1)

```
> restart:

eq1:=diff(u(x,t),t)=diff(diff(u(x,t),x),x);
```

$$eq1 := \frac{\partial}{\partial t}\,u(x,t) = \frac{\partial^2}{\partial x^2}\,u(x,t)$$

```
> N:=20;
y:=(2*n-1)/2*Pi;
An:=int((1-Ceq)*cos(y*x),x=0..1)/int(cos(y*x)^2,x=0..1);
C:=Ceq+sum(An*cos(y*x)*exp(-y^2*t),n=1..N):
dC:=diff(C,x):
```

$$N := 20$$

$$y := \frac{(2\,n-1)\,\pi}{2}$$

$$An := \frac{4\cos(\pi\,n)\,(-1+Ceq)}{2\,\pi\,n - 2\sin(\pi\,n)\cos(\pi\,n) - \pi}$$

```
>
```

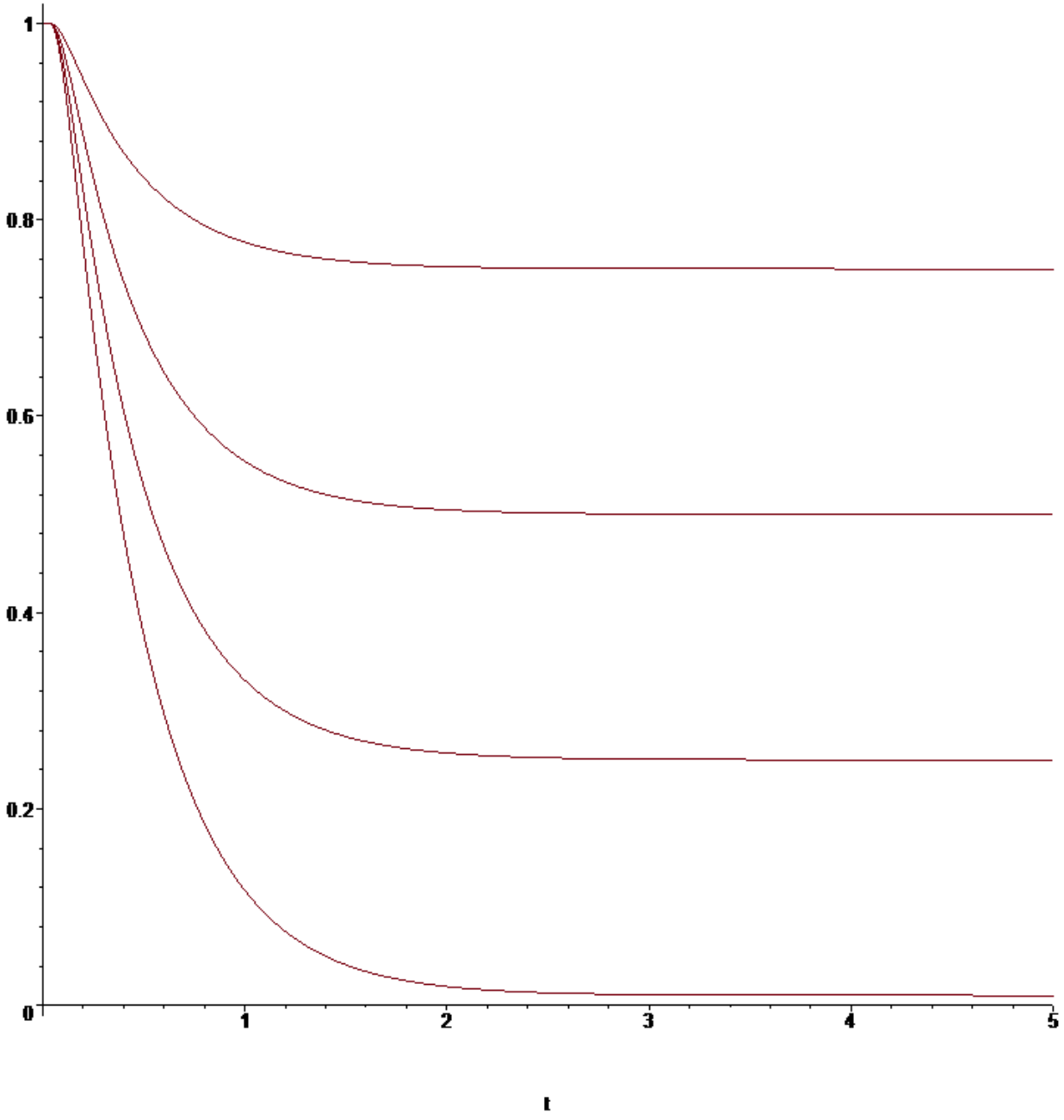
```
> Pi;
```

$$\pi$$

```
> c_1:=subs(x=0.,C):
> ##################### varying Cea vs concentration
################
with(plots):

> p1:=plot(subs(Ceq=0.01,c_1),t=0..5):
p2:=plot(subs(Ceq=0.25,c_1),t=0..5):
p3:=plot(subs(Ceq=0.50,c_1),t=0..5):
p4:=plot(subs(Ceq=0.75,c_1),t=0..5):

display(p1,p2,p3,p4);
```




```
>
> ############### long times, varying Ceq ###############
with(plots):
m:=1;F:=96485;D1:=1e-12;L:=100e-6;ci:=1000;
ibatt:=subs(x=1,-m*F*D1*ci/L*dC):
p11:=plot(subs([Ceq=0.01,t=D1/L^2*T],ibatt),T=0..500):
p12:=plot(subs([Ceq=0.25,t=D1/L^2*T],ibatt),T=0..500):
p13:=plot(subs([Ceq=0.50,t=D1/L^2*T],ibatt),T=0..500):
p14:=plot(subs([Ceq=0.75,t=D1/L^2*T],ibatt),T=0..500):
display(p11,p12,p13,p14);
```

