1. Consider the signal $x(t) = 2F \cdot \text{sinc}(Ft)\cos(2\pi f_0 t)$, where $f_0 >> F$.
   (a) Sketch the spectrum of x(t). (5%)
   (b) Sketch the spectrum of $x_p(t) = x(t) + j\hat{x}(t)$, $\hat{x}(t)$ is the Hilbert transform of x(t). (5%)
   (c) Sketch the complex envelope $\tilde{x}(t)$, where $x_p(t) = \tilde{x}(t) \cdot e^{j2\pi f_0 t}$, and also sketch its spectrum. (10%)

2. White Gaussian noise of zero mean and two-sided power spectral density N_0 is applied to a system shown in Fig. 1, where $f_c >> B$. The noise at the low-pass filter output is denoted by n(t).
   (a) Determine the power, power spectral density, and autocorrelation function of n(t). (10%)
   (b) Determine the probability density function (pdf) of n(t) at t = 10. (5%)
   (c) Determine the joint pdf of n(0) and n(1/B). (5%)

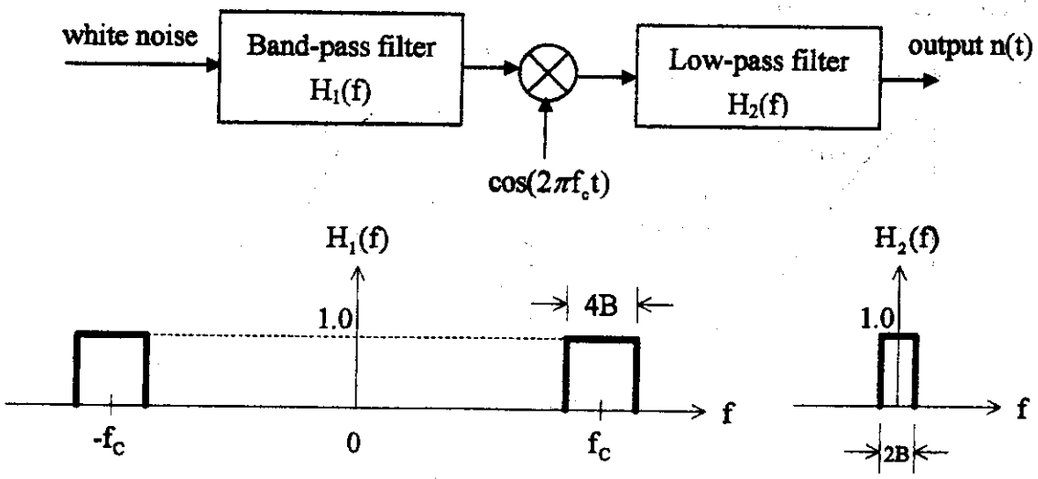

Fig. 1

3. A signal $x(t) = 10\cos 2000\pi t$ is quantized by a uniform quantizer with dynamic range (-10, 10). The bit rate of the quantized output is limited to 10kbps.
   (a) Determine the maximum signal to quantization noise ratio (in dB) of the output? (10%)
   (b) If the dynamic range of the quantizer is changed to be (-20, 20), what is the maximum signal to quantization noise ratio (in dB) of the output? (5%)
   (c) If a guard band of at least 500Hz is required at the sampling process and the dynamic range of the quantizer is as part (b), what is the maximum signal to quantization noise ratio (in dB) of the output? (5%)

（背面仍有題目，請繼續作答）

4. An information source has its output from alphabet set {A, B, C, D} with probabilities $P_r(A) = 0.2$, $P_r(B) = 0.5$, $P_r(C) = 0.1$, and $P_r(D) = 0.2$.
   (a) A general encoding scheme uses two bits 00, 01, 10, and 11 to represent A, B, C, and D, respectively. What is the coding efficiency of this scheme? (5%)
   (b) To increase the coding efficiency, Huffman code is used for this information source. What are the average codeword length and the coding efficiency? (5%)
   (c) For part (a), if a modulator with 1Mbps transmission rate transmits bit 0 by $S_0(t)$ and transmits bit 1 by $S_1(t)$ (as shown in Fig. 2, where $T = 1\,\mu$sec) through an AWGN channel with 20dB power loss and two-sided noise PSD = -60dBm/Hz, determine the received average bit energy E_b (in dBW) and the bit-error-rate in Q-function ($Q(u) = \int_u^\infty \frac{1}{2\pi} e^{-x^2/2} dx$.) of this system with optimal receiver. (10%)

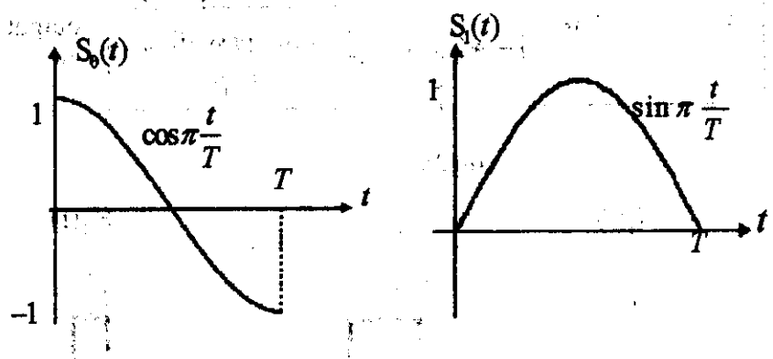

Fig. 2

5. The mapping between messages and codewords of an (n, k) block code is given as

Messages (m)	Codewords (u)	Messages (m)	Codewords (u)
000	000000	100	110100
001	101001	101	011101
010	011010	110	101110
011	110011	111	000111

   (a) Determine the values of n and k. (5%)
   (b) Show the generator matrix **G** and the parity-check matrix **H**, where $\underline{u} = \underline{m}\mathbf{G}$. (5%)
   (c) Determine the error-detecting capability and the error-correcting capability of this code. (5%)
   (d) If the received vector $\underline{r}$ = (1 1 1 1 0 1), determine the syndrome $\underline{s}$ and the decoded message? (5%)