**MATLAB Examples**

1. Laplace Transform and Inverse Laplace Transform:

$$f\left(t\right)=e^{-3t}cos⁡πt$$

syms s t % Define s and t as symbol variables

f=exp(-3\*t)\*cos(pi\*t); % Write an expression for f(t)

F=laplace(f) % Perform Laplace Transform

F =

 (s + 3)/((s + 3)^2 + pi^2)

$$F\left(s\right)=\frac{5(s+2)}{s^{2}(s+1)(s+3)}$$

 syms s t % Define s and t as symbol variables

 F=(5\*(s+2))/(s^2\*(s+1)\*(s+2)); % Write an expression for F(s)

 f=ilaplace(F) % Perform Laplace Transform

 f =

 5\*t + 5\*exp(-t) – 5

1. Partial Fraction Expansion:

$$F\left(s\right)=\frac{2s^{2}+4s+5}{s(s+1)}= \frac{2s^{2}+4s+5}{s^{2}+s}$$

 a=[2 4 5]; % Coefficients of numerator

 b=[1 1 0]; % Coefficients of denominator

 [r,p,k]=residue(a,b) % Function that performs PFE

 r =

 -3

 5

 p =

 -1

 0

 k =

 2

 This corresponds to : $F\left(s\right)=2+\frac{-3}{s+1}+\frac{5}{s}$

1. Solving ordinary differential equations using MATLAB:

syms s t Y % Define s t and Y as symbols

f=exp(-t)+5\*dirac(t-2); % Define the RHS of the equation

F=laplace(f); % Take the Laplace transform of the RHS

Y1=s\*Y; % Laplace of y'(t)

Y2=s^2\*Y; % Laplace of y''(t)

sol=solve(Y2+2\*Y1+2\*Y-F,Y) % Solve the equation

sol =

(5\*exp(-2\*s) + 1/(s + 1))/(s^2 + 2\*s + 2)

y=ilaplace(sol) % Take the inverse Laplace of the solution

y =

exp(-t) - exp(-t)\*cos(t) + 5\*heaviside(t - 2)\*sin(t - 2)\*exp(2 - t)

Solution: $y\left(t\right)=e^{-t}-e^{-t}\cos(\left(t\right))+5u\left(t-2\right)sin⁡(t-2)e^{2-t}$

1. Creating a transfer function and performing block diagram reduction operations:

% Define numerators and denominators and create all TFs:

n1=[1];

d1=[1 0 0];

G1=tf(n1,d1);

n2=[50];

d2=[1 1];

G2=tf(n2,d2);

n3=[2];

d3=[1 0];

G3=tf(n3,d3);

n4=[-2];

d4=[1];

G4=tf(n4,d4);

n5=[1 0];

d5=[1];

G5=tf(n5,d5);

Ge1=parallel(G4,G5); % Connect G4 and G5 in parallel

Ge2=feedback(G2,G3); % Apply feedback for G2 and G4

Ge3=series(series(G1,Ge1),Ge2); % Cascade the 3 TFs

Ge=feedback(Ge3,1) % Unity feedback to get equiv. TF

Ge =

 50 s^2 - 100 s

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 s^4 + s^3 + 150 s^2 - 100 s

Continuous-time transfer function.

1. Converting a TF to State Space and vice versa:

% Define the numerator and denominator of the TF

n=[8 10];

d=[1 5 1 5 13];

[A,B,C,D]=tf2ss(n,d) % Transfer Function to State Space

A =

 -5 -1 -5 -13

 1 0 0 0

 0 1 0 0

 0 0 1 0

B =

 1

 0

 0

 0

C =

 0 0 8 10

D =

 0

[num,den]=ss2tf(A,B,C,D) % State Space to Transfer Function

num =

 0 0 0 8 10

den =

 1.0000 5.0000 1.0000 5.0000 13.0000