1. (a) Consider the following trapezoidal pulse \( v(t) \): Evaluate the spectrum of \( v(t) \)

\[ \text{and sketch it (or use Matlab to plot it)?} \]

(b) Consider the periodic waveform \( w(t) \) shown below:

i. Find the dc value and the root mean square (RMS) of \( w(t) \)?

ii. Find the average normalized power of \( w(t) \) (write it in dB), and the normalized energy. Based on your results, determine whether \( w(t) \) is a power signal or an energy signal?

iii. Express \( w(t) \) using Fourier series, i.e., find the Fourier series coefficients?

iv. Write an expression for the spectrum of \( w(t) \) and sketch it?

v. What is the null bandwidth of \( w(t) \)?

vi. Evaluate the Power Spectral Density (PSD) of \( w(t) \)?

(c) Consider a LTI system (filter) with a frequency response

\[
H(f) = \begin{cases} 
0.5[1 + \cos(0.5\pi f/f_0)], & |f| \leq 2f_0 \\
0, & f \text{ elsewhere} 
\end{cases}
\]  

Let \( y(t) \) be the output signal of this system to the input waveform \( w(t) \) given in part (b):

i. Find the spectrum \( Y(f) \) of \( y(t) \)?

ii. Find \( y(t) \)?

iii. Find PSD of \( y(t) \)?
2. Given an audio signal with spectral components in the frequency band 300 to 3300 Hz, assume that a sampling rate of 10 KHz will be used to generate a PCM signal. Design an appropriate PCM system as follows:

(a) Draw a block diagram of the PCM system, including the transmitter, channel, and receiver.

(b) Specify the number of uniform quantization steps needed and the channel null bandwidth required, assuming that the peak-to-noise ratio at the receiver output needs to be at least 30 dB and that polar NRZ signaling is used.

(c) What are the four types of quantizing noise at the output of the PCM decoder?, and describe them briefly (you may use simple diagrams).

(d) How nonuniform quantization can be used to improve the performance of the system?

3. Write a summary of “How Telephone Systems Work”. The aim of this question is to understand how telephone systems work. You should read section 8.2 of the textbook. You are also encouraged to find relevant material from the Web/library and read them. Do not write an essay, but a short concise summary (say 1-2 pages depending on your handwriting).