國立台灣科技大學九十八學年度碩士班招生試題

系所組別： 電子工程系碩士班乙一組

科　　目： 通信系統

（總分爲 100 分）

1. The joint probability mass function of random variables **X** and **Y** is given in the table below,

$P_{XY}(x,y)$ (joint probability function of **X** and **Y**)

x \ y	y = 0	y = 1	y = 2
x = 0	0.1	0.2	0.3
x = 1	0.2	0.1	0.1

(a) (3%) Find the variance of **X**.

(b) (3%) Find the marginal probability mass function of **Y**.

(c) (3%) Find the probability of **X** being equal to 0 given that **Y** equals 1. In other words, Prob(**X**=0|**Y**=1) = ?

(d) (3%) Find the probability of **Y** being equal to 1 given that **X** equals 0. In other words, Prob(**Y**=1|**X**=0) = ?

2. Let **X** be the standard Gaussian random variable. Let Q(z) denote the probability of **X** being greater than z. Let **Y** be a random variable obtained from **X** by **Y**=3-2**X**.

(a) (5%) Find the probability of **Y** being greater than 5 (i.e. Prob(**Y**>5)). Please express your answer in terms of the Q function defined above.

(b) (3%) Let $f_Y(y)$ denote the probability density function of **Y**. Then, $f_Y(5)$=?

3. Assume that QPSK (quadrature phase shift keying) is adopted for data transmission in an AWGN channel with an E_b/N_0 of 7 dB, where E_b is the bit energy (measured in Joule) and $N_0/2$ is the two-sided power spectral density (measured in Watts/Hz) of the Gaussian noise.

(a) (3%) Can QPSK be demodulated noncoherently?

(b) (4%) Find the BER (bit error rate) in this data transmission. Please express your answer in terms of the Q function defined in Problem **2**.

(c) (2%) How many bits are carried in one QPSK symbol?

(d) (3%) In order to reduce the BER, the QPSK symbols should be assigned to the constellation diagram according to the rule of the Gray code. Please map those QPSK symbols to sequences of bits and plot them on the constellation diagram.

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4. A binary (n,k) linear block code is defined by the generator matrix

$$G=\begin{bmatrix}0 & 1 & 0 & 1 & 1\\ 1 & 1 & 1 & 0 & 1\end{bmatrix}.$$

(a) (3%) n=? k=?

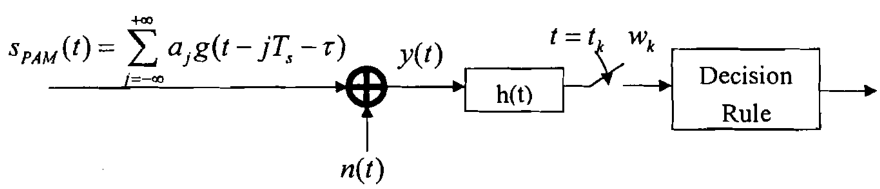
(b) (3%) List all the codewords.

(c) (3%) Find the minimum distance of the code.

(d) (4%) If [1 1 0 1 1] is received, which codeword should it be decoded into? What message word does this codeword represent?

(e) (5%) Suppose that $[c_1\ c_2\ c_3\ c_4\ c_5]$ is transmitted and $[d_1\ d_2\ d_3\ d_4\ d_5] = [c_1\ c_2\ c_3\ c_4\ c_5] + [e_1\ e_2\ e_3\ e_4\ e_5]$ is received, with $\mathrm{Prob}(e_k=1)=P_o$, for k=1,2,3,4,5. Find the probability that $[d_1\ d_2\ d_3\ d_4\ d_5]$ can not be correctly decoded. Please express your answer in terms of P_o.

5. The figure below shows the receiver of M-ary PAM. The receiver signal $y(t)$ consists of the M-ary PAM signal $s_{PAM}(t)=\sum_{j=-\infty}^{+\infty} a_j g(t-jT_s-\tau)$ and the white Gaussian noise $n(t)$. The received signal $y(t)$ is first filtered by the low-pass filter $h(t)$ and sampled at the time $t=t_k$. Then, the sampled signal w_k is used by the decision rule to decide a_k.



(a)(10%) Please compute the power spectral density of $s_{PAM}(t)$ if $\{a_j\}_{j=-\infty}^{+\infty}$ is wide-sense stationary and τ is distributed with the probability density function

$$f(\tau)=\begin{cases}\dfrac{1}{T_s}, & 0\le\tau\le T_s\\ 0, & elsewhere\end{cases}$$

(b)(5%) Evaluate w_k and point out the inter-symbol-interference (I.S.I.).

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(c)(10%) Suppose that there is no I.S.I., prove that the signal-to-noise of w_k can have the maximum value if $h(t)=g(-t)$ and $t_k = kT_s + \tau$.

(d)(5%) Suppose $h(t)=g(-t)$, prove that there is no I.S.I. if $\{g(t-jT_s)\}_{j=-\infty}^{+\infty}$ are orthogonal and $t_k = kT_s + \tau$.

(e)(10%) Suppose a_k has the probability mass function $p(a_k)=\dfrac{1}{M}$ for all k, compute the minimum symbol error rate.

6. (10%) As shown in the figure below, the signal X(t) which pass through a linear system with impulse response h(t) become the signal Y(t). Suppose X(t) is wide sense stationary process, please prove $R_{yy}(\tau)=R_{xx}(\tau)\otimes h(\tau)\otimes h(-\tau)$