taller1

November 26, 2018

```
In [49]: import numpy as np
         import matplotlib.pyplot as plt
         import math
         import pandas as pd
         import sympy
         from sympy import *
         from scipy import integrate
```

1 Polinomios de Legendre

```
In [2]: def Rodrigues(n):    # Aqui 'n' es el grado del polinomio
            x = sympy.Symbol('x')
            y = sympy.Symbol('y')
            y = (x**2 - 1)**n
            P = sympy.diff(y,x,n)/(2**n * math.factorial(n)) # Fórmula de Rodrigues
            return P
```

```
In [3]: P0 = Rodrigues(0)
        P0
```

```
Out[3]: 1
```

```
In [4]: P1 = Rodrigues(1)
        P1
```

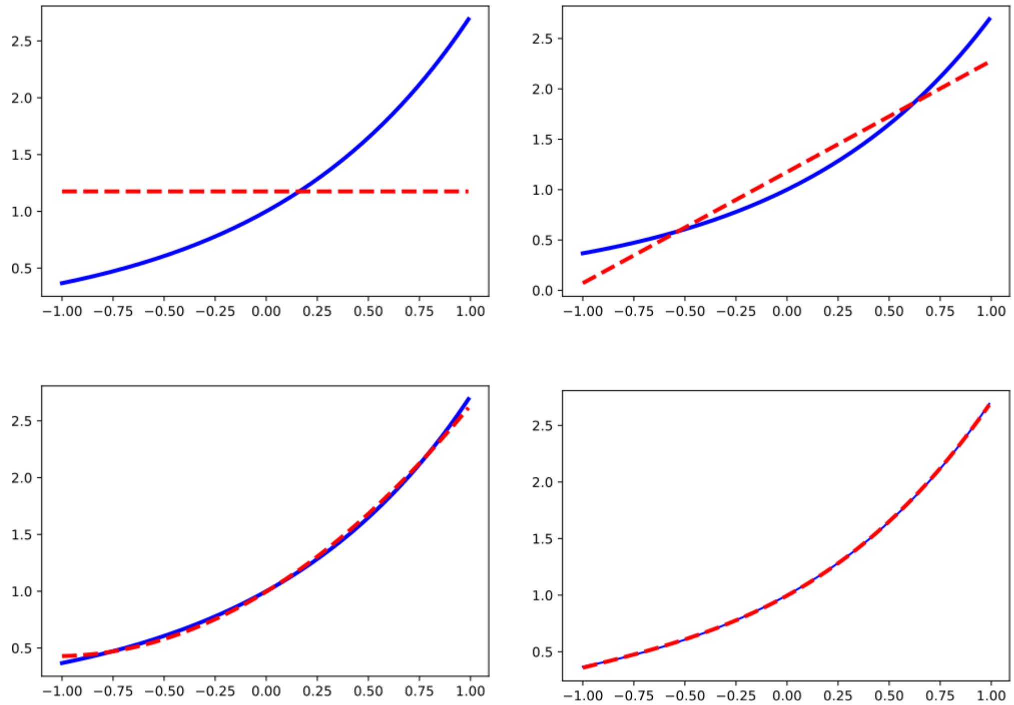
```
Out[4]: x
```

```
In [5]: P2 = Rodrigues(2)
        P2
```

```
Out[5]: (3*x**2 - 1)/2
```

```
In [6]: P3 = Rodrigues(3)
        P3
```

```
Out[6]: x*(5*x**2 - 3)/2
```



title

2 Aproximación

$f(x) = \sum_{k=1}^{\infty} \frac{2k+1}{2} \left[\int_{-1}^{1} f(t) P_k(t) dt \right] P_k(x)$

