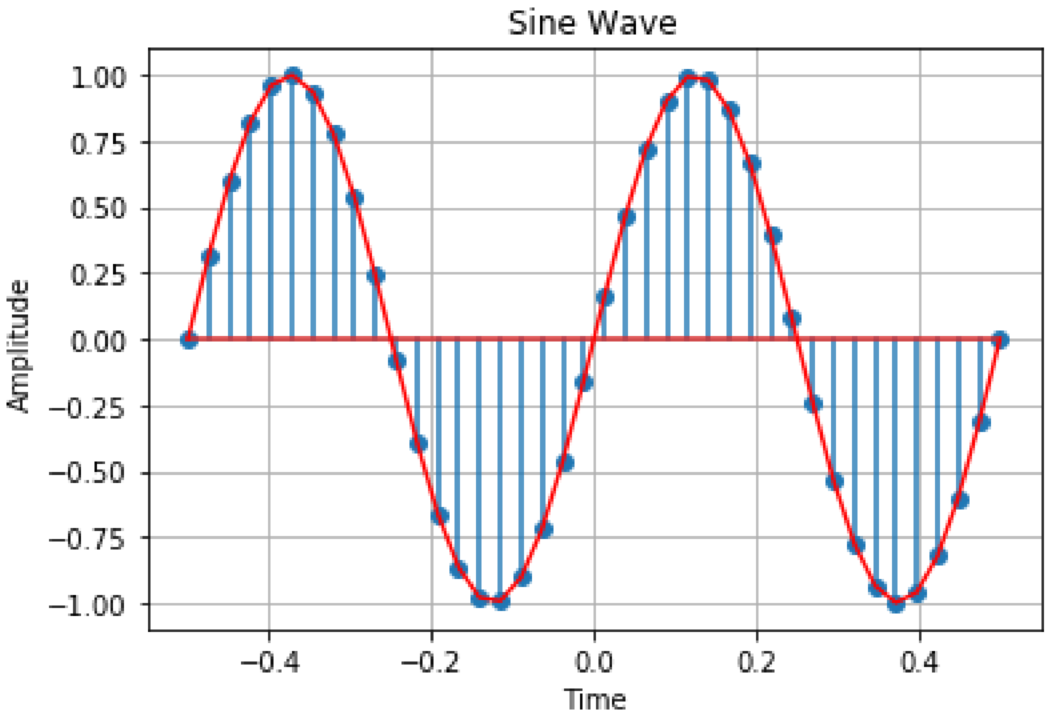
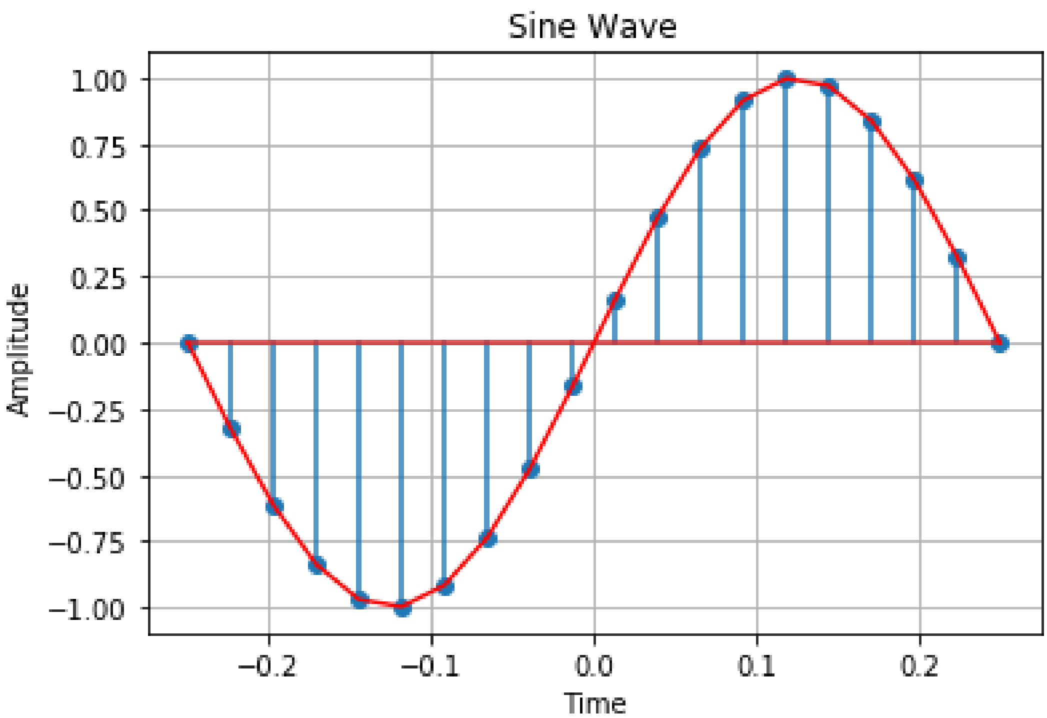
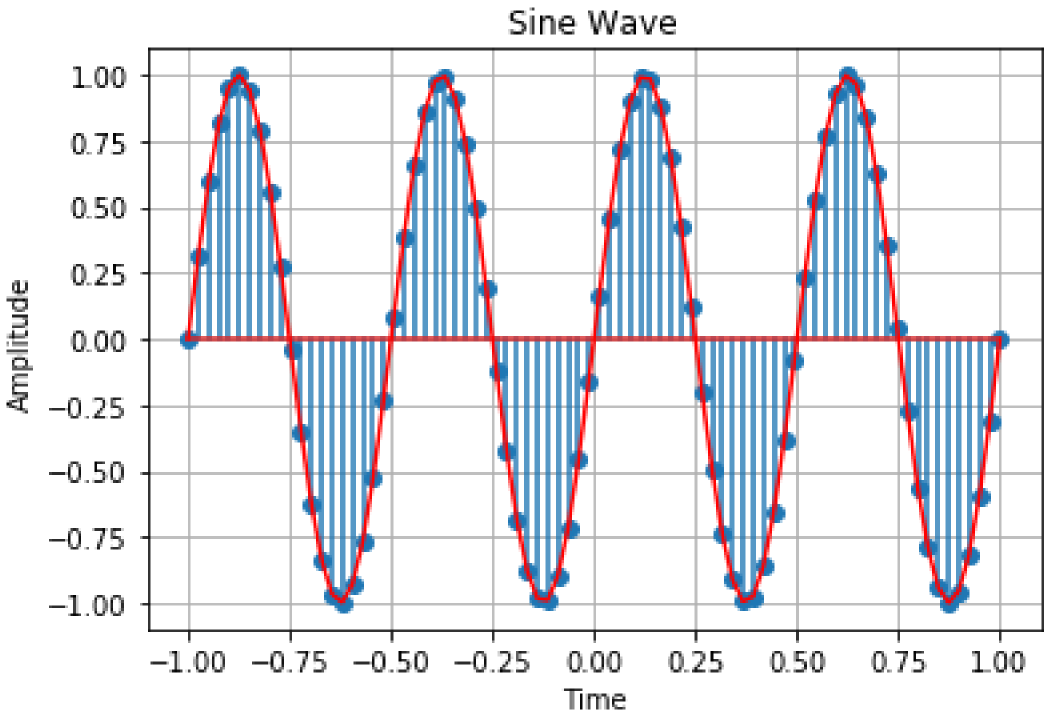
1. Input Frequency: 2
   Input Sampling Frequency: 20
   Input number of cycles: 2




