p5

June 16, 2022

[64]:
```
import math
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import matplotlib.colors as colors
from scipy.io import wavfile
from scipy import signal

from google.colab import drive
drive.mount('/content/drive')
```

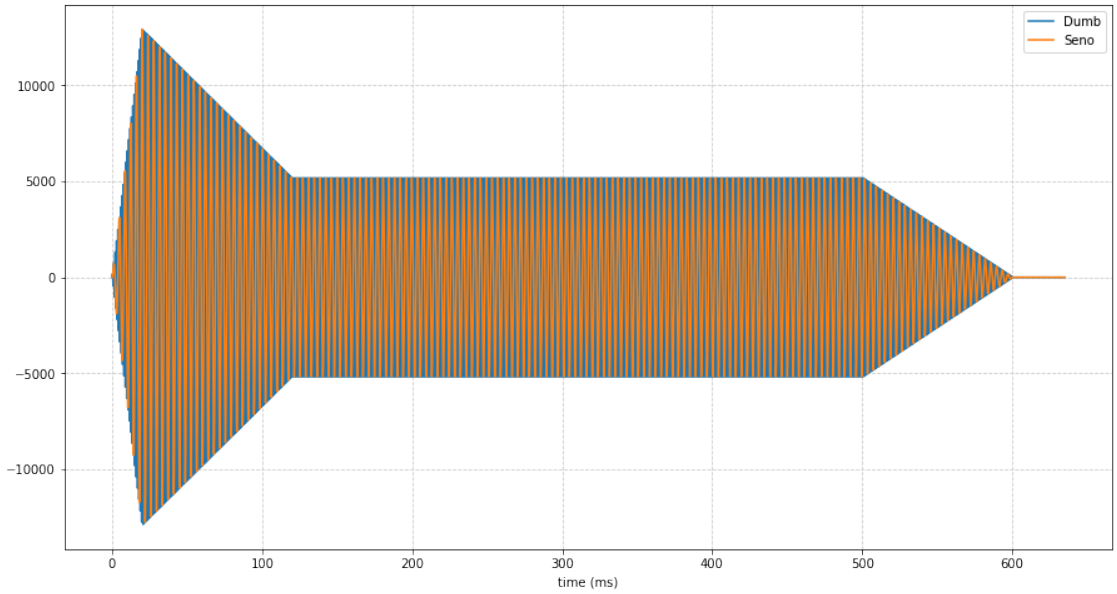
```
Drive already mounted at /content/drive; to attempt to forcibly remount, call
drive.mount("/content/drive", force_remount=True).
```

1 Dumb vs Seno

[65]:
```
samplerate, dumb = wavfile.read('/content/drive/My Drive/Raquel y Silvia/PAV/
 ↪Practica 5/dumb.wav')
samplerate, seno = wavfile.read('/content/drive/My Drive/Raquel y Silvia/PAV/
 ↪Practica 5/seno.wav')
dumb = dumb.astype('float64')
seno = seno.astype('float64')
```

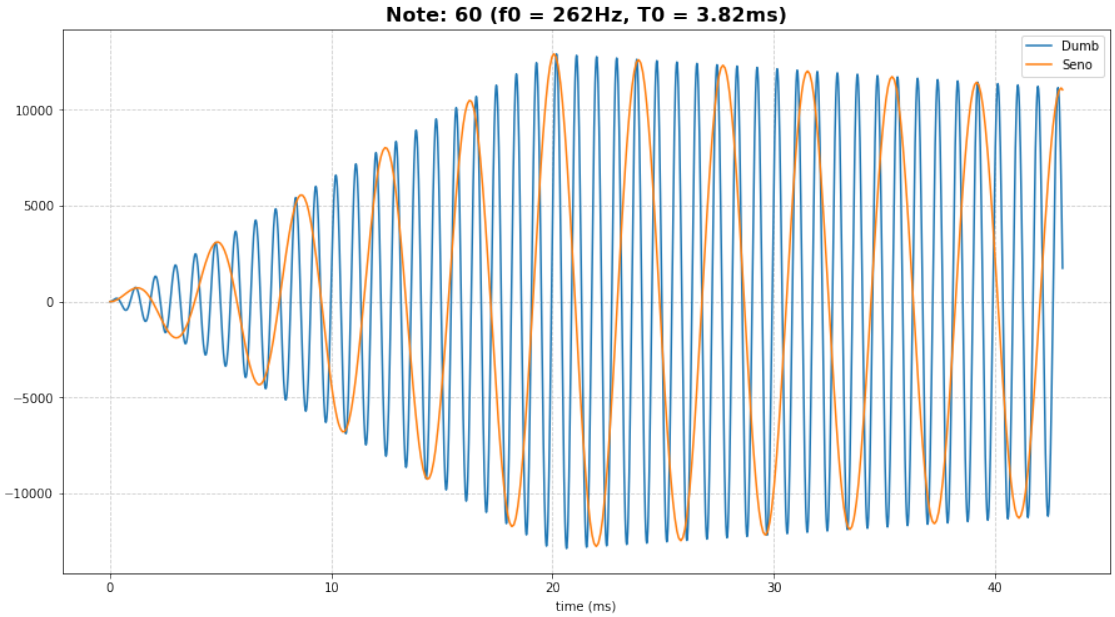
[ ]:
```
dumb_period = dumb[:28000]
seno_period = seno[:28000]
t = [float(i/samplerate)*1000 for i in range(len(dumb_period))]

fig, ax = plt.subplots(figsize=(15, 8))
plt.plot(t, dumb_period, label = 'Dumb')
plt.plot(t, seno_period, label = 'Seno')

ax.grid(which='major', color='#CCCCCC', linestyle='--')
ax.grid(which='minor', color='#CCCCCC', linestyle=':')

plt.xlabel('time (ms)')
plt.legend()
```