3 Primer punto

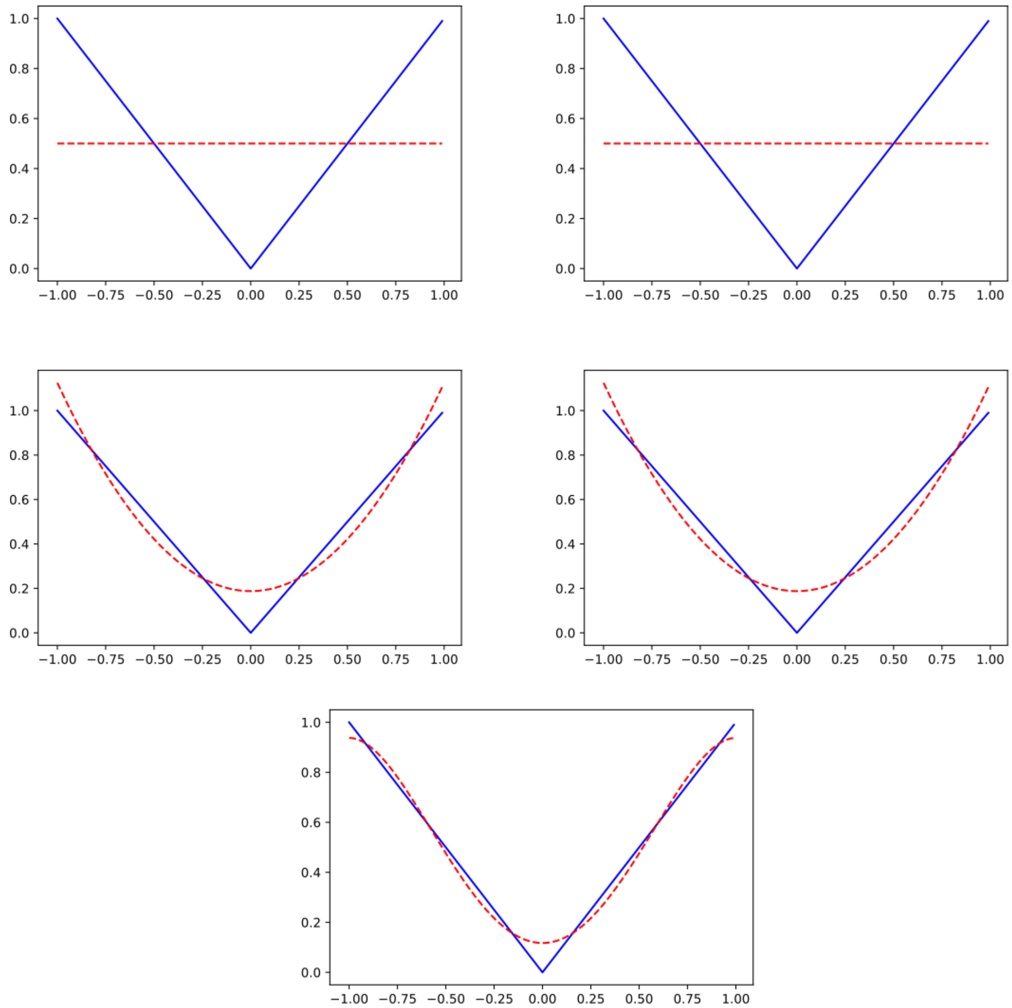
$f(x) = e^x$
$k = 0, ..., 3$

```
In [7]: a = np.arange(-1.0,1.0,0.01)
        f = np.zeros(len(a))

        x = sympy.Symbol('x')
        for k in range(4):    # k = 0,1,...,3
            temp = ((2*k+1)/2)*integrate(exp(x)*Rodrigues(k), (x, -1, 1))
            P    = lambdify(x,Rodrigues(k),"numpy") # Polinomios de Legendre
            f    = f + temp*P(a)    # Aproximacion de la funcion
```

