Transformada de Fourier, ejemplos Matlab sencillos

Presentación en vídeo en http://personales.upv.es/asala/YT/V/tfour.html

Este código ejecutó correctamente en Matlab **R2018b**

Tabla de Contenidos


```
syms t w real %usaremos la symbolic toolbox para las manipulaciones
s=1j*w; %analogía con Laplace (señales NO persistentes)
```

1.-Ejemplos de aplicación sobre señales

Exponencial causal:

```
FF1=1/(s+3)
```

FF1 =

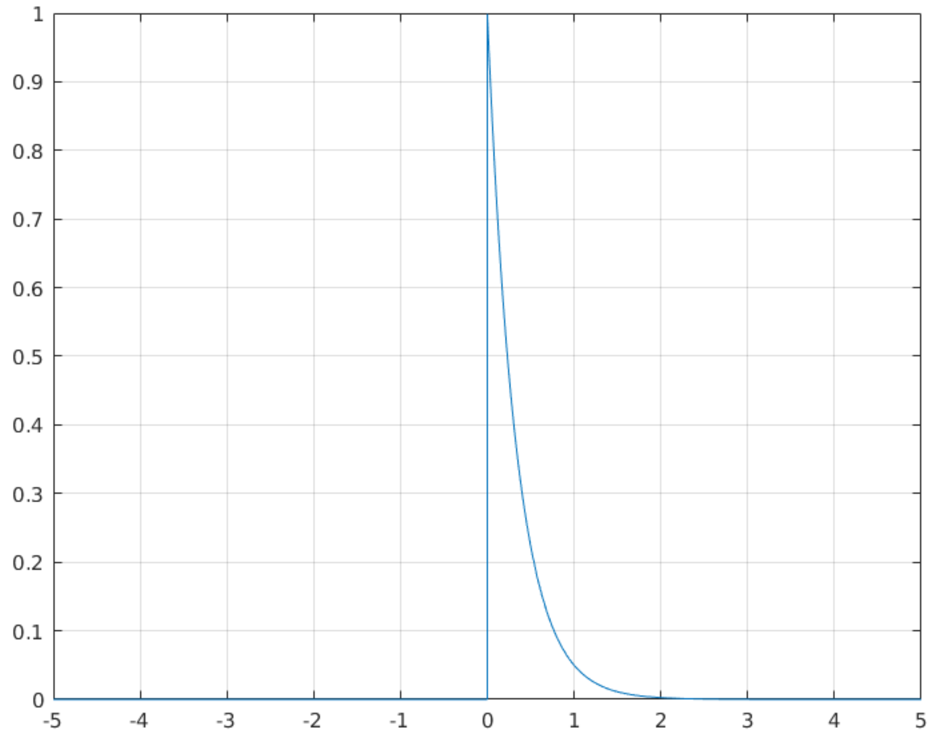
$$\frac{1}{3+w\,\mathrm{i}}$$

```
rr=ifourier(FF1)
```