Input frequency = 2
Input Sampling frequency = 20
Input number of cycles = 1



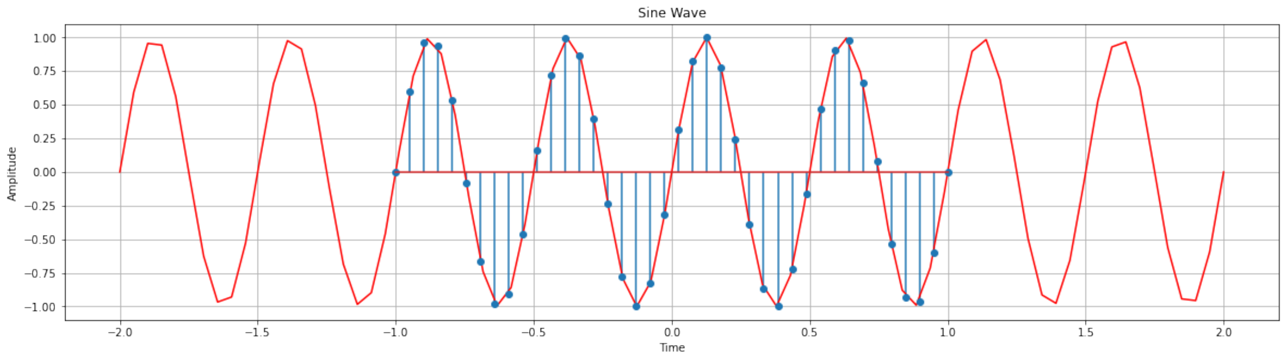
Input frequency = 2
Input Sampling frequency = 20
Input number of cycles = 4

