國立成功大學

110學年度碩士班招生考試試題

編　號：182

系　所：電腦與通信工程研究所

科　目：通信系統

日　期：0203

節　次：第 2 節

備　註：可使用計算機

編號： 182

國立成功大學 110 學年度碩士班招生考試試題

系　　所：電腦與通信工程研究所

考試科目：通信系統

考試日期：0203，節次：2

※ 考生請注意：本試題可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. (25%) Consider the random experiment of observing the output waveform of the following random binary waveform generator for $0 \le t < 2T$ where T is the bit interval. In any bit interval $iT \le t < (i+1)T$, i=0, 1, the output of the waveform generator is held at a constant level; the level is randomly set to be 2 Volt (representing "bit 1") or -2 Volt (representing "bit 0") with P(output level is 2 Volt) = 0.25 and P(output level is -2 Volt) = 0.75. In addition, the generator outputs in any two *distinct* bit intervals are independent. The output waveform observed is thus a random process, denoted as $X(t)$. Answer the following questions.
   (a) Plot all the sample functions of $X(t)$. Specify the probability that each sample function is observed. [5 points]
   (b) Find and plot the auto-covariance function $\mu_X(0.5T, 0.5T+\tau)$. Specifically, plot $\mu_X(0.5T, 0.5T+\tau)$ with respect to τ for $-0.5T \le \tau < 1.5T$. [10 points]
   (c) Is $X(t)$ a stationary process? Is $X(t)$ an ergodic process? Justify your answers. [10 points]

2. (25%) Answer the following questions.
   (a) Sample the continuous-time waveform $x(t) = \cos(2000\pi t)$ using the impulse-train sampling model where the sampling rate is 4000 samples/second. Determine the mathematical expression of the sampled signal. Plot the spectrum of the sampled signal. [10 points]
   (b) The discrete-time sequence $x[n]$ is obtained by sampling the continuous-time waveform $x(t) = \cos(2000\pi t)$ with a sampling frequency of 4000 Hz. Determine the mathematical expression of $x[n]$. Plot the DTFT spectrum of $x[n]$. [10 points]
   (c) Describe and explain how you can obtain the spectrum of 2(b) from that of 2(a). [5 points]

3. (20%) The received signal in a digital baseband system is either +A or -A, equally likely, for T seconds contiguous intervals. However, the timing is off at the receiver so that the integration starts ΔT late (positive) or early (negative). By assuming a zero threshold and considering two successive intervals. [i.e., (+A,-A), (+A, -A), (-A, +A), (-A,-A)], obtain an expression for the probability of error (P_E) as a function of ΔT. Assume that the base-band transmission with optimal detector (in terms of error probability) is applied over the AWGN environment; and the double-sided power spectral density $N_0/2$ W/Hz is assumed. Show that

$$P_E = \frac{1}{2}Q\left(\sqrt{\frac{2E_b}{N_0}}\right) + \frac{1}{2}Q\left[\sqrt{\frac{2E_b}{N_0}}\left(1 - \frac{2|\Delta T|}{T}\right)\right]$$

國立成功大學 110 學年度碩士班招生考試試題

系　　所：電腦與通信工程研究所

考試科目：通信系統

考試日期：0203，節次：2

4. (10%) Find the Gray code representation of the decimal numbers 0 through 15.

5. (20%) Derive the bit error probability for the 8PSK using the Gray encoding technique and the optimal detector (in terms of error probability). Herein, the AWGN with double-sided power spectral density $N_0/2$ W/Hz is assumed.