

國立臺灣科技大學

九十四學年度碩士班招生考試試題

系所組別：電子工程系碩士班乙一組

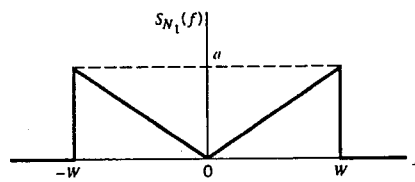
科目：通信系統

總分 100 分

1. A pair of noise processes $n_1(t)$ and $n_2(t)$ are related by

$$n_2(t) = n_1(t) \cos(2\pi f_c t + \theta) - n_1(t) \sin(2\pi f_c t + \theta),$$

where f_c is a constant, and θ is the value of a random variable Θ , which is uniformly distributed within $[0, 2\pi]$. $n_1(t)$ is stationary and its power spectral density is as shown below:



- (a) (5%) Find the autocorrelation function of $n_2(t)$.
- (b) (5%) Plot the corresponding power spectral density of $n_2(t)$.
2. Let $X(t)$ be a zero-mean, stationary, Gaussian process with autocorrelation function $R_X(\tau)$. The process is applied to a square-law device, which is defined by the input-output relation
- $$Y(t) = X^2(t).$$
- (a) (7%) Find the mean of $Y(t)$ (i.e., in terms of $R_X(\tau)$)?
- (b) (8%) Find the autocovariance function of $Y(t)$ (i.e., in terms of $R_X(\tau)$)?
3. (8%) What is the "White Gaussian Noise"?
4. Start with an FM signal $s(t) = A_c \cos[2\pi f_c t + \beta \sin(2\pi f_m t)]$
- (a) (5%) Depict the block diagram of a narrowband FM signal modulator.
- (b) (6%) Use the carrier phasor as a reference, represent the narrowband FM signal using a phasor diagram. Discuss the effect resulted from the two side-frequency phasors.
- (c) (6%) Use the carrier phasor as a reference, represent the AM signal using a phasor diagram. Discuss the effect resulted from the two side-frequency phasors.
5. An analog signal is sampled, quantized, and encoded into a binary PCM (pulse code modulation) wave. The sampling rate is 8 kHz, and the number of representation levels is 64. The PCM wave is transmitted over a baseband channel using binary PAM (pulse amplitude modulation).
- (a) (4%) Theoretically, what is the minimum bandwidth required (specified by Nyquist's criterion) for the transmission of the PCM wave?
- (b) (3%) In order to achieve the minimum-bandwidth transmission as described in (a), what type of PAM pulse shape should be adopted? Please choose your answer from the list: rectangular, triangular, sinc, sinc², Gaussian.
- (c) (3%) If the PAM pulse is chosen to have a raised cosine spectrum with roll-off factor 0.25, what is the bandwidth required for the transmission of the PCM wave?
- (d) (3%) In case that bandwidth is not large enough for PCM wave transmission, intersymbol

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interference (ISI) occurs, which degrades the bit error rate (BER) performance. What technique can be used to reduce the effect of ISI? Please choose your answer from the list: error control coding, carrier synchronization, adaptive equalization, BPSK modulation, QPSK modulation.

6. In BFSK (binary frequency shift keying) signal transmission, logical 0 and logical 1 are, respectively, mapped into waveforms $s_0(t) = A \cos 2\pi f_0 t$ and $s_1(t) = A \cos 2\pi f_1 t$ for $0 < t < T$, where A is a positive constant. Assume that the communication is through an AWGN (additive white Gaussian noise) channel, where the two-sided power spectral density of the noise is $N_0/2$.
- (3%) Find the average energy consumed in the transmission of one data bit. For ease of later reference, let us denote this quantity by E_b . Please express E_b in terms of A and T .
 - (3%) What is the smallest frequency spacing between f_0 and f_1 (i.e. $|f_0 - f_1|$) allowed that makes $s_0(t)$ orthogonal to $s_1(t)$ if detection is performed coherently?
 - (3%) If $E_b/N_0 = 9$ dB, find the BER if the detection is performed coherently. Please express your answer in terms of the Q function, which is defined by $Q(z) = \text{Prob}(Z > z)$, where Z is the standard Gaussian random variable.
 - (3%) What is the smallest frequency spacing between f_0 and f_1 (i.e. $|f_0 - f_1|$) allowed that makes $s_0(t)$ orthogonal to $s_1(t)$ if detection is performed noncoherently?
 - (3%) In implementation, what is the difference between coherent detection and noncoherent detection?
 - (4%) Plot the receiver structure for noncoherent BFSK detection.
7. This problem addresses the Viterbi algorithm for decoding of convolutional codes.
- (3%) Under what condition regarding communication channel is the Viterbi algorithm equivalent to maximum likelihood sequence detection when the path metric is chosen to be Hamming distance (i.e. hard decision is performed)?
 - (3%) Under what condition regarding communication channel is the Viterbi algorithm equivalent to maximum likelihood sequence detection when the path metric is chosen to be the square of the Euclidean distance (i.e. soft decision is performed)?
8. (4%) To fight bursty errors in data transmission, one simple technique is effective. What is it? Please choose your answer from the list: equalization, interleaving, modulation, Huffman coding, Hamming codes.
9. (4%) A pseudo-noise sequence is generated for CDMA (code-division multiple access) from a 12-stage linear feedback shift register circuit. What is the maximum period of this sequence?
10. (4%) If BER is the first priority in choosing a modulation scheme and bandwidth efficiency is the second priority, then between BPSK (binary phase shift keying) and QPSK (quadrature phase shift keying), which one should be adopted? Why?

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