Solve a DAE using non stabilized numerical schemes

```
> restart:
```

The DAE

```
> EQ1 := x(t)-sin(t) ;
  EQ2 := diff(x(t),t)+y(t) ;
```

$$EQ1 := x(t) - \sin(t)$$

$$EQ2 := \frac{d}{dt} x(t) + y(t) \quad (1)$$

Reduce the index

```
> DEQ1 := diff(EQ1,t) ;
```

$$DEQ1 := \frac{d}{dt} x(t) - \cos(t) \quad (2)$$

```
> subs(solve(DEQ1,{diff(x(t),t)}),EQ2) ;
  DEQ2 := diff(%,t) ;
```

$$\cos(t) + y(t)$$

$$DEQ2 := -\sin(t) + \frac{d}{dt} y(t) \quad (3)$$

Approximate solution of the ODE by using Explicit Euler

```
> ODE := {DEQ1,DEQ2} ;
```

$$ODE := \left\{ \frac{d}{dt} x(t) - \cos(t), -\sin(t) + \frac{d}{dt} y(t) \right\} \quad (1.1)$$

```
> SUBS := diff(x(t), t) = (x[k+1]-x[k])/h,
          diff(y(t), t) = (y[k+1]-y[k])/h,
          cos(t) = cos(k*h),
          sin(t) = sin(k*h);
```

$$SUBS := \frac{d}{dt} x(t) = \frac{x_{k+1} - x_k}{h}, \frac{d}{dt} y(t) = \frac{y_{k+1} - y_k}{h}, \cos(t) = \cos(k\,h), \sin(t) = \sin(k\,h) \quad (1.2)$$

```
> ExplicitEuler := subs(SUBS,ODE) ;
```

$$ExplicitEuler := \left\{ \frac{x_{k+1} - x_k}{h} - \cos(k\,h), -\sin(k\,h) + \frac{y_{k+1} - y_k}{h} \right\} \quad (1.3)$$

```
> ExplicitEulerAdvance := solve( ExplicitEuler, {x[k+1],y[k+1]} ) ;
```

$$ExplicitEulerAdvance := \left\{ x_{k+1} = x_k + \cos(k\,h)\,h, y_{k+1} = \sin(k\,h)\,h + y_k \right\} \quad (1.4)$$

```
> T := 10.5*Pi ;
  N := 500 ;
  h := T/N ;
```

$$T := 10.5\,\pi$$

$$N := 500$$

$$h := 0.02100000000\,\pi \quad (1.5)$$

```
> X := [0.1] ;
  Y := [1] ;
  for k from 1 to N do
    SOLSTEP := subs(x[k]=X[-1],y[k]=Y[-1],ExplicitEulerAdvance):
    X := [op(X),evalf(subs( SOLSTEP, x[k+1] ))] ;
    Y := [op(Y),evalf(subs( SOLSTEP, y[k+1] ))] ;
  end:
```

$$X := [0.1]$$

$$Y := [1] \quad \textbf{(1.6)}$$

```
> plot( [seq([X[k],Y[k]],k=1..N)]);
```