1. An FM modulator has unmodulated carrier $c(t) = 10\cos(4000\pi t)$ and the frequency-deviation constant $f_d = 10$. The input message of this modulator is $m(t) = 10\cos(10\pi t)$.
   (a) Determine the peak frequency deviation. (5%)
   (b) Determine the power of the modulated FM signal. (5%)
   (c) Determine the bandwidth according to the Carson's rule. (5%)

2. A twisted-pair telephone wireline with bandwidth = 10KHz is 100-Km long and has a loss of 3dB/Km. The noise temperature at the receiver (or repeater) is T_N = 580°K. (Boltzmann constant = $1.37\text{x}10^{-23}$ Joule/degree)
   (a) If the average transmitted power = 1W, determine the noise power (in dBm) and the S/N (in dB) at the receiver if the line contains no repeaters. (10%)
   (b) If repeaters with a gain of 30dB are used to boost the signal on the channel and if each repeater (or receiver) requires an input signal level of 0dBm, determine the number of repeaters, their spacing distance, and the received S/N (in dB) at the last receiver. (10%)

3. Consider the system shown in Figure 1. The signal $x(t)$ is defined by $x(t) = A\cos 2\pi f_c t$. The lowpass filter has unity gain in the passband and bandwidth = W, where $f_c < W$. The noise $n(t)$ is white with two-sided power spectral density $N_0/2$. The signal component of $y(t)$ is defined to be the component at frequency f_c. Determine the signal-to-noise ratio of $y(t)$.(10%)

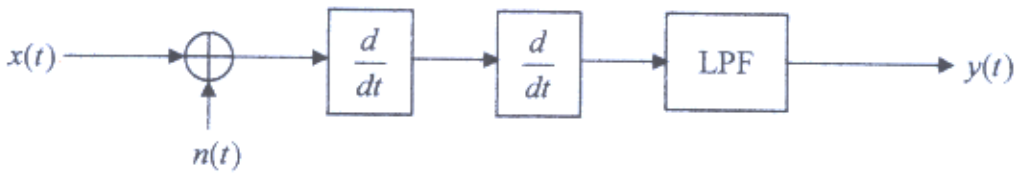

Figure 1

4. An information source can be modeled as a band-limited process with a bandwidth of 10KHz. This process is sampled at a rate higher than the Nyquist rate to provide a guard-band of 4KHz. It is observed that the resulting samples take values in the set A = {-2, -1, 0, 1, 2} with probabilities 0.2, 0.1, 0.2, 0.3, and 0.2.
   (a) What is the entropy of the discrete-time source in bits/output (sample)? (5%)
   (b) What is the entropy in bits/sec? (5%)
   (c) If Huffman code is used to encode the sampled values, what are the codeword length in bits/sample and coded bit rate in bits/sec? (10%)

(背面仍有題目,請繼續作答)

5. Show the ascending order of the required transmitted power for the following modulation schemes to send messages of the same data rate through the same AWGN channel at $P_b = 10^{-5}$. (10%)

   (a) BPSK; (b) QPSK; (c) 8FSK; (d) BFSK; (e) 16QAM.

6. Consider a systematic (8, 4) code whose parity-check equations are

$$v_0 = u_0 + u_1 + u_2 , \quad v_2 = u_0 + u_2 + u_3 ,$$
$$v_1 = u_0 + u_1 + u_3 , \quad v_3 = u_1 + u_2 + u_3 ,$$

   where u_0, u_1, u_2, and u_3 are message digits, v_0, v_1, v_2, and v_3 are parity-check digits. The codeword is $(v_0, v_1, v_2, v_3, v_4, u_0, u_1, u_2, u_3)$.

   (a) Determine the generator and parity-check matrices for this code. (10%)

   (b) Determine the error-detecting capability and the error-correcting capability of this code. (5%)

   (c) A 4-bit message block is encoded by this code and sent through an AWGN channel by using BFSK modulation with non-coherent detection. Given that the received E_b/N_0 is 9 dB, what is the successful reception probability of the whole block? (Hint: The bit-error-rate of BFSK modulation with non-coherent detection is $P_b = 1/2 \exp[-E_b/2N_0]$.) (10%)