國立交通大學九十一學年度碩士班入學考試試題

科目名稱：通訊原理(062)　　考試日期：91 年 4 月 20 日 第 3 節

系所班別：電信工程學系　組別：甲組　　第 一 頁, 共 二 頁

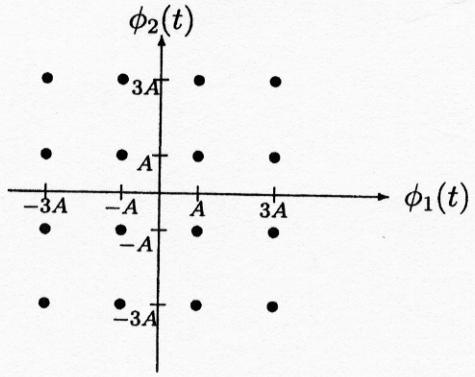
＊作答前, 請先核對試題、答案卷（試卷）與准考證上之所組別與考試科目是否相符!!

1. A baseband signal $x(t)$ with bandwidth W is sampled with sampling interval of T_s and a pulsed signal is formed as $x_p(t) = \sum_{n=-\infty}^{\infty} x(nT_s)p(t - nT_s)$, where $p(t)$ is an arbitrary pulse.
   (a) (6%) Find the Fourier transform of $x_p(t)$.
   (b) (3%) Find the conditions for perfect reconstruction of $x(t)$ from $x_p(t)$.
   (c) (3%) Determine the required reconstruction filter.

2. Consider a received modulated signal $x(t) = m(t)\cos(2\pi f_c t + \theta)$ where $m(t)$ is a wise-sense stationary baseband signal with bandwidth W and power spectral density $S_m(f)$, $n(t)$ is an AWGN with power spectral density $S_n(f) = N_0/2$, and $\cos(2\pi f_c t + \theta)$ is the carrier signal with a random phase θ distributed uniformly in $0 \le \theta \le 2\pi$. Assume $m(t), n(t)$, and θ are mutually independent.
   (a) (4%) Find the autocorrelation function of $x(t)$.
   (b) (3%) Find the power spectral density of $x(t)$.
   (c) (3%) Find the channel signal to noise power ratio SNR_c.
   (d) (3%) Draw the block diagram of a coherent receiver to detect baseband signal $m(t)$.
   (e) (4%) Describe a method to obtain the required local carrier used in the coherent receiver from the received signal.
   (f) (4%) Find the autocorrelation function of the output signal of the coherent receiver.
   (g) (3%) Find the output signal to noise power ratio SNR_o.

3. Consider digital transmission with a basic pulse waveform of $p(t)$ and at a symbol rate of R_s symbol/sec.
   (a) (4%) Under the above condition, describe the Nyquist pulse shaping criterion in words.
   (b) (4%) In baseband transmission, find and plot the waveform of $p(t)$ which uses the minimum bandwidth. What is the minimum bandwidth needed?
   (c) (4%) In passband transmission, find and plot the waveform of $p(t)$ which uses the minimum bandwidth. What is the minimum bandwidth needed?
   (d) (4%) Plot the time domain and frequency domain responses of the family of pulses with raised cosine spectra which can be used. Please indicate in your plot different roll-off factors.
   (e) (4%) Explain what trade-off factors are to be considered in order to choose an appropriate raised cosine roll-off factor in practice.

4. Consider a 16-QAM signal with the following signal space constellation, where $\phi_1(t)$ and $\phi_2(t)$ are two orthonormal basis functions and AWGN with power spectral density $S_n(f) = N_0/2$ is assumed in the following.



(a) (4%) Write down the equation of $\phi_1(t)$ and $\phi_2(t)$, assuming the 16-QAM symbol rate is R_s symbol/sec.

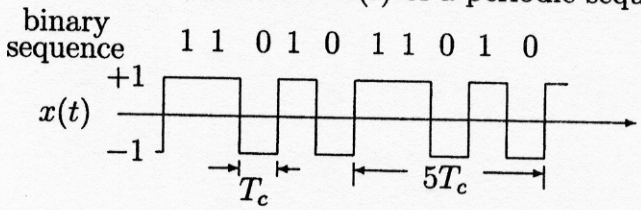
(b) (4%) Write down the equation of the 16-QAM signal.

(c) (4%) Derive the average symbol energy E_s.

(d) (4%) Treating the 16-QAM signal as two independently modulated quadrature signals, derive the average symbol error probability P_e. Please represent P_e as a function of E_s/N_0.

(e) (4%) Redraw the 16-QAM signal space constellation with the Gray encoded bit pattern indicated on each signal point.

5. Consider the waveform $x(t)$ of a periodic sequence 11010... (period $N = 5$):



Denote $R_x(\tau)$ and $S_x(f)$ as the time-averaged autocorrelation function and power spectral density of $x(t)$, respectively.

(a) (7%) Find and plot $R_x(\tau)$.

(b) (5%) Find $S_x(f)$, $f \in (-\frac{1}{10T_c}, \frac{1}{10T_c})$.

6. Suppose two discrete memoryless sources A and B have 3 and 4 symbols, respectively. Denote the probabilities of symbols as a_1, a_2, a_3 for A and b_1, b_2, b_3, b_4 for B. Assume Huffman coding is used for these two sources. Denote V_a and V_b as the average codeword lengths in bits for A and B, respectively, without the use of an extended code; and W_a and W_b as the average codeword lengths in bits for A and B, respectively, as the order of extension goes to ∞.

(a) (8%) Find and compare V_a and V_b. Is it always true that $V_b > V_a$?

(b) (4%) Find W_a and W_b.