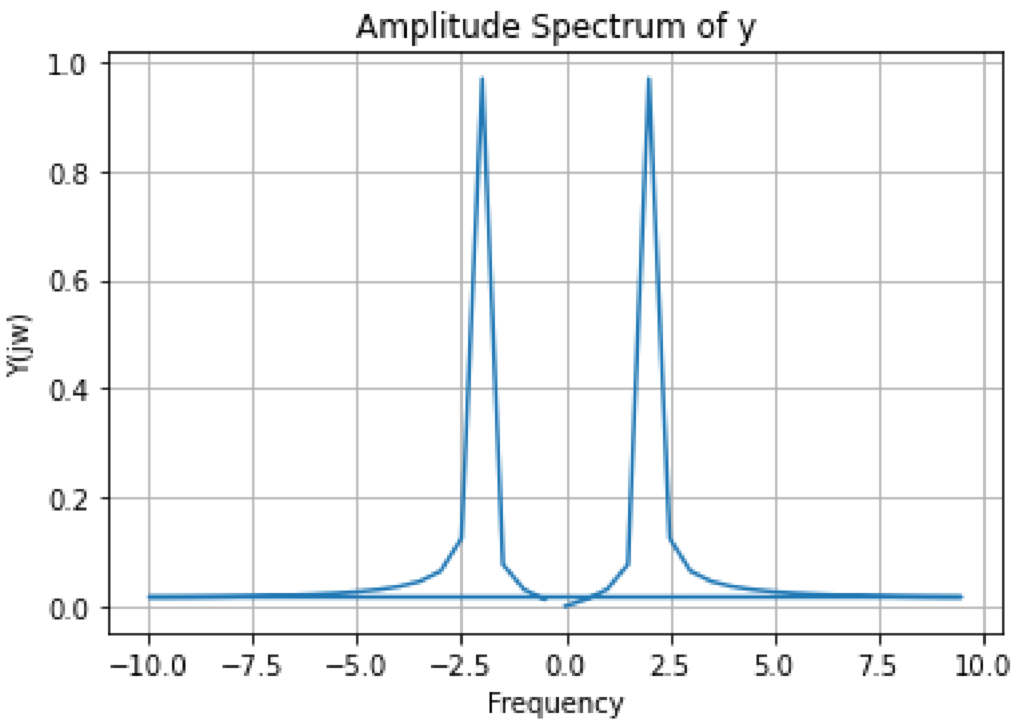



# Explanation:

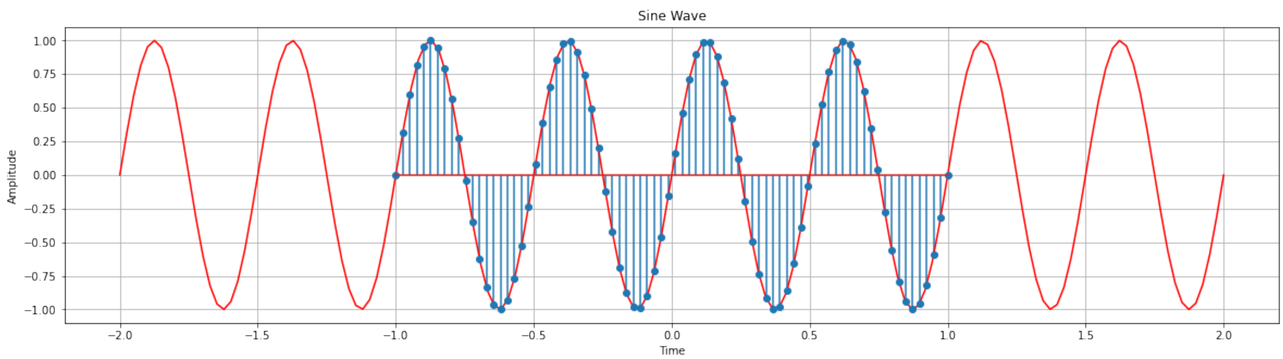
- linspace command creates an arithmetic progression in the given interval with given terms.
- since we are taking n cycles and time duration of each cycle is -1/2f to 1/2f, we multiply these values by n to get the desired time period for n cycles.
- sampling frequency = samples/cycle = fs. So total samples in the entire interval = n*fs which is the third parameter.
- Next we plot the sin wave in the form sin($2\pi$*f*t) where t values are in the array named x and plot it against x (time).

