國立臺灣科技大學
九十一學年度博士班招生考試試題

系所組別：電機工程系丙組
科　目：通訊工程

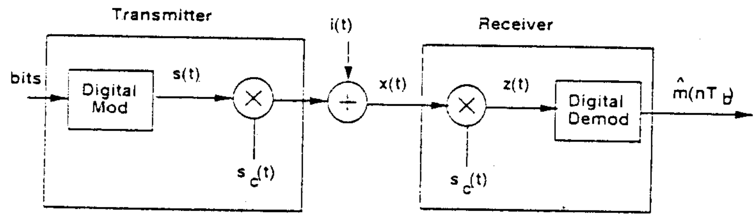
總分 100 分

1. (10 points) Provide a short answer for each question below:
   (a) Why is standard AM modulation used instead of the more power-efficient DSBSC (double-sideband suppressed carrier) in AM radio broadcasting?
   (b) Why in practice don't we generate SSB (single-sideband) modulated signals by using a DSBSC modulator followed by a bandpass filter that filters out one of the sidebands

2. (20 points) Consider the signal $x(t) = \cos(2\pi t/T_0)\ \mathrm{rect}(t/2/T_0)$
   (a) Sketch $x(t)$.
   (b) Sketch $X(f)$.

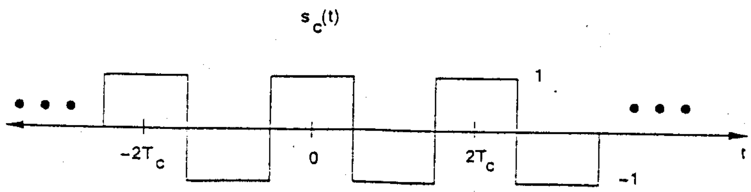
   Suppose now that $Y(f)$ is $X(f)$ sampled at integer multiples of $f_s = 1/4/T_0$.
   (c) Sketch $Y(f)$.
   (d) Sketch $y(t)$

3. (20 points) Consider the spread spectrum system shown below.



The modulated signal $s(t)$ is obtained using any type of digital modulation (e.g. ASK or PSK). This modulated signal is then multipled by a spreading sequence $s_c(t)$ in the transmitter. The signal input to the receiver is $x(t) = [s(t)s_c(t) + i(t)]$, where $i(t)$ is the interference signal. In the receiver the signal $x(t)$ is multipled by $s_c(t)$ and then passed to the binary demodulator. We assume that the $s_c(t)$ in the transmitter and receiver are identical (i.e. synchronized in time).

Assume that $s_c(t)$ is a periodic ~~pulse~~ train with period $2T_c$ and amplitude of ± 1, as shown below. The Fourier series coefficients of $s_c(t)$ are $c_n = sinc(.5n)$ for $n \neq 0$ and $c_0 = 0$. Assume that $T_b = 100T_c$, where T_b is the bit time of the digital modulator (in spread spectrum systems the period of the spreading sequence is always much smaller than a bit time).



(a) Sketch $S_c(f)$ assuming that the digital modulator has a data rate of 100 Kbps.

(b) For $i(t) = 0$, what is the bandwidth of $x(t) = s_c(t)s(t)$?

(c) For $i(t) = 0$, find $z(t)$, the signal input to the demodulator. How does $z(t)$ differ from $s(t)$ when there is no interference?

(d) For $i(t) = \cos(2\pi f_c t)$ with $f_c = 102.5$ MHz, sketch the spectrum of $w(t) = i(t)s_c(t)$. What is $W(f_c)$?

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4. (20 points) Consider an audio signal $s(t) = 5\cos 400\pi t$.
   (a) Find the mean square error of the quantization.
   (Assume that the quantization error is uniformly distributed in $[-\Delta/2, \Delta/2]$)
   (b) Find the signal to quantization noise ratio when this signal is quantized by using 12-bit PCM.
   (c) How many bits of quantization are needed to achieve a signal to quantization noise ratio of at least 40 dB?

5. (20 points) The generator matrix of a particular (7, 4) code is

$$[G] = \begin{pmatrix} 1 & 0 & 0 & 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 0 & 1 & 1 & 1 \\ 0 & 0 & 0 & 1 & 1 & 0 & 1 \end{pmatrix}$$

   (a) Find the generating matrix [H].
   (b) What is the minimum distance between code words?
   (c) How many errors can be detected? How many errors can be corrected?
   (d) Find the corrected code, if we receive the code word of 1010011.
   (Assume that single bit error is mostly occurred.)

6. (10 points) Show the mean and variance for the Poisson distribution.