[ ]: <matplotlib.legend.Legend at 0x7f93fc50de50>



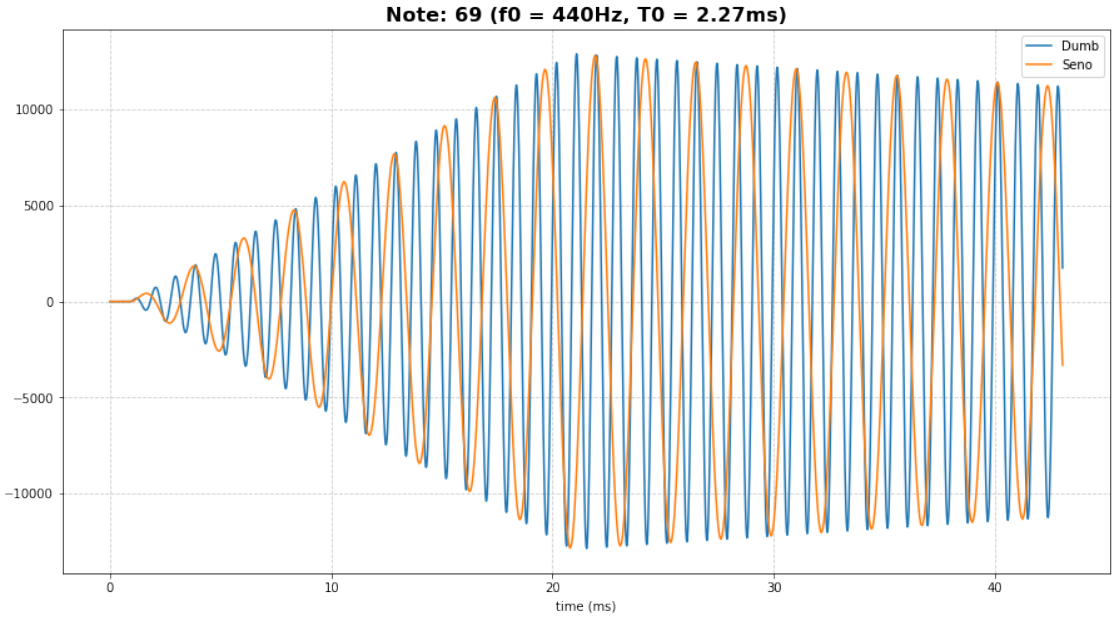
[ ]:
```
dumb_period = dumb[:1900]
seno_period = seno[:1900]
t = [float(i/samplerate)*1000 for i in range(len(dumb_period))]

fig, ax = plt.subplots(figsize=(15, 8))
plt.plot(t, dumb_period, label = 'Dumb')
plt.plot(t, seno_period, label = 'Seno')

ax.grid(which='major', color='#CCCCCC', linestyle='--')
ax.grid(which='minor', color='#CCCCCC', linestyle=':')

plt.xlabel('time (ms)')
plt.title('Note: 60 (f0 = 262Hz, T0 = 3.82ms)', fontweight='bold', size=16)
plt.legend()
```

[ ]: <matplotlib.legend.Legend at 0x7f93fc52a190>



[ ]:
```
dumb_period = dumb[147000:148900]
seno_period = seno[147000:148900]
t = [float(i/samplerate)*1000 for i in range(len(dumb_period))]

fig, ax = plt.subplots(figsize=(15, 8))
plt.plot(t, dumb_period, label = 'Dumb')
plt.plot(t, seno_period, label = 'Seno')

ax.grid(which='major', color='#CCCCCC', linestyle='--')
ax.grid(which='minor', color='#CCCCCC', linestyle=':')

plt.xlabel('time (ms)')
plt.title('Note: 69 (f0 = 440Hz, T0 = 2.27ms)', fontweight='bold', size=16)
plt.legend()
```

