國立中央大學110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3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

Answer the following questions (derivation processes are required for numerical results and derived equations):

1. [20%] Figure 1 is a simple model for a communication scenario. *x(t)* is the transmitted signal as the input and *y(t)* is the received signal as the output.
   (a) Please briefly describe what the scenario is in communications to have such a model. (5%)
   (b) Please write the transfer function of the system. (5%)
   (c) Please write the impulse response of the system. (5%)
   (d) If y(t) is further processed to have the output z(t) for recovering x(t), please draw the processing structure. (5%)

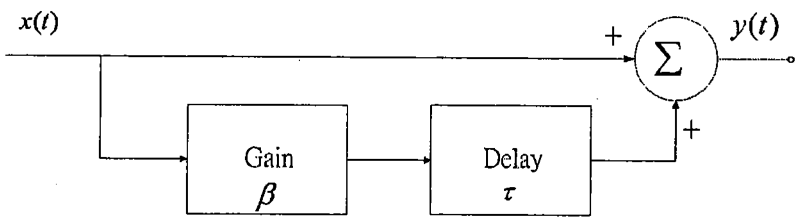

Figure 1.

2. [15%] Consider the system in Figure 2. Assume the average value of $m(t)$ is zero and that the maximum value of $|m(t)|$ is *M*. Also assume that the square-law device is defined by $y(t)=2x(t)+10x^2(t)$.
   (a) Write the expression for *y(t)* in terms of $m(t)$, cos(·), ω_c, and *t*. (5%)
   (b) Describe the filter that yields an AM signal for *g(t)*. Give the necessary filter type and the frequencies of interest. (5%)
   (c) What is the value of *M* to yield a modulation index of 0.2? (5%)

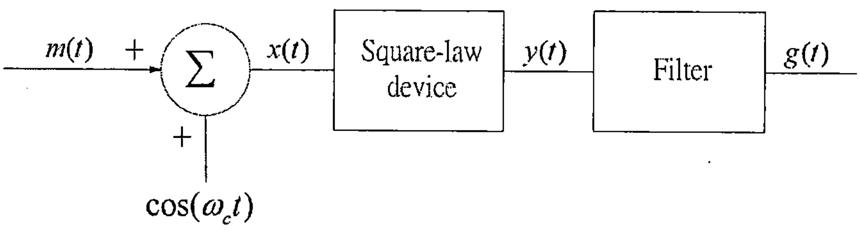

Figure 2.

注意:背面有試題

所別：通訊工程學系碩士班 不分組(一般生)　　　　共3頁　第2頁

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3. [15%] For M-ary PSK, the transmitted signal with equal probability is of the form

$$s_i(t) = A\cos(2\pi f_c t + i2\pi / M),\ i = 1, 2, \ldots, M,\ \text{ for } 0 \le t \le T_s.$$

(a) Find a set of basis functions for this signaling scheme. What is the dimension of the signal space? Express $s_i(t)$ by the form of the data vector, in terms of these basis functions and the mathematical symbols in the above expression. (5%)

(b) Please sketch the observation space and show the optimal partitioning of the observation space for *M=4.* (5%)

(c) Please sketch a block diagram of the optimal (minimum symbol error probability) receiver for *M=8.* (5%)

4. [15%] Define the functions $\Pi(\cdot)$ and $\Lambda(\cdot)$ as depicted in Figure 3(a).

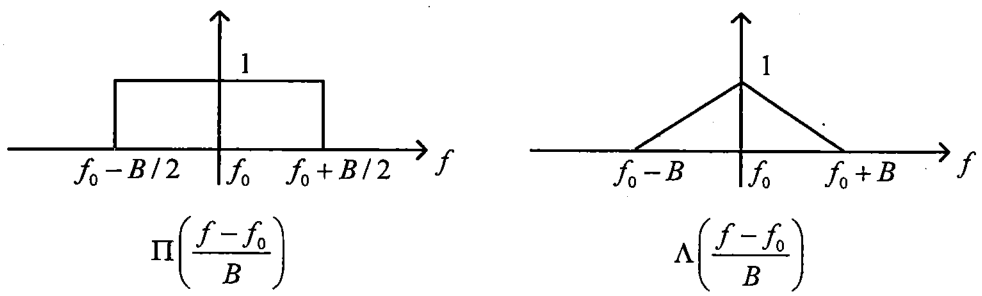

Figure 3(a).

