convolucion_senales

October 7, 2023

1 Convolución

$$y[n] = \sum_{k=-\infty}^{\infty} f[k] \cdot g[n-k]$$

[10]:

```
import numpy as np
import matplotlib.pyplot as plt

from scipy.signal import convolve
```

1.0.1 Creacion de la funcion convolución

[7]:

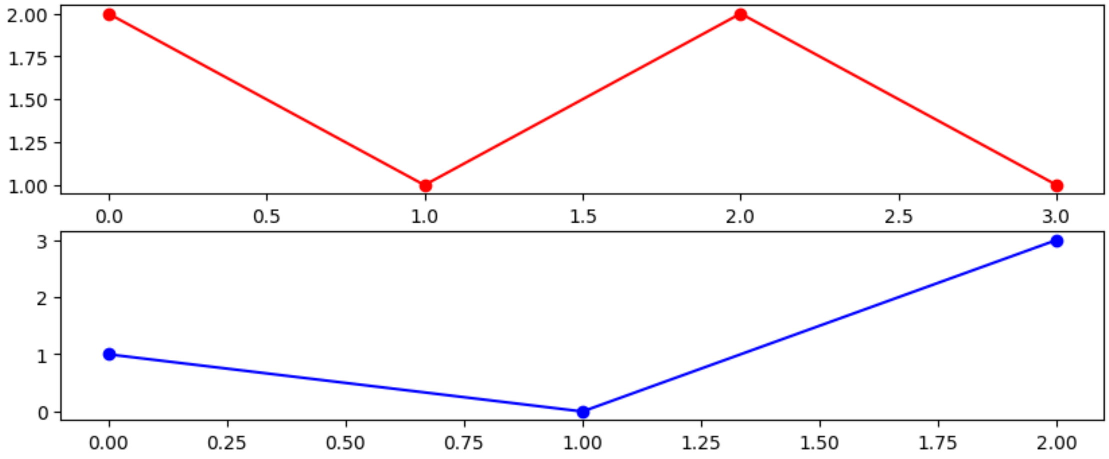
```
def convolucion(f, g):
  """Funcion de convolucion"""

  len_f = len(f)
  len_g = len(g)

  # creacion de vector resultado
  y = np.zeros(len_f + len_g - 1)

  # proceso de convolucion
  for n in range(len(y)):
    for k in range(len_f):
      if n - k >= 0 and n - k < len_g:
        y[n] += f[k] * g[n - k]

  return y
```

1.0.2 verificación

[5]:

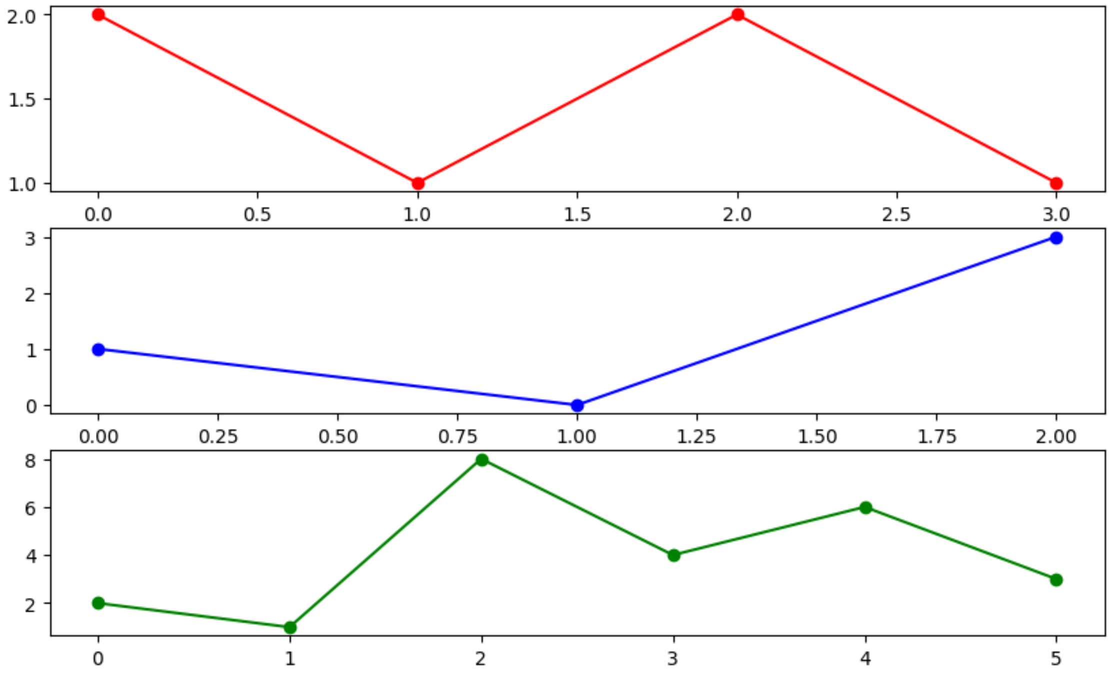
```
f = [2, 1, 2, 1]
g = [1, 0, 3]

plt.figure(figsize=(10,4))
plt.subplot(2,1,1)
plt.plot(f,'o-r')
plt.subplot(2,1,2)
plt.plot(g,'o-b')
```

