

Abstract geometric lines in the top left corner of the slide, consisting of several thin black lines forming overlapping, irregular shapes.

INTRODUCTION TO MATLAB/SIMULINK APPLICATION IN LINEAR CONTROL SYSTEMS

Fall 2024



SESSION 2

AGENDA

Solve Differential Equations

Laplace Transform

Transfer Function

Plot in MATLAB

State Space



SOLVE DIFFERENTIAL EQUATIONS

syms

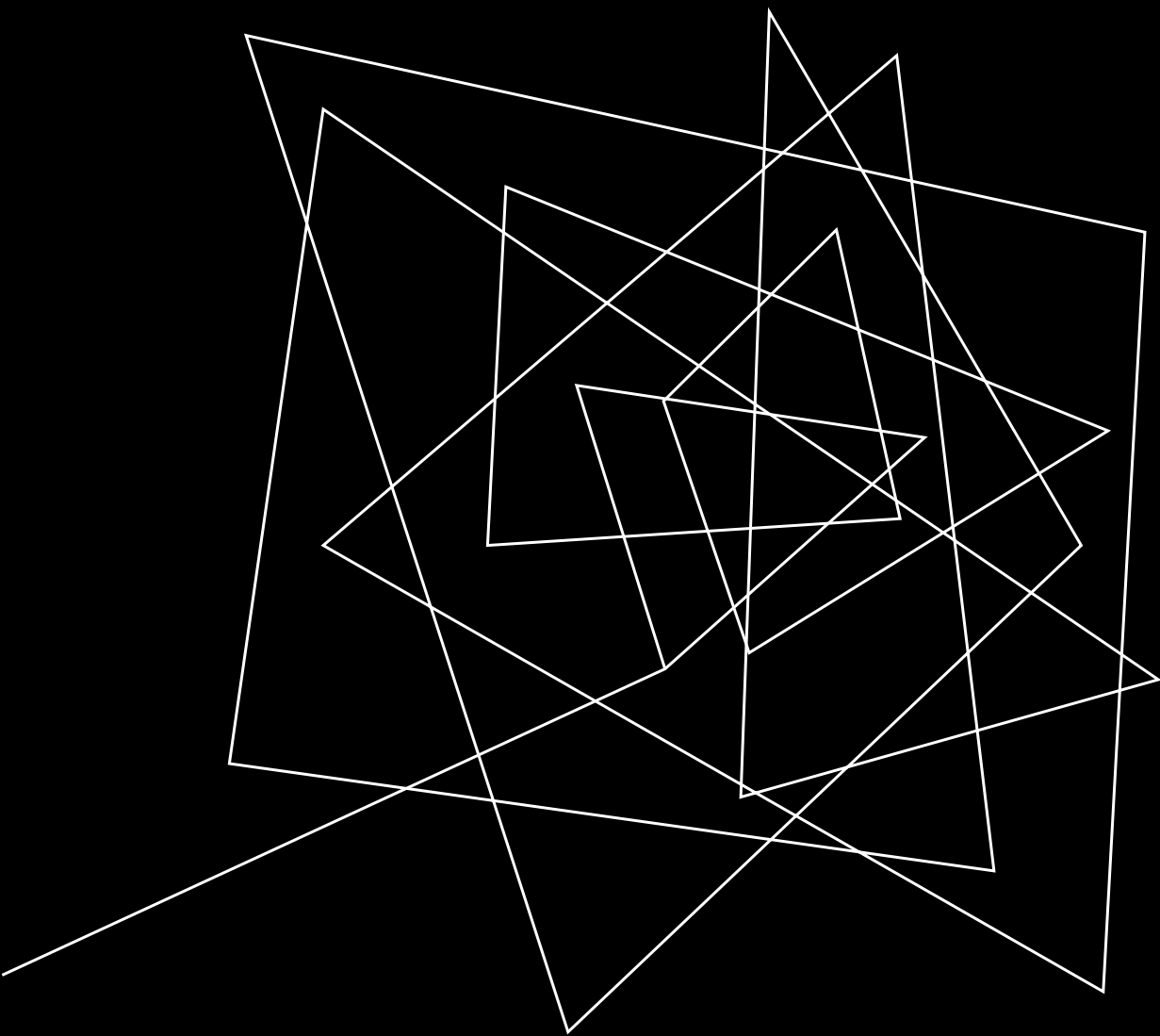
dsolve()

Solve the first-order differential equation $\frac{dy}{dt} = ay$.

