Communication systems Lab 3

Harshal Abhyankar 2019A3PS0282P

**Task 1**

import numpy as np

import matplotlib.pyplot as plt

from  numpy.fft import fft

start\_time=-2

stop\_time=2

fm = 10

fs=10\*fm

ts=1/fs

time = np.arange(start\_time,stop\_time,ts)

h\_t = 0.2\*np.sinc(2\*fm\*time)

h\_f = fft(h\_t)/fs

N=len(h\_f)

freq\_axis = np.linspace(-fs/2, fs/2, N)

hf\_abs= abs(h\_f)

hf\_abs\_sorted=np.fft.fftshift(hf\_abs)

fig, axis=plt.subplots(2)

axis[0].plot(time,h\_t)

axis[0].set(xlabel='Time',ylabel="Amplitude",title="Time Domain")

axis[1].plot(freq\_axis,hf\_abs\_sorted)

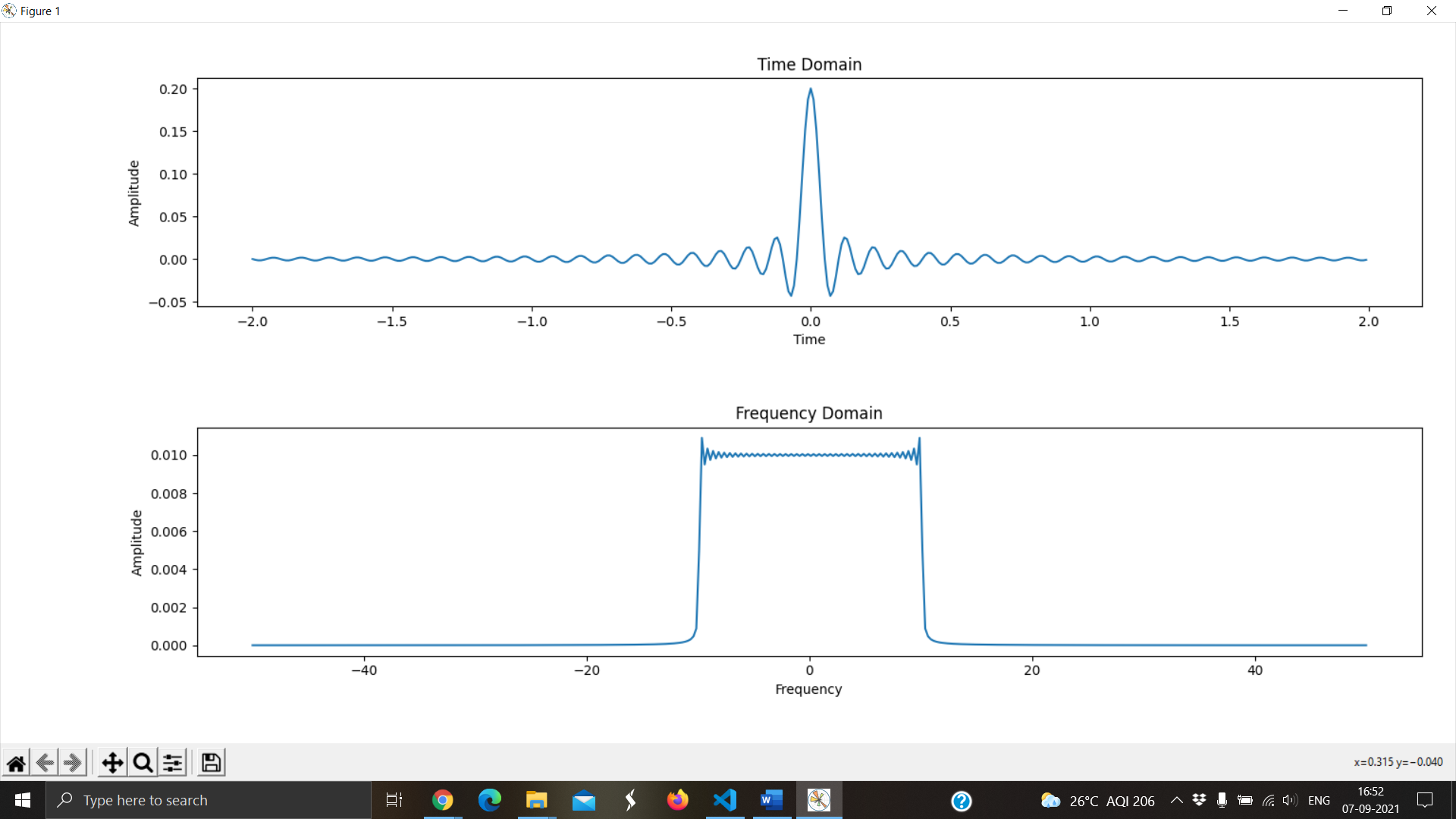
plt.title('Frequency Domain')

