1. The random process $Z(t)$ is defined by $Z(t)=X\cos(2\pi f_1 t+\theta)+Y\sin(2\pi f_2 t+\theta)$. Both X and Y are zero-mean Gaussian random variables with variances σ_x^2 *and* σ_y^2. Random variable θ is uniformly distributed over $(0,\ 2\pi)$. And all these three random variables are independent.
   (a) Determine the ensemble average $m_Z(t)$. (5%)
   (b) Determine the auto-correlation function $R_z(t_1,\ t_2)$. (5%)
   (c) Is $Z(t)$ wide-sense stationary (WSS)? (5%)
   (d) Determine and plot the two-sided power spectral density (PSD) of $Z(t)$. (5%)

2. A sinusoidal message signal $x(t)=\cos 16000\pi t$ modulates the carrier $c(t)=10\cos 2\pi f_c t$, $f_c \gg 10\text{kHz}$. The modulation scheme is conventional AM and the modulation index is 0.5. The channel noise is AWGN with two-sided PSD $=10^{-10}$ W/Hz. At the receiver the signal is processed as shown in Figure 2(a). The frequency response of the bandpass filter is shown in Figure 2(b), where $B_T=\Delta f$ =20kHz.
   (a) Determine the signal power (in dBm) and the noise power (in dBm) at the output of the BPF. (10%)
   (b) Determine the $(S/N)_o$ (in dB) at the output. (10%)

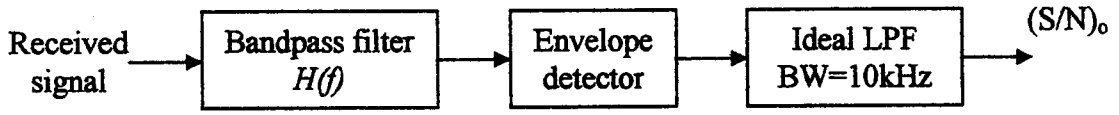

Figure 2(a)

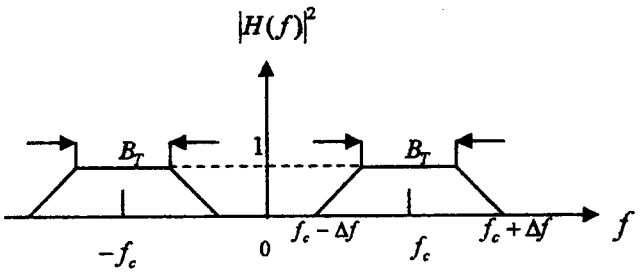

Figure 2(b)

3. A message source has the alphabet A = {-5, -3, -1, 0, 1, 3, 5} with corresponding probabilities {0.05, 0.05, 0.15, 0.1, 0.05, 0.25, 0.35}. This source is quantized according to the quantization rule

$$\begin{cases} q(-5)=g(-3)=4 \\ q(-1)=q(0)=q(1)=0 \\ q(3)=q(5)=-4. \end{cases}$$

   (a) Find the entropy of the quantized output. (5%)
   (b) Design a Huffman code for the quantized output. Determine the average codeword length and the coding efficiency. (5%)
   (c) Determine the signal to quantization noise ratio S_q/N_q (in dB), where S_q is the quantized signal power and N_q is the quantized noise power. (5%)

(背面仍有題目,請繼續作答)

4. Consider the transmission of a message via BPSK signal over a bandpass AWGN channel with an ideal frequency response over 810MZ≤f≤890MHZ Hz and single sided PSD = 10^{-8} W/Hz.
   (a) What is the maximum transmitted date rate if null-to-null bandwidth is considered? (5%)
   (b) If the raised cosine channel spectrum is desired, what is the transmitted data rate for roll-off factor α=33% (or 1/3). (5%)
   (c) If data rate = 40Mbps and the required bit-error-rate is 10^{-5}, determine the minimum received signal power (in dBm) for coherent detection of the BPSK signal. (10%)
   (d) If data rate = 60Mbps and received signal power = 37.8dBm, determine the bit-error-rate for non-coherent detection of the DEBPSK signal. (10%)

   (Note: 1. It is required E_b/N_0 = 12.6 dB for BFSK signal with coherent detection and $P_b = 10^{-5}$.

   2. The bit-error-rate of BFSK modulation with non-coherent detection is $P_b = \frac{1}{2} \cdot \exp(-E_b/2N_0)$.)

5. The generator polynomial of a (7, 4) linear cyclic code is $g(x) = 1+x+x^3$.
   (a) Determine the output (in polynomial form) of the encoder if the input message polynomial $m(x) = 1+x^2$. (5%)
   (b) If the received polynomial $r(x) = 1+x^3+x^5+x^6$ (i.e., $\underline{r} = (1001011)$), what is the decision of the error-detector at the receiver (error or no error)? Why? (10%)