國立臺北科技大學

九十六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【5】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) What is the advantage of QPSK as compared to BPSK? (4%)

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

(c) What is white noise? (4%)

(d) What modulation scheme is employed in the GSM system. What advantage(s) does this scheme have? (4%)

(e) Why a nonuniform μ-law (or A-law) quantization is commonly used in the PCM-based telephone network? (4%)

(f) How to overcome noise effects in the PCM system? (4%)

2. The PSD of a random process $X(t)$ is shown below.

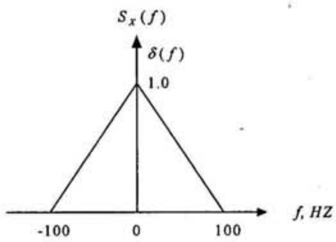
(a) Determine and sketch the autocorrelation function $R_X(\tau)$ of $X(t)$.(8%)

(b) Find the DC power contained in $X(t)$. (4%)

(c) Find the AC power contained in $X(t)$. (4%)

(d) How to make uncorrelated samples of $X(t)$?(4%)

(e) What condition will make samples in (d) statistically independent?(4%)



3. A discrete memoryless source has its output from alphabet set {A, B, C, D, E} with probability P(A)=1/2, P(B)=1/4, P(C)=1/8, P(D)=1/16, and P(E)=1/16, respectively.
   (a) Determine the entropy of this source. (5%)
   (b) Describe the meaning of the entropy. If possible, please explain it with the result obtained from (a). (5%)
   (c) Calculate the coding efficiency ($\eta = \frac{H(S)}{\bar{L}}$) if Huffman coding scheme is applied. (5%)

4. A speech signal is transmitted using an M-ary PAM system. The sampling rate is 10000 samples/sec and each sample is quantized to one of 256 levels (i.e.,8-bit quantization). Determine the minimum required bandwidth for transmitting the PAM wave if
   (a) M=4 using an ideal Nyquist channel. (5%)
   (b) M=32 using channel with raised cosine spectrum of $\alpha = 1$. (5%)

5. Three signals are given below.
   (a) Are they orthogonal to each other over the observation interval $0 \le t \le 2$? Describe your reason(s). (6%)
   (b) Using the Gram-Schmit orthogonalization procedure, find a set of orthonormal basis functions to represent the three signals. (15%)
   (c) Express each of these signals in terms of the set of basis functions found in (b). (6%)

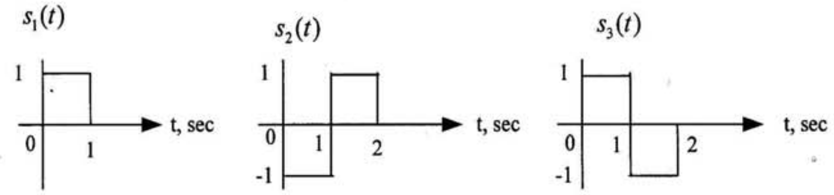


TABLE A6.3 ***Fourier-transform pairs***

Time Function	*Fourier Transform*
$\text{rect}\left(\frac{t}{T}\right)$	$T\,\text{sinc}(fT)$
$\text{sinc}(2Wt)$	$\frac{1}{2W}\text{rect}\left(\frac{f}{2W}\right)$
$\exp(-at)u(t), \quad a > 0$	$\frac{1}{a + j2\pi f}$
$\exp(-a\|t\|), \quad a > 0$	$\frac{2a}{a^2 + (2\pi f)^2}$
$\exp(-\pi t^2)$	$\exp(-\pi f^2)$
$\begin{cases} 1 - \frac{\|t\|}{T}, & \|t\| < T \\ 0, & \|t\| \geq T \end{cases}$	$T\,\text{sinc}^2(fT)$
$\delta(t)$	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