plt.xlabel('Frequency')

plt.ylabel('Amplitude')

plt.tight\_layout()

plt.show()



**Task 2**

**Code:**

import numpy as np

import matplotlib.pyplot as plt

from  numpy.fft import fft

start\_time=-2

stop\_time=2

fm = 10

fs=10\*fm

ts=1/fs

time = np.arange(start\_time,stop\_time,ts)

h\_t = 0.2\*np.sinc(2\*fm\*time)

h\_f = fft(h\_t)/fs

N=len(h\_f)

freq\_axis = np.linspace(-fs/2, fs/2, N)

hf\_abs= abs(h\_f)

hf\_abs\_sorted=np.fft.fftshift(hf\_abs)

m\_t = np.sin(10\*np.pi\*time) + np.sin(40\*np.pi\*time)

y\_t = np.convolve(m\_t,h\_t)

y\_f = fft(y\_t)/fs

Ny = len(y\_f)

freq\_axis\_y = np.linspace(-fs/2, fs/2, Ny)

yf\_abs = abs(y\_f)

yf\_abs\_sorted = np.fft.fftshift(yf\_abs)

fig, axes=plt.subplots(2)

axes[0].plot(y\_t)

axes[0].set(xlabel='Time',ylabel="Amplitude",title="Time Domain")

axes[1].plot(freq\_axis\_y,yf\_abs\_sorted)

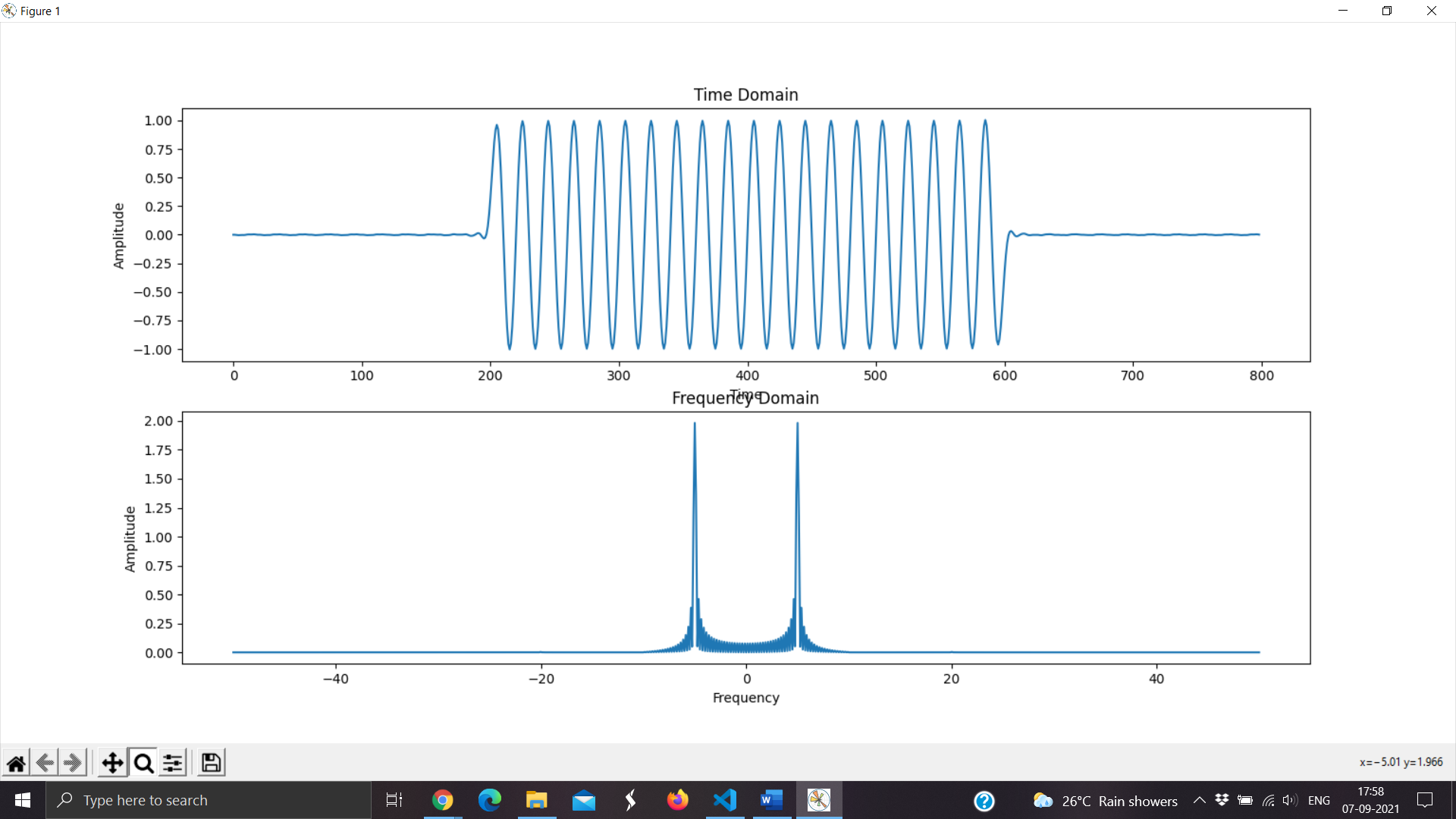
plt.title('Freq Domain')

