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18-660 HW1

1. $\dot{x} = -x \qquad x(t=0) = 1$

$$\frac{x(t_{n+1}) - x(t_n)}{\Delta t} \approx -x$$

$$\frac{x(t_{n+1}) - x(t_n)}{\Delta t} = -x(t_{n+1})$$

$$n=0 \Rightarrow \frac{x(t_1) - x(t_0)}{\Delta t} = -x(t_1)$$

$$\Rightarrow \frac{x(t_1) - 1}{\Delta t} = -x(t_1) \Rightarrow x(t_1) + \Delta t(x(t_1)) = 1$$

$$\Rightarrow x(t_1) = \frac{1}{1+\Delta t}$$

$$n=1 \Rightarrow \frac{x(t_2) - x(t_1)}{\Delta t} = -x(t_2)$$

$$\frac{x(t_2) - \frac{1}{1+\Delta t}}{\Delta t} = -x(t_2) \Rightarrow x(t_2) - \frac{1}{1+\Delta t} = -\Delta t(x(t_2))$$

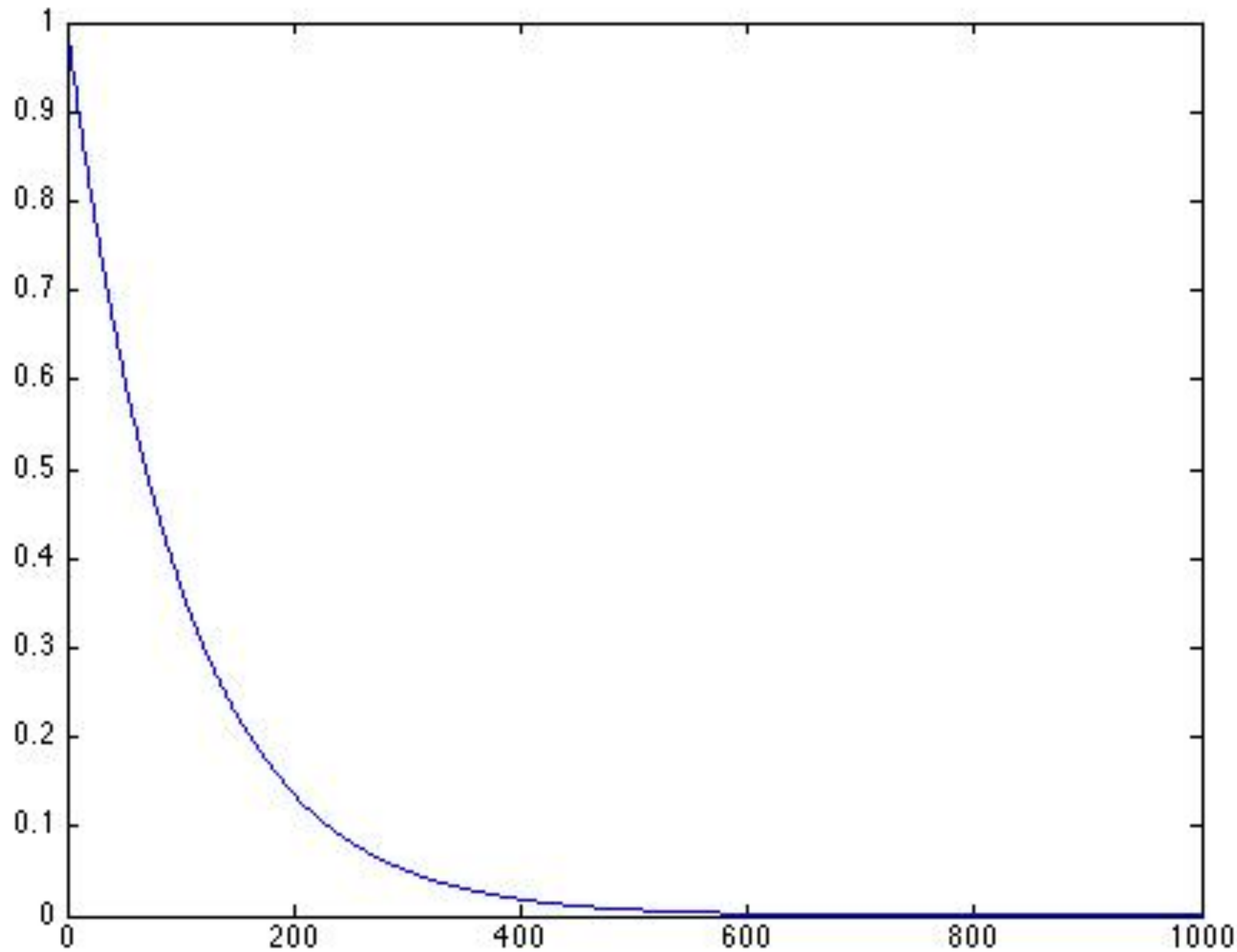
$$x(t_2) + \Delta t\, x(t_2) = \frac{1}{1+\Delta t}$$

$$x(t_2) = \frac{1}{(1+\Delta t)^2}$$

$$x(t_n) = \frac{1}{(1+\Delta t)^n}$$

```
function [ xtn ] = backwardEuler(deltaT, n )
    xtn = 1./(1 + deltaT).^n;
end
```

```
>> y = backwardEuler(0.01, 0:1000);
>> plot(0:1000, y);
```


1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
200
400
600
800
1000