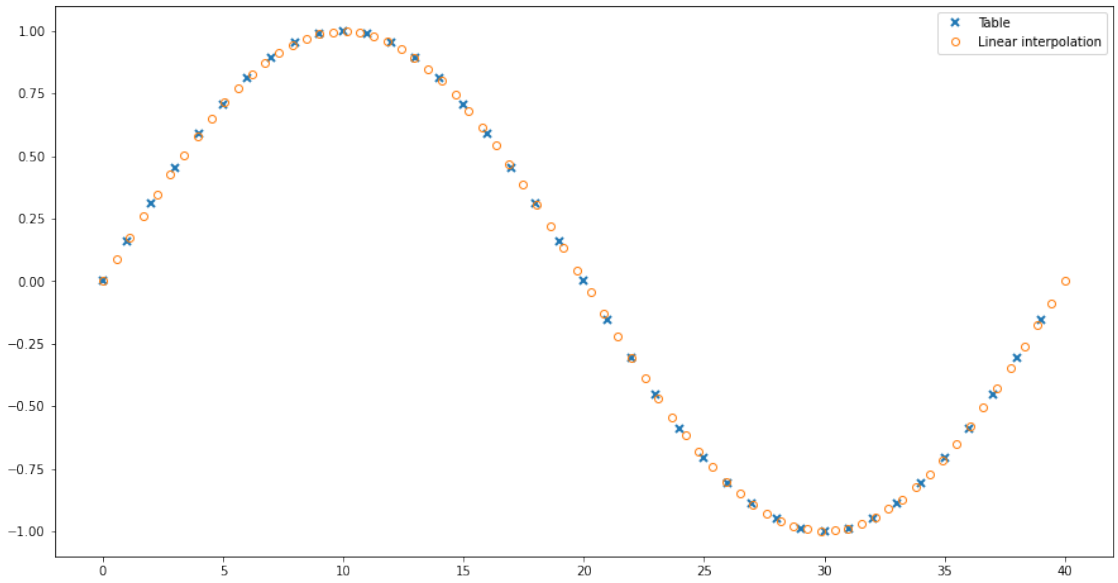
[ ]:
```
<matplotlib.legend.Legend at 0x7f93fc3e8dd0>
```



Seno values using linear interpolation

[ ]:
```
N = 40
T = 40
table = [math.sin(2*math.pi*e/N) for e in range(N)]

k = np.linspace(0.0, T, num=int(T*1.8))
res = []
for i in k:
  if i == int(i):
    res.append(table[int(i) % N])
  else:
    upper = math.ceil(i)
    lower = math.floor(i)
    res.append((upper-i)*table[lower % N] + (i - lower)*table[upper % N])

fig, ax = plt.subplots(figsize=(15, 8))
plt.plot(table, marker='x', linestyle = 'None', label='Table', mew=2)
plt.plot(k, res, marker='o', linestyle = 'None', markerfacecolor='None',␣
 ↪label='Linear interpolation')
plt.legend()
```