plt.xlabel('Freq')

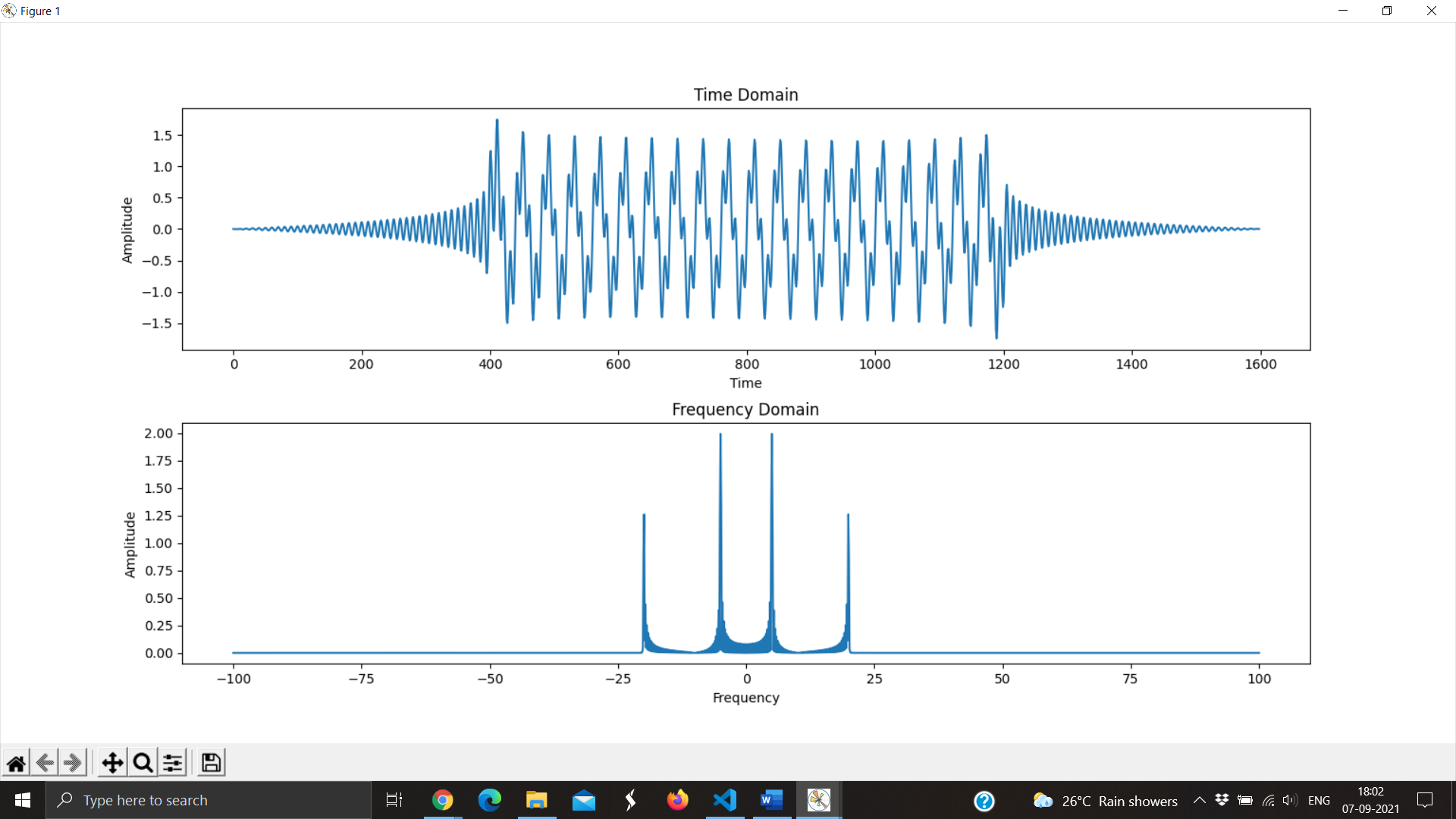
plt.ylabel('Amplitude')