rr =

$$\frac{e^{-3\,x}\,(\mathrm{sign}(x)+1)}{2}$$

```
fplot(rr), grid on
```



Exponencial anticausal:

```
FF2=1/(-s+3)
```

FF2 =

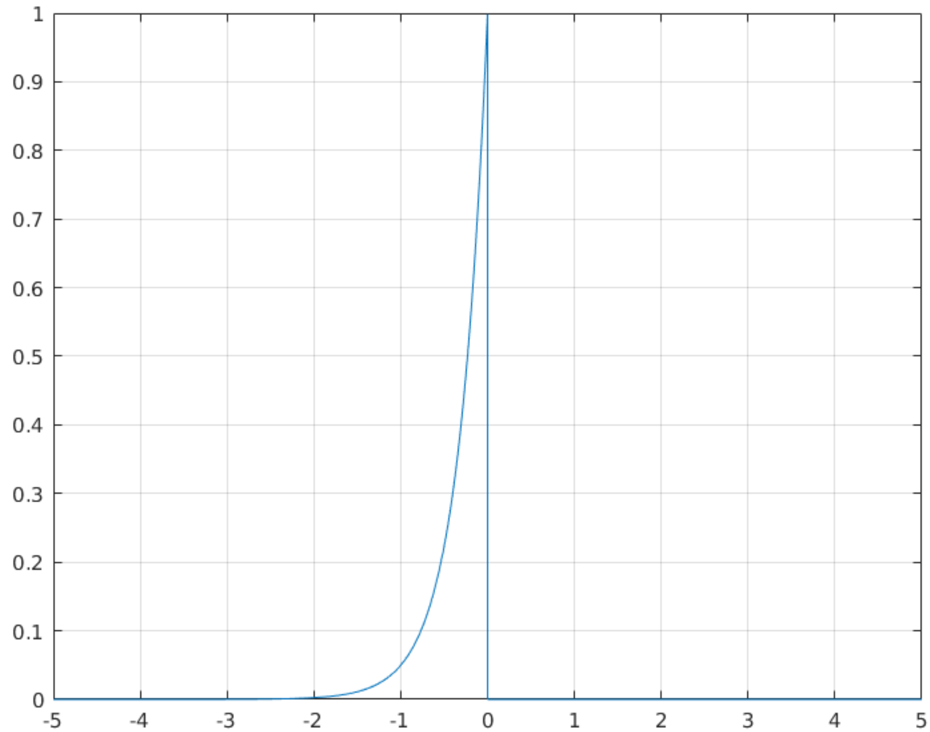
$$-\frac{1}{-3+w\,\mathrm{i}}$$

```
rr=ifourier(FF2)
```

rr =

$$-\frac{e^{3x}\,(\mathrm{sign}(x)-1)}{2}$$

```
fplot(rr), grid on
```



Exponencial causal+anticausal

```
FF=simplify(FF1+FF2) %6/(w^2+9)
```

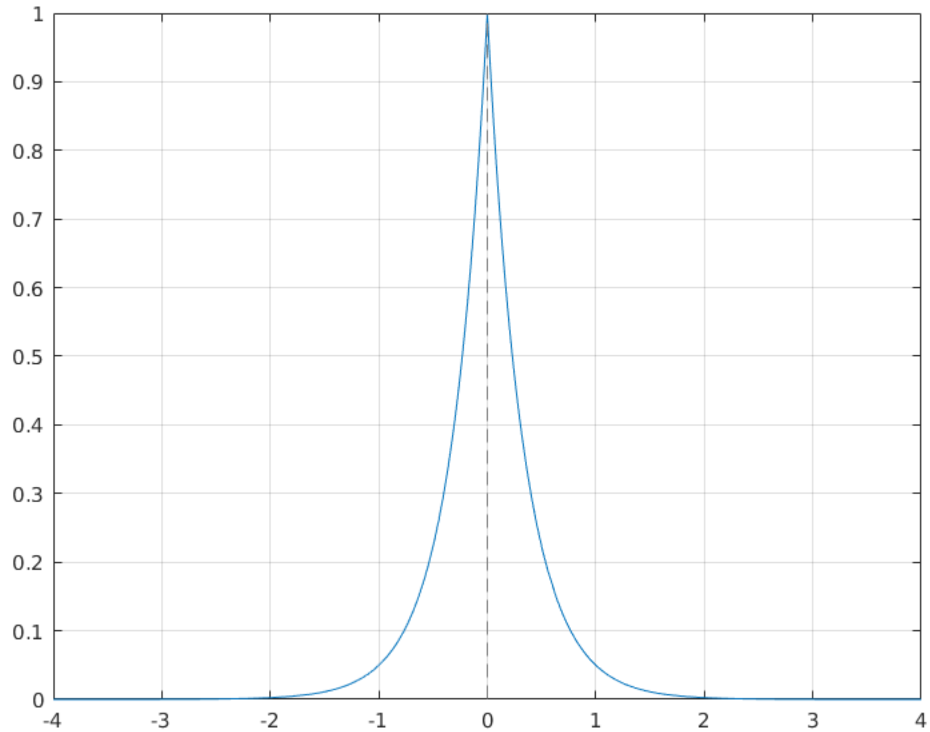
FF =

$$\frac{6}{w^2+9}$$

```
rr=ifourier(FF)
```

rr = $e^{-3\,|x|}$

```
fplot(rr),grid on, axis([-4 4 0 1])
```



2.-Respuesta ante escalón (como FdT)

```
fourier(heaviside(t)) %como el escalón es "persistente" cos(0t), tiene términos "delta
```

