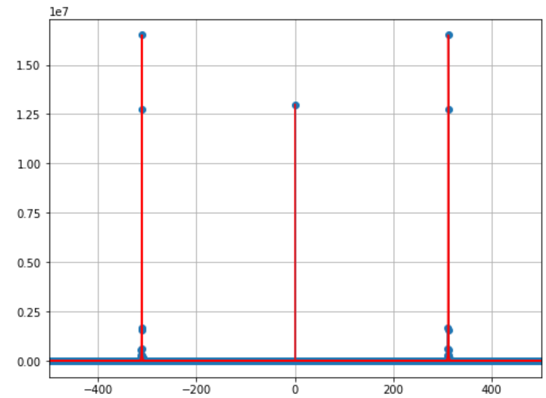
Part 0:

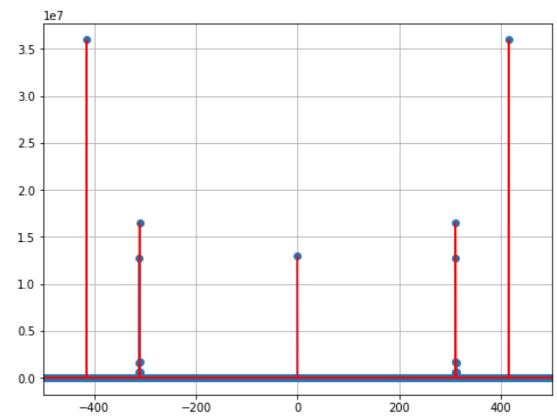
1. The two sets of indices are of the same modulus N, as dividing -2 by 5 yields a remainder of 3 while dividing -1 by 5 gives a remainder of 4.
2. The fftshift operation sets the zero to the center of the Fourier transform array and rearranges the rest by moving the last (n - 1) / 2 terms before the 0 and the remaining nonzero terms after it.
3. These frequencies will be the x coordinates of the peaks in the DFT graph.

Part 1:

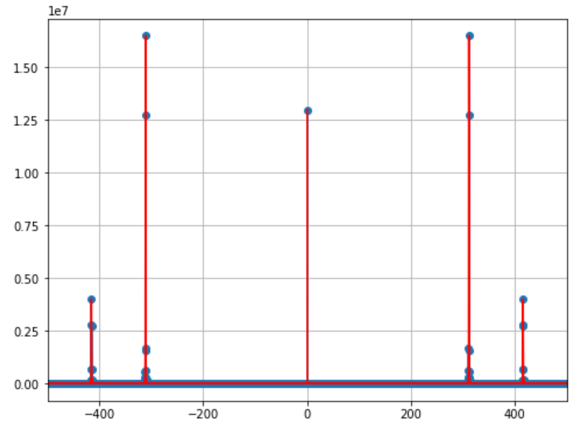
1. $DC = 0.3, f_1 = 311.13\ (0 \le t \le 5)$:



2. $DC = 0.3, f_1 = 311.13\ (0 \le t \le 5), f_2 = 415.30\ (0 \le t \le 5)$:

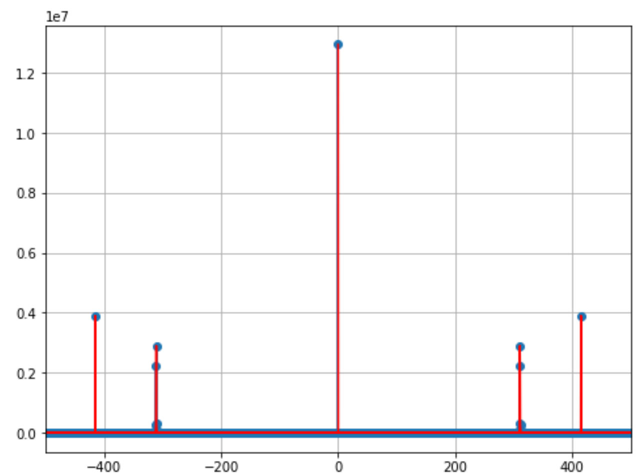


3. $DC = 0.3, f_1 = 311.13\ (0 \le t \le 5), f_2 = 415.30\ (1 \le t \le 2)$:



Part 2:

1. This code serves as a lowpass filter, diminishing higher frequencies while maintaining signals of lower frequencies.
2. Running the code multiple times stacks the filtering effect, further diminishing high frequency signals.



Part 2b:

1.

$y[k] = 0.8y[k - 1] + 0.2x[k]$ $\quad$ $Y = 0.8YR^{1} + 0.2X$ $\quad$ $Y - 0.8YR = 0.2X$

$(1 - 0.8R)Y = 0.2X$ $\quad$ $\frac{5Y}{X} = \frac{1}{1-0.8R}$ $\quad$ $\frac{Y}{X} = \frac{1}{5-4R}$

2.

Transfer Function: $(\frac{Y}{X})^2 = (\frac{1}{5-4R})^2 = \frac{1}{(5-4R)^2}$

Difference Equation: $\frac{1}{(5-4R)^2} = \frac{1}{16R^2-40R+25} = \frac{Y}{X}$ $\quad$ $\frac{Y(16R^2-40R+25)}{X} = 1$

$16YR^2 - 40YR + 25Y = X25Y = 16YR^2 - 40YR + X$

$Y = YR^2 - \frac{8}{5}YR + \frac{1}{25}X$ $\quad$ $y[k] = y[k - 2] - \frac{8}{5}y[k - 1] + \frac{1}{25}x[k]$

3.

$$dbv = 20log(\frac{V_{out}}{V_{in}})$$

311.13 Hz Portion:

$$dbv = 20log(\frac{0.3}{1.7}) = -15.067$$

415.30 Hz Portion:

$$dbv = 20log(\frac{0.4}{3.6}) = -19.085$$