※ 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. (10%) Is the discrete-time Fourier transform (DTFT) spectrum periodic in frequency? Please justify your answer.

2. (10%) When the desired signal component of the received signal takes on the values of +2 and -2 with equal probability and the signal-to-noise ratio (SNR) of the received signal is 10 dB, determine the noise power. Justify your answer.

3. (10%) Interpret the (continuous-time) orthogonal frequency division multiplexing (OFDM) signal in terms of continuous-time Fourier series expansion. **Hint:** You could ignore the cyclic prefix (CP) for now.

4. (20%) Consider a communication system whose transmitted signal, denoted as S, is modeled as a random variable (RV) with a zero mean and a variance of σ_s^2. The received signal is modeled as $R = hS + N$ where h denotes the (real-valued) <u>constant</u> channel gain between the transmitter and the receiver, and N denotes the receiver noise. We assume that N is of zero mean and a variance of σ_n^2. We also assume that the noise and the transmitted signal are mutually independent. Note that all the RVs mentioned above are all real-valued.

   (a) (5%) Determine the signal-to-noise ratio (SNR) of R.

   (b) (5%) Determine the average power of the received signal.

   (c) (10%) If both the noise and transmitted signal are Gaussian distributed, find the probability density function of the received signal.

5. (35%) We are now considering the DPSK modulation scheme. Please answer the following question.

   (a) (10%) Fill out the blankets of the two rows, encoded sequence and transmitted phase in Table I.

   (b) (10%) The block diagram in Figure I illustrates the generation of DPSK. Plot the optimum receiver for binary DPSK.

   (c) (15%) Derive the error rate probability for DPSK.

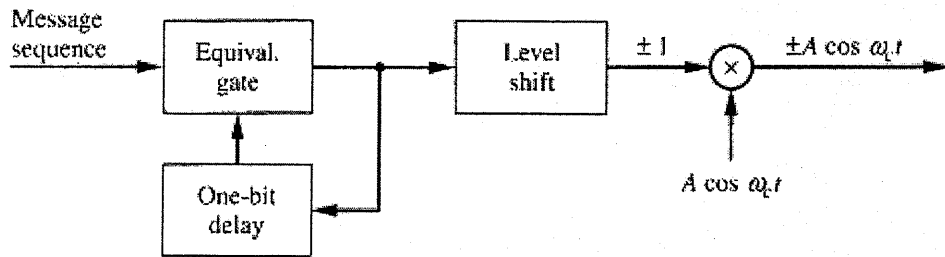| Message sequence:		1	0	0	1	0	1	0	0	0
Encoded sequence:	1									
Reference digit:	↑									
Transmitted phase:	0									

Table I

Figure I

6. (15%) Consider M-ary PSK. Denote P_{bit} and P_{symbol} as the bit and symbol error rate, respectively. Please answer the following questions.

(a) (5%) Take 8-PSK as an example, how can you code a symbol to minimize the bit error rate?

(b) (5%) Following (a), what's the relationship between P_{bit} and P_{symbol}?

(c) (5%) Except the relationship between P_{bit} and P_{symbol} you answer in (b), what else the relationship between P_{bit} and P_{symbol} do you suggest?