[ ]:
```
<matplotlib.legend.Legend at 0x7f93fc412690>
```



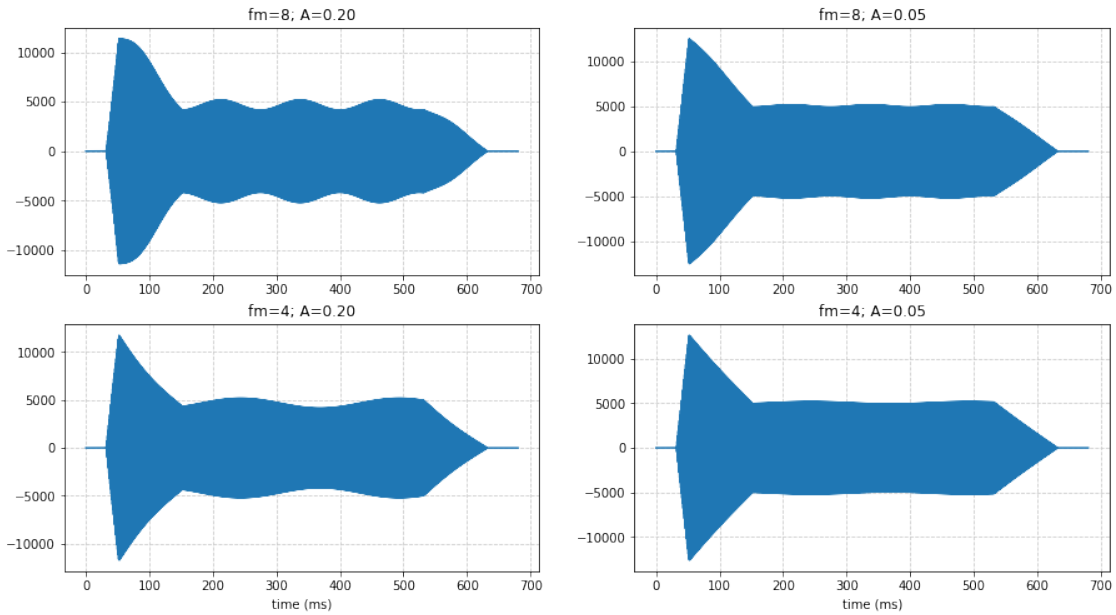
2 Tremolo and Vibrato effects

[ ]:
```
samplerate, tremolo = wavfile.read('/content/drive/My Drive/Raquel y Silvia/PAV/
 ↪Practica 5/doremi_tremolo.wav')
samplerate, doremi_8_005 = wavfile.read('/content/drive/My Drive/Raquel y␣
 ↪Silvia/PAV/Practica 5/doremi_8_005.wav')
samplerate, doremi_4_005 = wavfile.read('/content/drive/My Drive/Raquel y␣
 ↪Silvia/PAV/Practica 5/doremi_4_005.wav')
samplerate, doremi_4_02 = wavfile.read('/content/drive/My Drive/Raquel y Silvia/
 ↪PAV/Practica 5/doremi_4_02.wav')
tremolo = tremolo.astype('float64')
doremi_8_005 = doremi_8_005.astype('float64')
doremi_4_005 = doremi_4_005.astype('float64')
doremi_4_02 = doremi_4_02.astype('float64')
```

[ ]:
```
tremolo_period = tremolo[28000:58000]
t = [float(i/samplerate)*1000 for i in range(len(tremolo_period))]

fig, ax = plt.subplots(nrows=2, ncols=2, figsize=(15, 8))
ax[0,0].plot(t, tremolo_period)
ax[1,0].plot(t, doremi_4_02[28000:58000])
ax[0,1].plot(t, doremi_8_005[28000:58000])
ax[1,1].plot(t, doremi_4_005[28000:58000])

ax[0,0].set_title('fm=8; A=0.20')
ax[1,0].set_title('fm=4; A=0.20')
```

```
ax[0,1].set_title('fm=8; A=0.05')
ax[1,1].set_title('fm=4; A=0.05')

ax[0,0].grid(which='major', color='#CCCCCC', linestyle='--')
ax[0,0].grid(which='minor', color='#CCCCCC', linestyle=':')
ax[1,0].grid(which='major', color='#CCCCCC', linestyle='--')
ax[1,0].grid(which='minor', color='#CCCCCC', linestyle=':')
ax[0,1].grid(which='major', color='#CCCCCC', linestyle='--')
ax[0,1].grid(which='minor', color='#CCCCCC', linestyle=':')
ax[1,1].grid(which='major', color='#CCCCCC', linestyle='--')
ax[1,1].grid(which='minor', color='#CCCCCC', linestyle=':')

ax[1,0].set_xlabel('time (ms)')
ax[1,1].set_xlabel('time (ms)')
```