4 Segundo punto

$f(x) = |x|$
$k = 0, 1, ..., 4$



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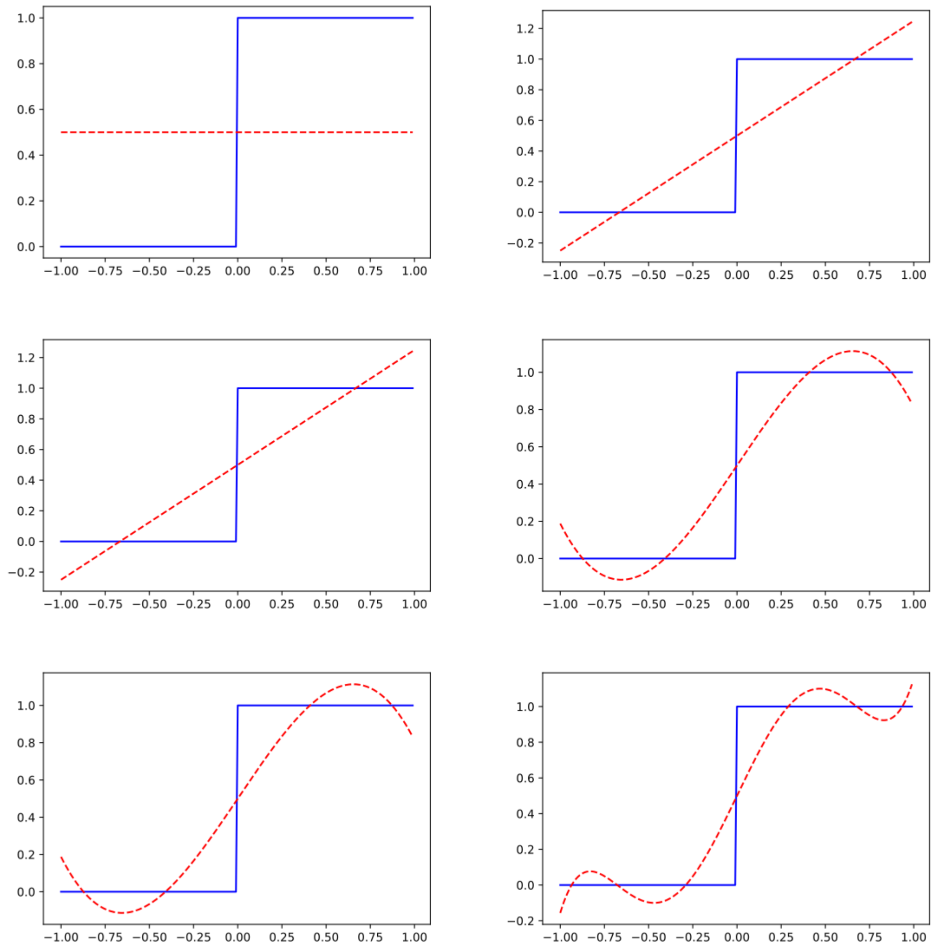
```
In [8]: a = np.arange(-1.0,1.0,0.01)
        f = np.zeros(len(a))

        x = sympy.Symbol('x')
        for k in range(5):    # k = 0,1,...,4
            temp = ((2*k+1)/2)*integrate(abs(x)*Rodrigues(k), (x, -1, 1))
            P    = lambdify(x,Rodrigues(k),"numpy") # Polinomios de Legendre
            f    = f + temp*P(a)    # Aproximacion de la funcion
```

$$f(x) = \begin{cases} 0 \quad si \quad -1 < x < 0 \\ \\ 1 \quad si \quad \; 0 \leq x < 1 \end{cases}$$

$k = 0, 1..., 5$

```
In [9]: def fx(x):
            f = np.zeros(len(x))
            pos = 0
```



title

```
    for i in x:
        if (-1 < i < 0):
            f[pos] = 0.0
        elif (0 <= i < 1):
            f[pos] = 1.0
        pos = pos + 1
    return f
```

```
In [10]: a = np.arange(-1.0,1.0,0.01)
         for k in range(6):    # k = 0,1,...,5
             temp = ((2*k+1)/2)*integrate(Rodrigues(k), (x, 0, 1))  # de -1 a 0 es cero
             P    = lambdify(x,Rodrigues(k),"numpy") # Polinomios de Legendre
             f    = f + temp*P(a)    # Aproximacion de la funcion
```

```
In [ ]:
```

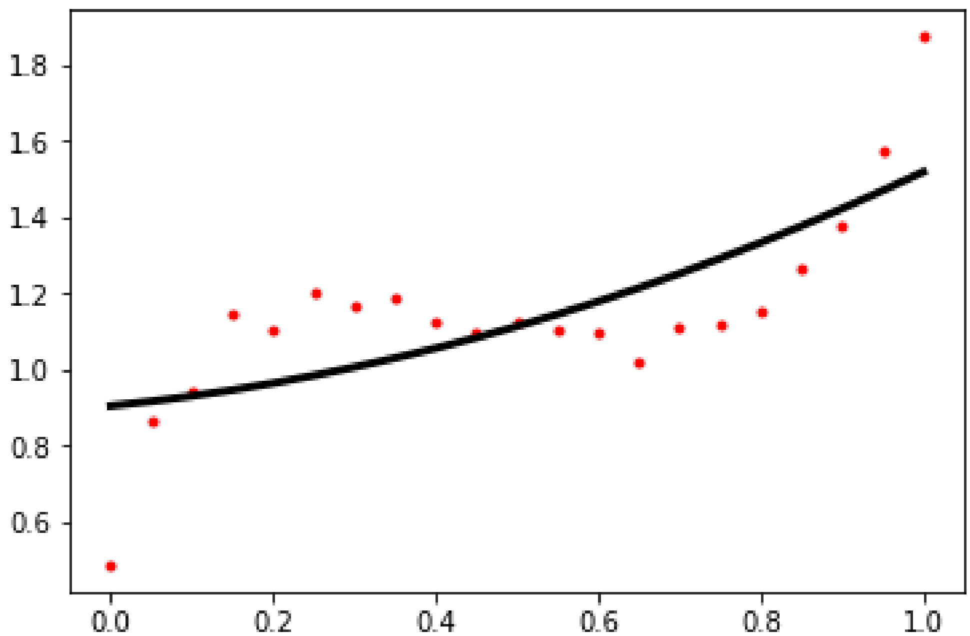
5 Tercer punto

```
In [11]: x = np.arange(0.00,1.05,0.05)
         y = np.array([0.486,0.866,0.944,1.144,1.103,1.202,1.166,1.191,1.124,1.095,1.122,1.102
                       1.111,1.117,1.152,1.265,1.380,1.575,1.875])
```

