Poles/Zeros & Time Response using Scilab

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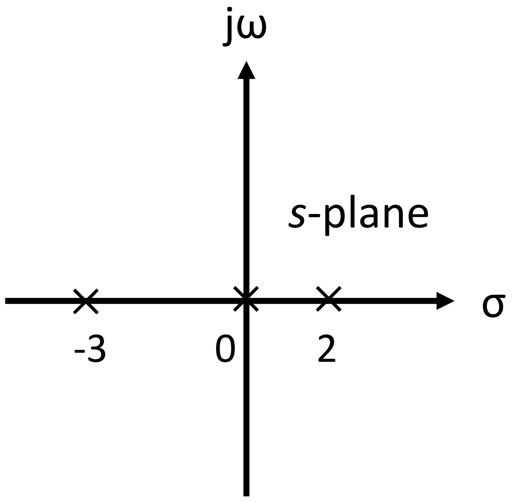
Concept of Poles & Zeros

Poles:

1. Values of the Laplace transform variable, s, that cause the transfer function to become infinite,
   - The roots of the characteristic polynomial in the denominator
   - {0,-3}

$$\frac{(s-2)}{s(s-2)(s+3)}$$

2. Any roots of the denominator of the transfer function that are common to roots of the numerator
   - If a factor of the denominator can be canceled by the same factor in the numerator, the root of this factor no longer causes the transfer function to become infinite.
   - {2}



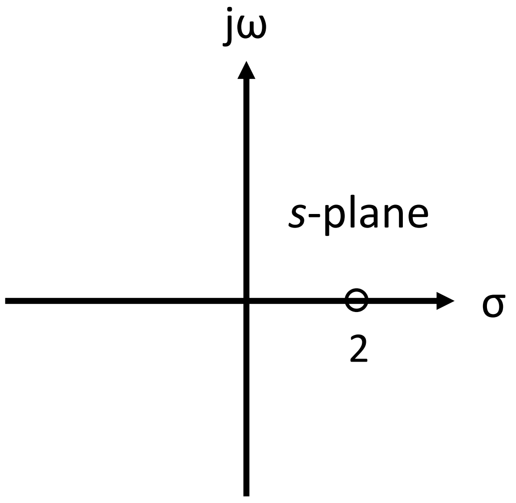
× for the pole

Concept of Poles & Zeros

Zeros:

1. The values of the Laplace transform variable, s, that cause the transfer function to become zero, or
   - The roots of the numerator are values of s that make the transfer function zero and are thus zeros
   - {2}

$$\frac{(s-2)}{2s(s+3)}$$



○ for a zero

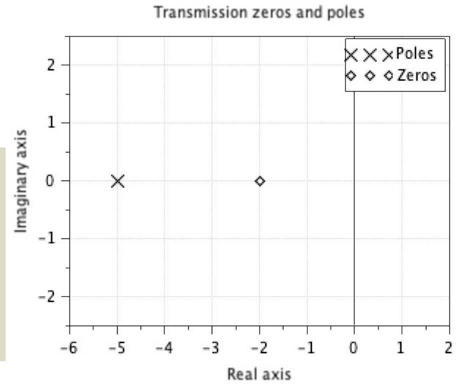
2. Any roots of the numerator of the transfer function that are common to roots of the denominator.
   - In control systems, the root of the canceled factor in the numerator as a zero even though the transfer function will not be zero at the value.

Scilab: Poles and Zeros of a 1st Order System

Given the transfer function $G(s) = \dfrac{(s+2)}{(s+5)}$

- a pole exists at $s = -5$, and
- a zero exists at -2.

```
--> s=poly(0,'s');
--> n=[2+s];
--> d=[5+s];
--> h=syslin('c',n./d);
--> plzr(h)
```



To see the properties of the poles and zeros, we find the unit step response:

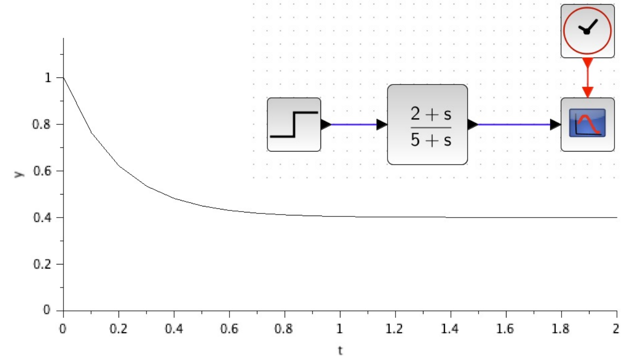
$$C(s) = \frac{s+2}{s(s+5)} = \frac{A}{s} + \frac{B}{s+5}$$

$$= \frac{2/5}{s} + \frac{3/5}{s+5}$$

Time response: $c(t) = \dfrac{2}{5} + \dfrac{3}{5}e^{-5t}$

$\frac{2}{5}$: Forced response; $\frac{3}{5}e^{-5t}$: Natural response

Xcos




```
--> t=0:0.01:2;
--> x=2/5;
--> y=3/5*exp(-5*t);
--> z=2/5+3/5*exp(-
5*t);
--> plot(t,x,'+-
',t,y,'o-',t,z,'r-');
--> legend('forced
response','natural
response','response')
;
--> xlabel('time
(sec)')
```