

How do you convert State Variable Models to transfer functions?

$$\begin{cases} \dot{x} = Ax + Bu \\ y = Cx + Du \end{cases} \Rightarrow G(s) = C(sI - A)^{-1}B + D$$

Example

Convert $\begin{cases} \dot{x} = \begin{pmatrix} 1 & 0 \\ 2 & 3 \end{pmatrix}x + \begin{pmatrix} 0 \\ 1 \end{pmatrix}u \\ y = (1 \quad -1)x + 0u \end{cases}$ to a transfer function

$$G(s) = (1 \quad -1) \begin{pmatrix} s-1 & 0 \\ -2 & s-3 \end{pmatrix}^{-1} \begin{pmatrix} 0 \\ 1 \end{pmatrix} + 0 = (1 \quad -1) \frac{1}{(s-1)(s-3)} \begin{pmatrix} s-3 & 0 \\ 2 & s-1 \end{pmatrix} \begin{pmatrix} 0 \\ 1 \end{pmatrix}$$
$$= \frac{-s+1}{s^2-4s+3}$$

Conversion Using MATLAB

```
>> A=[1 0; 2 3]; B=[0;1]; C=[1 -1]; D=0;  
>> [num,den]=ss2tf(A,B,C,D)
```

num =

0 -1 1

den =

1 -4 3