Solving first order differential equations. And Finding a general solution to linear, constant coefficient differential equations.

Electrical Engineering department

What is MATLAB?

Matlab = Matrix Laboratory

A software environment for interactive numerical computations.

Examples:

- Matrix computations and linear algebra
- Solving nonlinear equations
- Numerical solution of differential equations
- Mathematical optimization
- Statistics and data analysis
- Signal processing
- Simulation of engineering systems

MATLAB Toolboxes

- MATLAB has a number of add-on software modules, called *toolboxes*, that perform more specialized computations.

Signal & Image Processing

Signal Processing- Image Processing Communications - System Identification - Wavelet Filter Design

- Control Design

Control System - Fuzzy Logic - Robust Control -

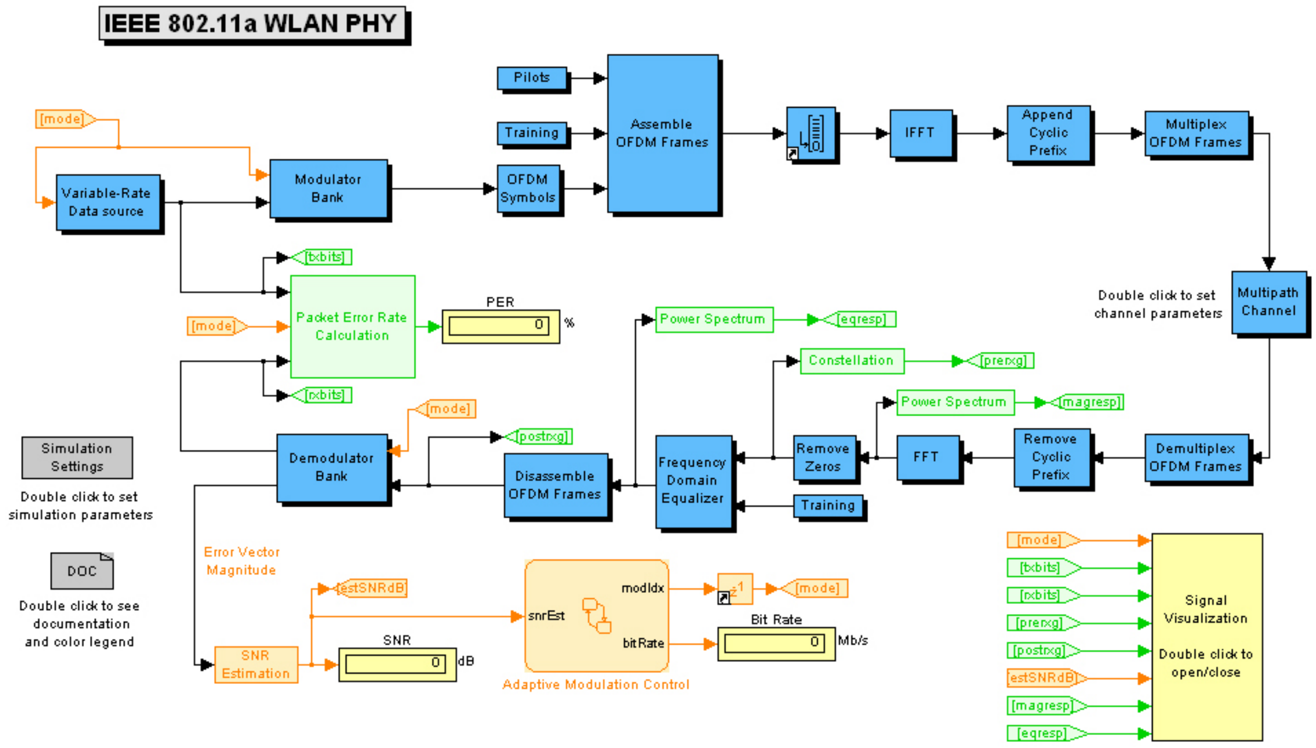
µ-Analysis and Synthesis - LMI Control

Model Predictive Control

More than 60 toolboxes!

