科目： 通訊原理　　　　系所組：電機工程學系碩士班甲組

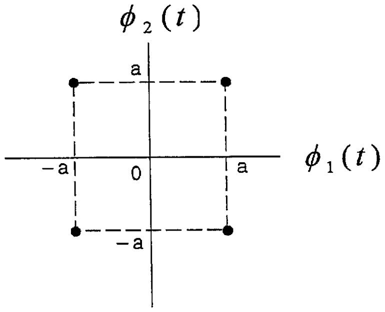
1 Let $\delta(t)$ be the unit impulse function such that $\delta(t)=0$ for $t\neq 0$ and $\int_{-\infty}^{\infty}\delta(t)dt=1$, $h(t)$ be a continuous function and t_0 be a time constant. (a) Find $\int_{-\infty}^{\infty}h(t)\delta(t-t_0)dt=?$ (b) Find $h(t)*\delta(t-t_0)$ where * is the convolution operation. (8%)

2 The amplitude modulation (AM) is expressed by $x_c(t)=2(A+m(t))\cos 2\pi f_c t$ where $m(t)$ is the message signal. If $m(t)=\cos 2\pi f_m t$ and $f_c=10Hz, f_m=1Hz$, (a) Plot the waveform of $x_c(t)$ if A=2, (b) Plot the double-sided amplitude spectra of $x_c(t)$ if A=2 (c) Find the range of A such that $m(t)$ can be recovered by noncoherent demodulation (e.g., envelope detector). (12%)

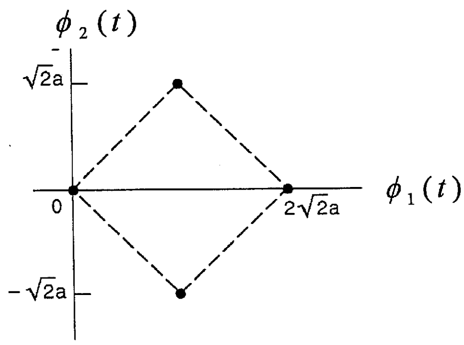
3 The additive white Gaussian noise (AWGN) is often appeared in communication systems. (a) What does "additive" mean? (b) What does "white" mean? (C) What does "Gaussian" mean? (12%)

4 Let $n1$ and $n2$ be uncorrelated, zero-mean Gaussian noise with variance σ^2, and $w1=n1+n2$, $w2=n1-n2$. (a) Find the variance of $w1$. (b) Find the variance of $w2$ (c) Determine if $w1$ and $w2$ are uncorrelated or not (hint: random variables X and Y are uncorrelated if E(XY)=E(X)E(Y).) (12%)

5 Assume that the message points in the following signal constellation are equally likely and $\phi_1(t),\phi_2(t)$ are unit-energy basis functions. (a) Determine which signal constellation has a lower symbol error rate, WHY? (b) Compute the average transmission energies of both signal constellations and determine which has minimum average energy. (8%)



(a)



(b)

※ 注意：1.考生須在「彌封答案卷」上作答。
2.本試題紙空白部份可當稿紙使用。
3.考生於作答時可否使用計算機、法典、字典或其他資料或工具，以簡章之規定為準。

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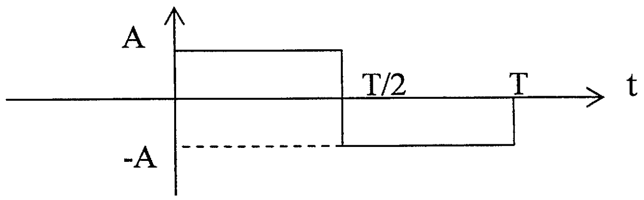
6 Sampling Theorem: Let signal $x(t)$ contain no frequency components for frequencies $f > W$, and $x_\delta(t)$ be the sampled function of $x(t)$ at every T sampling intervals, i.e., $x_\delta(t) = \sum_{n=-\infty}^{\infty} x(nT)\delta(t-nT)$. (a) Describe the sampling theorem. (b) What is the aliasing effect? (8%)

7 (a) Let $s_i(t) = \sqrt{2/T}\cos(2\pi f_i t)$, $f_i >> 1/T$, i=1,2, $0 \le t \le T$. Derive the relation of f_1 and f_2 such that $s_1(t)$ and $s_2(t)$ are orthogonal signals, i.e., $\int_0^T s_1(t)s_2(t)dt = 0$. (5%)

(b) The multipath propagation in wireless communications will cause the intersymbol interference (ISI) effects. Explain the phenomenon of ISI effect. (5%)

8 Consider the signal s(t) plotted as follows. We want to design a filter h(t) matched to s(t).

(a.) Find the impulse response of the matched filter and plot it as a function of time. (5%)
(b.) Plot the output of the matched filter as a function of time. (5%)
(c.) Find the time that the peak value of the output is achieved. What the peak value is. (5%)
(d.) Show that a correlator receiver can be realized as a matched filter. (5%)



9 Consider a set of noisy signals $x_n(t) = \alpha_n m(t) + w_n(t), 1 \le n \le N$, where α_n is a positive real fading coefficient, noise components $w_n(t)$ are zero-mean with equal power and are statistically independent, that is, $E\left[w_j(t)w_k(t)\right] = \sigma^2$ if k=j, $E\left[w_j(t)w_k(t)\right] = 0$ if k≠j, and $m(t)$ denotes a message signal with unit power. The receiver consists of a linear combiner whose output is given by $y(t) = \sum_{n=1}^{N} c_n x_n(t)$, where the parameters c_n are to be determined.

(a.) Simplify the output signal-to-noise ratio (SNR) by calculating

$$SNR_o = \frac{E[\{\sum_{n=1}^{N} c_n \alpha_n m(t)\}^2]}{E[\{\sum_{i=1}^{N} c_n w_n(t)\}^2]} = ? \quad (5\%)$$

(b.) Use the Schwarz inequality (hint: $(\sum_{n=1}^{N} a_n b_n)^2 \le (\sum_{n=1}^{N} a_n^2)(\sum_{n=1}^{N} b_n^2)$) to find the optimum coefficients c_n to achieve the maximum output SNR. (5%)

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