

※ 考生請注意：本試題 可 不可 使用計算機

**注意: Part 1 (填充題) 不必在答案卷上填寫計算過程，僅需將答案依題序在答案卷**

**「第一頁」上明確填寫，務必標明格號，可自行製作適當表格填寫。**

**Part 1: 填充題 (60 分，每格 5 分)**

1. An analog random signal source has an output described by the probability density function

$$f_x(x) = \begin{cases} x/2, & 0 \leq x \leq 2 \\ 0, & \text{otherwise} \end{cases}$$

This source is sampled and quantized into 4 levels using the 3 quantizing boundaries of  $x_k = 0.5k$ ,  $k = 1, 2, 3$ . The resulting levels are encoded using a Huffman code.

- (a) The average information carried in each quantization-output is     (1)    .
- (b) After Huffman encoder, the average bit-length for each quantization-output is     (2)    .
- (c) The coding efficiency of the Huffman code is     (3)    . (5%)

2. A signal  $x(t) = 2 \cos 2000\pi t$  is quantized by a uniform quantizer with dynamic range  $(-4, 4)$ . The output of the quantizer is modulated by polar NRZ code and transmitted through a channel with one-sided mainlobe bandwidth of 20KHz. The quantization noise is assumed to be uniformly distributed.

- (a) The maximum number of quantum steps of the quantizer without aliasing distortion is     (4)    .
- (b) The signal to quantization noise ratio (in dB) of the quantizer's output is     (5)    .

3. The power spectral density of a random process  $x(t)$  is shown in Fig. 1.

- (a) Express the autocorrelation function  $R_x(\tau)$  as     (6)    .
- (b) The dc power contained in  $x(t)$  is     (7)    .
- (c) The ac power contained in  $x(t)$  is     (8)    .
- (d) To have uncorrelated samples of  $x(t)$ , the possible sampling rates are     (9)    .

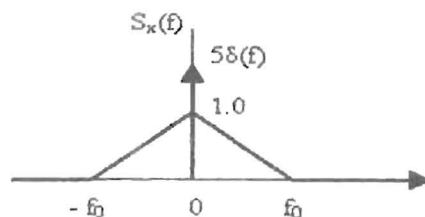


Fig. 1.

(背面仍有題目,請繼續作答)

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4. A superheterodyne receiver operates in the frequency range of 700-2500KHz.

The IF frequency ( $f_{IF}$ ) and the local oscillator frequency ( $f_{LO}$ ) are chosen such that  $f_{IF} < f_{LO}$ .

It is required that the image frequencies must fall outside of the 700-2500KHz region.

(a) The minimum required  $f_{IF}$  is       (10)      .(b) The range of the corresponding  $f_{LO}$  is       (11)      .5. Through a channel of raised cosine spectrum with roll-off factor  $\alpha = 33.3\%$  and bandwidth = 10MHz, the maximum transmission data rate for OQPSK modulation scheme is       (12)      .**Part 2: (40 分)**1. In an AWGN channel with a noise power spectral density of  $N_0/2$ , two equally likely messages are transmitted by

$$s_1(t) = \begin{cases} \frac{At}{T} & 0 \leq t \leq T \\ 0 & \text{otherwise} \end{cases} \quad \text{and} \quad s_2(t) = \begin{cases} A - \frac{At}{T} & 0 \leq t \leq T \\ 0 & \text{otherwise} \end{cases}.$$

(a) Determine  $E_b$ , the bit energy. (5%)

(b) Depict the optimal receiver and determine the threshold value for the receiver. (5%)

(c) With the optimal receiver, determine the bit-error-rate (BER) in terms of Q-function

( $Q(u) = \int_u^{\infty} \frac{1}{\sqrt{2\pi}} e^{-x^2/2} dx$ ) and parameters  $A$ ,  $T$ , and  $N_0$ . (5%)(d) Known that  $E_b/N_0 = 10.5\text{dB}$  is required to get  $\text{BER} = 10^{-6}$  for coherent QPSK signal, what is the required  $E_b/N_0$  (in dB) for this system to get  $\text{BER} = 10^{-6}$ ? (5%)

2. The output of a (3, 1, 2) convolutional code are determined by

 $v_i^{(1)} = u_i + u_{i-1} + u_{i-2}$ ,  $v_i^{(2)} = u_i + u_{i-2}$ , and  $v_i^{(3)} = u_i + u_{i-1}$ , where  $\{u_i\}$  is the input message sequence.

(a) Draw the encoder of this code. (5%)

(b) Draw the state-transition diagram of this code. (5%)

(c) Draw the trellis diagram for this code. (5%)

(d) If the input message is [1 0 0 1 1 0], what is the transmitted (encoded) sequence? (5%)