SIMULINK

Simulink - a package for modeling dynamic systems



Matlab command

- **General**

Help : help facility

Demo : run demonstrations

who : list variables in memory

what : list M-files on disk

Size : row and column dimensions

Length : vector length clear

Clear : workspace

exit : exit MATLAB quit same as exit

Introduction to Differential Equations

- Given independent variable *t* and dependent variable *y*(*t*), a **linear ordinary differential equation with constant coefficients** is an equation of the form.

$$A_n \frac{d^n y}{dt^n} + \ldots + A_1 \frac{dy}{dt} + A_0 y(t) = f(t)$$

where A_0, A_1, …, A_n, are constants

Symbolic Differential Equation Terms

y	y
$\frac{dy}{dt}$	Dy
$\frac{d^2 y}{dt^2}$	D2y
$\frac{d^n y}{dt^n}$	Dny

Examples

- Examples of linear ordinary differential equation with constant coefficients:

$$\frac{dy}{dt} + 2y = 12 \qquad y(0) = 10$$

```
>> y = dsolve('Dy + 2*y = 12', 'y(0)=10')

y =

4*exp(-2*t) + 6
```

Examples

>> ezplot(y, [0 3])

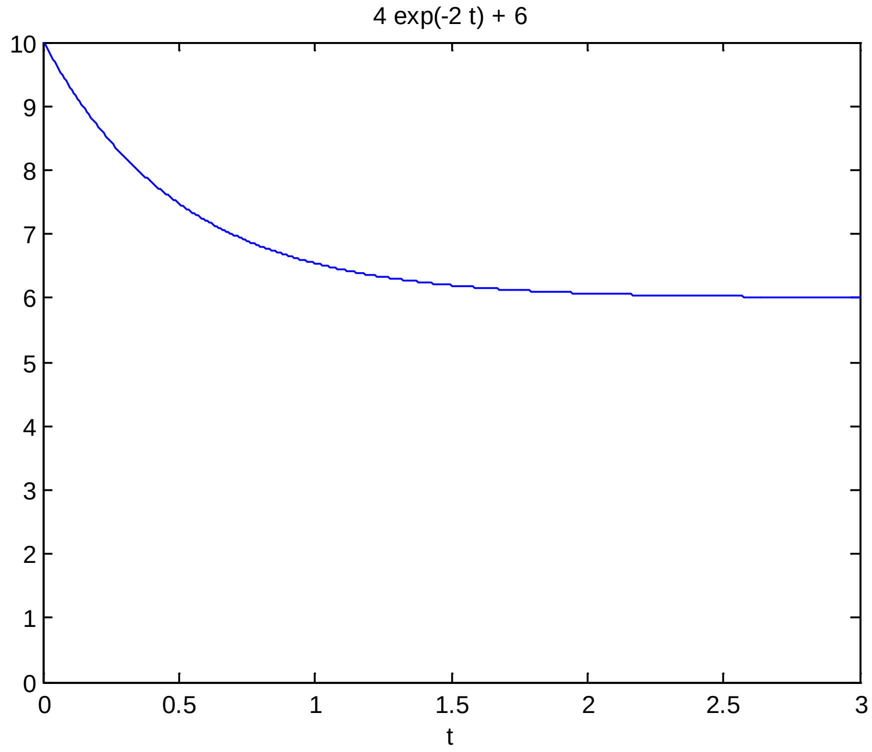
Plot symbolic expression, equation, or function.

ezplot(f,[min,max]) plots f over the specified range. If f is a univariate expression or function, then [min,max]specifies the range for that variable.

By default, ezplot plots a univariate expression or function over the range [–2π 2π].

>> axis([0 3 0 10])

Result



Example

$$\frac{dy}{dt} + 2y = 12\sin 4t \qquad y(0) = 10$$

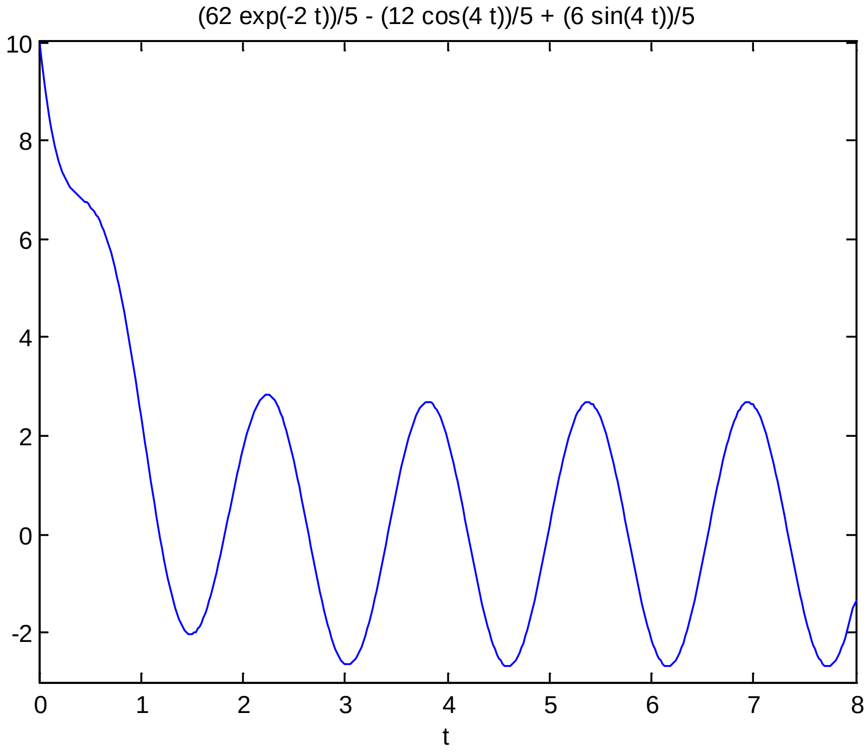
```
>> y = dsolve('Dy + 2*y = 12*sin(4*t)',
'y(0)=10')

y =(62*exp(-2*t))/5 - (12*cos(4*t))/5 + (6*sin(4*t))/5

>> ezplot(y, [0 8])

>> axis([0 8 -3 10])
```