5.1 Polinomios de Chebyshev. Orden 2

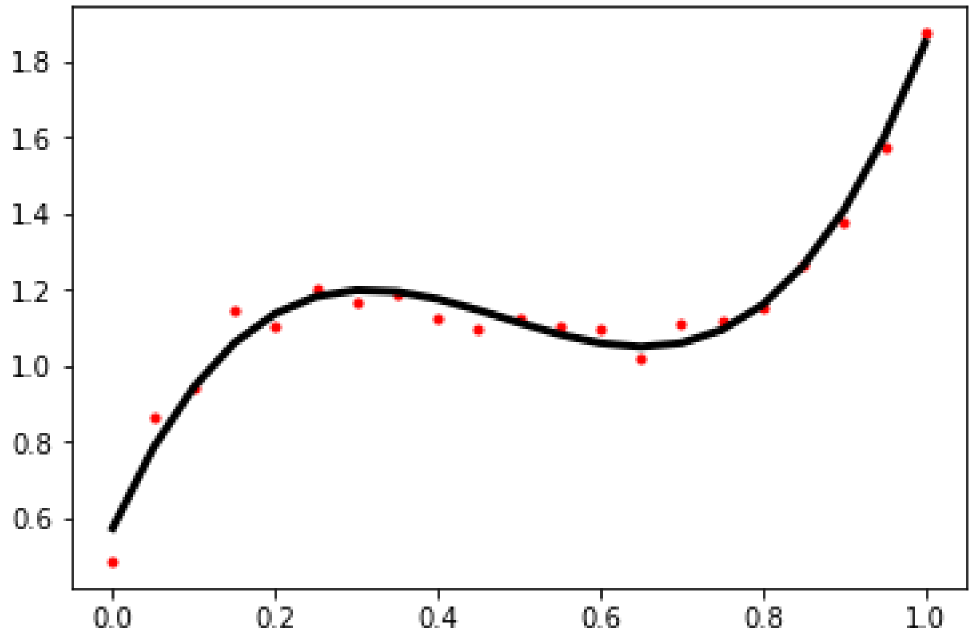
```
In [12]: p = np.polynomial.Chebyshev.fit(x,y,2)
```

```
In [13]: plt.plot(x, y, 'r.')
         plt.plot(x, p(x), 'k-', lw=3)
         plt.show()
```



5.2 Polinomios de Chebyshev. Orden 2

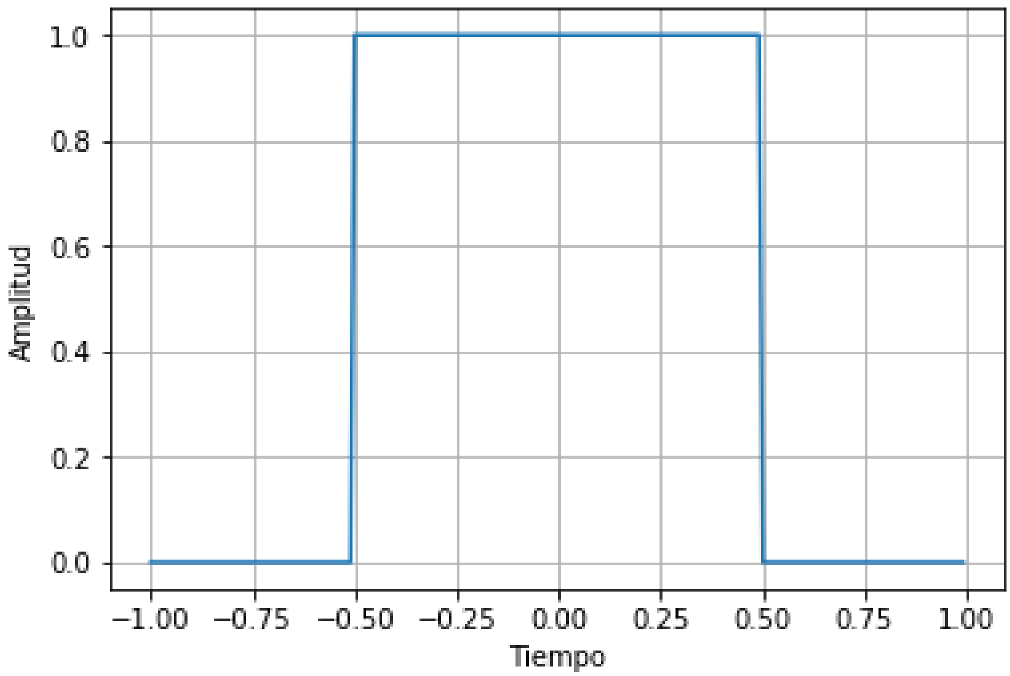
```
In [14]: p = np.polynomial.Chebyshev.fit(x,y,3)
         plt.plot(x, y, 'r.')
         plt.plot(x, p(x), 'k-', lw=3)
         plt.show()
```




```
In [ ]:
```

