系所組別：工程科學系甲組

考試科目：通信系統 考試日期：0223，節次：2

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

(20 marks)

1. With reference to Fig. 1 as shown below, illustrate the basic elements of a digital communication system, answer the following questions:

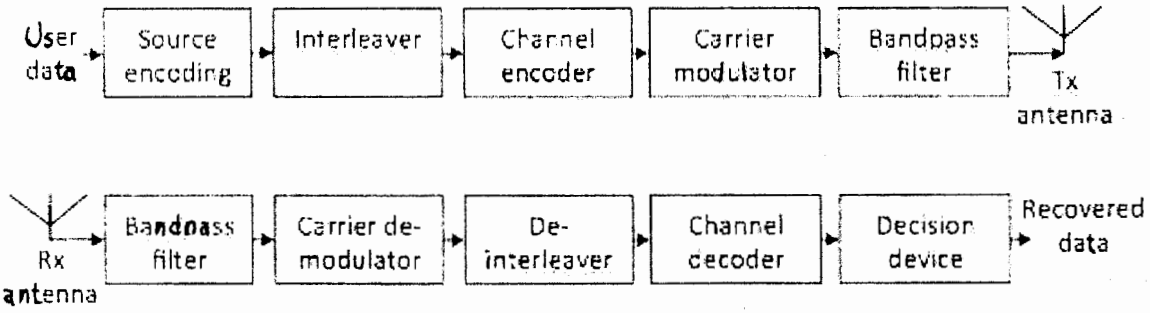

Fig. 1 Block diagram for a basic digital communication system, including a transmitter (Tx) and a receiver (Rx).

(a) Why it needs “source encoding” at receiver?
(b) What is the purpose of “channel encoder” at transmitter and “channel decoder” at receiver?
(c) Why it needs “interleaver” at transmitter and “de-interleaver” at receiver, respectively?
(d) Why it needs “band-pass filter” at both transmitter and receiver?
(e) Explain how is the performance of a digital communication system measured?

（背面仍有題目，請繼續作答）

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(20 marks)

2. Square-pulse shaped carrier waveform, as shown in Fig. 2, has been widely used in communication systems.

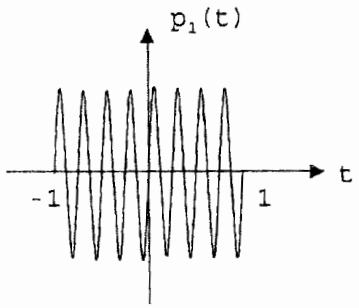

Fig. 2. Square-pulse shaped carrier waveform used in a communication system.

In particular, the square-pulse shaped carrier waveform can be written as

$$p_1(t) = \sin(8\pi t)\ \Pi\left(\frac{t}{2}\right),$$

where

$$\Pi(t) \triangleq \begin{cases} 1, |t| \leq \frac{1}{2}; \\ 0, \text{otherwise.} \end{cases},$$

and please find the spectrum of $p_1(t)$ using Fourier transform.

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(20 marks)

3. Mobile cellular communication systems have been evolving rapidly, and the fourth generation (4G) mobile cellular systems (LTE-Advanced) will be deployed in many countries of the world very soon. Answer the following questions about mobile cellular communication systems.

(a) Give a name of the first generation (1G) mobile cellular communication system.

(b) What is the most important multiple access technology used in the 1G mobile cellular communication system?

(c) What is the most popular second generation (2G) mobile cellular system in the world?

(d) What are the multiple access technologies used by the 2G mobile cellular systems?

(e) What is the most important third generation (3G) mobile cellular communication system in Taiwan?

(f) What is the dominant multiple access technology used by the 3G systems?

(g) What is the multiple access technology used by LTE-Advanced system?

(h) What is the peak data transmission rate to be offered by 4G systems?

(i) Do you think which multiple access technology will be used in beyond 4G systems?

(j) What are the major differences between LTE and LTE-Advanced systems?

（背面仍有題目，請繼續作答）

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(20 marks)

4. Binary PSK (BPSK) is used for data transmission over an AWGN channel with power spectral density $N_0/2 = 10^{-10}$ W/Hz. The transmitted signal energy is $E_b = A^2T/2$, where T is the bit duration and A is the signal amplitude. Determine the value of A needed to achieve an error probability of 10^{-6}, if the data rate is:

(a) 10 Kbit/s

(b) 100 Kbit/s

(c) 1 Mbit/s

(20 marks)

5. A multipath fading channel has a multipath spread of $T_m = 1$ s and a Doppler spread $B_d = 0.01$ Hz. The total channel bandwidth at bandpass available for signal transmission is W = 5 Hz. To reduce the effect of inter-symbol interference, the signal designer selects a pulse duration of T = 10 s.

(a) Determine the coherence bandwidth and the coherence time of the channel.

(b) Is the channel frequency selective? Justify your answer.

(c) Does the channel suffer slow or fast fading? Justify your answer.