Specify the first-order derivative by using `diff` and the equation by using `==`. Then, solve the equation by using `dsolve`.

```
syms y(t) a
eqn = diff(y,t) == a*y;
S = dsolve(eqn)
```

$$S = C_1 e^{at}$$



LAPLACE TRANSFORM

laplace()

```
syms a t y
f = exp(-a*t);
F = laplace(f)
```

F =

$$\frac{1}{a + s}$$

ilaplace()

```
syms a s
F = 1/(s-a)^2;
f = ilaplace(F)
```

$$f = t e^{at}$$

An abstract graphic featuring two thin, dark grey lines that intersect on a light grey background. One line is oriented diagonally from the top-left towards the bottom-right, while the other is oriented from the top-right towards the bottom-left. To the right of the intersection, the words "TRANSFER" and "FUNCTION" are stacked vertically in a bold, black, sans-serif typeface.

TRANSFER FUNCTION

tf()

$$sys(s) = \frac{1}{2s^2 + 3s + 4}.$$

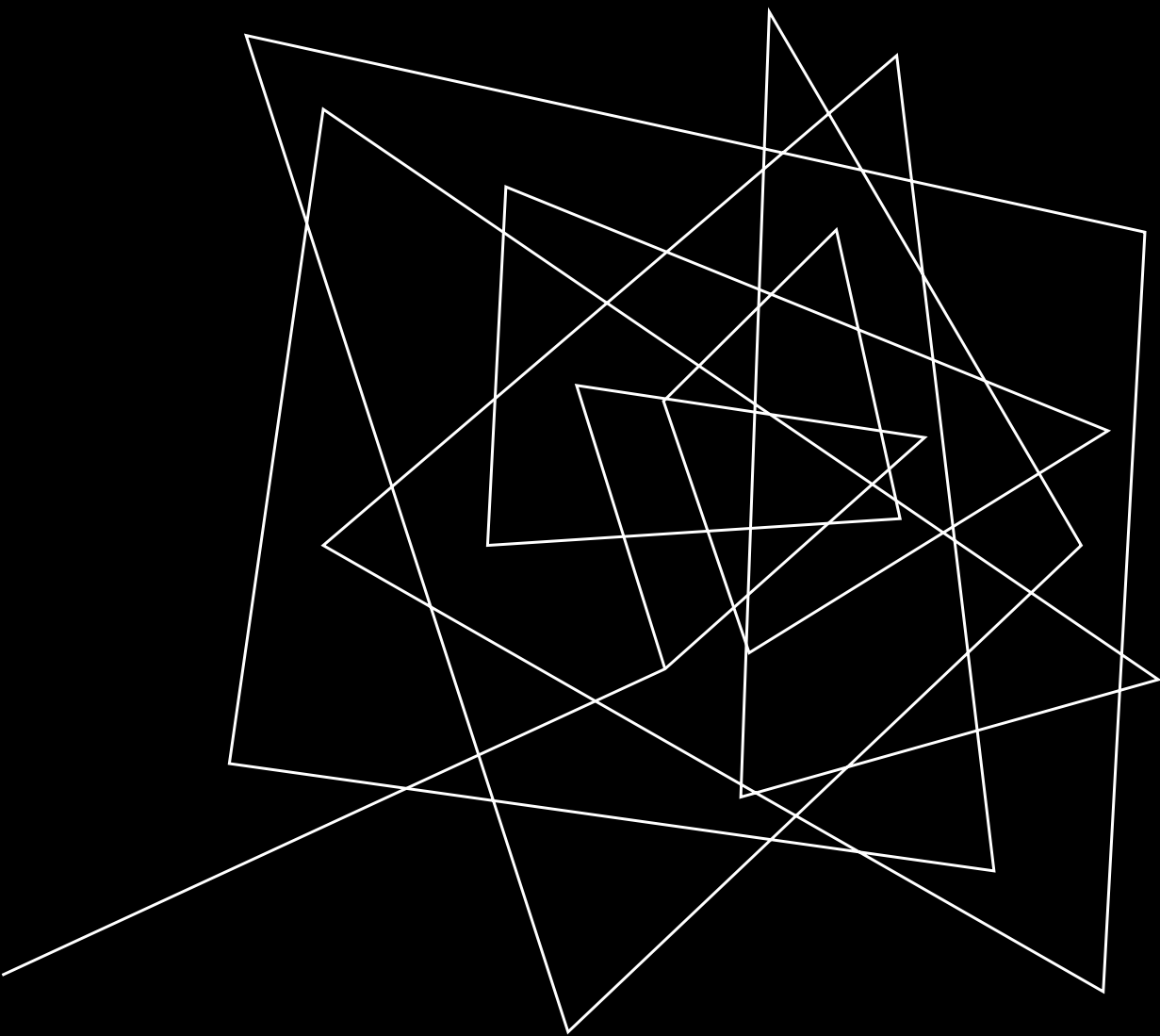
Specify the numerator and denominator coefficients ordered in descending powers of s , and create the transfer function model.

```
numerator = 1;  
denominator = [2,3,4];  
sys = tf(numerator,denominator)
```