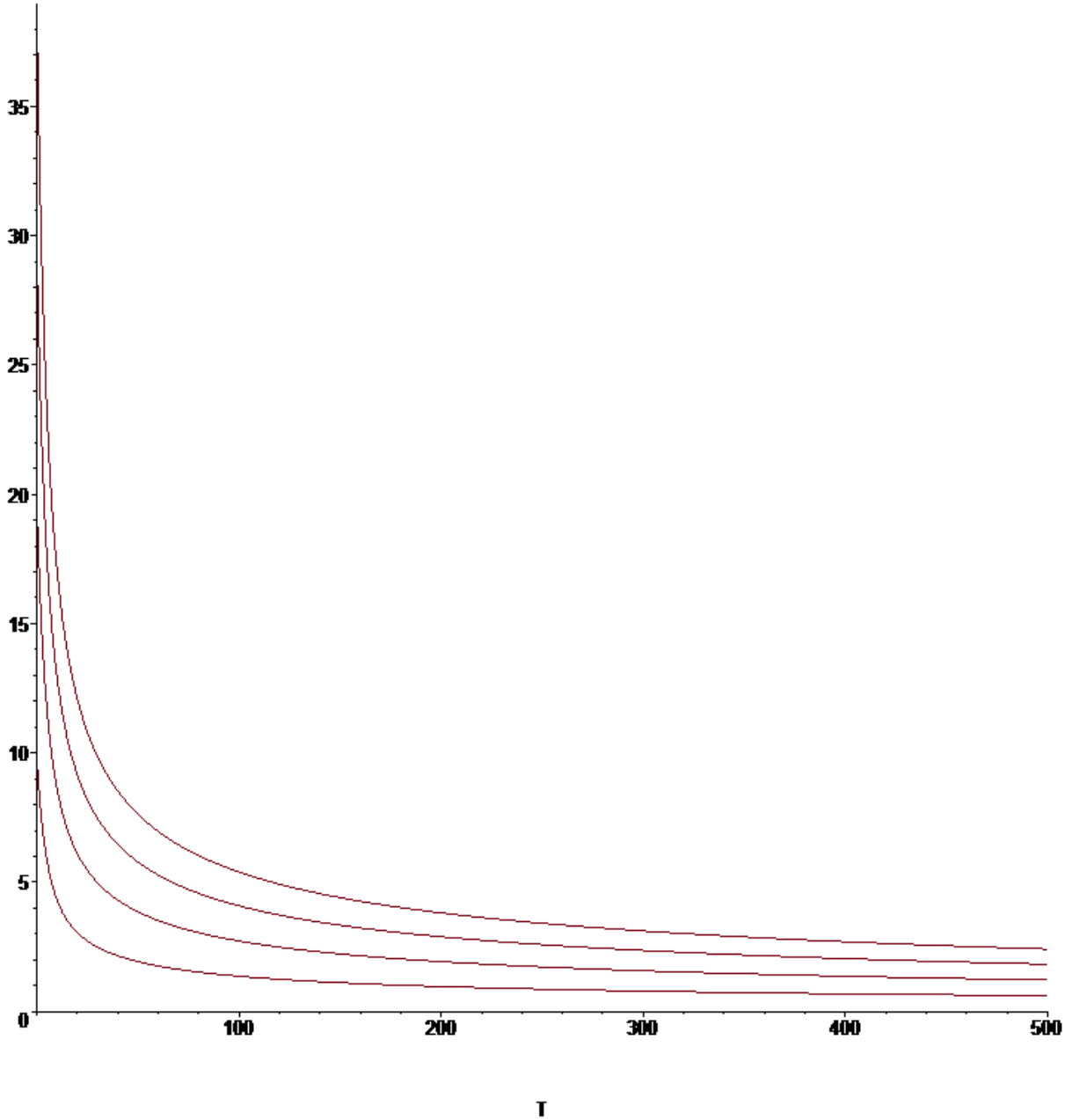
$$m := 1$$

$F := 96485$

$D1 := 0.1\ 10^{-11}$

$L := 0.000100$

$ci := 1000$




```
> ############## long times, varying L ##############
with(plots):
m:=1;F:=96485;D1:=1e-12;L:=100e-6;ci:=1000;
ibatt:=subs(x=1,-m*F*D1*ci/L*dC):
p21:=plot(subs([Ceq=0.25,t=D1/L^2*T],ibatt),T=0..700):
L:=50e-6;ibatt:=subs(x=1,-m*F*D1*ci/L*dC):
```

```
p22:=plot(subs([Ceq=0.25,t=D1/L^2*T],ibatt),T=0..700):
L:=25e-6;ibatt:=subs(x=1,-m*F*D1*ci/L*dC):
p23:=plot(subs([Ceq=0.25,t=D1/L^2*T],ibatt),T=0..700):
L:=10e-6;ibatt:=subs(x=1,-m*F*D1*ci/L*dC):
p24:=plot(subs([Ceq=0.25,t=D1/L^2*T],ibatt),T=0..700):
display(p21,p22,p23,p24);
```