plt.show()

For fm=10:



For fm=20:



**Task 3**

Code:

import numpy as np

import matplotlib.pyplot as plt

from  numpy.fft import fft

start\_time=-2

stop\_time=2

fm = 20

fs=10\*fm

ts=1/fs

time = np.arange(start\_time,stop\_time,ts)

h\_t = 0.2\*np.sinc(2\*fm\*time)

hf = fft(h\_t)/fs

N=len(hf)

freq\_axis = np.linspace(-fs/2, fs/2, N)

hf\_abs= abs(hf)

hf\_abs\_sorted=np.fft.fftshift(hf\_abs)

m\_t = 2\*fm\*np.sinc(2\*fm\*time)

y\_t = np.convolve(m\_t,h\_t)

y\_f = fft(y\_t)/fs

Ny = len(y\_f)

freq\_axis\_y = np.linspace(-fs/2, fs/2, Ny)

yf\_abs = abs(y\_f)

yf\_abs\_sorted = np.fft.fftshift(yf\_abs)

fig, axes=plt.subplots(2)

axes[0].plot(y\_t)

axes[0].set(xlabel='Time',ylabel="Amplitude",title="Time Domain")

axes[1].plot(freq\_axis\_y,yf\_abs\_sorted)

plt.title('Frequency Domain')

