國立臺灣大學101學年度碩士班招生考試試題

1. [6 分] In what condition the aliasing effect will occur?

2. [9 分] Find the Fourier series of

$$x(t)=t \qquad \text{for } 0<t<5, \qquad x(t)=x(t+5)$$

3. [8 分] Find the discrete-time Fourier transform of

$2^{-n}(n+1)u[n]$, where $u[n]$ is a unit step function.

4. (a) [8 分] Find the inverse Z transform of

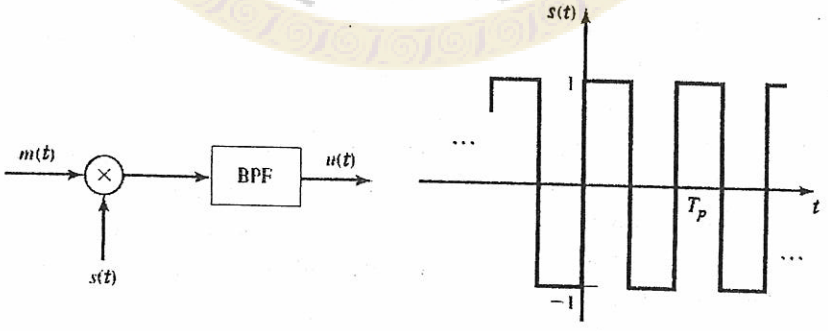
$$\frac{1}{6-11z^{-1}+6z^{-2}-z^{-3}}$$

(b) [8 分] Suppose that $X(z)$ is the Z transform of $x[n]$. What is the Z transform of

$$\sum_{k=-\infty}^{n} k\,x[k]$$

5. Suppose that both $x(t)$ and $y(t)$ are mutually independent white noises.
(a) [6 分] Is $x(t)+y(t)$ also a white noise? Why?
(b) [5 分] Is $\exp(-\pi|t|)x(t)$ also a wide-sense stationary random process? Why?

6. [10 分] A signal $u(t)$ is generated by multiplying a message signal $m(t)$ with the periodic rectangular waveform shown in the following figure, and filtering the product with a bandpass filter (BPF) tuned to the reciprocal of the period T_p, with bandwidth $2W$, where W is the bandwidth of the message signal, and $1/W >> T_p$. Show that the output $u(t)$ of the BPF is a double-sideband suppressed carrier (DSB-SC) amplitude modulation (AM) signal with message $m(t)$ and carrier frequency $1/T_p$.



7. [10 分] Consider the following single-sideband (SSB) modulator. Let the message signal $m(t)=\cos 2\pi f_m t$, where $f_m < W$, and W is the bandwidth of the lowpass filters (LPF).

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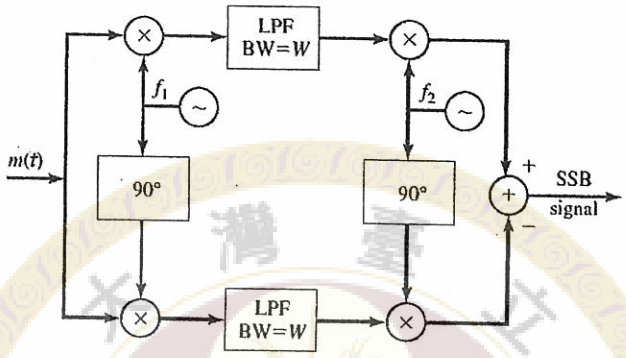
Assume that f_1 is selected such that $|f_1 - f_m| < W$ and $f_1 + f_m > W$. Show that the output of this modulator is indeed a SSB signal, and find the carrier frequency of this SSB signal.



8. The discrete sequence

$$r_k = \sqrt{E_b}c_k + n_k, \quad k = 1, 2, \ldots, n$$

represents the output sequence of samples from a demodulator, where $c_k = \pm 1$ are elements of one of two possible code words, $C_1 = [1 \quad 1 \cdots 1]$ containing n +1's, and $C_2 = [1 \quad 1 \cdots 1 \quad -1 \cdots -1]$ having its first w elements as +1 and the remaining $n-w$ elements as −1, where w is some nonnegative integer. The noise sequence $\{n_k\}$ is white Gaussian with zero mean and variance σ^2. Assume that C_1 and C_2 occur with the same probability.

(a). [8 分] Derive a detector that can minimize the probability of detection error for the two possible transmitted signals.

(b). [6 分] Determine the probability of error as a function of the parameters (σ^2, E_b, w).

(c). [4 分] What is the value of w that minimizes the error probability?

9. Each sample of a Gaussian memoryless source has a variance equal to 4 and the source produces 8000 samples/sec. The source is to be transmitted via an additive white Gaussian noise channel with a bandwidth equal to 4000 Hz. It is desirable to have a distortion/sample not exceeding 1 at the destination (assume squared-error distortion).

(a) [6 分] What is the minimum required signal-to-noise ratio of the channel?

(b) [6 分] If it is further assumed that, on the same channel, a binary PSK scheme is employed with hard-decision decoding, what will be the minimum required channel signal-to-noise ratio?

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