[5]: [<matplotlib.lines.Line2D at 0x7acf888f9cf0>]



[8]:
```
y = convolucion(f,g)

plt.figure(figsize=(10,6))
plt.subplot(3,1,1)
plt.plot(f,'o-r')
plt.subplot(3,1,2)
plt.plot(g,'o-b')
plt.subplot(3,1,3)
plt.plot(y,'o-g')
```

[8]: [<matplotlib.lines.Line2D at 0x7acf883e1570>]

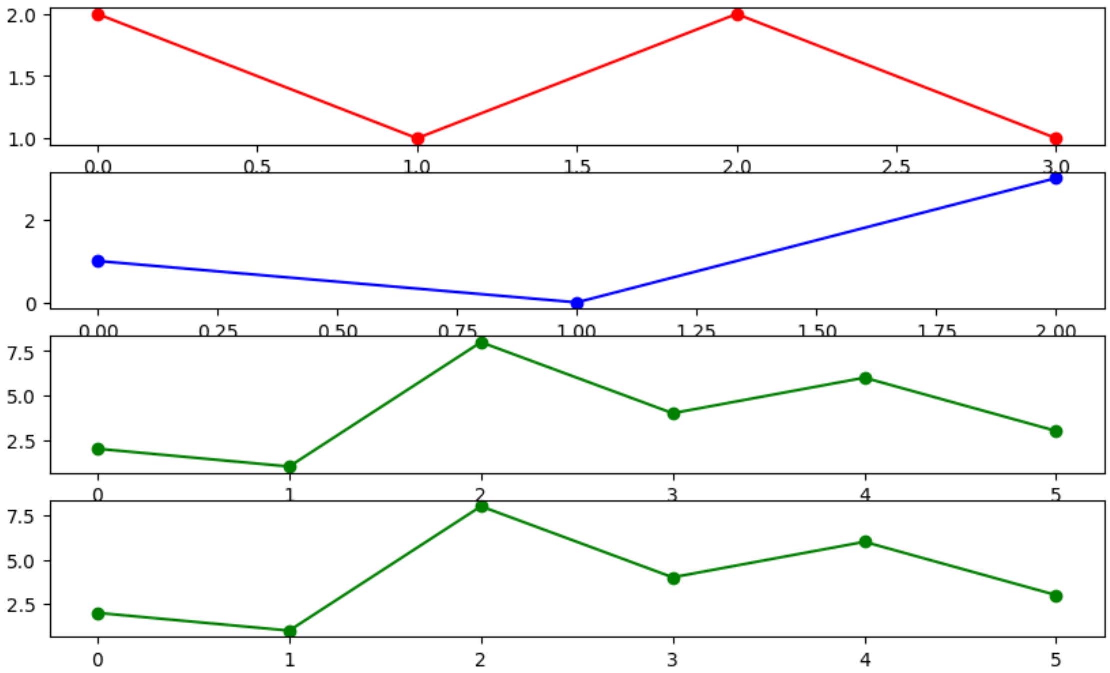


[12]:

```
f = [2, 1, 2, 1]
g = [1, 0, 3]

y = convolucion(f,g)
y_ = convolve(f,g)

plt.figure(figsize=(10,6))
plt.subplot(4,1,1)
plt.plot(f,'o-r')
plt.subplot(4,1,2)
plt.plot(g,'o-b')
plt.subplot(4,1,3)
plt.plot(y,'o-g')
plt.subplot(4,1,4)
plt.plot(y_,'o-g')
```