6 Cuarto punto

```
In [19]: u = lambda t:np.piecewise(t,t>=0,[1,0]);
         def f(t): return u(t+0.5)-u(t-0.5);
         dt = 0.01;
         t = np.arange(-1,1,dt);
         plt.plot(t,f(t))
         plt.xlabel('Tiempo')
         plt.ylabel('Amplitud')
         plt.grid()
         plt.show()
```



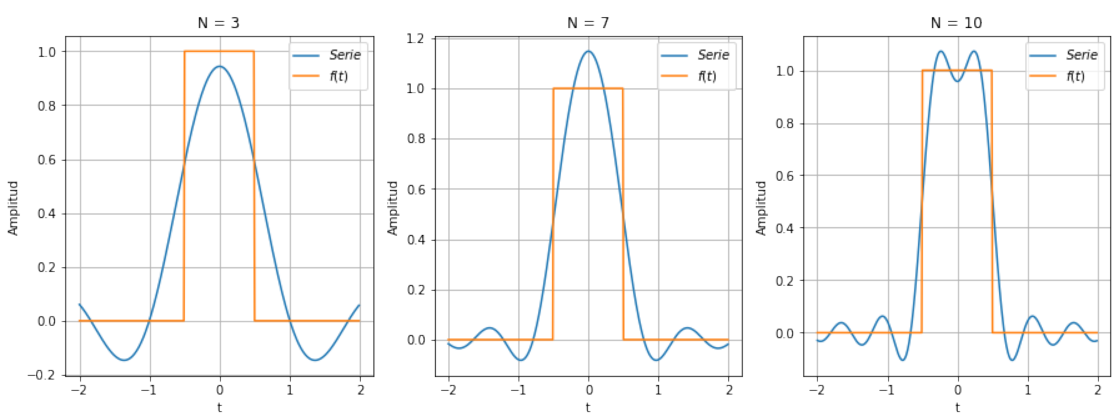

```
In [20]: def serie_Fourier(f,N):
             t = sympy.symbols('t')
             a0, err0 = integrate.quad(lambda x: f(x),-np.pi,np.pi)
             a0 = (1/np.pi)*a0;
             y = a0*0.5;
             n = 1;
             while (n<=N):
                 an, errn = integrate.quad(lambda x: f(x)*np.cos(n*x),-np.pi,np.pi);
                 an = (1/np.pi)*an;
                 bn, errn = integrate.quad(lambda x: f(x)*np.sin(n*x),-np.pi,np.pi);
                 bn = (1/np.pi)*bn;
                 y += an*sympy.cos(n*t)+bn*sympy.sin(n*t);
                 n = n+1;
             return y
```

```
In [24]: print('Aproximación con N = 3: ',Serie_F1)
         print('Aproximación con N = 7: ',Serie_F2)
         print('Aproximación con N = 10: ',Serie_F3)
```

```
Aproximación con N = 3:  0.305211778162803*cos(t) + 0.267848533961049*cos(2*t) + 0.21167501477
Aproximación con N = 7:  0.305211778162803*cos(t) + 0.267848533961049*cos(2*t) + 0.21167501477
Aproximación con N = 10:  0.305211778162803*cos(t) + 0.267848533961049*cos(2*t) + 0.2116750147
```

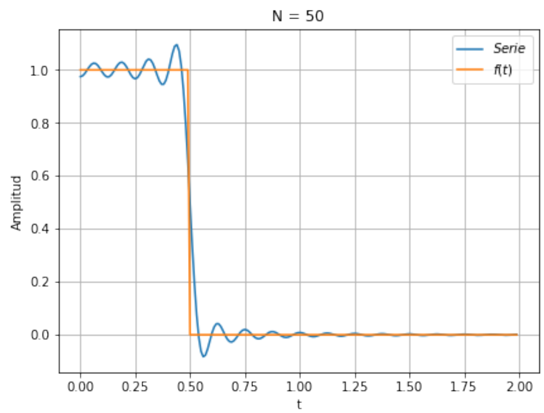
```
In [25]: t_axis = np.arange(-2,2,0.01);
         y_axis1 = [];
```