`sys =`

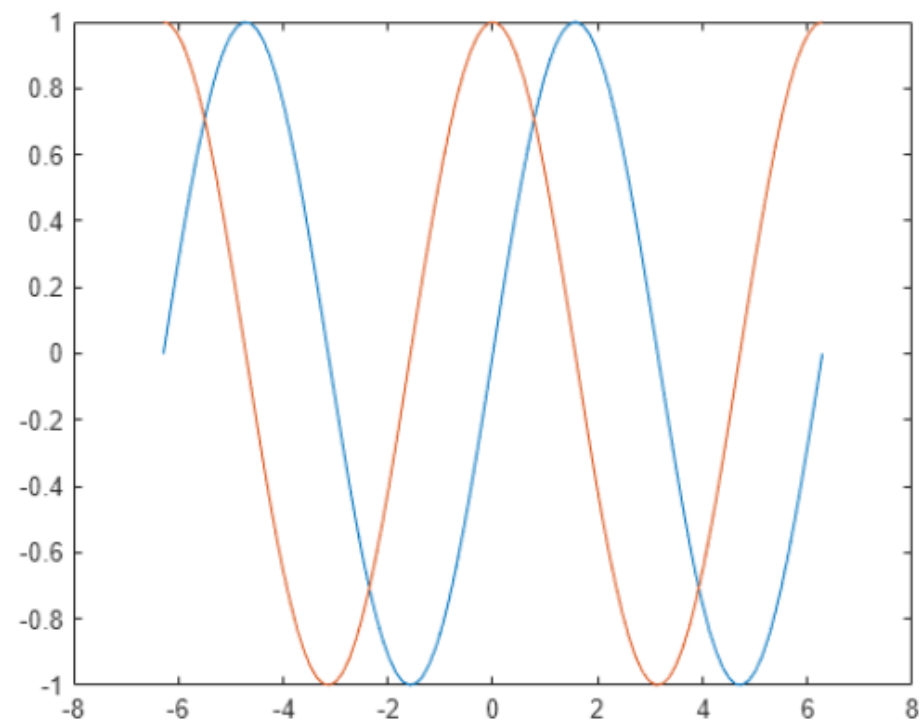
$$\frac{1}{2 s^2 + 3 s + 4}$$

Continuous-time transfer function.



PLOT IN MATLAB

```
x = linspace(-2*pi,2*pi);  
y1 = sin(x);  
y2 = cos(x);  
  
figure  
plot(x,y1,x,y2)
```





STATE SPACE

The image features a minimalist design on a light gray background. Two thin, dark gray lines intersect diagonally. One line slopes downwards from the top-left towards the bottom-right, while the other slopes upwards from the bottom-left towards the top-right. To the right of this intersection, the words 'STATE SPACE' are written in a bold, black, sans-serif typeface.

Create the SISO state-space model defined by the following state-space matrices:

$$A = \begin{bmatrix} -1.5 & -2 \\ 1 & 0 \end{bmatrix} \quad B = \begin{bmatrix} 0.5 \\ 0 \end{bmatrix} \quad C = [0 \ 1] \quad D = 0$$

Specify the A, B, C and D matrices, and create the state-space model.

```
A = [-1.5, -2; 1, 0];  
B = [0.5; 0];  
C = [0, 1];  
D = 0;  
sys = ss(A, B, C, D)
```