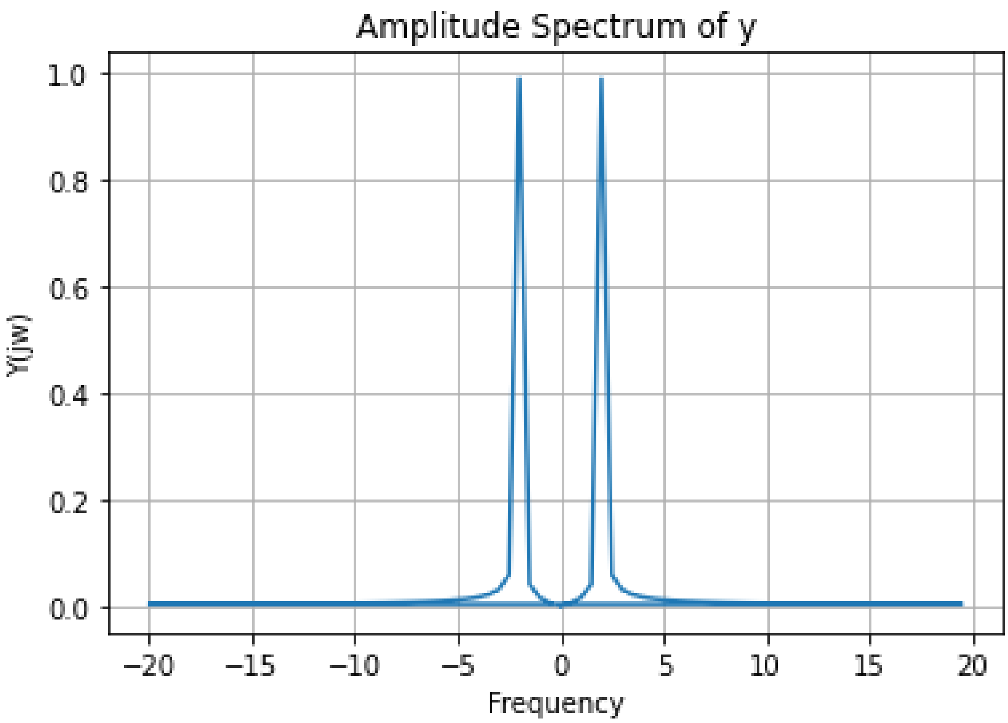
2. (a) Input T: 2
Input T1: 1
Wave frequency f: 2
Input sampling frequency fs: 10