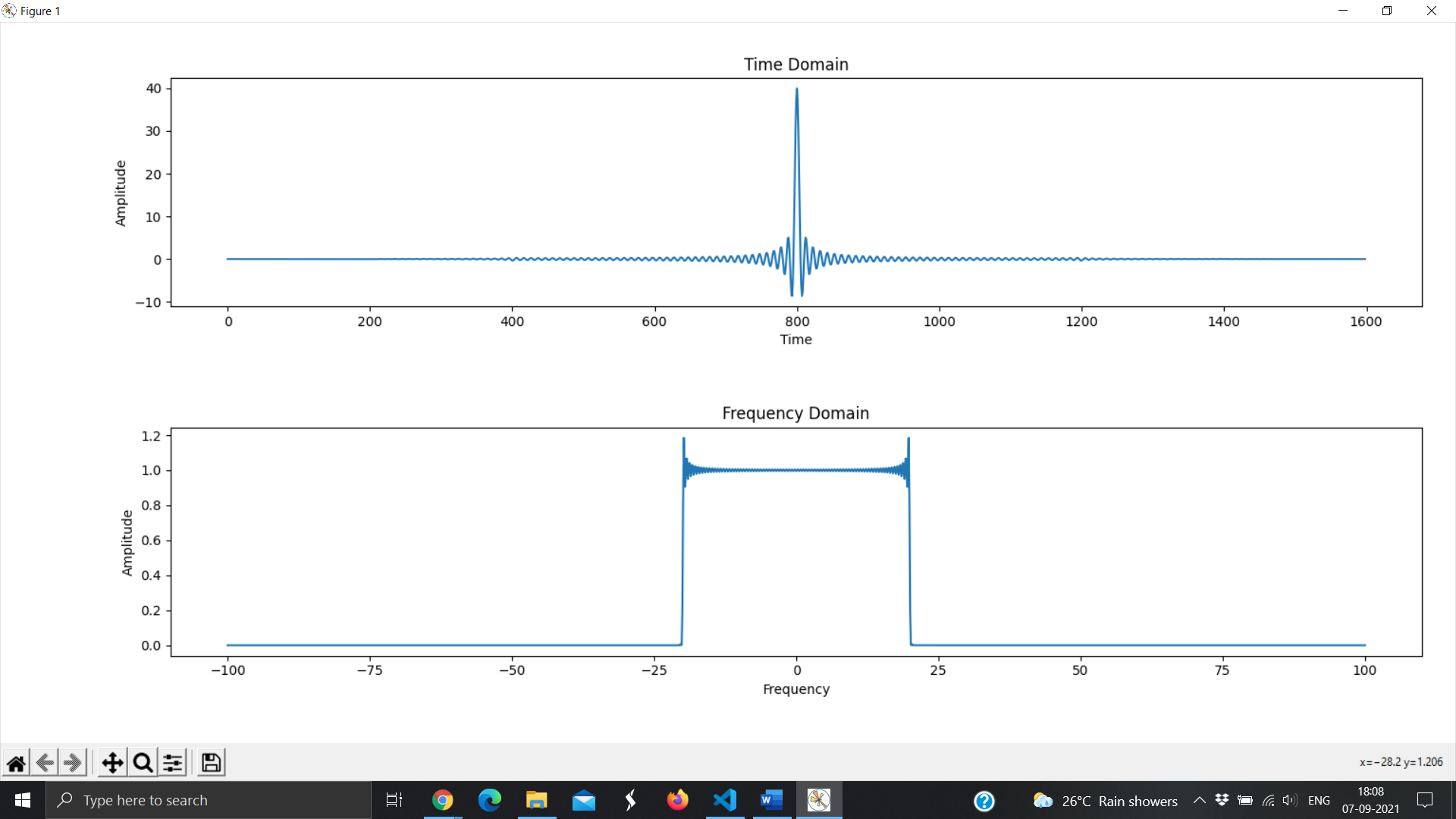
plt.xlabel('Frequency')

plt.ylabel('Amplitude')

