國立中央大學九十三學年度碩士班研究生入學試題卷 共 1 頁 第 1 頁

所別：通訊工程學系碩士班 乙組 科目：通訊系統

(20%) 1. Given the signals $x_1(t)$ and $x_2(t)$ as follows.

(10%) (a) Let $x_1(t)=\Pi\left(\frac{t}{2}\right)*\operatorname{sinc}(t)$, where Π represents the rectangular function and $*$ represents the convolution operation. Find the minimum sampling frequency that can reconstruct $x_1(t)$ from its samples.

(10%) (b) Let $x_2(t)=2\operatorname{sinc}(2t)*\operatorname{sinc}(t)$. Calculate $\int_{-\infty}^{\infty} x_2(t)dt$.

(20%) 2. A message signal $m(t)=\cos^2(2\pi f_m t),\ 0\le f_m\le W$, is modulated by a double sideband system where the modulated signal is $x_c(t)=(A+m(t))\cos\omega_c t$, where A is a constant.

(10%) (a) Compute the bandwidth of the modulated signal.

(10%) (b) An envelope detector, which can simply be implemented by cascading a diode, an RC low-pass filter, and an AC coupling capacitor, is used for demodulation. What is the demodulated output signal?

(10%) 3. A message signal $m(t)=\frac{3f_m}{f_2}\cos(2\pi f_m t)$, with the possible frequency range $f_1\le f_m\le f_2$, is modulated by a frequency modulation system, where the modulated signal is $x_c(t)=\cos\left[2\pi f_c t+2\pi f_d\int m(\alpha)d\alpha\right]$. Assume f_1 = 100 Hz, f_2 = 15 KHz, f_c = 300 MHz, and f_d = 40 KHz/V, what is the approximate bandwidth of the modulated signal?

(20%) 4. Consider signals given as

$$s_i(t)=a_i\cos\omega_c t+b_i\sin\omega_c t,\qquad 0\le t\le T_s,$$

where $a_i, b_i\in\{\pm A,\pm 3A,\pm 5A\}$ with equal probability. Assume that the signals are transmitted over the AWGN channel with double-sided power spectral density $\frac{N_0}{2}$. Let E_s denote the average energy per signal. For an optimal detector, compute the error probability in terms of $\frac{E_s}{N_0}$.

(15%) 5. Consider the matched-filter receiver designed for the transmitter with two signals $s_1(t)=A\cos\omega_c t$ and $s_2(t)=-2A\cos\omega_c t$. Compute the detected error probability of this receiver if the transmitted signals are $s_1(t)=2A\cos\omega_c t$ and $s_2(t)=-A\cos\omega_c t$ in fact. Assume that $s_1(t)$ and $s_2(t)$ are transmitted with equal probability.

(15%) 6. Consider a communication system as follows. At the transmitter, one information bit is fed into an encoder of the repetition code to obtain a 3-bit output. Then the three coded bits are sent into a BPSK modulator successively. Suppose that BPSK signals are transmitted over the AWGN channel with double-sided power spectral density $\frac{N_0}{2}$. Consider a receiver shown below. The matched filter is used to produce the soft-decision value of coded bit v_k, $k\in\{1,2,3\}$. Then the decoder makes a maximum-likelihood decision of the information bit accoding to v_1, v_2 and v_3. Represent the error probability of the information bit in terms of $\frac{E_b}{N_0}$, where E_b denotes the energy per **information** bit.