[12]:

```
[<matplotlib.lines.Line2D at 0x7acf7e4518d0>]
```

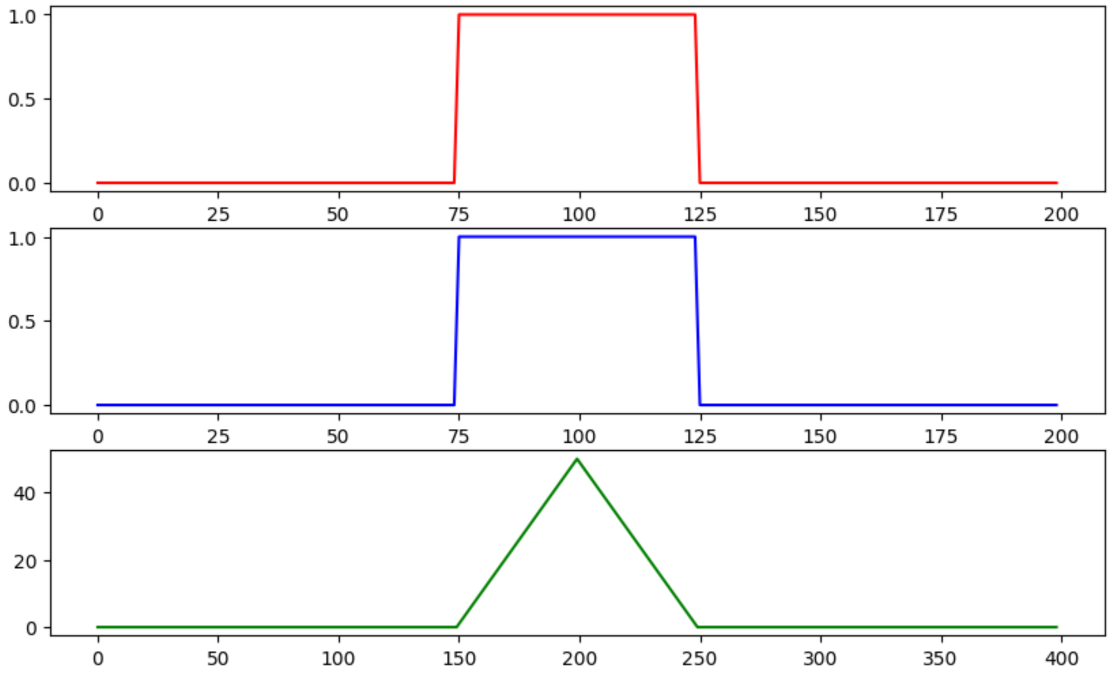


[20]:

```
x = np.zeros(200)
x[75:125] = np.ones(50)
h = np.zeros(200)
h[75:125] = np.ones(50)

y = convolve(x, h)

plt.figure(figsize=(10,6))
plt.subplot(3,1,1)
plt.plot(x,'-r')
plt.subplot(3,1,2)
plt.plot(h,'-b')
plt.subplot(3,1,3)
plt.plot(y,'-g')
```