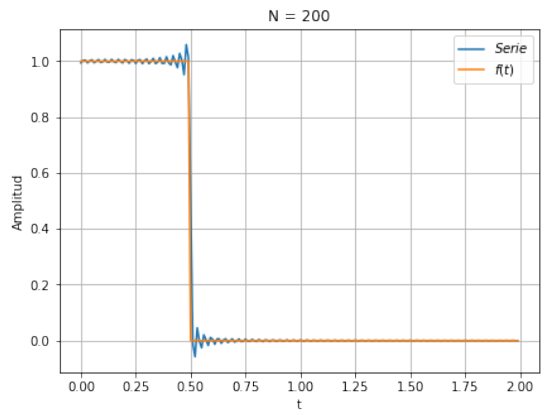
```python
y_axis2 = [];
y_axis3 = [];

for index in t_axis:
    y_axis1.append(Serie_F1.subs('t',index));
    y_axis2.append(Serie_F2.subs('t',index));
    y_axis3.append(Serie_F3.subs('t',index));

fig = plt.figure(figsize=(15,5))
plt.subplot(1,3,1)
plt.plot(t_axis,y_axis1,label='$Serie$')
plt.plot(t_axis,f(t_axis),label='$f(t)$')
plt.xlabel('t')
plt.ylabel('Amplitud')
plt.title('N = 3')
plt.legend()
plt.grid()
plt.subplot(1,3,2)
plt.plot(t_axis,y_axis2,label='$Serie$')
plt.plot(t_axis,f(t_axis),label='$f(t)$')
plt.xlabel('t')
plt.ylabel('Amplitud')
plt.title('N = 7')
plt.legend()
plt.grid()
plt.subplot(1,3,3)
plt.plot(t_axis,y_axis3,label='$Serie$')
plt.plot(t_axis,f(t_axis),label='$f(t)$')
plt.xlabel('t')
plt.ylabel('Amplitud')
plt.title('N = 10')
plt.legend()
plt.grid()
plt.show()
```



```
In [27]: Serie_F50 = serie_Fourier(f,50);
         Serie_F200 = serie_Fourier(f,200);

         t_axis = np.arange(0,2,0.01);
         y_axis1 = [];
         y_axis2 = [];

         for index in t_axis:
             y_axis1.append(Serie_F50.subs('t',index));
             y_axis2.append(Serie_F200.subs('t',index));

         fig = plt.figure(figsize=(15,5))
         plt.subplot(1,2,1)
         plt.plot(t_axis,y_axis1,label='$Serie$')
         plt.plot(t_axis,f(t_axis),label='$f(t)$')
         plt.xlabel('t')
         plt.ylabel('Amplitud')
         plt.title('N = 50')
         plt.legend()
         plt.grid()
         plt.subplot(1,2,2)
         plt.plot(t_axis,y_axis2,label='$Serie$')
         plt.plot(t_axis,f(t_axis),label='$f(t)$')
         plt.xlabel('t')
         plt.ylabel('Amplitud')
         plt.title('N = 200')
         plt.legend()
         plt.grid()
         plt.show()
```