$$m := 1$$

$$F := 96485$$

$$D1 := 0.1\ 10^{-11}$$

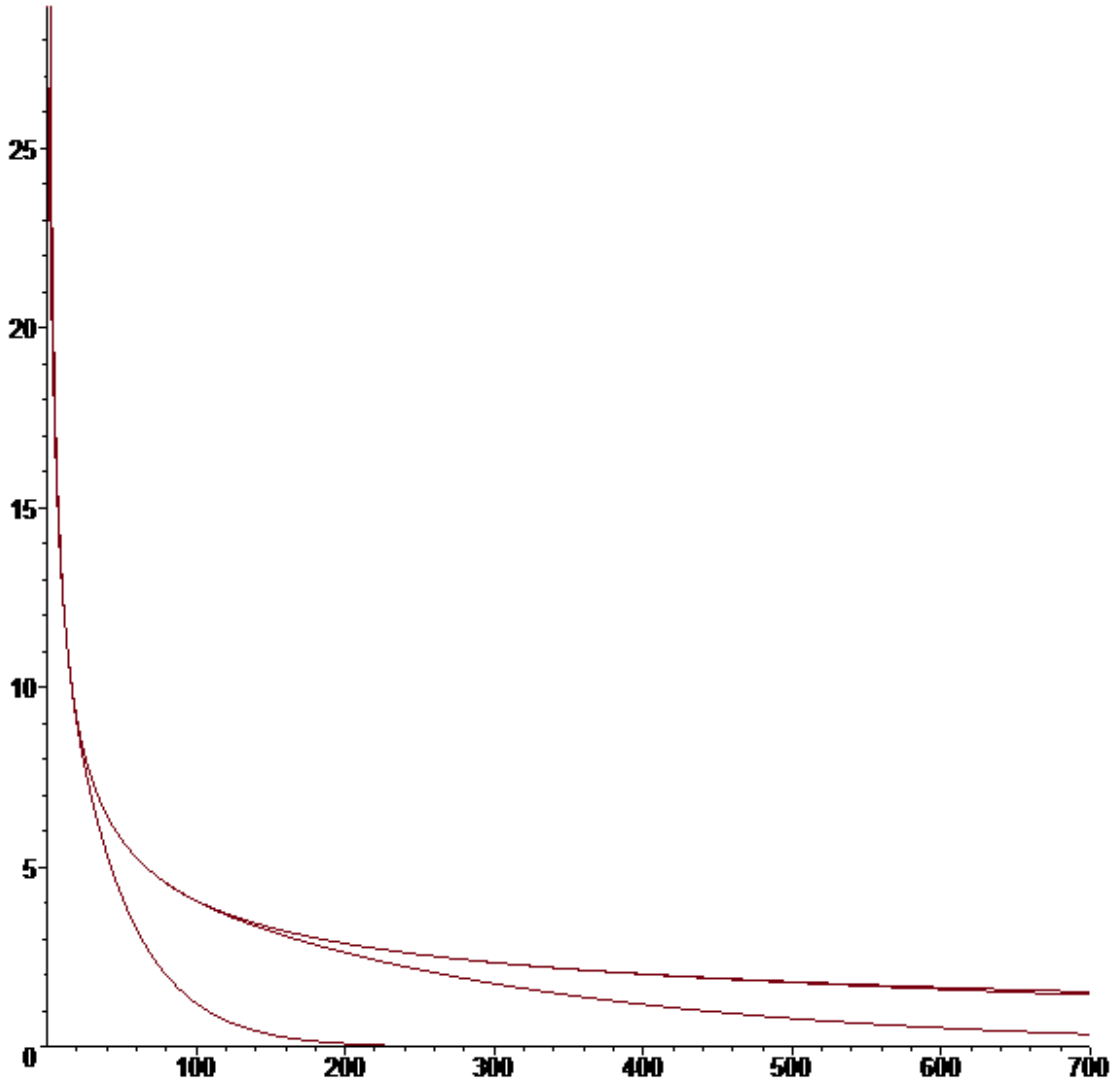
$$L := 0.000100$$

$$ci := 1000$$

$$L := 0.000050$$

$$L := 0.000025$$

$$L := 0.000010$$




```
> ###################### varying L, short times ################
with(plots):
m:=1;F:=96485;D1:=1e-12;L:=100e-6;ci:=1000;
ibatt:=subs(x=1,-m*F*D1*ci/L*dC):
p21:=plot(subs([Ceq=0.5,t=D1/L^2*T],ibatt),T=0..0.01):
L:=50e-6;ibatt:=subs(x=1,-m*F*D1*ci/L*dC):
p22:=plot(subs([Ceq=0.5,t=D1/L^2*T],ibatt),T=0..0.01):
L:=25e-6;ibatt:=subs(x=1,-m*F*D1*ci/L*dC):
p23:=plot(subs([Ceq=0.5,t=D1/L^2*T],ibatt),T=0..0.01):
L:=10e-6;ibatt:=subs(x=1,-m*F*D1*ci/L*dC):
p24:=plot(subs([Ceq=0.5,t=D1/L^2*T],ibatt),T=0..0.01):
display(p21,p22,p23,p24);
```