ans =

$$\pi\,\delta\left(w\right) - \frac{\mathrm{i}}{w}$$

```
escalon_t=heaviside(t)*exp(-0.0001*t); %aproximación no persistente para poder utilizar

tablaLaplaceExponencial=1/(s+0.0001)
```

tablaLaplaceExponencial =

$$\frac{1}{\frac{1}{10000} + w\,\mathrm{i}}$$

```
escalon_f=fourier(escalon_t)
```

escalon_f =

$$\frac{1}{\frac{1}{10000} + w\,\mathrm{i}}$$

```
%escalon_f=1/s NO ES CORRECTO... para que Laplace y Fourier sean
%equivalentes, no debe haber "polos" en eje imaginario, todo debe ser
```

```
%"exponencialmente estable".
```

Caso causal estable:

```
FF=3/(s+3)*escalon_f
```

```
FF =
```

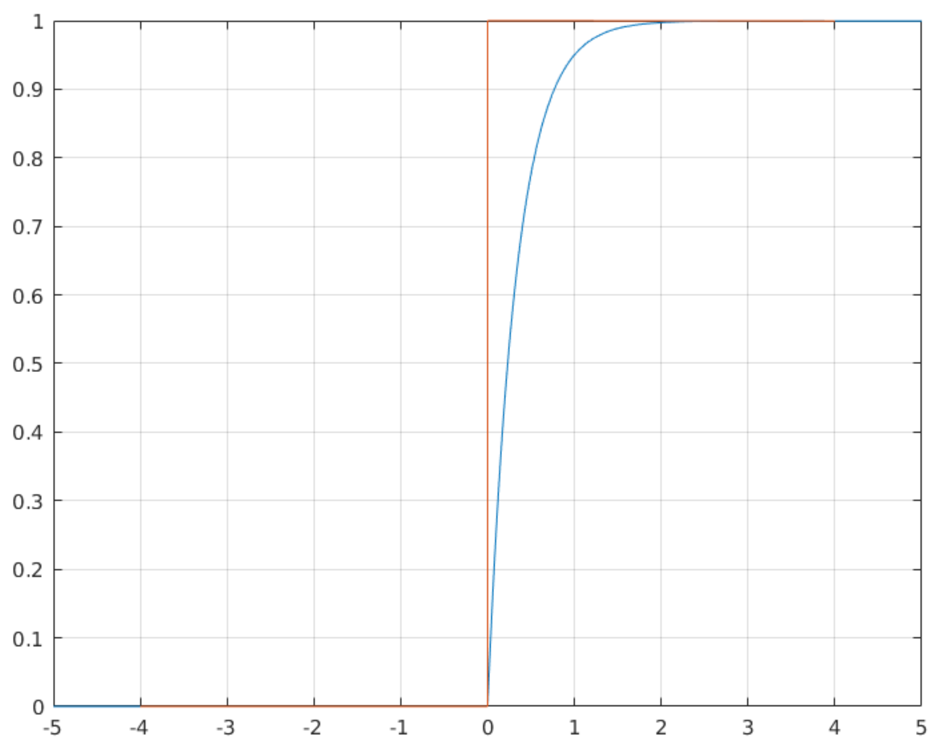
$$\frac{3}{(3+w\,\mathrm{i})\left(\frac{1}{10000}+w\,\mathrm{i}\right)}$$

```
rr1=simplify(ifourier(FF))
```

```
rr1 =
```

$$-\frac{15000\left(\mathrm{e}^{-3\,x}-\mathrm{e}^{-\frac{x}{10000}}\right)(\mathrm{sign}(x)+1)}{29999}$$

```
fplot(rr1), grid on, hold on, fplot(escalon_t,[-4 4]), hold off
```



