Background: A function called a "raised cosine" is a useful pulse shape in communications because it has many fewer high-frequency side lobes than a rectangular pulse, thus requires less bandwidth. The raised cosine can be expressed as:

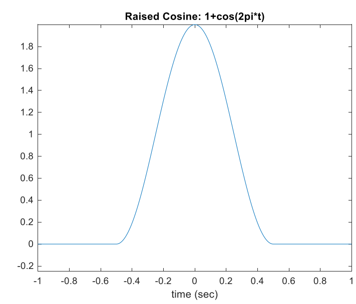
$$f(t) = \begin{cases} 1 + cos(2\pi t) & |t| < 0.5 \\ 0 & \text{elsewhere} \end{cases}$$

1. Sketch $f(t)$ by hand or with a graphing resource (website, etc. – be sure to include in Doc statement!). It looks sort of Gaussian doesn't it? Look up the Fourier transform of a Gaussian, which is also a Gaussian, and sketch it by hand or with a graphing resource. A Gaussian pulse has very small tails (i.e., fewer higher frequency terms) in both the time and frequency domain!

2. Plot the raised cosine pulse, $f(t)$ over the interval -1 < t < 1, using Python or MATLAB. There are different approaches, but here is one approach in MATLAB:

```
t = -1:.001:1; % time axis in seconds
t_cos= -?:?:?; % time axis for plotting just the cosine, from -0.5<t<.5
f_t=[zeros(??) 1+cos(2*pi*t_cos) zeros(??)];  % you can figure out the
                                               % ?? yourself
plot(t,f_t)
title('Raised Cosine 1+cos(2*pi*t)')
xlabel('time [sec]')
```

Your plot should look like this →



3. Mathematically (using the Fourier coefficient integral) find the exponential Fourier-series coefficients, F_n, for the raised-cosine pulse, over the interval (-1,1), where

$$f(t) = \sum_{n=-N}^{N} F_n e^{jn\omega_0 t}$$

4. Using Python or MATLAB, plot the signal defined by your answer to Problem 3 **superimposed** over your plot from Problem 2 for $N = 1$, $N = 2$, $N = 3$, and $N = N_{perfect}$, where $N_{perfect}$ is the value of N where the sum nearly matches the plot perfectly (as subjectively determined by you). What is your value of $N_{perfect}$? Include your code along with your 4 figures.

5. Repeat Problem 4 over the interval (-5, 5). How does your plot differ from the original signal that you plotted in Problems 2 and 4? Explain.