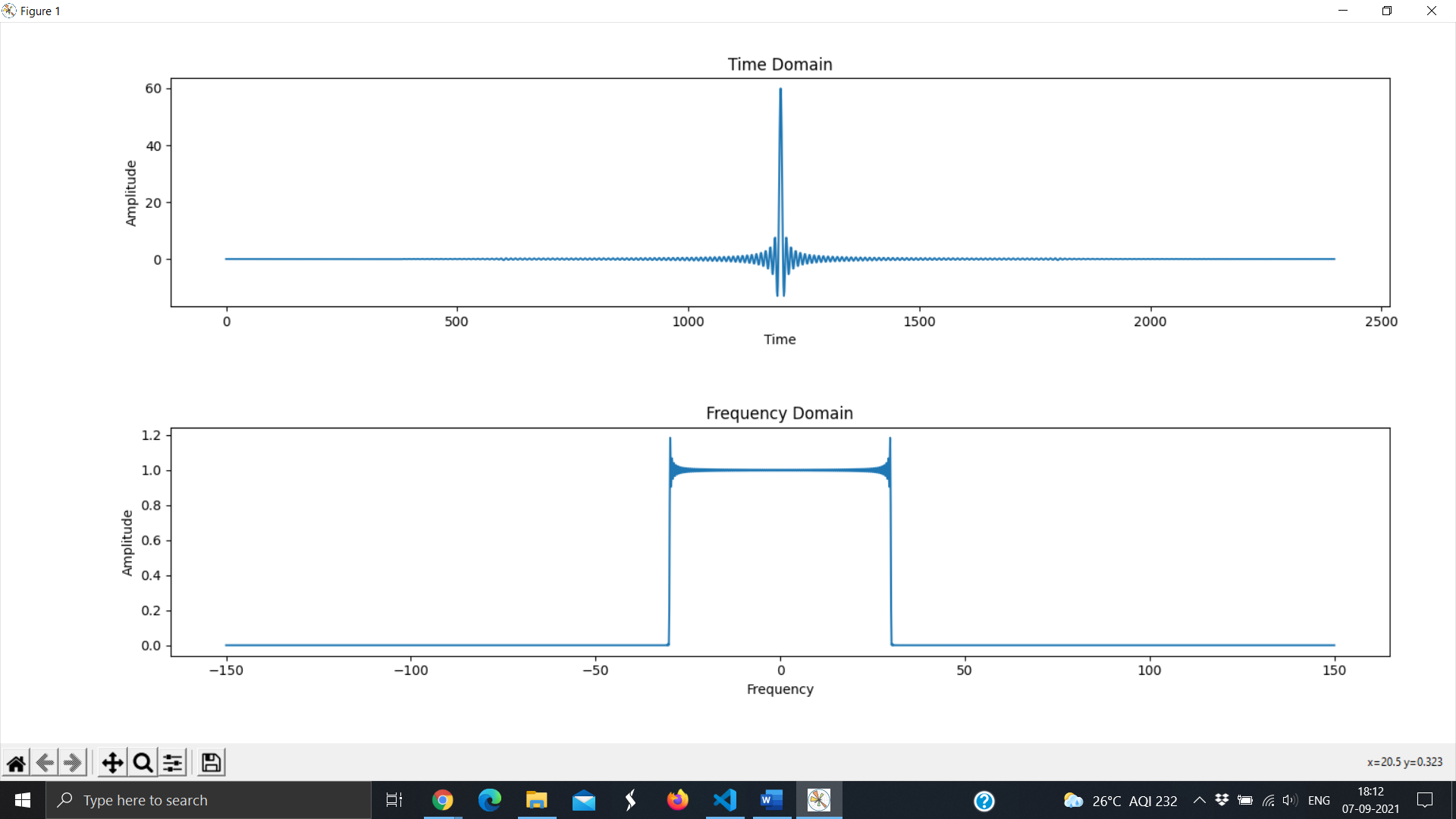
plt.tight\_layout()

plt.show()

For fm=10:



For fm=30:



**Task 4**

Code:

import numpy as np

import matplotlib.pyplot as plt

from  numpy.fft import fft

start\_time=-2

stop\_time=2

fm = 10

fs=10\*fm

ts=1/fs

time = np.arange(start\_time,stop\_time,ts)

h\_t = 0.2\*np.sinc(2\*fm\*time)

hf = fft(h\_t)/fs

N=len(hf)

freq\_axis = np.linspace(-fs/2, fs/2, N)

hf\_abs= abs(hf)

hf\_abs\_sorted=np.fft.fftshift(hf\_abs)

T=1

m\_t = [1 if abs(i)<=T/2 else 0 for i in time]

y\_t = np.convolve(m\_t,h\_t)

y\_f = fft(y\_t)/fs

Ny = len(y\_f)

freq\_axis\_y = np.linspace(-fs/2, fs/2, Ny)

yf\_abs = abs(y\_f)

yf\_abs\_sorted = np.fft.fftshift(yf\_abs)

fig, axes=plt.subplots(2)

axes[0].plot(y\_t)

axes[0].set(xlabel='Time',ylabel="Amplitude",title="Time Domain")

axes[1].plot(freq\_axis\_y,yf\_abs\_sorted)

plt.title('Freq Domain, for T=1')