[20]:

```
[<matplotlib.lines.Line2D at 0x7acf7e25b070>]
```

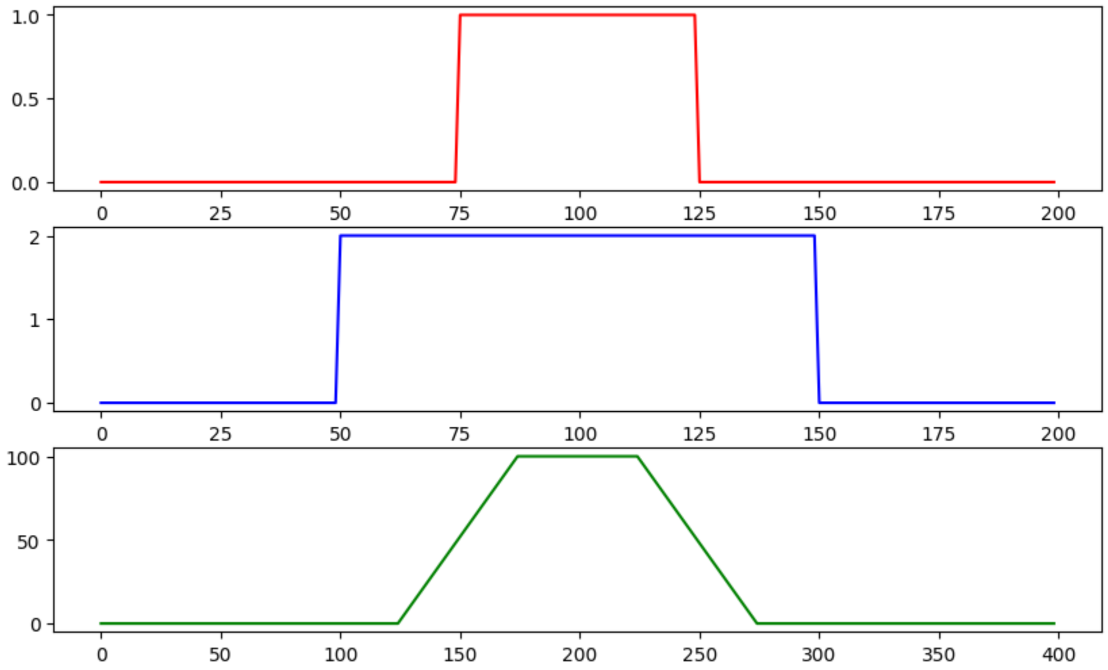


[23]:

```
x = np.zeros(200)
x[75:125] = np.ones(50)
h = np.zeros(200)
h[50:150] = 2*np.ones(100)

y = convolve(x, h)

plt.figure(figsize=(10,6))
plt.subplot(3,1,1)
plt.plot(x,'-r')
plt.subplot(3,1,2)
plt.plot(h,'-b')
plt.subplot(3,1,3)
plt.plot(y,'-g')
```

[23]:

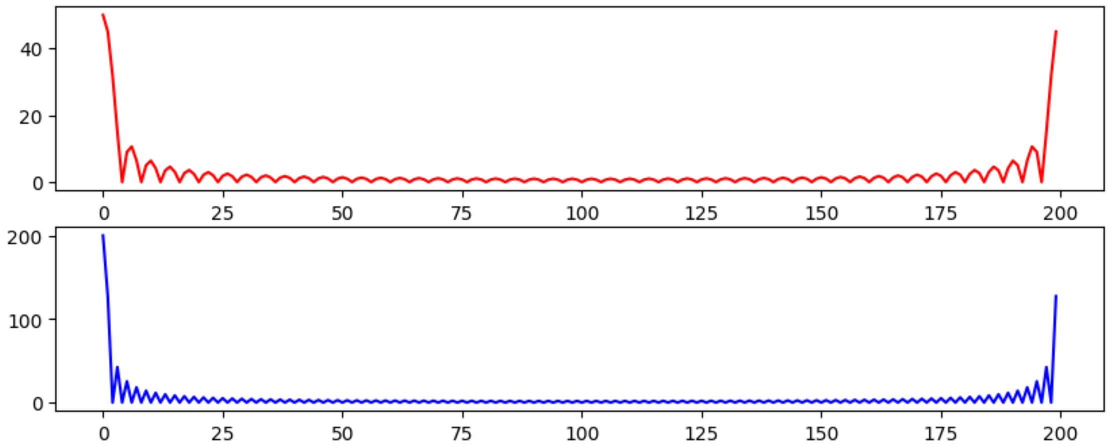
```
[<matplotlib.lines.Line2D at 0x7acf7dce35e0>]
```



1.1 Propiedad transformada de fourier

[24]:
```
from scipy.fft import fft, ifft

x = np.zeros(200)
x[75:125] = np.ones(50)
h = np.zeros(200)
h[50:150] = 2*np.ones(100)

X_ = fft(x)
H_ = fft(h)



plt.figure(figsize=(10,6))
plt.subplot(3,1,1)
plt.plot(np.abs(X_),'-r')
plt.subplot(3,1,2)
plt.plot(np.abs(H_),'-b')
#plt.subplot(3,1,3)
#plt.plot(y,'-g')
```