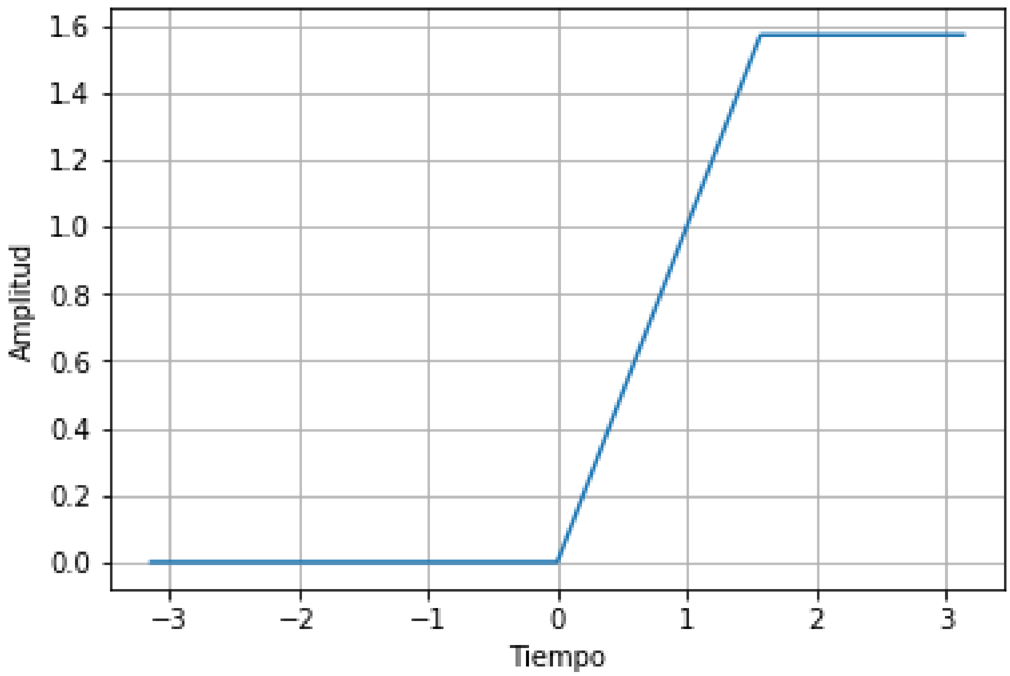
```
/home/guerreroasus/anaconda3/lib/python3.7/site-packages/scipy/integrate/quadpack.py:385: Integ
  If increasing the limit yields no improvement it is advised to analyze
  the integrand in order to determine the difficulties.  If the position of a
  local difficulty can be determined (singularity, discontinuity) one will
  probably gain from splitting up the interval and calling the integrator
  on the subranges.  Perhaps a special-purpose integrator should be used.
  warnings.warn(msg, IntegrationWarning)
```



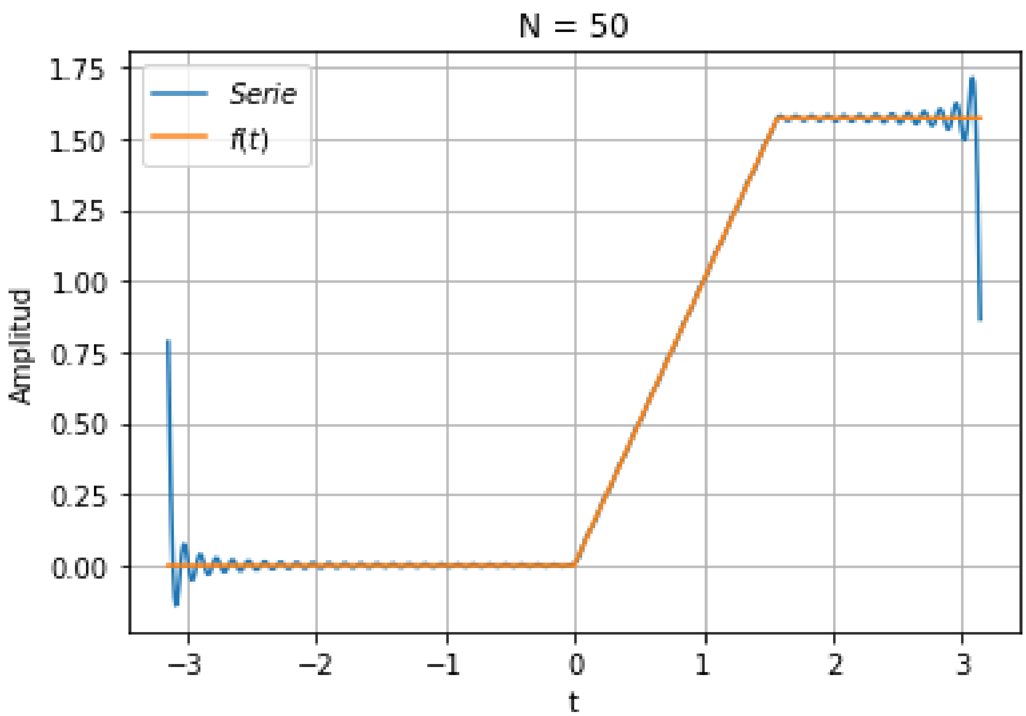


6.1 Quinto punto

In [28]:
```
u = lambda t:np.piecewise(t,t>=0,[1,0]);
def f(t): return t*u(t)+(np.pi/2-t)*u(t-np.pi/2);
dt = 0.01;
t = np.arange(-np.pi,np.pi,dt);
plt.plot(t,f(t))
plt.xlabel('Tiempo')
plt.ylabel('Amplitud')
plt.grid()
plt.show()
```



```
In [29]: Serie_F = serie_Fourier(f,50);

         t_axis = np.arange(-np.pi,np.pi,0.01);
         y_axis = [];
         for index in t_axis:
             y_axis.append(Serie_F.subs('t',index));

         plt.plot(t_axis,y_axis,label='$Serie$')
         plt.plot(t_axis,f(t_axis),label='$f(t)$')
         plt.xlabel('t')
         plt.ylabel('Amplitud')
         plt.title('N = 50')
         plt.legend()
         plt.grid()
         plt.show()
```



