MATLAB Examples

1. Laplace Transform and Inverse Laplace Transform:

$$f(t) = e^{-3t}\cos \pi t$$

```
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)
```

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

```
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
```

2. Partial Fraction Expansion:

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

```
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 : $F(s) = 2 + \frac{-3}{s+1} + \frac{5}{s}$

3. 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: $y(t) = e^{-t} - e^{-t}\cos(t) + 5u(t-2)\sin(t-2)e^{2-t}$

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

Continuous-time transfer function.
```

5. 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
```