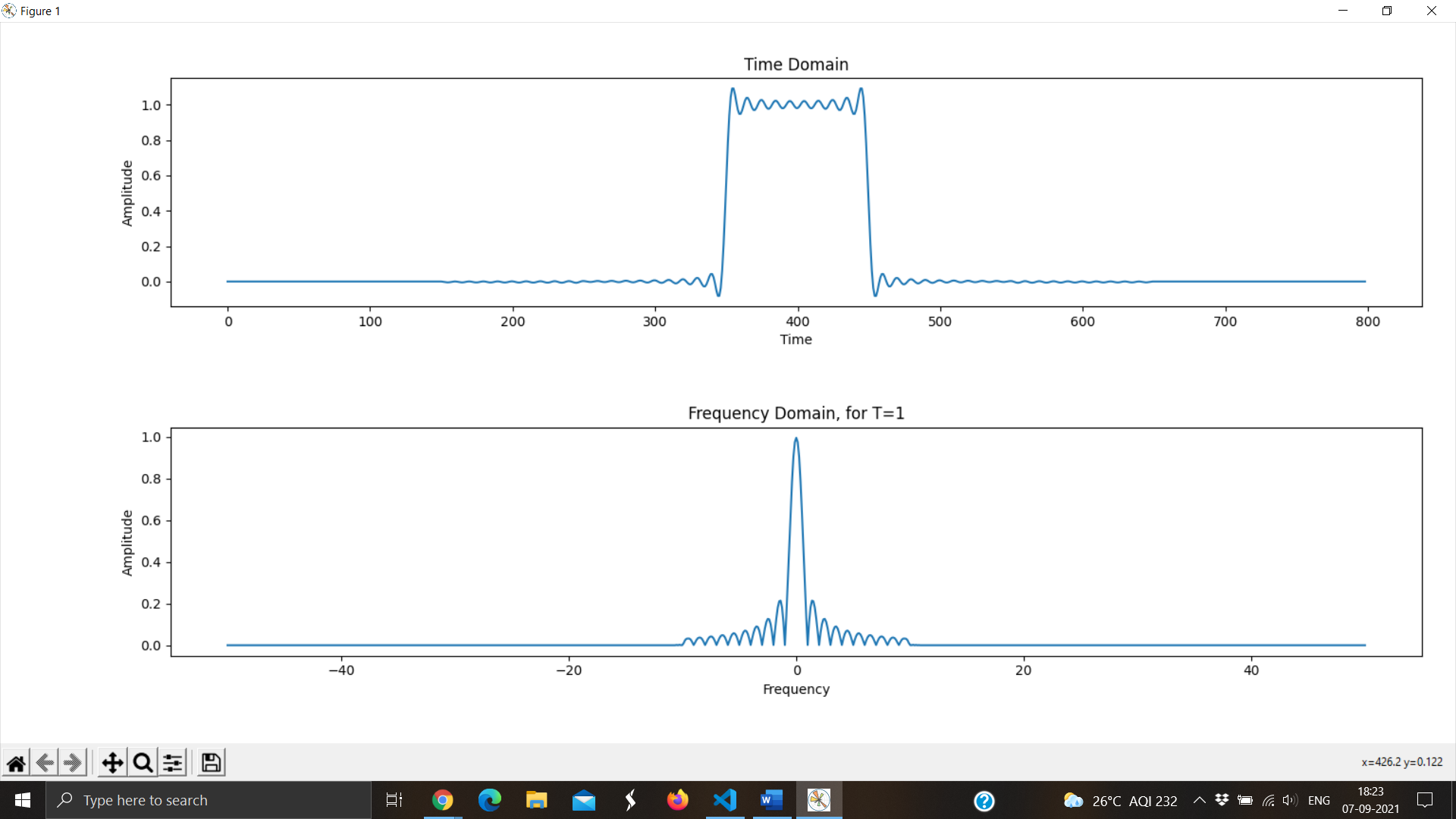
plt.xlabel('Freq')

plt.ylabel('Amplitude')

plt.tight\_layout()

plt.show()

For T=1:



For T=2:

