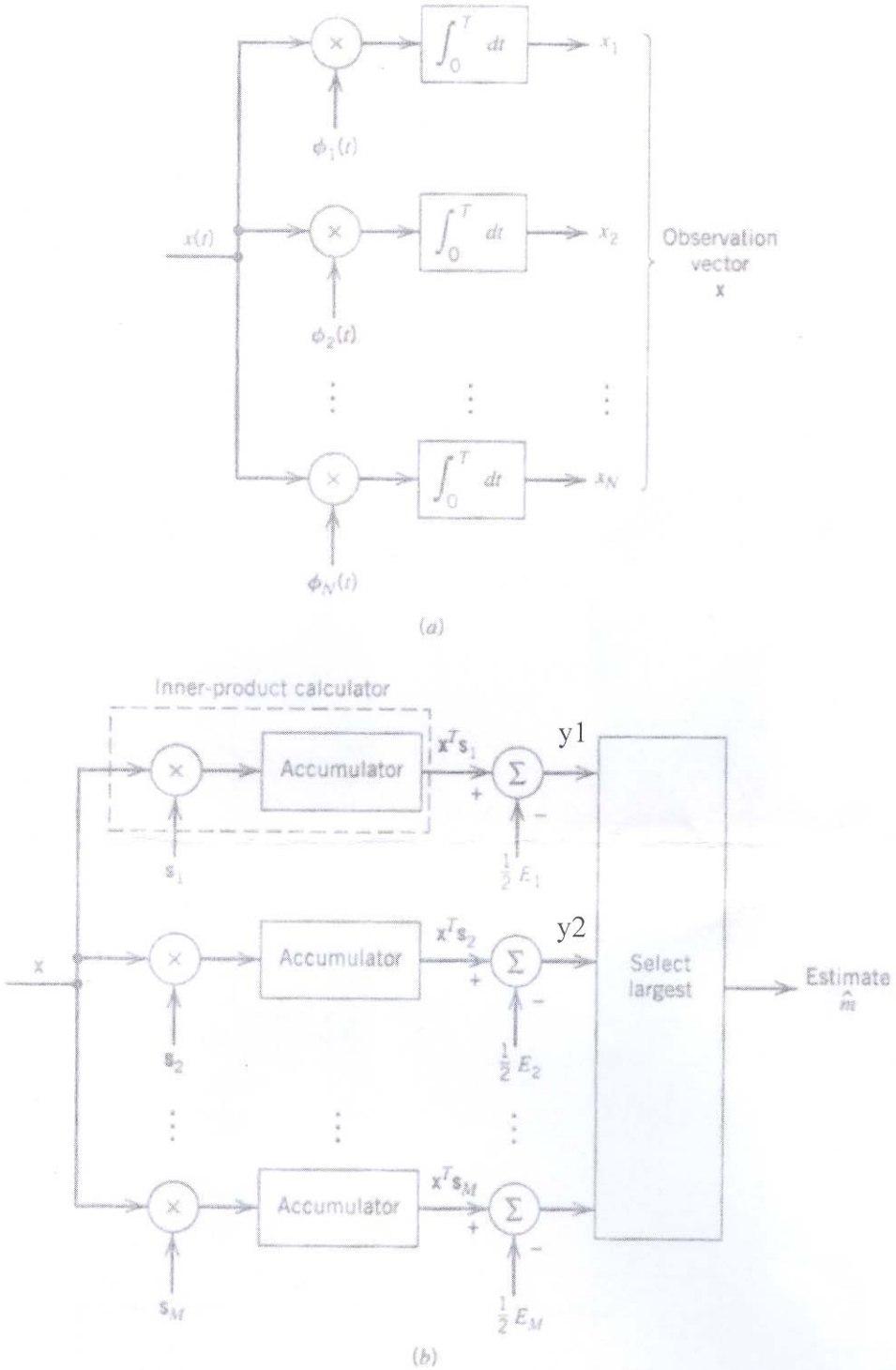


FIGURE 5.9 (a) Detector or demodulator. (b) Signal transmission decoder.

(a) Please determine the orthonormal basis function then plot the signal constellation and decision regions for optimum detection in the signal space. (8%)

(b) Assume that $w(t) = 1.5,\ 0 \le t \le 1$, calculate the values of y1 and y2 if $s_2(t)$ was transmitted. Describe your detection result in this case. (6%)

6. A pair of sinusoidal waves of a BPSK system is represented by $s_1(t) = \sqrt{\frac{2E_b}{T_b}}\cos(2\pi f_c t)$ and $s_2(t) = \sqrt{\frac{2E_b}{T_b}}\cos(2\pi f_c t + \pi) = -\sqrt{\frac{2E_b}{T_b}}\cos(2\pi f_c t)$, where $0 \le t \le T_b$, and E_b is the transmitted signal energy per bit. ($s_1(t)$ for symbol 1 and $s_2(t)$ for symbol 0) The received signal is defined by $x(t) = s_k(t) + w(t)$, $0 \le t \le T_b$, $k = 1,2$, where $w(t)$ is an AWGN of zero mean and with PSD $N_0/2$.

(a) Assign orthonormal basis function(s) for this system. (3%)

(b) Plot signal-space diagram for this system and indicate it optimum decision boundary. (6%)

(c) Show that for the case of equiprobable symbols, the bit error rate for coherent BPSK over the AWGN channel is $p_e = \frac{1}{2}erfc(\sqrt{\frac{E_b}{N_0}})$. (9%)

TABLE A6.3 ***Fourier-transform pairs***

Time Function	*Fourier Transform*
$\text{rect}\left(\frac{t}{T}\right)$	$T\,\text{sinc}(fT)$
$\text{sinc}(2Wt)$	$\frac{1}{2W}\,\text{rect}\left(\frac{f}{2W}\right)$
$\exp(-at)u(t), \quad a > 0$	$\frac{1}{a + j2\pi f}$
$\exp(-a\lvert t\rvert), \quad a > 0$	$\frac{2a}{a^2 + (2\pi f)^2}$
$\exp(-\pi t^2)$	$\exp(-\pi f^2)$
$\begin{cases} 1 - \frac{\lvert t\rvert}{T}, & \lvert t\rvert < T \\ 0, & \lvert t\rvert \geq T \end{cases}$	$T\,\text{sinc}^2(fT)$
$\delta(t)$	1
1	$\delta(f)$
$\delta(t - t_0)$	$\exp(-j2\pi f t_0)$
$\exp(j2\pi f_c t)$	$\delta(f - f_c)$
$\cos(2\pi f_c t)$	$\frac{1}{2}[\delta(f - f_c) + \delta(f + f_c)]$
$\sin(2\pi f_c t)$	$\frac{1}{2j}[\delta(f - f_c) - \delta(f + f_c)]$
$\text{sgn}(t)$	$\frac{1}{j\pi f}$
$\frac{1}{\pi t}$	$-j\,\text{sgn}(f)$
$u(t)$	$\frac{1}{2}\delta(f) + \frac{1}{j2\pi f}$
$\sum_{i=-\infty}^{\infty} \delta(t - iT_0)$	$\frac{1}{T_0}\sum_{n=-\infty}^{\infty} \delta\left(f - \frac{n}{T_0}\right)$

Notes: $u(t)$ = unit step function
$\delta(t)$ = delta function, or unit impulse
$\text{rect}(t)$ = rectangular function of unit amplitude and unit duration centered on the origin
$\text{sgn}(t)$ = signum function
$\text{sinc}(t)$ = sinc function