$$m := 1$$

$$F := 96485$$

$$D1 := 0.1\ 10^{-11}$$

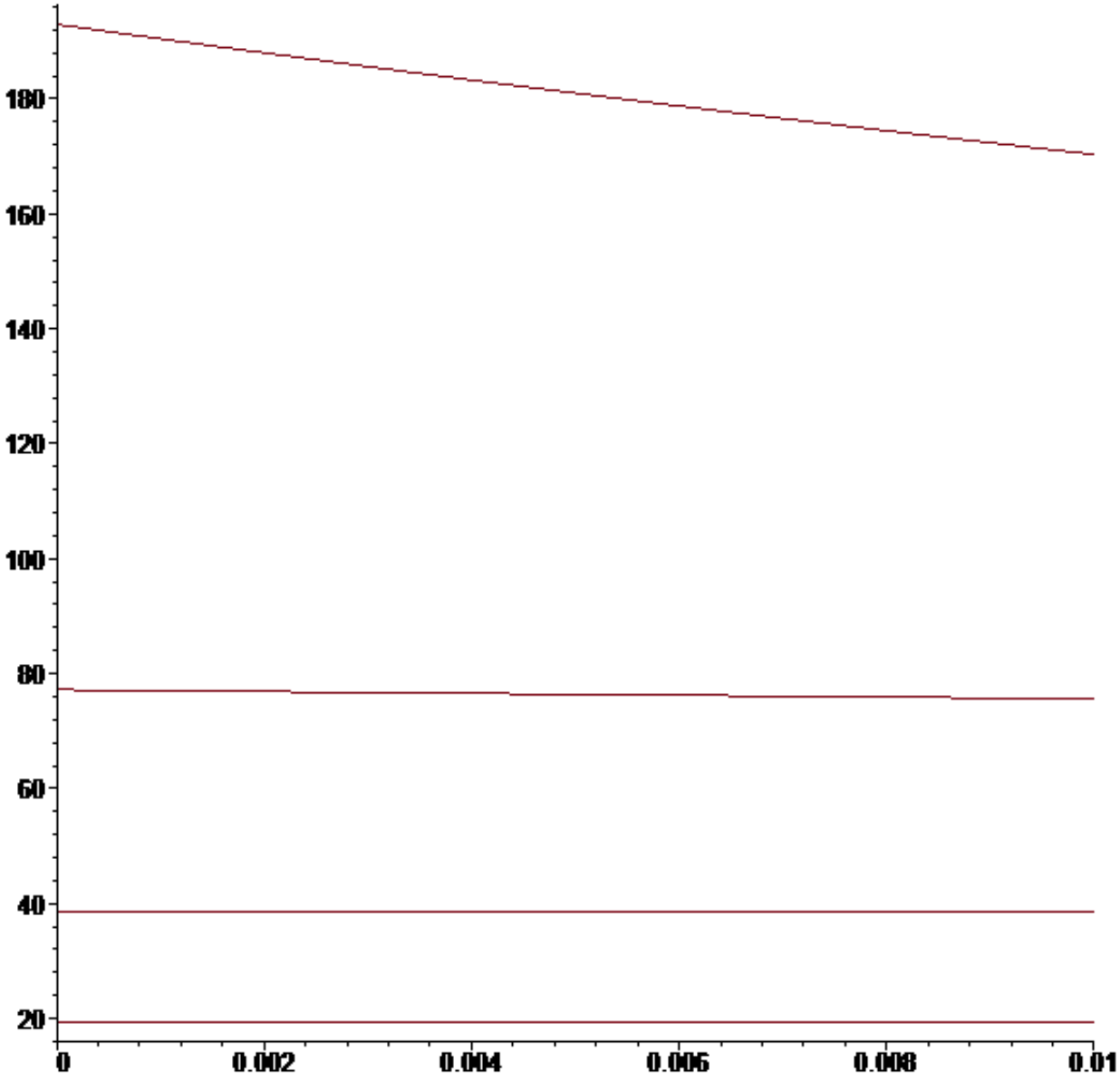
$$L := 0.000100$$

$$ci := 1000$$

$$L := 0.000050$$

$$L := 0.000025$$

$$L := 0.000010$$




```
> ###################### varying D, long time ################
with(plots):
```

```
m:=1;F:=96485;D1:=1e-12;L:=100e-6;ci:=1000;
ibatt:=subs(x=1,-m*F*D1*ci/L*dC):
p41:=plot(subs([Ceq=0.5,t=D1/L^2*T],ibatt),T=0..700):
D1:=1e-11;ibatt:=subs(x=1,-m*F*D1*ci/L*dC):
p42:=plot(subs([Ceq=0.5,t=D1/L^2*T],ibatt),T=0..700):
D1:=1e-13;ibatt:=subs(x=1,-m*F*D1*ci/L*dC):
p43:=plot(subs([Ceq=0.5,t=D1/L^2*T],ibatt),T=0..700):
D1:=1e-14;ibatt:=subs(x=1,-m*F*D1*ci/L*dC):
p44:=plot(subs([Ceq=0.5,t=D1/L^2*T],ibatt),T=0..700):
display(p41,p42,p43,p44);
```