Results



Example

$$\frac{d^2y}{dt^2} + 3\frac{dy}{dt} + 2y = 24$$

$$y(0) = 10 \qquad y'(0) = 0$$

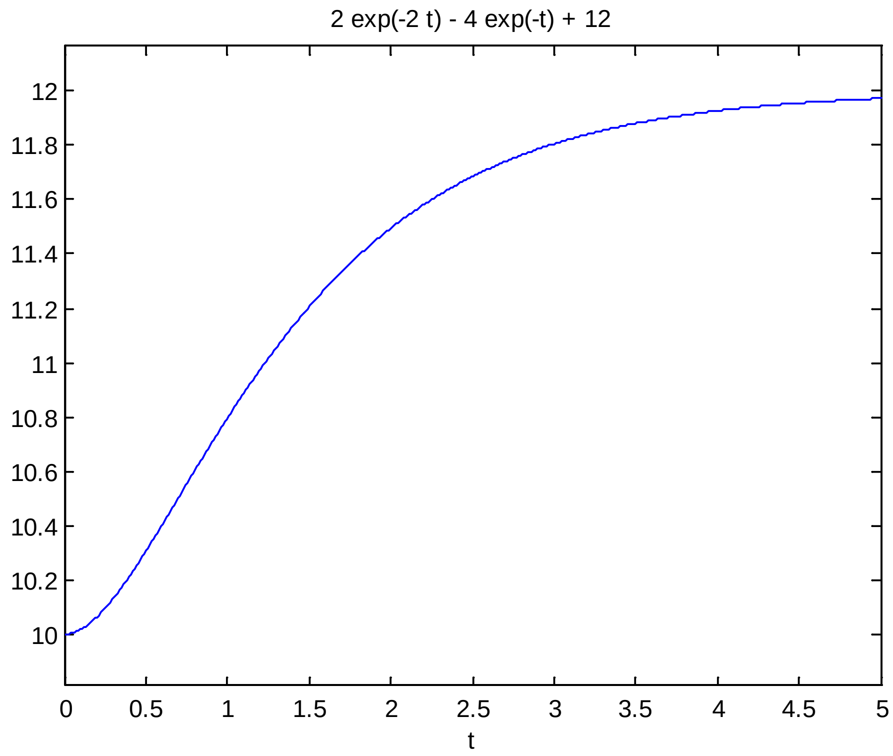
```
>> y = dsolve('D2y + 3*Dy + 2*y = 24', 'y(0)=10',  'Dy(0)=0')

y =

2*exp(-2*t) - 4*exp(-t) + 12

>> ezplot(y, [0 5])
```

Result


2 exp(-2 t) - 4 exp(-t) + 12
12
11.8
11.6
11.4
11.2
11
10.8
10.6
10.4
10.2
10
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
t

Example without initial condition

$$\frac{dy}{dt} + 2y = 12$$

```
>> y = dsolve('Dy + 2*y = 12')
```

- y = C14*exp(-2*t) + 6
- The resulting solutions contain arbitrary constants C1, C2,....

1st-Order Equations (ode45)

- MATLAB has several numerical procedures for computing the solutions of first-order equations and systems of the form y’ = f(t, y);
- Numerically approximate the solution of the first order differential equation.
- The first step is to enter the equation by creating an “M-file” which contains the definition of your equation and is given a name for reference, such as “diffeqn”
- The second step is to apply ode45 by using the syntax: [t, y] = ode45(‘diffeqn’, [t0,tf], y0)

1st-Order Equations (ode45)

- $y' = y^2 - t$, $y(0) = 0$, for $0 \le t \le 4$
- First create the M-file and enter the following text.
- function ypr=example1(t,y)
  ypr=y^2-t;
- Running ode45. Return to the Command Window, and enter the following:
- [t, y] = ode45(‘example1’, [0, 4], 0);

Result

You can plot the solution y(t) by typing plot(t,y)