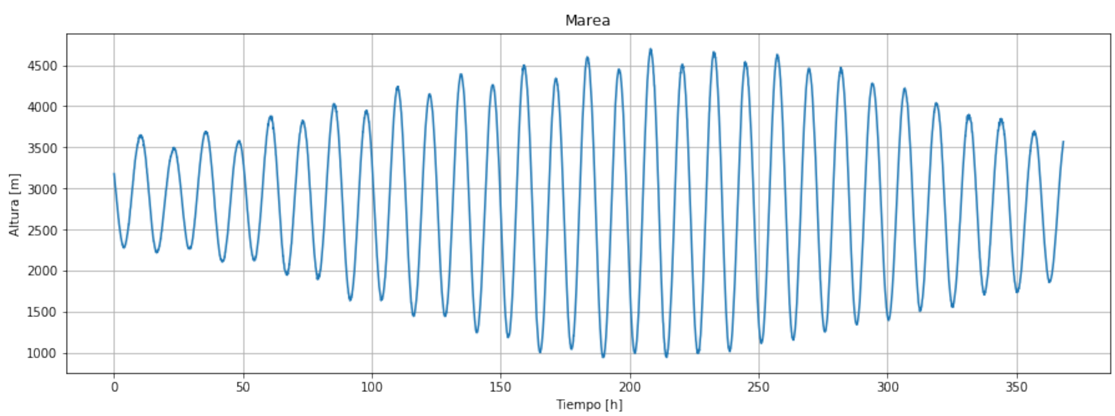
6.2 Sexto punto

```
In [41]: data = pd.read_csv('/media/guerreroasus/TOSHIBA EXT/Universidad/Master/Semester_II/Ap
         data.head(5)
```

Out[41]:

	Code	Date	Time	Height(m)
0	2	18/09/2018	0:00:00	3180
1	2	18/09/2018	0:05:00	3150
2	2	18/09/2018	0:10:00	3120
3	2	18/09/2018	0:15:00	3100
4	2	18/09/2018	0:20:00	3070

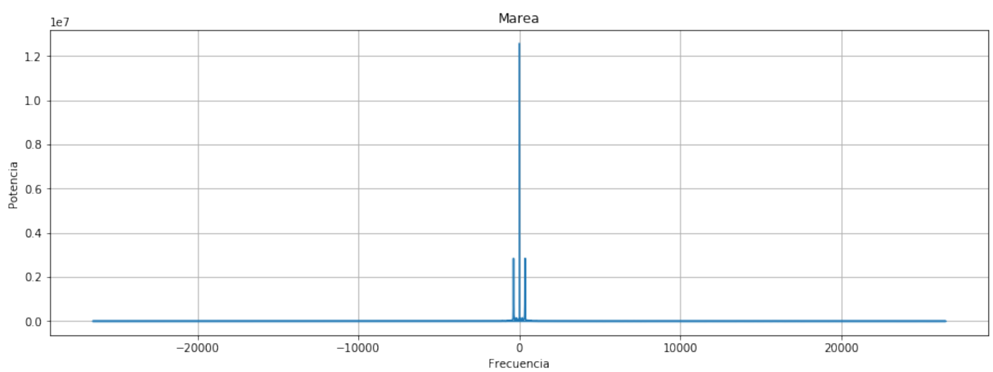
In [42]:
```
marea = data.values;
altura = marea[:,3];
hora = np.arange(len(marea))*5/60
fig = plt.figure(figsize=(15,5))
plt.plot(hora,altura);
plt.xlabel('Tiempo [h]')
plt.ylabel('Altura [m]')
plt.title('Marea')
plt.grid()
plt.show()
```



In [ ]:
```
f = 12  # Hz
dt = 1 / (f * len(altura))  # Espaciado, N puntos por período
Potencia=fft(altura);
frq = fftfreq(len(altura), dt)
```

In [ ]:
```
fig = plt.figure(figsize=(12,5))
plt.plot(frq,abs(Potencia))
plt.xlabel('Frecuencia')
plt.ylabel('Potencia')
plt.title('Marea')
plt.grid()
plt.show()
```

In [ ]:



Marea
1e7
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Potencia
−20000
−10000
0
10000
20000
Frecuencia

title