sys =

A =

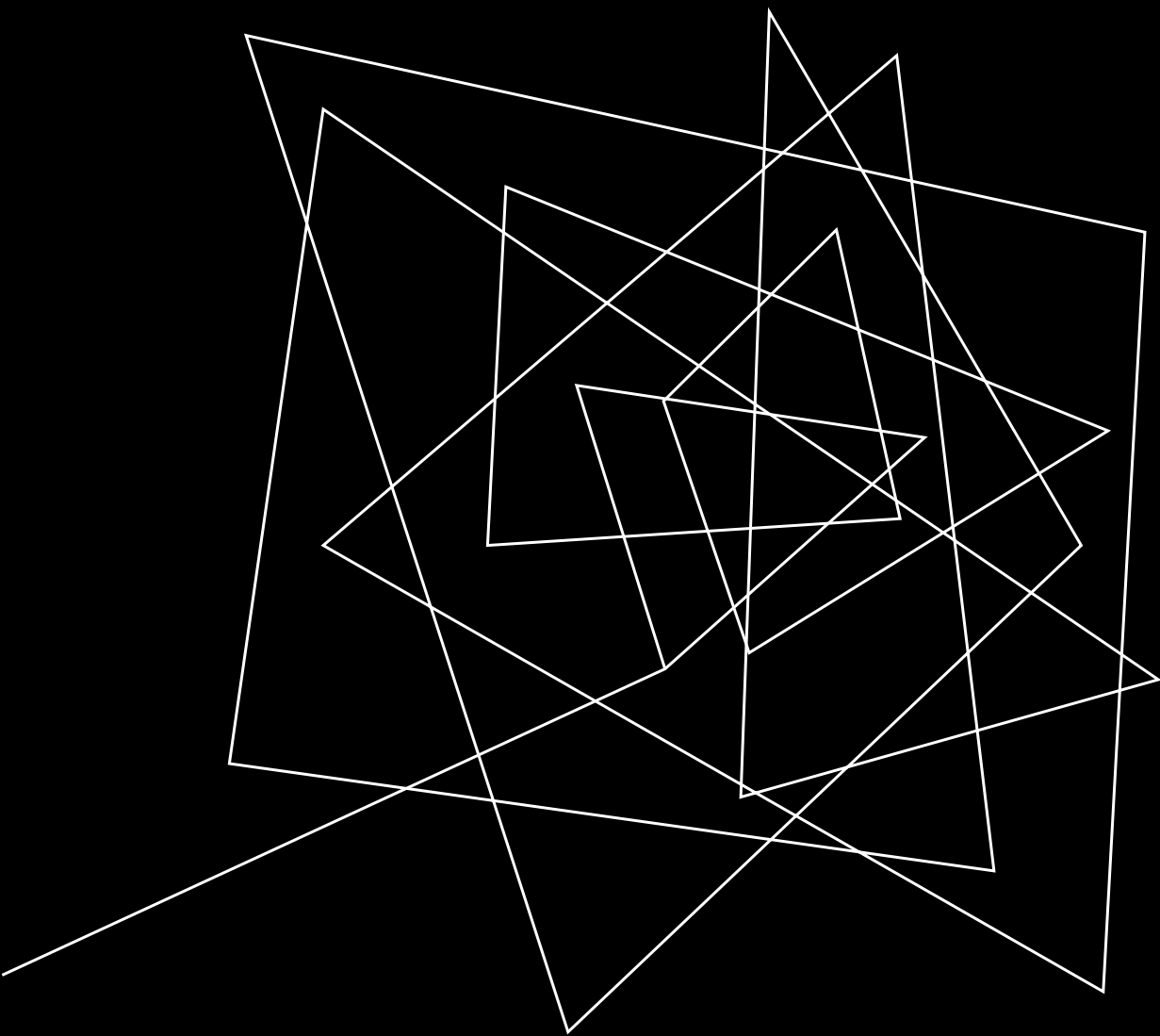
	x1	x2
x1	-1.5	-2
x2	1	0

B =

	u1
x1	0.5
x2	0

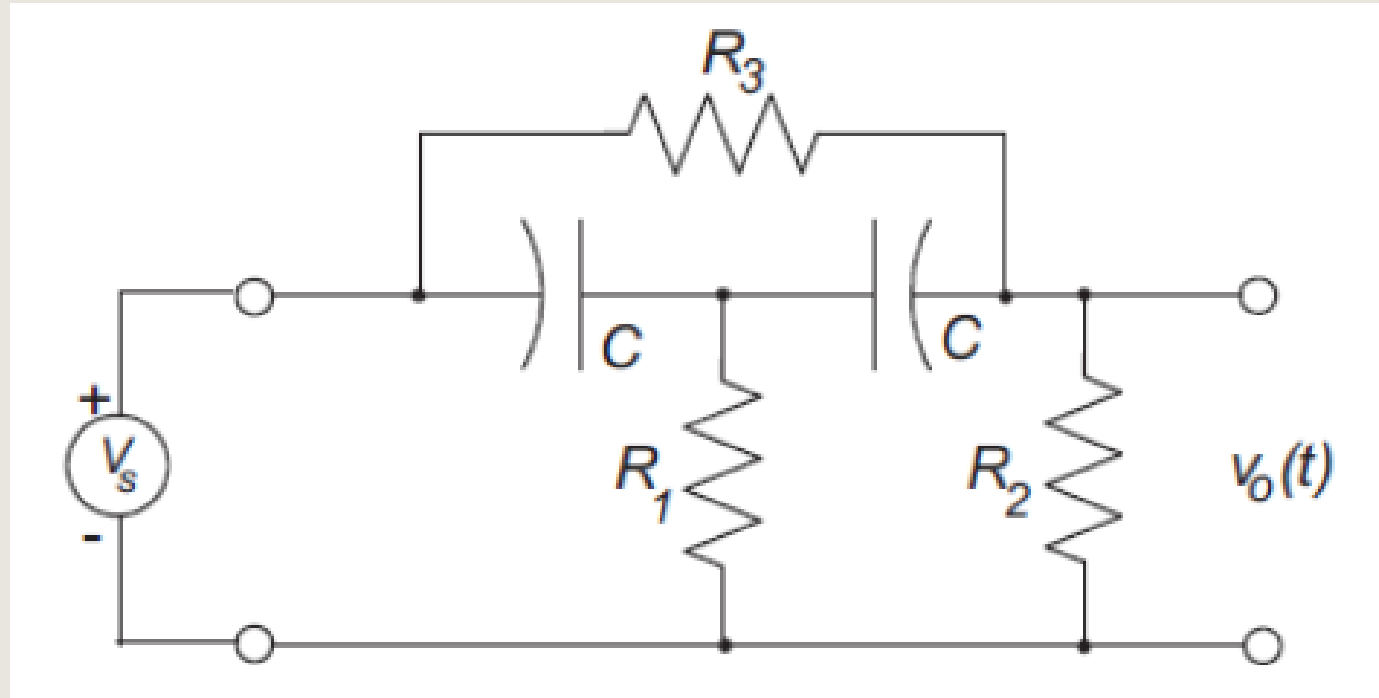
C =

	x1	x2
y1	0	1

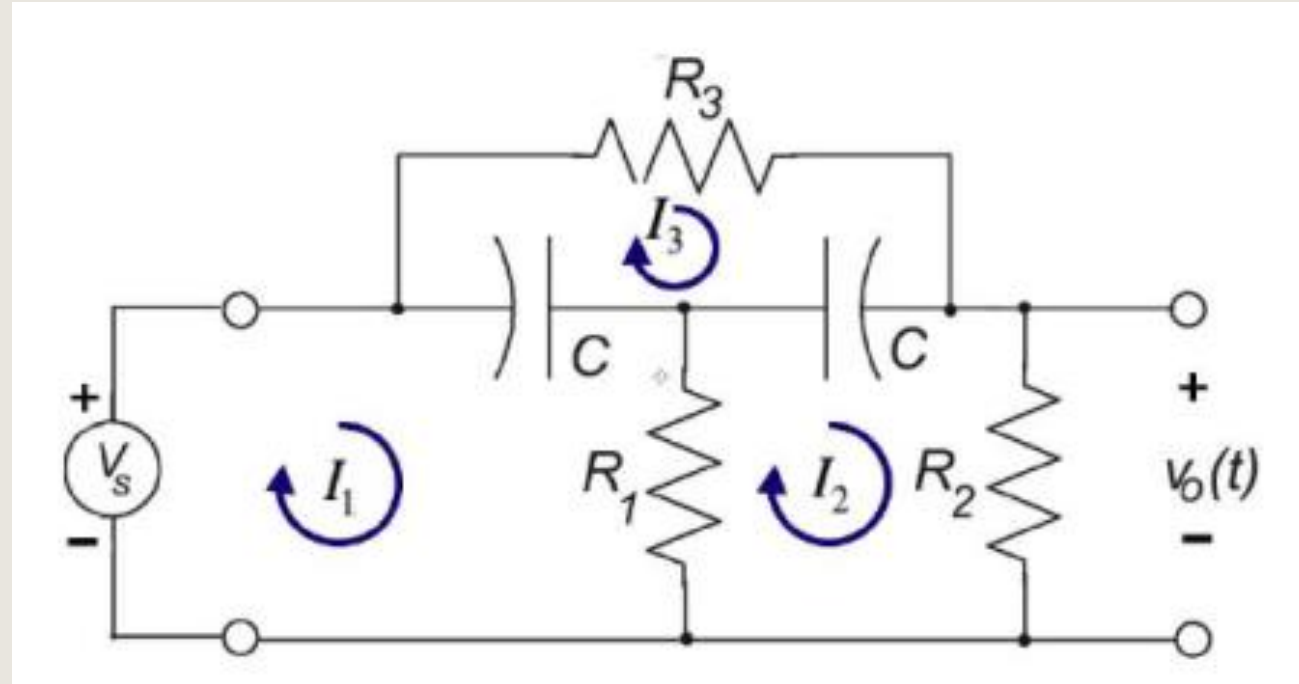


EXAMPLE

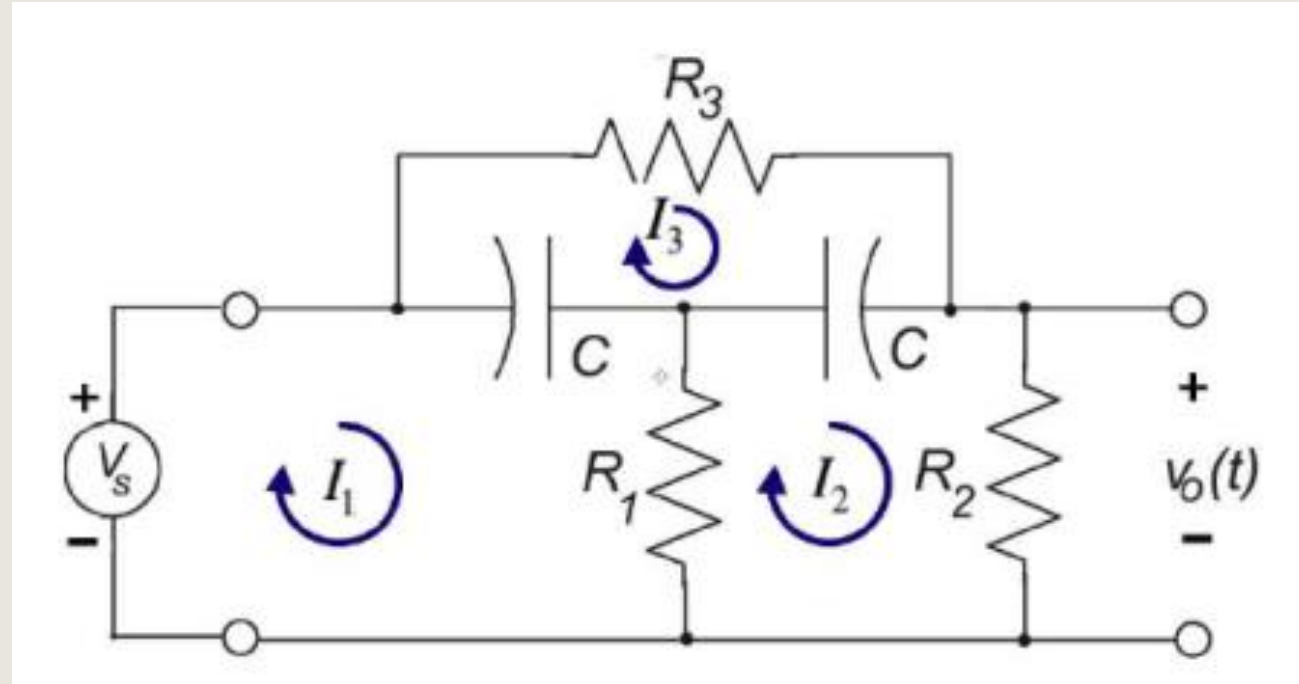
Bridged-T Filter



