1. The positive portion of the envelope of the output of an AM modulators is shown in Figure 1. The message signal is a periodic waveform having zero dc value and period = $T$. Determine the modulation index, the carrier power, the power in the sidebands, and the power efficiency. (15%)

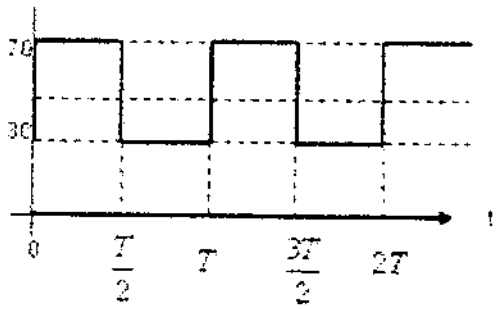


Figure 1

2. The input to a filter with impulse response h(t)=10sinc(100t) is white, Gaussian signal with single-sided power spectral density (PSD) of 5 W/Hz. Determine the followings:
   (a) The mean of the output. (5%)
   (b) The two-sided power spectral density (PSD) of the output. (5%)
   (c) The power of the output. (5%)
   (d) The autocorrelation function of the output. (5%)
   (e) The probability density function (pdf) of the output's amplitude at an arbitrary time $t_1$. (5%)

3. An FM modulator has carrier $c(t)=10\cos(2\pi f_c t)$ and the frequency-deviation constant $f_d=50$. The input of this modulator is $m(t)=10\cos(100\pi t)$.
   (a) Express the output of this modulator. (5%)
   (b) Determine the power of the output signal. (5%)
   (c) Determine the modulation index β and the bandwidth by the Carson's rule. (5%)

4. A signal can be modeled as a lowpass stationary process $x(t)$ whose pdf at any time $t_0$ is $f_x(x)=\Lambda(x)$, where $\Lambda(x)$ is the triangular function. The bandwidth of this signal is 10kHz, and it is desired to transmit it using a PCM system with a uniform quantizer.
   (a) If a 16-level quantizer is employed, what are the resulting lowest bit rate and the corresponding signal to quantization noise ratio (in dB)? (5%)
   (b) If the available transmission rate of the channel is 120 kbps, what is the highest achievable signal to quantization noise ratio (in dB)? (5%)

(背面仍有題目,請繼續作答)

5. In an AWGN channel with a noise power spectral density of $N_0/2$, two equiprobable messages are transmitted by

$$s_1(t)=\begin{cases}\frac{At}{T} & 0\le t\le T\\ 0 & otherwise\end{cases} \qquad s_2(t)=\begin{cases}A-\frac{At}{T} & 0\le t\le T\\ 0 & otherwise\end{cases}$$

(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 ($Q(u)=\int_u^\infty \frac{1}{2\pi}e^{-x^2/2}dx$) and parameters $A$, $T$, and $N_0$. (5%)

(d) Knowing that $E_b/N_0$ = 9.6dB is required to get BER=$10^{-5}$ for coherent BPSK signal, what is the required $E_b/N_0$ (in dB) for this system to get BER=$10^{-5}$? (5%)

6. The output of a (3, 1, 2) convolutional code are determined by $v_i^{(1)}=u_i+u_{i-1}$, $v_i^{(2)}=u_i+u_{i-2}$, and $v_i^{(3)}=u_i+u_{i-1}+u_{i-2}$, where $\{u_i\}$ is the input information sequence.

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

(b) If the input information sequence is [1 1 1 0 1] where the left bit is the first bit, what is the output sequence of the encoder? (5%)

(c) If the received sequence at the decoder is (110,100,100,010,110,010), what is the decoded information sequence? (5%)