Caso "inestable" en Laplace, que en Fourier cuando converge es "anticausal"

```
FF=3/(-s+3)*escalon_f
```

```
FF =
```

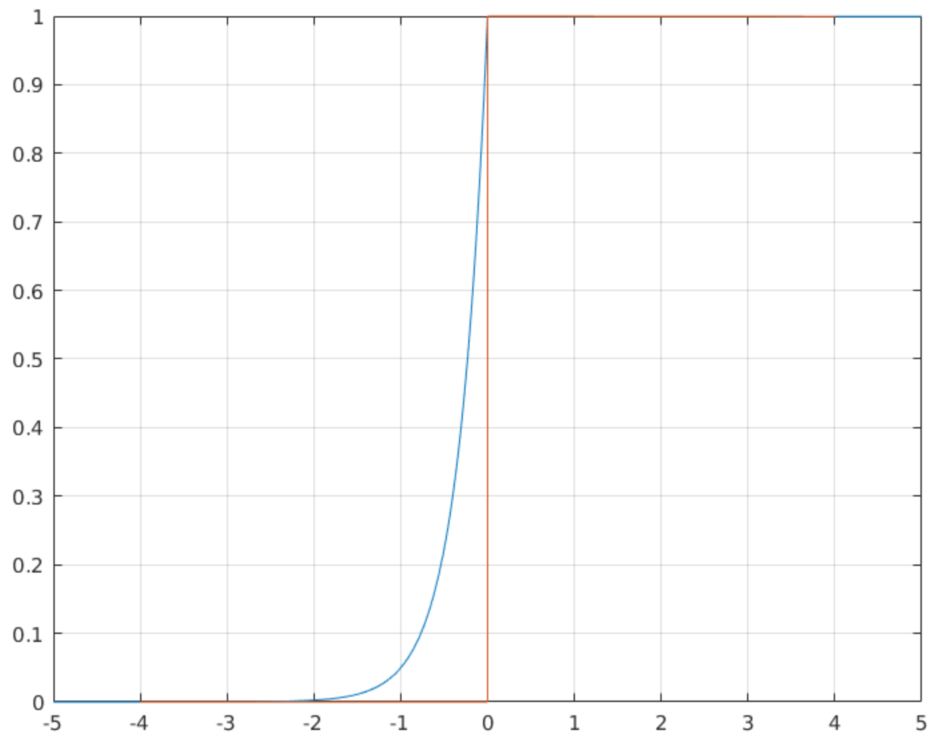
$$-\frac{3}{(-3+w\,\mathrm{i})\left(\frac{1}{10000}+w\,\mathrm{i}\right)}$$

```
rr2=simplify(ifourier(FF))
```

```
rr2 =
```

$$-\frac{\frac{30000\,\pi\,\mathrm{e}^{3\,x}\,(\mathrm{sign}(x)-1)}{30001}-\frac{30000\,\pi\,\mathrm{e}^{-\frac{x}{10000}}\,(\mathrm{sign}(x)+1)}{30001}}{2\,\pi}$$

```
fplot(rr2), grid on,hold on, fplot(escalon_t,[-4 4]), hold off
```



2.1- Zero-Phase filtering

Caso causal+anticausal, muy común en "suavizado" en la práctica.

La función de transferencia 0.5(3/(s+3)+3/(-s+3)) tiene un Bode de fase CERO (real positivo). [Comprobadlo]

```
FF=9/(w^2+9)*escalon_f
```

```
FF =
```

