1. Let y(t) be a band-limited signal to W = 1 kHz, signal y(t) is sampled at a rate 30% higher than the Nyquist rate to provide a guard band.
    1) What is the sample rate for y(t)?
    2) Please use diagrams to explain what aliasing is and why in general sampling has to meet the Nyquist sampling theorem.
    3) Please use diagrams to explain why the oversampling is easier to design a simple filter.
2. The maximum acceptable error for signal x(t) in the sample amplitude (the maximum quantization error) is 1% of the peak-to-peak voltage, where x(t) is with amplitude $0 \leq x(t) \leq 2$.
    1) How many quantization levels are required? How many bits per sample are required?
    2) Assuming the sampling rate of this system is 8kHz, what is the maximum bit rate (digital bandwidth) of this system?
    3) Calculated the bit rate required to transmit x(t) as a linearly quantised PCM signal maintaining an SQNR of 55 dB. (Assume that the signal's peak to mean ratio is 20dB).

3. If x(t) is quantised by a non-uniform quantiser Q and power P = 100. The quantiser Q is defined by the following four quantisation regions: R0 = [0,1], R1 = [1,3], R2 = [3, 7] and R3 = [7,15].) Symbols ai, i = 1, 2, 3 and 4, correspond to the amplitudes produced by each quantisation region Ri and the probabilities pi that the amplitude of x(t) is in each region Ri are as follows

p_0	p_1	p_2	p_3
0.17	0.49	0.25	0.09

    1) What are the quantisation noise power in each region assuming that the noise is distributed uniformly, the average quantisation noise power, and the SQNR in dB.
    2) Obtain the information content of each symbol and entropy of the information source under the probabilities in 1).
4. Consider a source having an *M*=4 symbol alphabet where $P(x_1) = 1/2$; $P(x_2) = 1/4$ $P(x_3) = P(x_4) = 1/8$ and symbols are statistically independent.
    1) Calculate the information conveyed by the receipt of the symbol x_1, x_2 , x_3. and x_4.

    2) What is the source entropy and the redundancy?