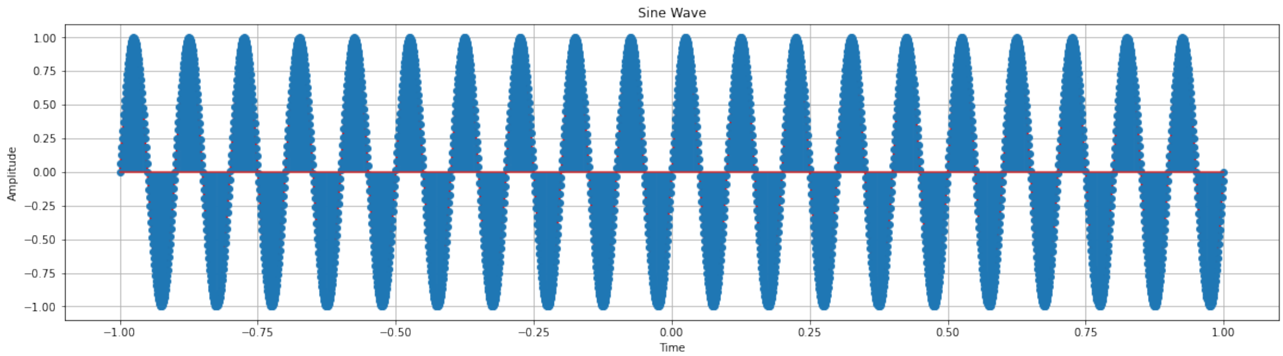



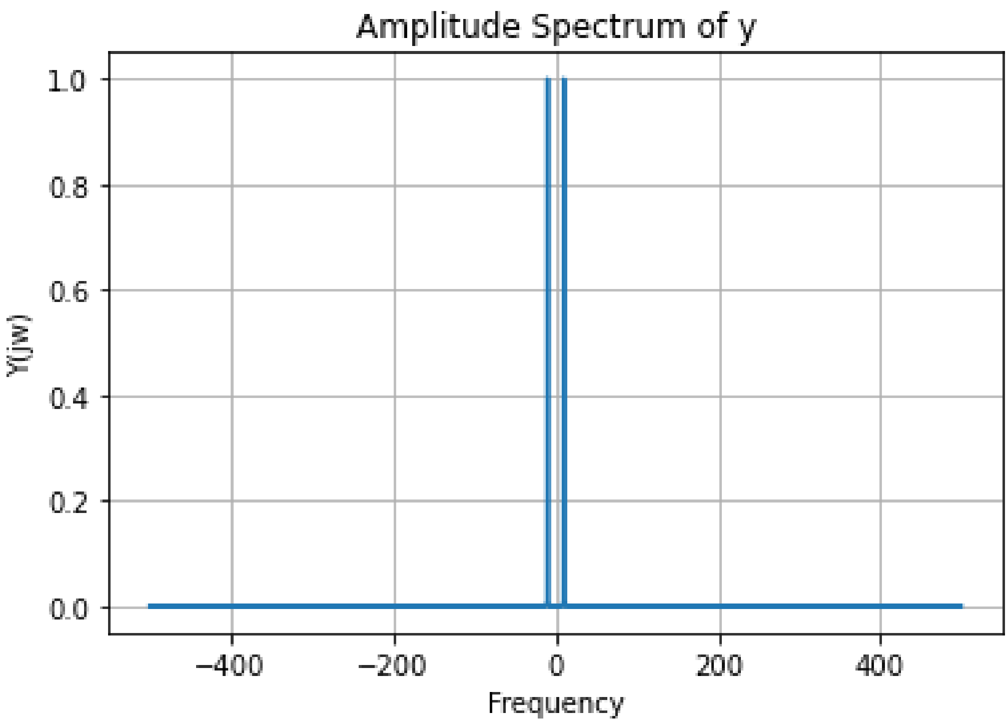
Input T: 2
Input T1: 1
Wave frequency f: 2
Input sampling frequency fs: 20



(b) Input T: 1
Input T1: 1
Wave frequency f: 10
Input sampling frequency fs: 100



# Explanation:

- We can represent truncated sine wave as a multiplication of sine wave and a rectangular function of appropriate thickness.

- Using multiplication in time domain equivalents to convolution in frequency domain, and using Fourier transform of sine and sum of two Dirac delta functions located at (+f) and (-f) and sinc being the Fourier transform of rectangular wave, we get convolution between sum of Dirac delta and sinc.

- Using properties of convolution and Dirac delta, we get two shifted sinc functions in frequency domain.

$$rect(t) = \begin{cases} 1 & \text{; -T1 <= t <= T1} \\ 0 & \text{; elsewhere} \end{cases} \tag{1}$$

$$F(rect(t)) = 2T1[sinc(2 * f * T1)] \tag{2}$$

$$sinc(t) = \frac{sin(\pi t)}{\pi t} \tag{3}$$

$$F(sin(t)) = \frac{1}{2}[d(f - f_0) + d(f + f_0)] \tag{4}$$

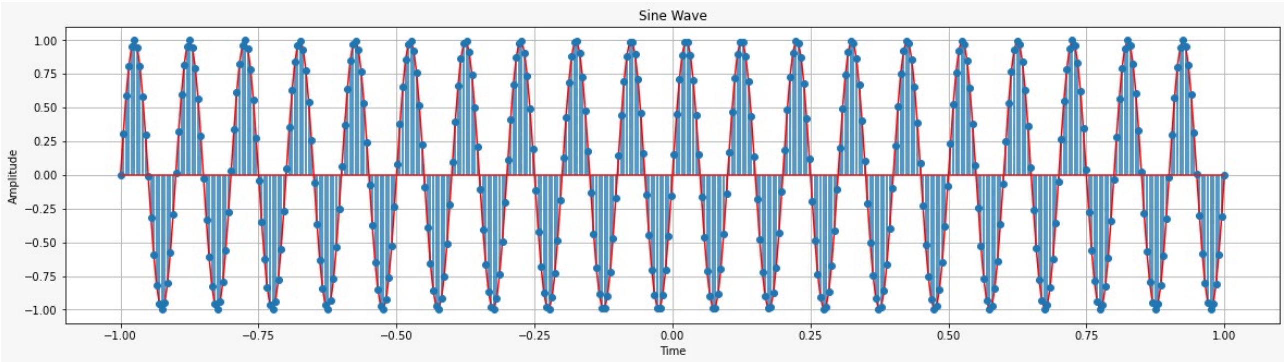
Convolving (2) and (4) and using shifting property, we get:

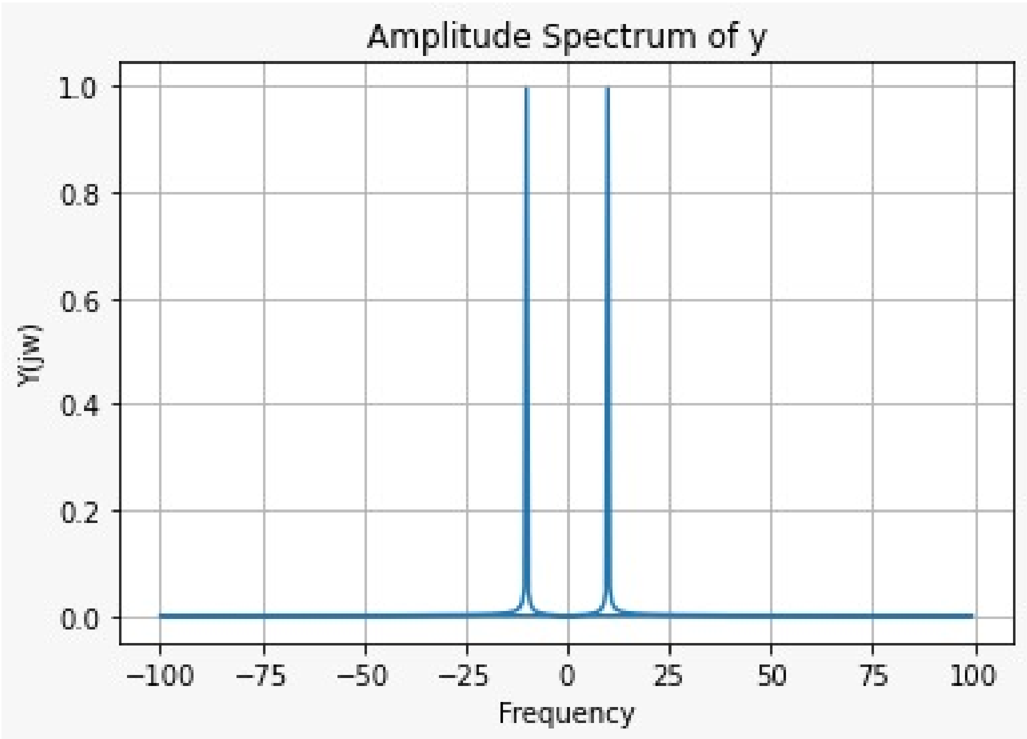
$$T1 * [sinc(2 * f * T1 - 2 * f_0 * T1) + sinc(2 * f * T1 + 2 * f_0 * T1)] \tag{5}$$

- Note that we multiplied the amplitude by 2 in the plot so we will have to consider a factor of 2 while solving analytically.

- Putting the values as $f_0$ = 10, T1 = T = 1 and fs = 100 we get the amplitude to be approximately equal to 0.5 which is then multiplied by 2 and therefore we'll have one as final answer, which in turn matches with the results found out using the code. We got closer to analytical result by taking T1 = T which resulted in a sharper Fourier transform since it included more samples from the entire length of the function given.

(c) If T=T1
Input T: 1
Input T1: 1
Wave frequency f: 10
Input sampling frequency fs: 20




# Explanation:

- At T1 = T, the amplitude spectrum of x(t) and y(t) will be same. The spikes when T1 = T will be higher than the spikes when T1 < T and also higher than the spikes when T1 > T.
- For T1 < T, we can say that the sine wave has lost some of its characteristics because of the reduction of samples in the part [-T,-T1) and (T1,T].
- For T1 > T, the portion in [-T1,-T) and (T,T1] will have zeros and therefore it'll mean than we've degraded the original sine wave which will cause decrease in the length of spikes in this case.