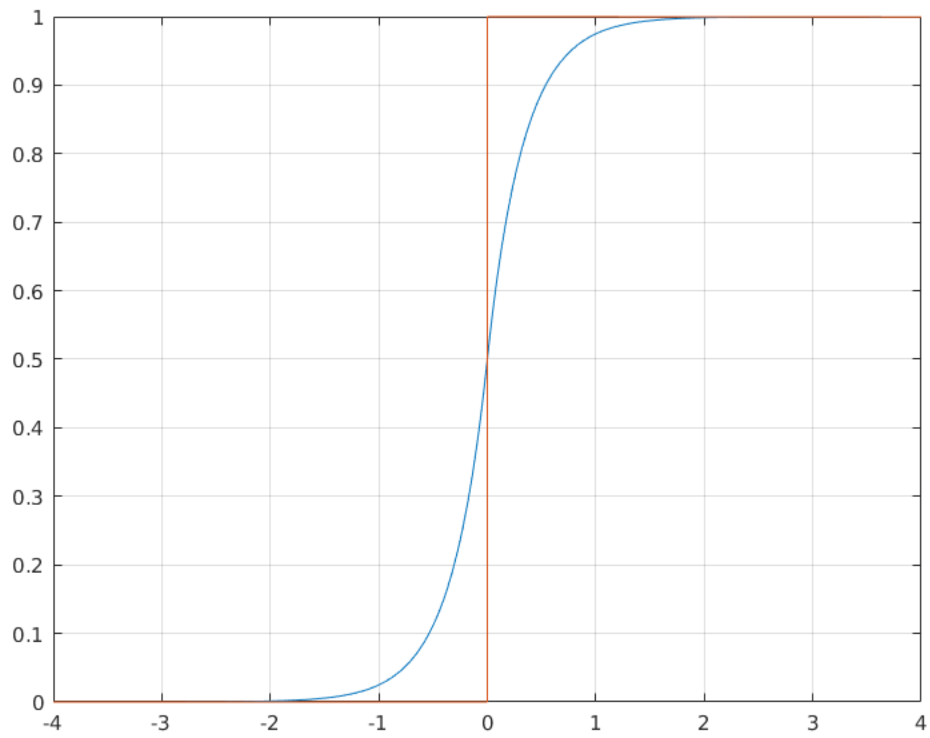
$$\frac{9}{\left(\frac{1}{10000}+w\,\mathrm{i}\right)(w^2+9)}$$

```
rr=simplify(ifourier(FF))
```