[ ]:
```
Text(0.5, 0, 'time (ms)')
```

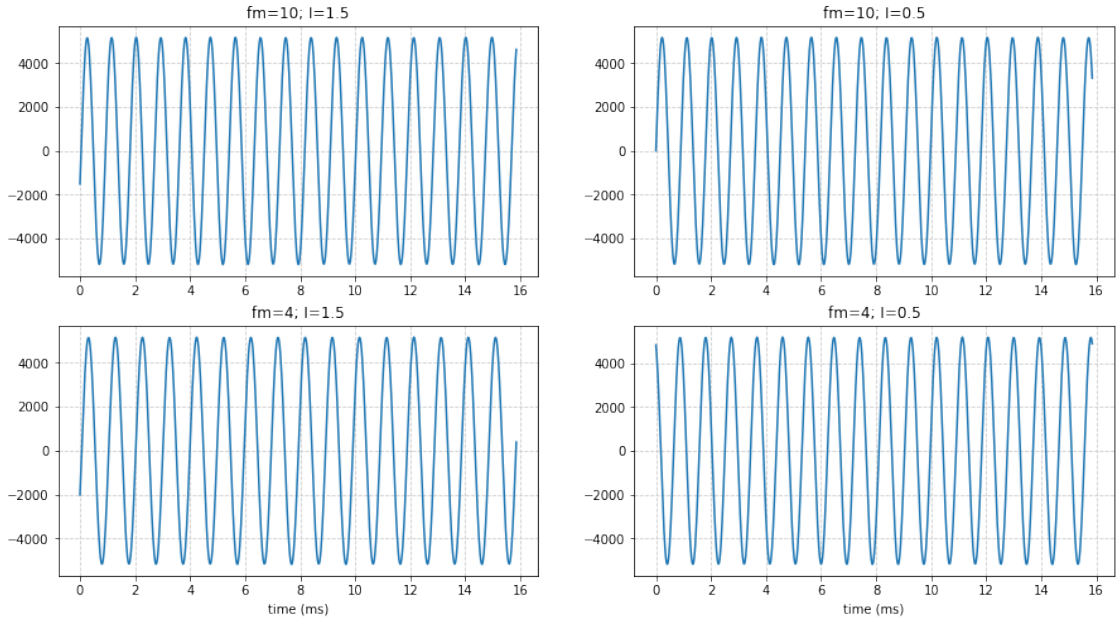


[ ]:
```
samplerate, doremi_10_15 = wavfile.read('/content/drive/My Drive/Raquel y␣
↪Silvia/PAV/Practica 5/doremi_10_15.wav')
samplerate, doremi_4_15 = wavfile.read('/content/drive/My Drive/Raquel y Silvia/
↪PAV/Practica 5/doremi_4_15.wav')
samplerate, doremi_10_05 = wavfile.read('/content/drive/My Drive/Raquel y␣
↪Silvia/PAV/Practica 5/doremi_10_05.wav')
samplerate, doremi_4_05 = wavfile.read('/content/drive/My Drive/Raquel y Silvia/
↪PAV/Practica 5/doremi_4_05.wav')
doremi_10_15 = doremi_10_15.astype('float64')
```

```
doremi_4_15 = doremi_4_15.astype('float64')
doremi_10_05 = doremi_10_05.astype('float64')
doremi_4_05 = doremi_4_05.astype('float64')
```

[ ]:
```
t = [float(i/samplerate)*1000 for i in range(len(doremi_10_15[38000:38700]))]

fig, ax = plt.subplots(nrows=2, ncols=2, figsize=(15, 8))
ax[0,0].plot(t, doremi_10_15[38000:38700])
ax[1,0].plot(t, doremi_4_15[38000:38700])
ax[0,1].plot(t, doremi_10_05[38000:38700])
ax[1,1].plot(t, doremi_4_05[38000:38700])

ax[0,0].set_title('fm=10; I=1.5')
ax[1,0].set_title('fm=4; I=1.5')
ax[0,1].set_title('fm=10; I=0.5')
ax[1,1].set_title('fm=4; I=0.5')

ax[0,0].grid(which='major', color='#CCCCCC', linestyle='--')
ax[0,0].grid(which='minor', color='#CCCCCC', linestyle=':')
ax[1,0].grid(which='major', color='#CCCCCC', linestyle='--')
ax[1,0].grid(which='minor', color='#CCCCCC', linestyle=':')
ax[0,1].grid(which='major', color='#CCCCCC', linestyle='--')
ax[0,1].grid(which='minor', color='#CCCCCC', linestyle=':')
ax[1,1].grid(which='major', color='#CCCCCC', linestyle='--')
ax[1,1].grid(which='minor', color='#CCCCCC', linestyle=':')

ax[1,0].set_xlabel('time (ms)')
ax[1,1].set_xlabel('time (ms)')
```

[ ]:
```
Text(0.5, 0, 'time (ms)')
```

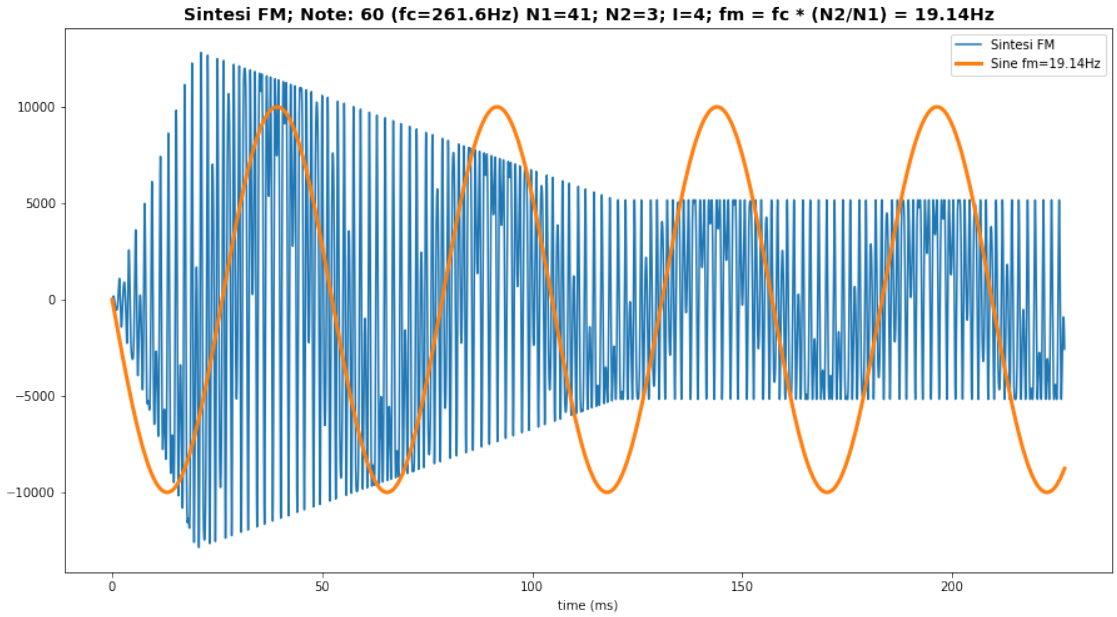


3 Sintesi FM

[ ]:
```
samplerate, sintesi = wavfile.read('/content/drive/My Drive/Raquel y Silvia/PAV/
↪Practica 5/sintesifm.wav')
sintesi = sintesi.astype('float64')
```

