

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

$$\begin{aligned}y'(t) &= \sin(t) - y(t); \\ y(0) &= 1;\end{aligned}$$

ode_eqs.m

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

main.m

```
t0 = 0;  
tfinal=15;  
  
NSTEPS = 200;  
  
for j=1:NSTEPS  
    tspan(j)= t0 + (j-1)*(tfinal-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

$$y''(t) = -2\pi^2 \sin^2(t) y(t)$$

$$\begin{aligned} y_1 &= y \\ y_2 &= y' \end{aligned}$$

$$\begin{aligned} y_1' &= y_2; \\ y_2'(t) &= -2\pi^2 \sin^2(t) y_1; \end{aligned}$$

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;  
  
Y1 = 0;  
Y2 = 1;  
  
for j=1:NSTEPS  
    tspan(j)= t0 + (j-1)*(tfinal-t0)/(NSTEPS-1);  
end  
  
options = odeset('RelTol',1e-5, 'AbsTol',1e-7);  
  
init = [y1,y2];  
  
[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.) ლორენცის ატრაქტორი

$$x'(t) = 10(y-x)$$

$$y'(t) = x(28-z) - y$$

$$z'(t) = xy - 2.7z$$

initial conditions:

$$x(0) = 0.1 \cdot \text{rand};$$

$$y(0) = 0.1 \cdot \text{rand};$$

$$z(0) = 0.1 \cdot \text{rand};$$

solve for: $t=(0-100)$