As shown in Figure 3(b), the input signal $s(t)$ is multiplied by a carrier signal $2\cos(2\pi f_0 t)$ and then is passed through a nonlinear system $y(t) = g(x(t))$ to generate the output signal $y(t)$. Suppose that the spectrum of $s(t)$ is $\Pi(f/6)$, the center frequency is $f_0 = 10$, and the nonlinear system is defined by $y(t) = x(t) + 0.3x^2(t)$.

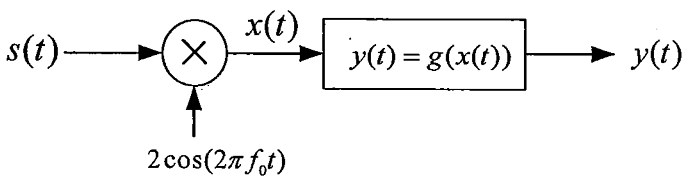

Figure 3(b).

(a) Write the expression of the spectrum of $y(t)$ in terms of $\Pi(\cdot)$ and $\Lambda(\cdot)$. (10%)

(b) Sketch the spectrum of $y(t)$, labeling all important frequencies and amplitudes. (5%)

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5. [15%] The received signal of a signal $s(t)$ transmitting over a multipath channel is expressed as

$$r(t) = s(t - T_1) + 0.2s(t - T_2),$$

where $T_2 = 3T_1$. Assume that $r(t)$ is sampled at the frequency $f_s = 1/T_1$.

(a) What is the z-transform expression $h[z]$ of the impulse response of the multipath channel? (5%)

(b) By ignoring the propagation delay T_1 at the receiver, draw the structure of a tapped-delay-line equalizer with weighting coefficients not less than 10^{-3} and give the coefficient values in order to accommodate the channel. (10%)

6. [20%] As shown in Figure 4, the transmitted signal has a binary number $X \in \{+1, -1\}$. The received signal is added by a random noise N with the probability density function (PDF) as depicted in the figure. The resultant signal Y is also binary and obtained with a sign-function as the decision threshold is at Z, i.e., $\{Y | Y=+1 \text{ if } X+N \geq Z \text{ and } Y=-1 \text{ if } X+N<Z\}$.

(a) If the binary number of X is transmitted with equal probability $P(+1)=P(-1)=0.5$, what is the error probability for detecting X from Y when $Z=0$? (5%)

(b) If the binary number of X is transmitted with unequal probabilities $P(+1)=0.6$ and $P(-1)=0.4$. Find the optimum decision threshold Z such that the error probability for detecting X from Y is minimum? What is the minimum detection error probability? (10%)

(c) Whether the case in (b) has smaller error probability than that in (a)? Do you think it could be a good communication policy to send the binary number with unequal probabilities based on minimum transmission error probability? Explain your reason. (5%)

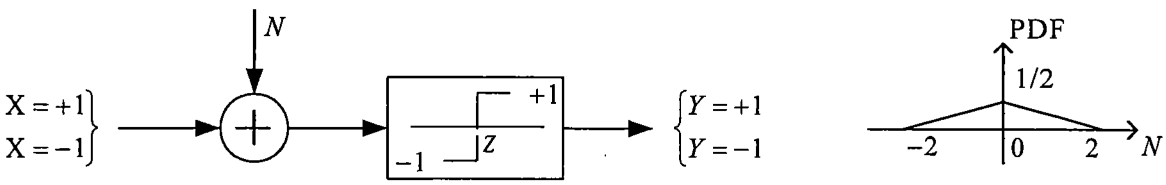

Figure 4.