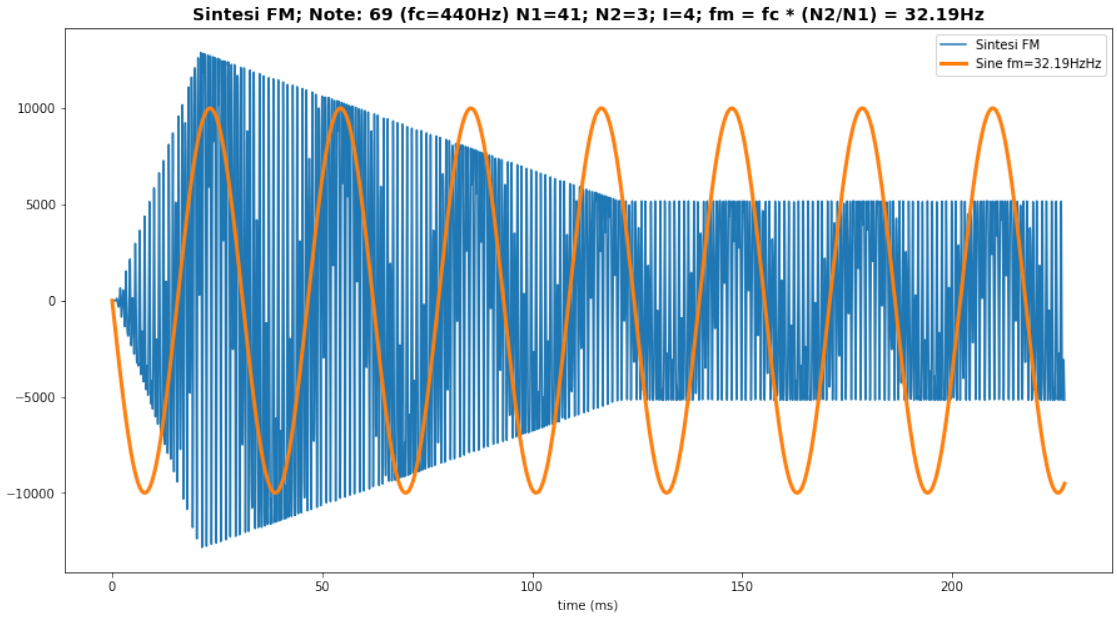
[ ]:
```
fc = 261 *(3/41)
sin = [math.sin(2*math.pi*fc*i/samplerate)*-10000 for i in range(len(sintesi[:
↪10000]))]
t = [float(i/samplerate)*1000 for i in range(len(sintesi[:10000]))]
fig, ax = plt.subplots(figsize=(15, 8))
ax.plot(t, sintesi[:10000], label='Sintesi FM')
ax.plot(t, sin, linewidth=3, label='Sine fm=19.14Hz')
plt.xlabel('time (ms)')
plt.title('Sintesi FM; Note: 60 (fc=261.6Hz) N1=41; N2=3; I=4; fm = fc * (N2/
↪N1) = 19.14Hz', fontweight='bold', size=14)
plt.legend()
```

[ ]:
```
<matplotlib.legend.Legend at 0x7f93fc345550>
```



[ ]:
```
fc = 440 *(3/41)
sin = [math.sin(2*math.pi*fc*i/samplerate)*-10000 for i in␣
 ↪range(len(sintesi[147000:157000]))]
t = [float(i/samplerate)*1000 for i in range(len(sintesi[147000:157000]))]
fig, ax = plt.subplots(figsize=(15, 8))
ax.plot(t, sintesi[147000:157000], label='Sintesi FM')
ax.plot(t, sin, linewidth=3, label='Sine fm=32.19HzHz')
plt.xlabel('time (ms)')
plt.title('Sintesi FM; Note: 69 (fc=440Hz) N1=41; N2=3; I=4; fm = fc * (N2/N1)␣
 ↪= 32.19Hz', fontweight='bold', size=14)
plt.legend()
```