[24]:
```
[<matplotlib.lines.Line2D at 0x7acf7d8c35e0>]
```

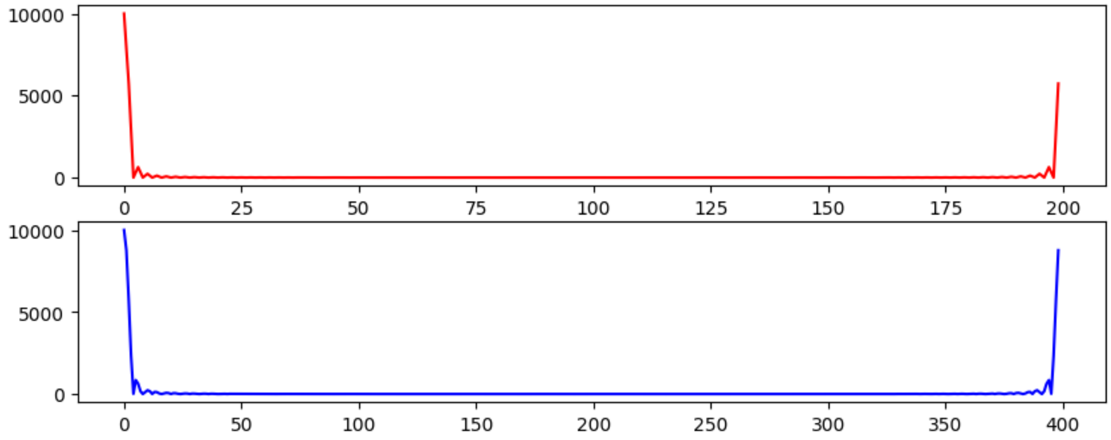


[25]:

```
Y_f = X_*H_

y_c = convolve(x,h)
Y_c = fft(y_c)

plt.figure(figsize=(10,6))
plt.subplot(3,1,1)
plt.plot(np.abs(Y_f),'-r')
plt.subplot(3,1,2)
plt.plot(np.abs(Y_c),'-b')
#plt.subplot(3,1,3)
#plt.plot(y,'-g')
```

[25]:

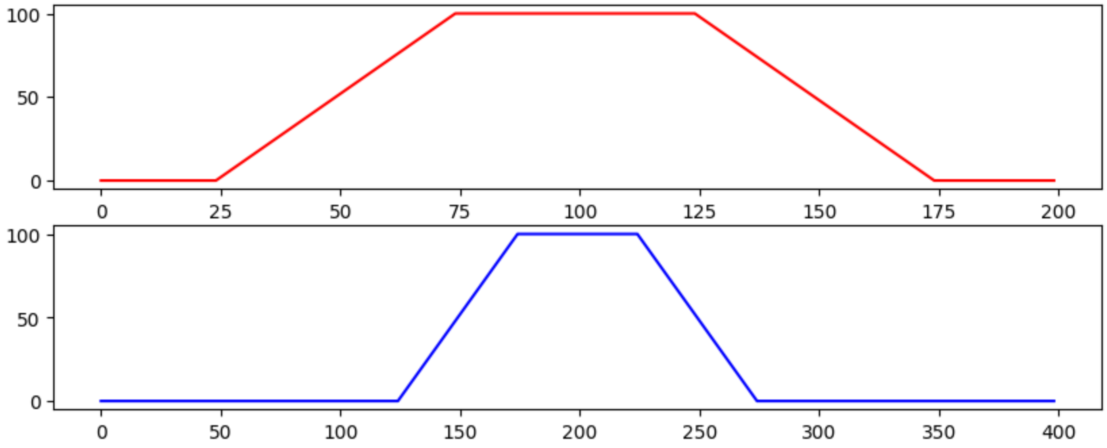
```
[<matplotlib.lines.Line2D at 0x7acf7d813c40>]
```



[27]:
```
y_f = ifft(Y_f)
N = len(y_f)
y_fr = np.zeros(N)
y_fr[0:int(N/2)] = y_f[int(N/2):N]
y_fr[int(N/2):N] = y_f[0:int(N/2)]

plt.figure(figsize=(10,6))
plt.subplot(3,1,1)
plt.plot(y_fr,'-r')
plt.subplot(3,1,2)
plt.plot(y_c,'-b')
#plt.subplot(3,1,3)
#plt.plot(y,'-g')
```

```
<ipython-input-27-179de87a2de7>:4: ComplexWarning: Casting complex values to
real discards the imaginary part
  y_fr[0:int(N/2)] = y_f[int(N/2):N]
<ipython-input-27-179de87a2de7>:5: ComplexWarning: Casting complex values to
real discards the imaginary part
  y_fr[int(N/2):N] = y_f[0:int(N/2)]
```

