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> # Prof. Dr. Serkan Dağ
> # ME 310 Numerical Methods
> # File 13.1
> # Euler's Method
> # Solves the first-order ODE  $dy/dt = f(t,y)$ 
> # Applicable for both linear and nonlinear ODE's
> # Interval of interest is  $[a,b]$ 
> #  $n$  is the number of segments
> #  $y_0$  is the initial condition

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> restart :
> Digits := 16 :

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> # Open the output file

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> #out:= fopen("E:\\Courses\\2019_Spring\\ME310\\Files\\result4.txt", 'WRITE', 'TEXT') :

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> # Define the right-hand-side function

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> f := (1 + 4·t)·sqrt(y);

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$$f := (1 + 4 t) \sqrt{y}$$

(1)

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> # Interval end points

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> a := 0. :

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> b := 1. :

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> # Number of segments

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> n := 8 :

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> # Initial condition

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> y0 := 1 :

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> # Step size

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> h :=  $\frac{(b-a)}{n}$ ;

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$$h := 0.12500000000000000$$

(2)

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> # Analytical solution

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> ytrue :=  $\frac{(2 \cdot t^2 + t + 2)^2}{4}$ ;

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$$ytrue := \frac{1}{4} (2 t^2 + t + 2)^2$$

(3)

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> # Initiate the integration

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> t0 := a :

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> for i from 1 by 1 to n
>   while true do

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    if i = 1 then

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      printf("\n %4.1f %10.6f %10.6f %10.6f", i - 1, y0, y0, t0) :

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      #ffprintf(out, "\n %5.1f %15.10f %15.10f %10.6f", i - 1, y0, y0, t0) :

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```

    end if:

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    yeuler := y0 + subs( {t=t0, y=y0}, f) · h :

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    tn := t0 + h :

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    ytruen := subs(t=tn, ytrue) :

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    ytrueo := subs(t=t0, ytrue) :

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ylocal := ytrueo + subs( {t=t0,y=y0},f) · h :
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gloerror :=  $\frac{(\textit{ytruen} - \textit{yeuler})}{\textit{ytruen}} \cdot 100$  :
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```
locerror :=  $\frac{(\textit{ytruen} - \textit{ylocal})}{\textit{ytruen}} \cdot 100$  :
```

```
printf("n %4.1f %10.6f %10.6f %10.6f %4.1f %4.1f", i, ytruen, yeuler, tn, gloerror,  
      locerror) :
```

```
#fprintf(out, "n %5.1f %15.10f %15.10f %8.6f %8.1f %8.1f", i, ytruen, yeuler, tn, gloerror,  
      locerror) :
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t0 := tn :
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y0 := yeuler :
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end do:
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0.0	1.000000	1.000000	0.000000		
1.0	1.162354	1.125000	0.125000	3.2	3.2
2.0	1.410156	1.323874	0.250000	6.1	3.5
3.0	1.763916	1.611523	0.375000	8.6	3.7
4.0	2.250000	2.008229	0.500000	10.7	4.0
5.0	2.900635	2.539649	0.625000	12.4	4.1
6.0	3.753906	3.236861	0.750000	13.8	4.2
7.0	4.853760	4.136424	0.875000	14.8	4.1
8.0	6.250000	5.280448	1.000000	15.5	4.0

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=> #fclose(out) :
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=>
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