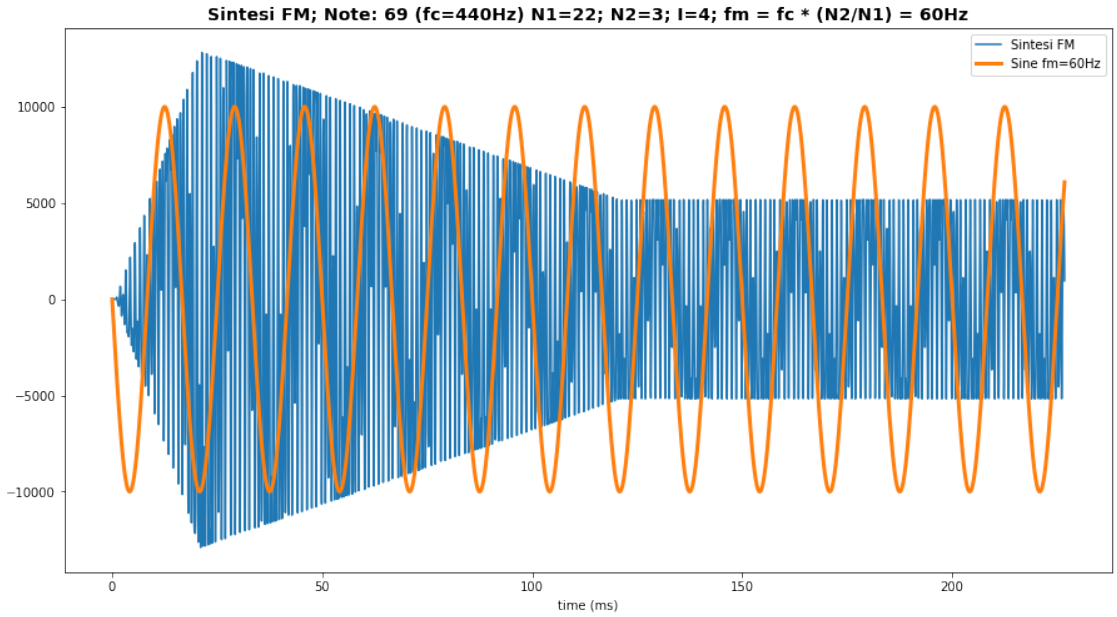
[ ]:
```
<matplotlib.legend.Legend at 0x7f93fc1210d0>
```



[ ]:
```
samplerate, sintesi = wavfile.read('/content/drive/My Drive/Raquel y Silvia/PAV/
 ↪Practica 5/sintesifm2.wav')
sintesi = sintesi.astype('float64')
```

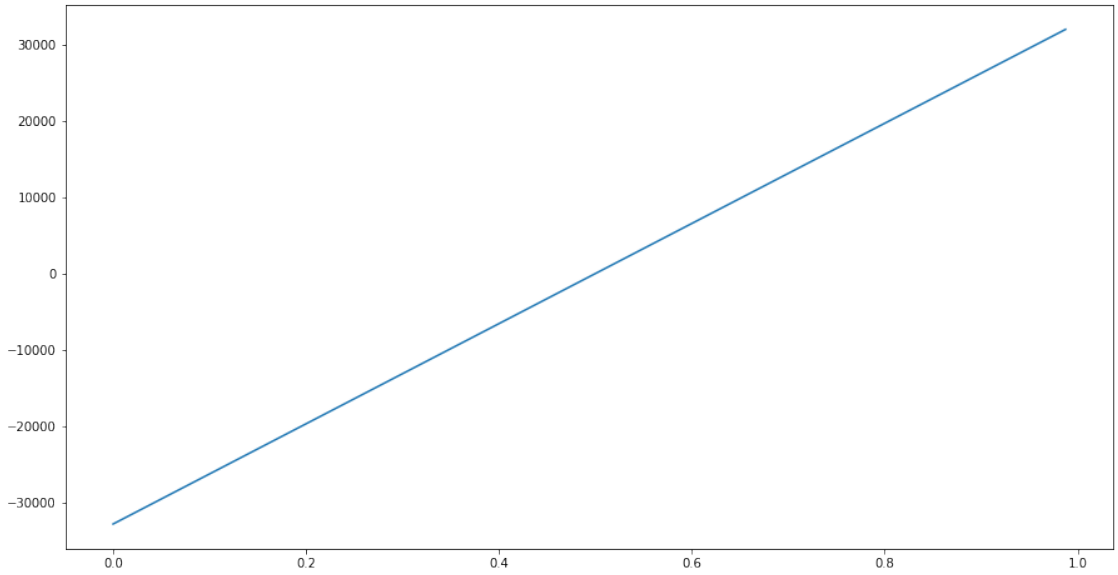
[ ]:
```
fc = 440 *(3/22)
sin = [math.sin(2*math.pi*fc*i/samplerate)*-10000 for i in␣
 ↪range(len(sintesi[147000:157000]))]
t = [float(i/samplerate)*1000 for i in range(len(sintesi[147000:157000]))]
fig, ax = plt.subplots(figsize=(15, 8))
ax.plot(t, sintesi[147000:157000], label='Sintesi FM')
ax.plot(t, sin, linewidth=3, label='Sine fm=60Hz')
plt.xlabel('time (ms)')
plt.title('Sintesi FM; Note: 69 (fc=440Hz) N1=22; N2=3; I=4; fm = fc * (N2/N1)␣
 ↪= 60Hz', fontweight='bold', size=14)
plt.legend()
```