[27]:
```
[<matplotlib.lines.Line2D at 0x7acf7d60ee60>]
```

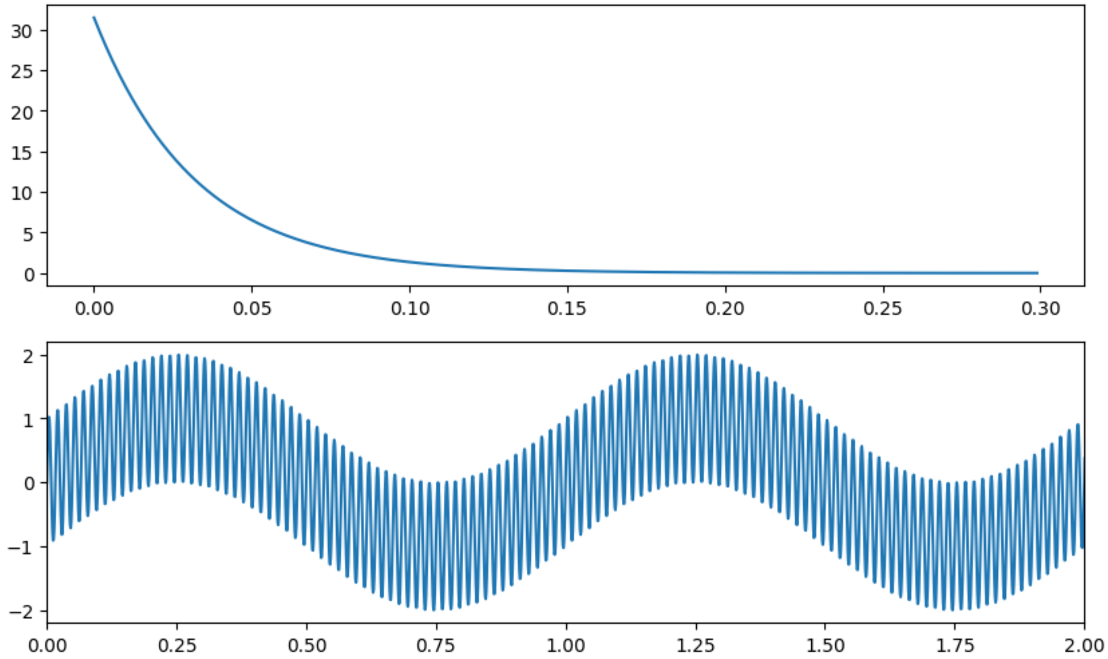


2 Prueba de filtros

[48]:
```
t = np.arange(0,10,0.001)
h = 31.446*np.exp(-31.446*t[0:300]) # respuesta al impulso del filtro RC (1/
 ↪(RCs+1))
# fc = 5
x = np.sin(2*np.pi*1*t) + np.sin(2*np.pi*60*t)
```

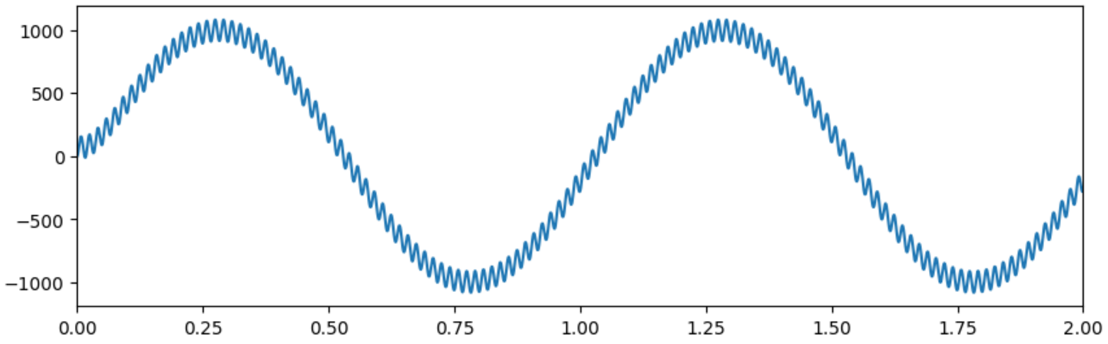
```
plt.figure(figsize=(10,6))
plt.subplot(2,1,1)
plt.plot(t[0:300],h)
plt.subplot(2,1,2)
plt.plot(t,x)
plt.xlim(0,2)
```

```
[48]: (0.0, 2.0)
```



```
[49]: y = convolve(x,h)

      plt.figure(figsize=(10,3))
      plt.plot(t,y[0:10000])
      plt.xlim(0,2)
```

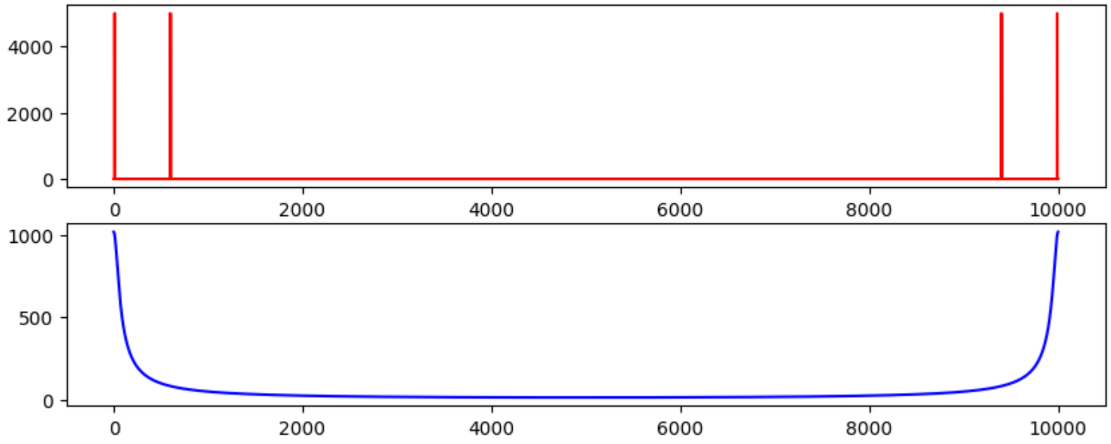
```
[49]: (0.0, 2.0)
```



2.1 Transformada de fourier

[50]:
```
X_ = fft(x, 10000)
H_ = fft(h, 10000)

plt.figure(figsize=(10,6))
plt.subplot(3,1,1)
plt.plot(np.abs(X_),'-r')
plt.subplot(3,1,2)
plt.plot(np.abs(H_),'-b')
#plt.subplot(3,1,3)
#plt.plot(y,'-g')
```

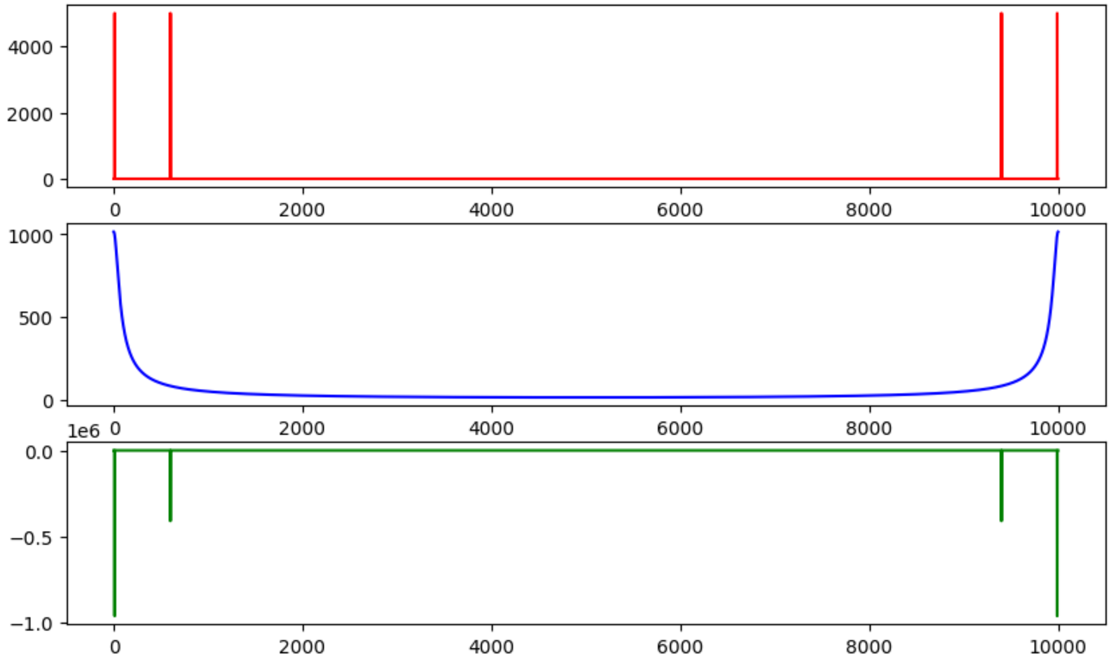
[50]:
```
[<matplotlib.lines.Line2D at 0x7acf7b1c7fd0>]
```



