Signals and Communication II: Review Questions

1. Consider the signal $x_1(t) = \sin(\pi t)$.
   (a) What is the frequency of $x_1(t)$?
   (b) What is the Nyquist rate of $x_1(t)$?
   (c) Determine the Fourier transform of $x_1(t)$
2. Consider the signal $x_2(t) = \cos(\pi t) + \cos(3\pi t) + \cos(5\pi t)$.
   (a) Determine the Fourier transform of $x_2(t)$
   (b) Determine the bandwidth of $x_2(t)$
   (c) What is the Nyquist rate of $x_2(t)$?
3. The Fourier transform of a signal $x(t)$ is given by

$$X(f) = \begin{cases} -f+1 & 0 < f \leq 1 \\ f+1 & -1 \leq f \leq 0 \\ 0 & \text{otherwise} \end{cases} \tag{1}$$

   The signal is sampled at a rate f_s to form a sampled signal $x_s(t)$ whose Fourier transform is $X_s(f)$
   (a) Sketch $X_s(f)$ for the following values of $f_s = 1, 1.5, 2, 4$
   (b) Determine the value of $X_s(f)$ at $f = 1$ for the following values of $f_s = 1, 1.5, 2, 4$
4. The signal $\sin^2(2\pi t)$ is to be sampled and quantized using a mid rise uniform quantizer. The samples will be represented using 3 bits.
   (a) Determine the step size of the quantizer.
   (b) Draw a graph showing the relationship between the input level and output level.
   (c) If the signal is sampled at $t = 0.5$, give the corresponding output level of the quantizer.
5. The signal $\sin(2\pi t)$ is to be sampled and quantized using a mid tread uniform quantizer. The samples will be represented using 3 bits.
   (a) Determine the step size of the quantizer.
   (b) Draw a graph showing the relationship between the input level and output level.
   (c) Give a possible binary representation of the quantisation levels.
   (d) If the signal is sampled at $t = 0.125$, give the corresponding output level of the quantizer.
6. Consider the probability distribution function given by

$$f_E(e) = \begin{cases} \frac{1}{\Delta} & -\frac{\Delta}{2} \leq e \leq \frac{\Delta}{2} \\ 0 & \text{otherwise} \end{cases} \tag{2}$$

   Compute
   (a) $\int_{-\infty}^{\infty} f_E(e)de$
   (b) $\int_{-\infty}^{\infty} ef_E(e)de$
   (c) $\int_{-\infty}^{\infty} e^2 f_E(e)de$