國立中央大學107學年度碩士班考試入學試題

所別： 通訊工程學系碩士班 不分組(一般生)　　共2頁 第1頁

科目： 通訊系統

本科考試禁用計算器　　＊請在答案卷(卡)內作答

1. Consider a coherent detection 8-PSK signal

$$x_i(t) = \sqrt{\frac{2E_b}{T}}\cos\left(\omega_c t - \emptyset_i(t)\right),\ \emptyset_i(t) = \frac{\pi i}{4}, i = 0, 1, \ldots, 7,\ 0 \le t \le T$$

where E_b is the transmitted signal energy per symbol, T is the symbol duration, and ω_c is the carrier frequency in radian. Assume the 8-PSK signal is transmitted over the channel of the additive white Gaussian noise (AWGN) with two-sided power spectral density $N_0/2$.

(a) (5%) Draw the signal space of the 8-PSK signal along with Gray-code (bit mapping) that minimizes the bit error probability.

(b) (10%) Calculate the approximate symbol error probability of the coherent 8-PSK signal from the aspect of nearest neighbors in terms of the Q function, defined as

$$\mathrm{Q}(x) = \frac{1}{\sqrt{2\pi}}\int_x^\infty \exp(\frac{-\tau^2}{2})d\tau$$

(c) (5%) Following (a) and (b), what is the approximate bit error probability of the coherent 8-PSK signal?

2. The natural sampling Pulse Amplitude Modulation (PAM) waveform $x_{\mathrm{PAM}}(t)$ is produced from multiplying the message signal $x(t)$ by a periodic train of rectangular pulses $p(t)$ whose period is T_S and pulse width is T, where $T < T_S$, as depicted in Fig. 1.

(a) (5%) Use the notation $\prod(\frac{t}{T})$ to denote the rectangular pulse of pulse width T. Please write down the mathematical expression for $p(t)$.

(b) (10%) Derive the Fourier transform of $x_{\mathrm{PAM}}(t)$ in terms of frequency *f*.

(c) (5%) Determine the frequency response of the reconstruction filter for $x(t)$ from $x_{\mathrm{PAM}}(t)$.

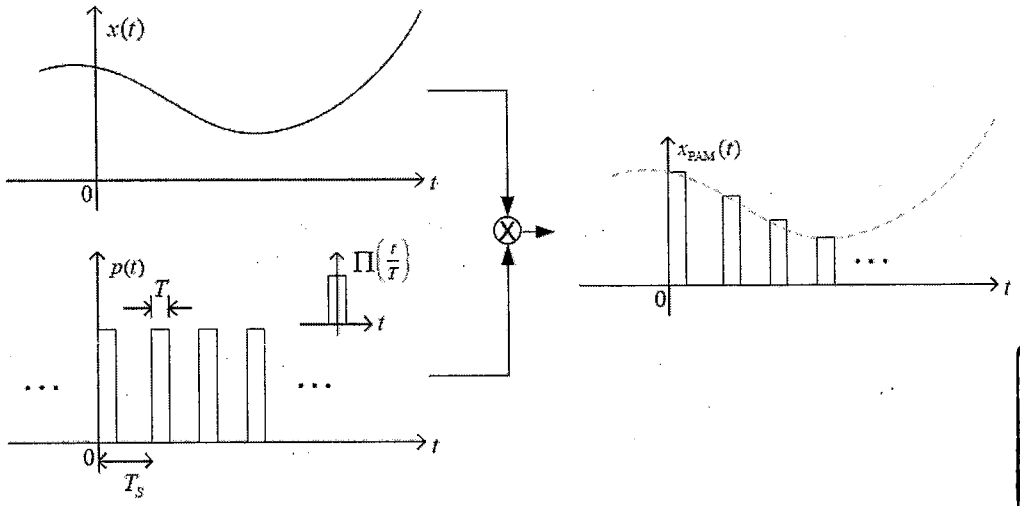

Fig. 1

注意:背面有試題

參考用

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3. (10%) The radio band of the Frequency Modulation (FM) spans from 88 MHz to 108 MHz. Let the FM receiver have the intermediate frequency (IF) at 10.7 MHz. Find two possible frequency ranges of the local oscillator (LO) for the receiver and their corresponding image frequency ranges.

4. The transmitted FM signal is $x(t) = A\cos(2\pi f_c t + \phi(t))$ and the received signal is $y(t) = x(t) + n(t)$ where $n(t)$ is AWGN. The receiver generates an estimate of $\phi(t)$, $\hat{\phi}(t)$.
(a) (6%) For fixed $t = t_1$, the receiver uses maximum-likelihood estimation. In other words, the conditional probability of receiving $y(t)$ given $\phi(t_1)$ reaches the maximum value when $\phi(t_1) = \hat{\phi}(t_1)$. Is it the best estimation? If the answer is "no", what is the best criterion in your opinion? Explain your answer.
(b) (6%) The receiver uses a phase-locked loop whose voltage-controlled oscillator has output $A'\cos(2\pi f_c t + \hat{\phi}(t))$. The differentiation of $\hat{\phi}(t)$ is in proportional to its input, a function of $\psi(t) = \hat{\phi}(t) - \phi(t)$. There are three candidates of the function: $\cos(\psi(t))$, $|\psi(t)|$, and $\tan(\psi(t))$. Which one is suitable? Explain your answer.

5. Please use several sentences to explain the reasons of the following facts.
(a) (6%) FM has better acoustic quality than AM especially when the weather is bad.
(b) (6%) Digital TV has better image quality than analog TV.

6. Consider a signal set containing sixteen signals

$$s_i(t) = a_i\cos(\omega_c t + \phi_i), \quad 0 \le t \le T_s, \quad i = 1, 2, \cdots, 16$$

where $a_i = \begin{cases} R_1, & 1 \le i \le 4 \\ R_2, & 5 \le i \le 16 \end{cases}$, $R_1 < R_2$, and $\phi_i = \begin{cases} \frac{\pi}{2} \times i - \frac{\pi}{4}, & 1 \le i \le 4 \\ \frac{\pi}{6} \times (i-4) - \frac{\pi}{12}, & 5 \le i \le 16. \end{cases}$
(a) (4%) Represent the average energy per symbol E_s in terms of R_1, R_2, and T_s.
(b) (4%) Draw the decision regions in the signal constellation.
(c) (6%) The minimum Euclidean distance, $d_{\min}$, is defined as the minimum value of the Euclidean distance between any two different signal points. What is the value of R_2/R_1 which maximizes $d_{\min}$ for fixed E_s? ($\sin(\pi/12) = 0.25882$)
(d) (6%) Based on the optimal value of R_2/R_1 in (c), derive the average symbol error probability P_s (only the terms with $d_{\min}$ are needed) in terms of the Q-function and E_s.
(e) (6%) Find the bit labeling of signal points for minimizing the bit error probability P_b. Perform it in the signal constellation. By this bit labeling, find the approximate mathematical expression of P_b in terms of P_s.

注意:背面有試題