[51]:
```
Y_ = X_*H_

plt.figure(figsize=(10,6))
plt.subplot(3,1,1)
plt.plot(np.abs(X_),'-r')
plt.subplot(3,1,2)
plt.plot(np.abs(H_),'-b')
plt.subplot(3,1,3)
plt.plot(Y_,'-g')
```

```
/usr/local/lib/python3.10/dist-packages/matplotlib/cbook/__init__.py:1335:
ComplexWarning: Casting complex values to real discards the imaginary part
  return np.asarray(x, float)
```

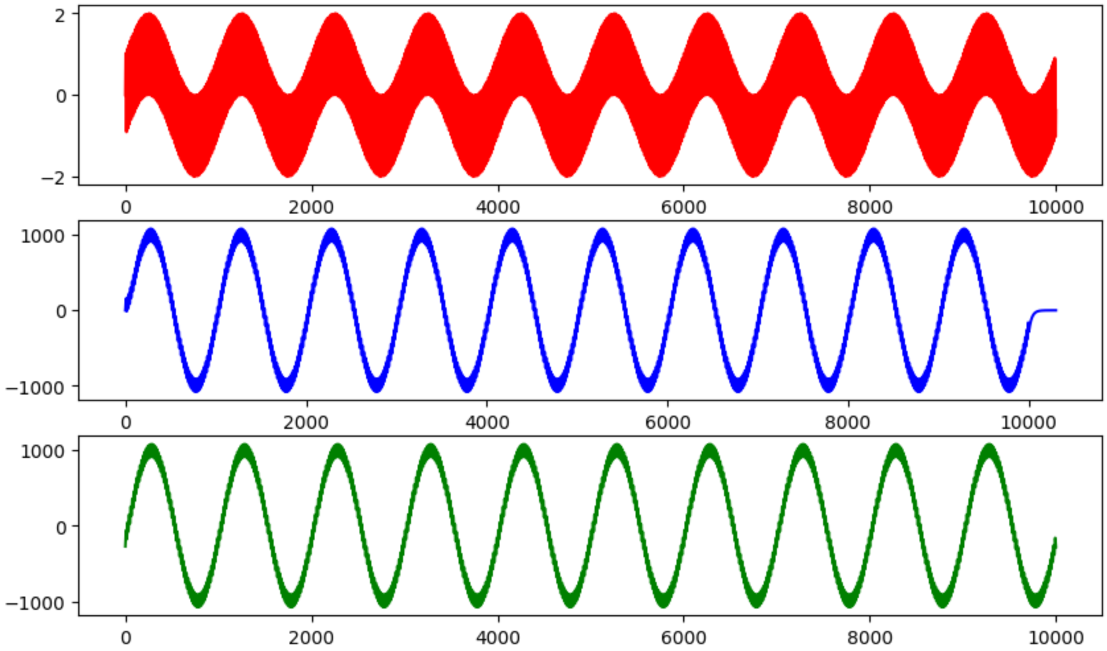
```
[51]: [<matplotlib.lines.Line2D at 0x7acf7b101060>]
```



```
[54]: y_ = ifft(Y_)
      N = len(y_)
      y_r = np.zeros(N)
      y_r[0:int(N/2)] = y_[int(N/2):N]
      y_r[int(N/2):N] = y_[0:int(N/2)]

      y = convolve(x,h)

      plt.figure(figsize=(10,6))
      plt.subplot(3,1,1)
      plt.plot(x,'-r')
      plt.subplot(3,1,2)
plt.plot(y,'-b')
plt.subplot(3,1,3)
plt.plot(y_,'-g')
```

```
<ipython-input-54-2157976c33ef>:4: ComplexWarning: Casting complex values to
real discards the imaginary part
  y_r[0:int(N/2)] = y_[int(N/2):N]
<ipython-input-54-2157976c33ef>:5: ComplexWarning: Casting complex values to
real discards the imaginary part
  y_r[int(N/2):N] = y_[0:int(N/2)]
/usr/local/lib/python3.10/dist-packages/matplotlib/cbook/__init__.py:1335:
ComplexWarning: Casting complex values to real discards the imaginary part
  return np.asarray(x, float)
```

```
[54]: [<matplotlib.lines.Line2D at 0x7acf7b2b62c0>]
```



```
[ ]: !apt-get install texlive texlive-xetex texlive-latex-extra pandoc
     !pip install pypandoc
     from google.colab import drive
     drive.mount('/content/drive')
     !cp "drive/MyDrive/Colab Notebooks/Senales/convolucion_senales.ipynb" ./
     !jupyter nbconvert --to PDF "convolucion_senales.ipynb"
```

```
Reading package lists… Done
Building dependency tree… Done
Reading state information… Done
```