Bridged-T Filter

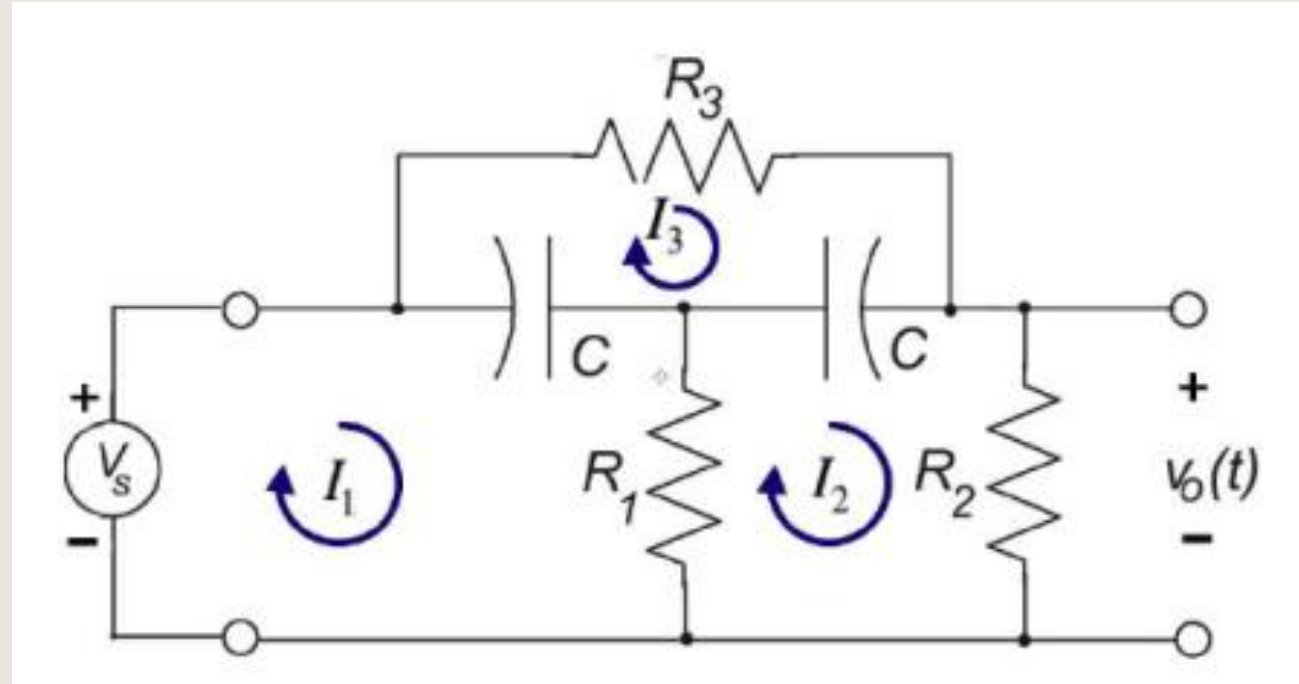


Bridged-T Filter



$$\text{Loop 1: } -V_s + \frac{1}{C_s}(I_1 - I_3) + R_1(I_1 - I_2) = 0$$

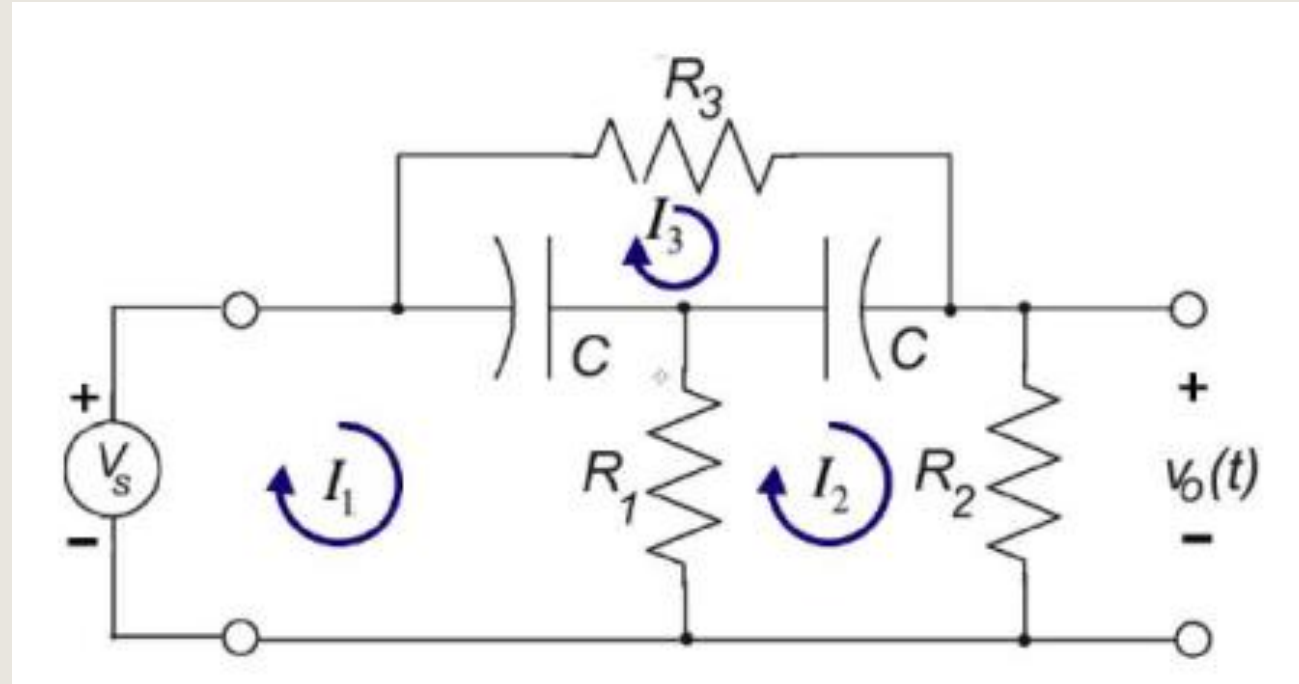
Bridged-T Filter



$$\text{Loop 1: } -V_s + \frac{1}{C_s}(I_1 - I_3) + R_1(I_1 - I_2) = 0$$

