1. A single-frequency carrier is modulated by a square wave into an AM wave with modulation index 0.5. The carrier frequency is much higher than the fundamental frequency of the square wave.
   (a) Plot the power spectrum of the square wave. Indicate the fundamental frequency of the square wave in your plot. (5%)
   (b) Plot the AM wave. (5%)
   (c) Plot the power spectrum of the AM wave. Indicate the carrier frequency and the fundamental frequency of the square wave in your plot. (5%)
   (d) Calculate the power of the AM wave (assume the amplitude of the square wave is equal to one). (5%)

2. A single-frequency carrier is modulated by a sinusoidal wave into a FM wave with modulation index u. The carrier frequency is much higher than the frequency of the sinusoidal wave.
   (a) Plot the power spectrum of the FM wave for u=3. How many significant lines in your plot. (5%)
   (b) Plot the power spectrum of the FM wave obtained by using the same sinusoidal wave in (a) but double the amplitude and half the frequency of the sinusoidal wave. How many significant lines in your plot. You are required to use the same scale as in (a) in your plot. (5%)
   (c) Is the bandwidth of the FM wave in (a) the same as that in (b), if not, what is the relationship between them. (5%)
   (d) The FM waves in (a) and (b) are demodulated by the same circuit. Is the signal-to-noise ratio at the demodulator output in (a) equal to that in (b), if not, what is the relationship between them. (5%)

3. (a) Draw the block diagram of the Costas receiver. Explain how the message signal can be recovered. (5%)
   (b) Draw the block of a FM receiver using PLL. Explain how the message signal can be recovered. (5%)

4. A source has an alphabet {x,y,z} with corresponding probabilities {0.73, 0.25, 0.02}.
   (a) What is the minimum required average codeword length to represent this source? (5%)
   (b) Design a Huffman code for this source. Determine the average codeword length and the coding efficiency. (5%)
   (c) Design a Huffman code for the second extension of this source (i.e., take two letters at a time). Determine the average codeword length and the coding efficiency. (5%)

(背面仍有題目,請繼續作答)

5. The output of a (2,1,2) convolutional code are determined by $v_i^{(1)} = u_i + u_{i-1} + u_{i-2}$ and $v_i^{(2)} = u_i + u_{i-2}$, where $\{u_i\}$ is the input message sequence, i.e., the generator sequences of this code is $g_1 = [111]$ and $g_2 = [101]$.
   (a) Draw the encoder of this code. (5%)
   (b) Draw the state-transition diagram of this code. (5%)
   (c) If the message is [1 1 0 1 0], what is the transmitted (output) sequence of the encoder? (5%)
   (d) If the received bit sequence at the decoder is [1 1 1 1 0 0 0 1 0 1 0 1 0 0], determine the decoded message. (5%)

6. Suppose that Offset QPSK (OQPSK) is used to transmit information over an AWGN with a two-sided power spectral density of 10^{-8} W/Hz. The transmitted signal is $10\cos(2\pi f_0 t + \phi_n)$, where ϕ_n is the modulated phase.
   (a) Draw the modulator. (5%)
   (b) Draw the structure of optimal receiver. (5%)
   (c) Determine the maximum data rate that can be sent with bit-error-rate $P_b \le 10^{-5}$. (Note : For orthogonal BFSK, it is required that $E_b/N_0 = 12.6$dB to have $P_b \le 10^{-5}$.) (5%)