I. Overview of The problem

You are requested to perform the STFT (Short-Time Fourier transform) over a generalized harmonic sine wave, and report the power contained by each harmonics in the resulting Frequency scale.

II. Generalized wave equation

Consider a generalized harmonic wave given by

$$v(t) = \sum_{i=1}^{n} a_i * \sin(i\omega t) \tag{1}$$

which upon expansion gives :

$$v(t) = a_1 sin(\omega t) + a_2 sin(2\omega t) + \ldots + a_n sin(n\omega t)$$

Take it's discrete time form

$$v[n] = \sum_{i=1}^{n} a_i sin(i * 2\pi f n) \tag{2}$$

III. short-time fourier transform

The Short-time fourier transform,in it's simple terms, performs the following:

1) Consider a window of length N_w. It can be any standard window. We shall consider Blackman, but do with Hamming, if it's too complex. Let's denote it with $w[n]$.
2) Divide the signal into chunks of length N_w, and window it. Let the windowed signal be $v_w[n] = v[n] * w[n]$. We shall get a number of such windowed chunks.
3) Perform a Nfft sized DFT on each windowed chunk. Store each complex DFT chunk. This will give us a matrix with Nfft rows.
4) Now calculate the energy of each frequency as normalized square amplitude. Store that expression.

For reference, look up wikipedia, as well as oppenheim. The windowing process is sometimes called Welch windowing process. A sample implementation is available in matlab as spectrogram function. Have a look at it.

I request you to please complete this by monday,if possible. Else, by tuesday. I don't want to be late like last time. You can play with Matlab to get a feel for how STFT works. During fault regions, there will be a surge in power in fundamental as well a higher order harmonics energies. I want to capture that for fault detection.

Divide the work if needed.

Thank you