$$\text{Loop 2: } R_1(I_2 - I_1) + \frac{1}{C_s}(I_2 - I_3) + R_2 I_2 = 0$$

Bridged-T Filter

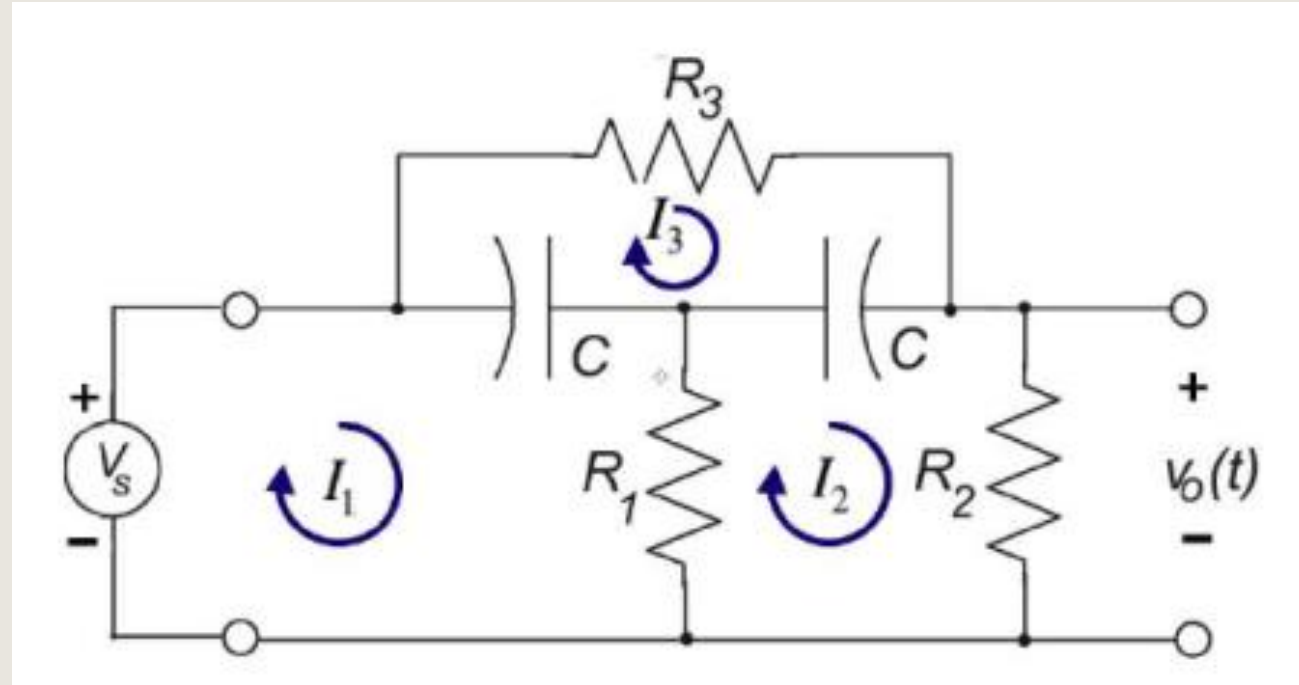


$$\text{Loop 1: } -V_s + \frac{1}{C_s}(I_1 - I_3) + R_1(I_1 - I_2) = 0$$

$$\text{Loop 2: } R_1(I_2 - I_1) + \frac{1}{C_s}(I_2 - I_3) + R_2 I_2 = 0$$

$$\text{Loop 3: } \frac{1}{C_s}(I_3 - I_1) + R_3 I_3 + \frac{1}{C_s}(I_3 - I_2) = 0$$

Bridged-T Filter



$$H(s) = \frac{V_o(s)}{V_s(s)} = \frac{(R_1 R_3 C^2 s^2 + 2R_1 C s + 1)R_2}{R_1 R_3 R_2 C^2 s^2 + (2R_1 R_2 + 2R_1 R_3 + R_3 R_2)C s + R_2 + R_3}$$

A series of white, thin, intersecting lines on a black background, forming an abstract geometric pattern on the left side of the slide.

THANK YOU

GitHub: <https://github.com/LinearControlSystems/MATLAB-Simulink-Applications>