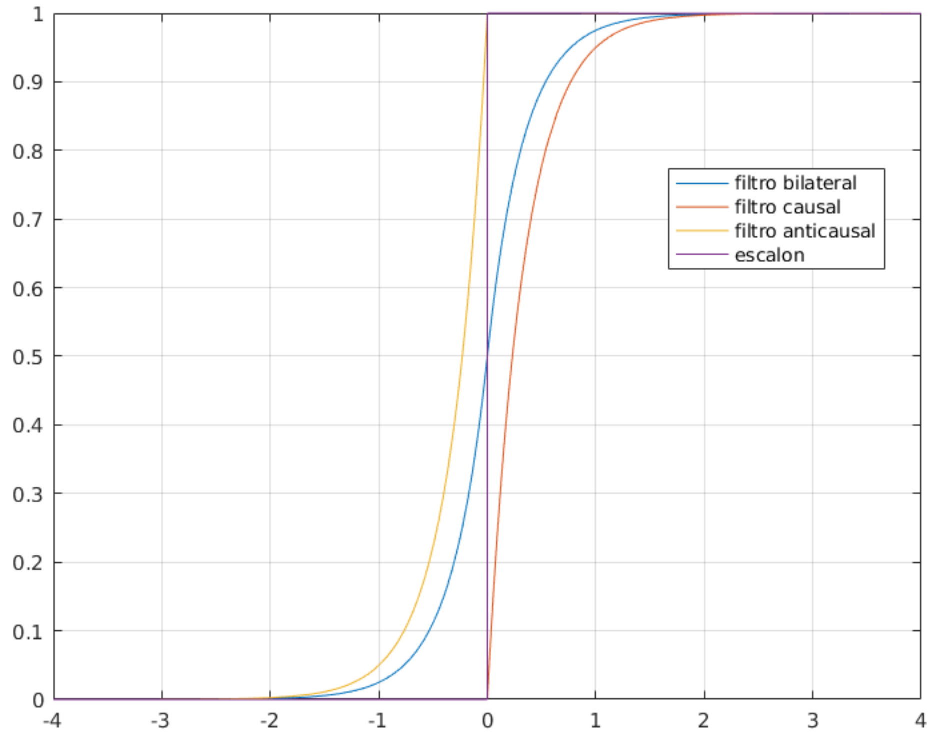
```
rr =
```

$$-\frac{\frac{30000\,\pi\,e^{-3\,|x|}}{899999999}-\frac{900000000\,\pi\,e^{-\frac{x}{10000}}\,(\mathrm{sign}(x)+1)}{899999999}+\frac{900000000\,\pi\,e^{-3\,|x|}\,\mathrm{sign}(x)}{899999999}}{2\,\pi}$$

```
fplot(rr,[-4 4]), grid on, hold on, fplot(escalon_t,[-4 4]), hold off
```

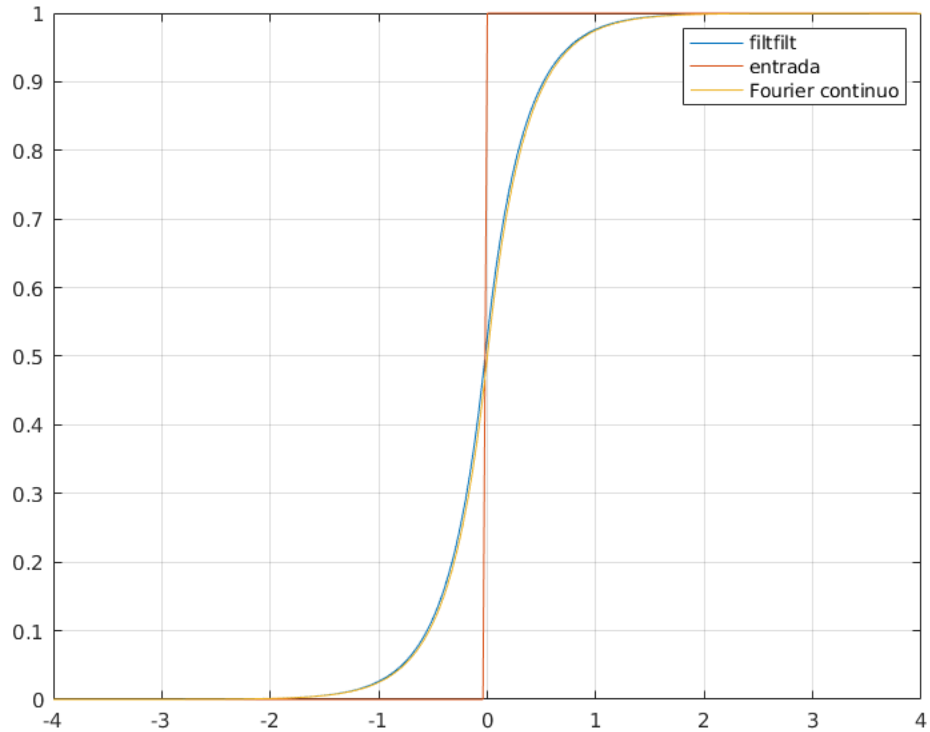



```
%todo junto:
fplot([rr rr1 rr2],[-4 4]), grid on, hold on, fplot(escalon_t,[-4 4]), hold off
legend('filtro bilateral','filtro causal','filtro anticausal','escalon','Location','bes
```



2.2- Implementación con filtfilt (signal processing toolbox)

```
s=tf('s');
G=3/(s+3);
Ts=0.04;
Gd=c2d(G,Ts,'tustin'); %discretización aproximada
u=[zeros(1,100) ones(1,100)];
y=filtfilt(Gd.num{:},Gd.den{:},u);
plot((0:199)*Ts-100*Ts,[y;u]'), grid on,
hold on, fplot(rr,[-4 4]),hold off, legend('filtfilt','entrada','Fourier continuo')
```



filtfilt
entrada
Fourier continuo
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-4
-3
-2
-1
0
1
2
3
4