[ ]:
```
<matplotlib.legend.Legend at 0x7f93fbfcf410>
```



4 Generate triangular signal

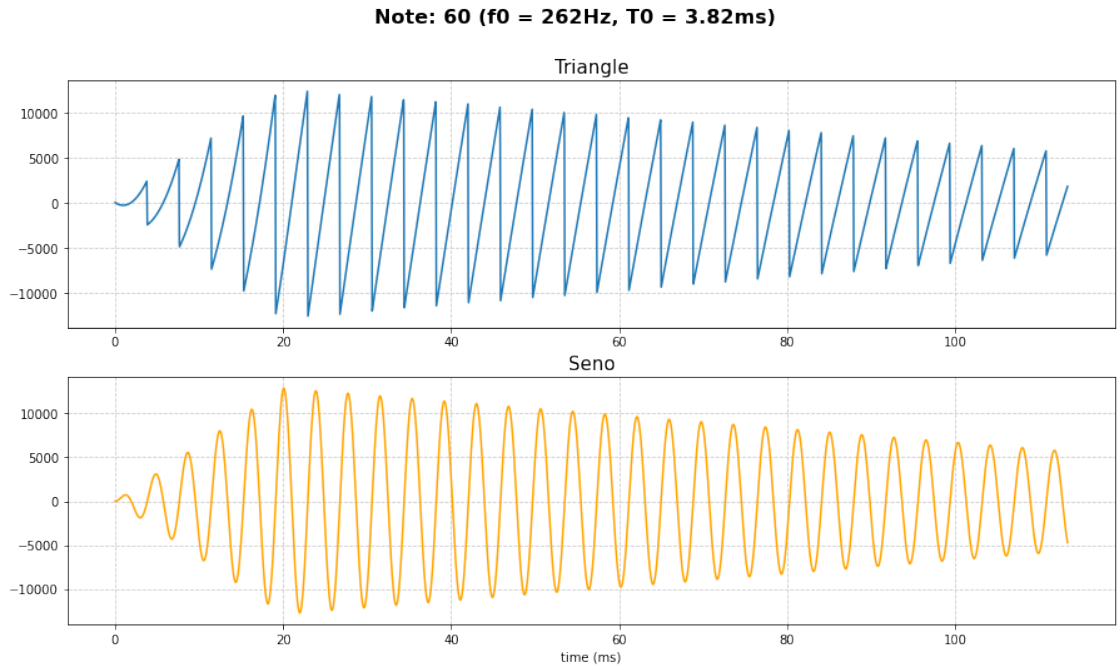
[ ]:
```
samplerate = 44100
N = 80
fm = 40
t = np.linspace(0, (N-1)/N, N)
triangle = (2**15-1)*signal.sawtooth(2 * np.pi * t)
fig, ax = plt.subplots(figsize=(15, 8))
ax.plot(t, triangle)
wavfile.write('/content/drive/My Drive/Raquel y Silvia/PAV/Practica 5/triangle.
 ↪wav', samplerate, triangle.astype(np.int16))
```



[66]:
```
samplerate, fictabla = wavfile.read('/content/drive/My Drive/Raquel y Silvia/
 ↪PAV/Practica 5/fictabla.wav')
fictabla = fictabla.astype('float64')
```

[85]:
```
fictabla_period = fictabla[:5000]
seno_period = seno[:5000]
t = [float(i/samplerate)*1000 for i in range(len(fictabla_period))]

fig, ax = plt.subplots(2,1, figsize=(15, 8))
ax[0].plot(t, fictabla_period)
ax[1].plot(t, seno_period, color='orange')

ax[0].grid(which='major', color='#CCCCCC', linestyle='--')
ax[0].grid(which='minor', color='#CCCCCC', linestyle=':')
ax[1].grid(which='major', color='#CCCCCC', linestyle='--')
ax[1].grid(which='minor', color='#CCCCCC', linestyle=':')

ax[0].set_title('Triangle', size=15)
ax[1].set_title('Seno', size=15)
ax[1].set_xlabel('time (ms)')
fig.suptitle('Note: 60 (f0 = 262Hz, T0 = 3.82ms)', fontweight='bold', size=16)
```

[85]:
```
Text(0.5, 0.98, 'Note: 60 (f0 = 262Hz, T0 = 3.82ms)')
```


Note: 60 (f0 = 262Hz, T0 = 3.82ms)
Triangle
10000
5000
0
−5000
−10000
0
20
40
60
80
100
Seno
10000
5000
0
−5000
−10000
0
20
40
60
80
100
time (ms)

[ ]: