```
>> cd  c:\
```

$v0 := 40$

```
>> global v0
>> v0 = 40
```

[File] [New] [M-File]

```
function yp = yprime(t)
global v0

yp = v0 - 9.8*t;
```

[File] [Save] yprime.m

$y'(t) := v0 - \frac{98}{10} \cdot t$

$y'(0) = 40$

```
>> yprime(0)
```

$y0 := 0$

```
>> global y0
>> y0 = 0
```

[File] [New] [M-File]

```
function yval = y(t)
global y0

for i=1:length(t)

  yval(i) = y0 + ...
            quad8('yprime',0,t(i));
end
```

[File] [Save] y.m

$y(t) := y0 + \int_0^t y'(t)\, dt$

$y(1) = 35.1$

```
>>  y(1)
```

$t := 0, 0.1 .. 10$

```
>> t = [0 : 0.1 : 10];
```


```
>> plot(t, y(t), 'r-')

>> hold on
>> plot(t, yprime(t), 'k-')
>> hold off
```

$t := 10$ <-- Initial guess for t

```
>> t = 10;
```

Given

$y(t) = 0$

$t := \mathit{Find}(t)$

```
>> t = fzero('y', t)
```

$t = 8.163$

$y(t) = 5.354 \cdot 10^{-5}$

```
>> y(t)
```

$$newt(f, f', t, tol) := \left| \begin{array}{l} \textbf{while } |f(t)| > tol \\ \quad t \leftarrow t - \dfrac{f(t)}{f'(t)} \\ t \end{array} \right.$$

[File] [New] [M-File]

```
function root = ...
  newt(f,fprime,t, tol)

  while abs( feval(f,t) ) > tol

    t = t - feval(f,t) / ...
            feval(fprime,t);
  end

  root = t;
```

[File] [Save] newt.m

$t := 10$

$t := newt\left(y, y', t, 10^{-5}\right)$

```
>> t = 10;

>> t = newt('y','yprime',t,1e-5)
```

$t = 8.163$

$y(t) = -5.479 \cdot 10^{-10}$

```
>> y(t)
```

$$y(t) := y0 + \int_0^t y'(t)\, dt \rightarrow 40 \cdot t - \frac{49}{10} \cdot t^2$$

$$y(1) \rightarrow \frac{351}{10}$$

$y(1) = 35.1$

Symbolic solutions in Mathcad and MATLAB via built-in Maple kernel

Given

$y(t) = 0$

$$t := Find(t) \rightarrow \begin{bmatrix} 0 & \frac{400}{49} \end{bmatrix}$$

$$t^T = \begin{bmatrix} 0 \\ 8.163 \end{bmatrix}$$

$$y'(t, y) := v0 - \frac{98}{10} \cdot t$$

[File] [New] [M-File]

```
function yp = yprime2(t,y)
global v0

yp = v0 - 9.8*t;
```

[File] [Save] yprime2.m

Reference:D:\DATA\mathcad\saw\system.mcd(R)

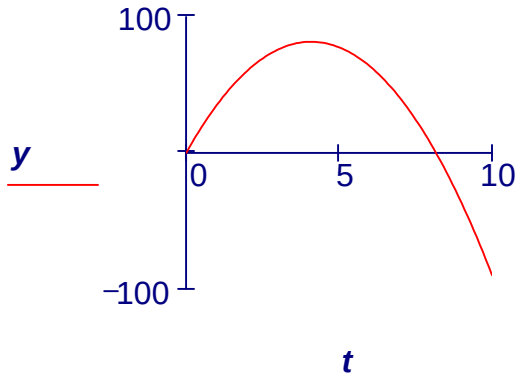
$t := range(0, 0.1, 10)$

```
>> t = [0 : 0.1 : 10];
```

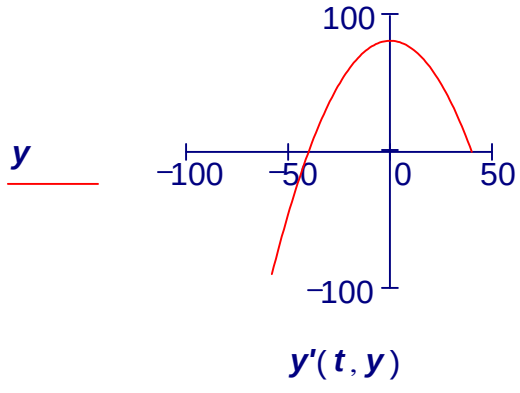
$D(t, y) := system(t, y, y', 1)$

$y := solution(t, y0, D, 1)$

```
>> [t,y] = ode45('yprime2',t,y0);
```




```
>> subplot(2,1,1)
>> plot(t, y, 'r-')
```




```
>> subplot(2,1,2)
>> plot(yprime2(t,y), y, 'r-')
```

$$\mathbf{euler}(t0, y0, f', tend, n) := \left| \begin{array}{l} Dt \leftarrow \dfrac{tend - t0}{n - 1} \\ t_1 \leftarrow t0 \\ y_1 \leftarrow y0 \\ \textbf{for } i \in 2..n \\ \quad \left| \begin{array}{l} t_i \leftarrow t_{i-1} + Dt \\ y_i \leftarrow y_{i-1} + Dt \cdot f'(t_{i-1}, y_{i-1}) \end{array} \right. \\ \begin{bmatrix} t \\ y \end{bmatrix} \end{array} \right.$$

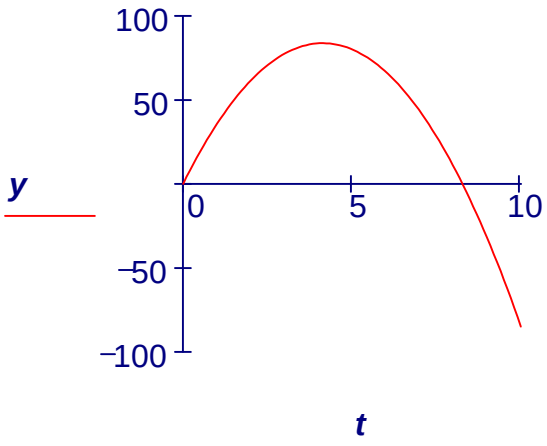
[File] [New] [M-File]

```
function [t,y] = ...
  euler(t0,y0,fprime,tend,n)

delta_t = (tend - t0)/(n - 1);

t(1) = t0;
y(1) = y0;

for i=2:n
  t(i) = t(i-1) + delta_t;
  y(i) = y(i-1) + delta_t * ...
            feval(fprime,t(i-1),y(i-1));
end
```

[File] [Save] euler.m

$$\begin{bmatrix} t \\ y \end{bmatrix} := \mathbf{euler}(0, y0, y', 10, 100)$$

```
[t,y] = ...
  euler(0,y0,'yprime2',10,100);
```




```
>> plot(t, y, 'r-')
```

$$t := \begin{bmatrix} 0 \\ 1 \\ 2 \\ 3 \\ 4 \end{bmatrix} \qquad v := \begin{bmatrix} 40 \\ 30 \\ 20 \\ 10 \\ 0 \end{bmatrix}$$

```
>> t = [0 1 2 3 4]';

>> v = [40 30 20 10 0]';
```

$a := slope(t, v)$ $\quad a = -10$

$b := intercept(t, v)$ $\quad b = 40$

```
>> ba = polyfit(t,v,1)

>> b = ba(1);
>> a = ba(2);
```

$ORIGIN := 1$

$M^{\langle 1 \rangle} := t^0 \qquad M^{\langle 2 \rangle} := t^1$

$$M = \begin{bmatrix} 1 & 0 \\ 1 & 1 \\ 1 & 2 \\ 1 & 3 \\ 1 & 4 \end{bmatrix}$$

$$\begin{bmatrix} b \\ a \end{bmatrix} := \left(M^T \cdot M\right)^{-1} \cdot M^T \cdot v$$

$a = -10 \qquad b = 40$

```
>> M = [t.^0  t.^1]

>> ba = inv(M'*M)*(M'*v)

>> b = ba(1);
>> a = ba(2);
```