國立臺北科技大學

九十二學年度電腦通訊與控制研究所入學考試

通訊系統試題

填准考證號碼

注意事項：

1. 本試題共 5 題，配分共 100 分。
2. 請按順序標明題號作答，不必抄題。
3. 全部答案均須答在答案卷之答案欄內，否則不予計分。

1. (20pts)

(a) Given the observation vector x and the requirement to estimate the transmitted M-ary signal s_i, define the likelihood function and write down the likelihood function in an AWGN channel with two-sided power spectral density $N_0/2$ (assume the signal space is N-dimensional).

(b) Explain why maximum likelihood decision rule in an AWGN channel is just to choose the transmitted signal point closest to the received signal point in signal space.

2. (20pts)

Let g(t) be the transmitted signal, n(t) be the additive white Gaussian noise(AWGN) with two-sided power spectral density $N_0/2$, and h(t) be the receiver filter impulse response. Prove that the matched filter matched to g(t) maximizes the signal-to-noise ratio(SNR) at its output t=T (signaling interval). JUSTIFY EVERY STEP IN YOUR PROOF.

3. (20pts)

Let $x(t)=\cos(20\pi t)+\cos(200\pi t)$. Determine the Nyquist rate of x(t). If the sampling rate is 150 samples/second, find the signal reconstructed from the ideal form of sampling using an ideal low-pass filter with frequency response

$$H(f)=\begin{cases}1 & |f|\le 75\\ 0 & \text{otherwise}\end{cases}$$

JUSTIFY EVERY STEP IN YOUR ANSWER.

4. (20pts)

(a) Define the union bound on the probability of error for the M-ary signal s_i,. Also explain why the union bound (an upper bound) has very poor accuracy when the SNR is very low. Assume all symbols are transmitted with equal probabilities, the distance between symbols s_i and s_k is d_{ik} , and the AWGN variance is $N_0/2$

(b) Compute the average symbol error probability of 16QAM (using nearest neighbor approximation of union bound). Assume all symbols are transmitted with equal probabilities, the minimum distance between symbols is d , and the AWGN variance is $N_0/2$

EXPRESS YOUR ANSWERS to (a)(b) IN TERMS OF Q-FUNCTION

$$Q(v)=\frac{1}{\sqrt{2\pi}}\int_{v}^{\infty}\exp(-x^2/2)dx$$

5. (20pts)

(a) Draw the transmitter and receiver block diagrams for a direct-sequence spread spectrum (DSSS) system with BPSK modulation. Define all notations.

(b) Explain intuitively why a DSSS system has anti-jamming ability equal to the processing gain.

(c) Compare general AM, DSB-SC SSB, and VSB, in terms of sidebands and carrier.

(d) Compare continuous-wave modulation and pulse modulation. Also give two examples for each.