ODE solvers

```
[T,Y] = solver(odefun,tspan,y0,options)

solvers: ode23, ode45, ode113, ode15s, ode23s, ode23t
odefun:  function_name.m
tspan:   time vector
y0:      initial conditions
options: relative tolerance, absolute tolerance;
```

Solver	Problem Type	Order of Accuracy	When to Use
ode45	**Nonstiff**	**Medium**	**Most of the time. This should be the first solver you try.**
ode23	Nonstiff	Low	For problems with crude error tolerances or for solving moderately stiff problems.
ode113	Nonstiff	Low to high	For problems with stringent error tolerances or for solving computationally intensive problems.
ode15s	Stiff	Low to medium	If ode45 is slow because the problem is stiff.
ode23s	Stiff	Low	If using crude error tolerances to solve stiff systems and the mass matrix is constant.
ode23t	Moderately Stiff	Low	For moderately stiff problems if you need a solution without numerical damping.
ode23tb	Stiff	Low	If using crude error tolerances to solve stiff systems.

ODE equation

$$y'(t) = \sin(t) - y(t);$$
$$y(0) = 1;$$

ode_eqs.m

```
function dy = ode_eqs(t,y);

dy = sin(t) – y;
```

main.m

```
t0 = 0;
tfin=15;

NSTEPS = 200;

for j=1:NSTEPS
   tspan(j)= t0 + (j-1)*(tfin-t0)/(NSTEPS-1);
end

options = odeset('RelTol',1e-5,'AbsTol',1e-7);
y0 = 1;


[t,y] = ode45(@ode_eqs,tspan,y0,options);

figure(1);
plot(t,y);
xlabel(’t’);
ylabel(’y’);
```

High order ODE

```
y''(t) = 2*pi^2*sin^2(t)*y(t)

y1 = y
y2 = y'
y1' = y2;
y2'(t) = 2*pi^2*sin^2(t)*y1;
```

oden_eqs.m

```
function dy = oden_eqs(t,y);

dy = ones(2,1);

dy(1) = y(2);
dy(2) = 2*pi^2*sin^2(t)*y(1);
```

main.m

```
t0 = 0;
tfin=20;

NSTEPS = 200;

y0 = 0;
y1 = 1;

for j=1:NSTEPS
   tspan(j)= t0 + (j-1)*(tfin-t0)/(NSTEPS-1);
end

options = odeset('RelTol',1e-5,'AbsTol',1e-7);

init = [y0,y1];

[t,y] = ode45(@oden_eqs,tspan,init,options);

A1 = y(:,1);
A2 = y(:,2);
```

```
figure(1);
plot(t,A1);
xlabel('t');
ylabel('y');
```

To do

1.) 4th order ODE

$5z'''' + 4z''' + 3z'' + 2z' + z = \sin(t)$

$z(0) = 0$
$z'(0) = 10$
$z''(0) = 20$
$z'''(0) = 30$

solve for: t=(0-100)

2.) 3rd order system

$x'(t) = 10(y-x)$
$y'(t) = x(28-z) - y$
$z'(t) = xy - 2.7*z$

initial conditions:
$x(0) = 0.1*rand;$
$y(0) = 0.1*rand;$
$z(0) = 0.1*rand;$

solve for: t=(0-50)

1) plot: x vs. y
x vs. z
y vs. z

2) plot: comet3