$$m := 1$$

$$F := 96485$$

$$D1 := 0.1\ 10^{-11}$$

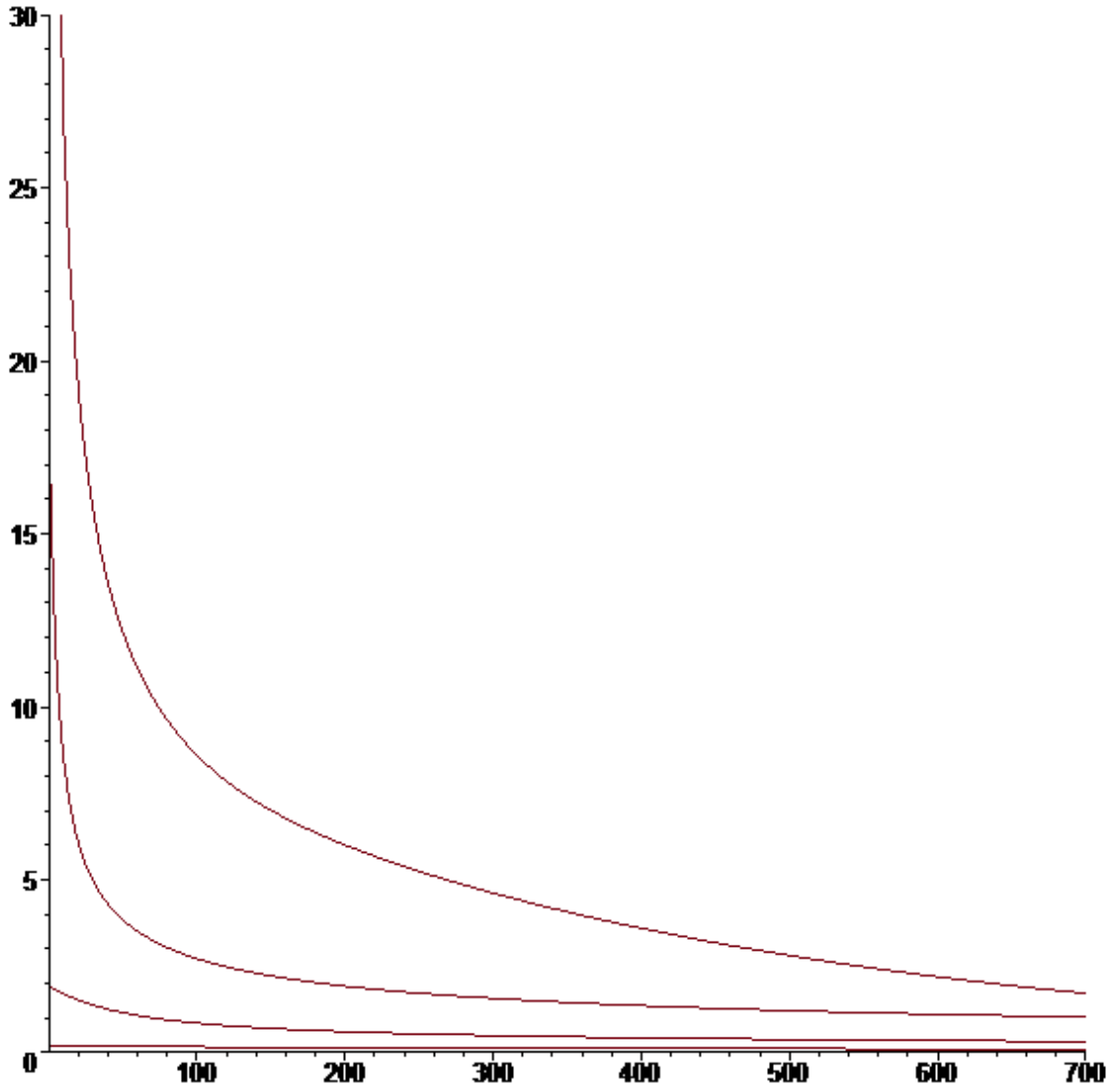
$$L := 0.000100$$

$$ci := 1000$$

$$D1 := 0.1\ 10^{-10}$$

$$D1 := 0.1\ 10^{-12}$$

$$D1 := 0.1\ 10^{-13}$$




```
> ###################### varying ci, long time ################
with(plots):
m:=1;F:=96485;D1:=1e-12;L:=100e-6;ci:=1000;
ibatt:=subs(x=1,-m*F*D1*ci/L*dC):
p41:=plot(subs([Ceq=0.5,t=D1/L^2*T],ibatt),T=0..700):
ci:=2000;ibatt:=subs(x=1,-m*F*D1*ci/L*dC):
p42:=plot(subs([Ceq=0.5,t=D1/L^2*T],ibatt),T=0..700):
ci:=500;ibatt:=subs(x=1,-m*F*D1*ci/L*dC):
p43:=plot(subs([Ceq=0.5,t=D1/L^2*T],ibatt),T=0..700):
ci:=250;ibatt:=subs(x=1,-m*F*D1*ci/L*dC):
p44:=plot(subs([Ceq=0.5,t=D1/L^2*T],ibatt),T=0..700):
display(p41,p42,p43,p44);
```

$$m := 1$$

$$F := 96485$$

$$D1 := 0.1\ 10^{-11}$$

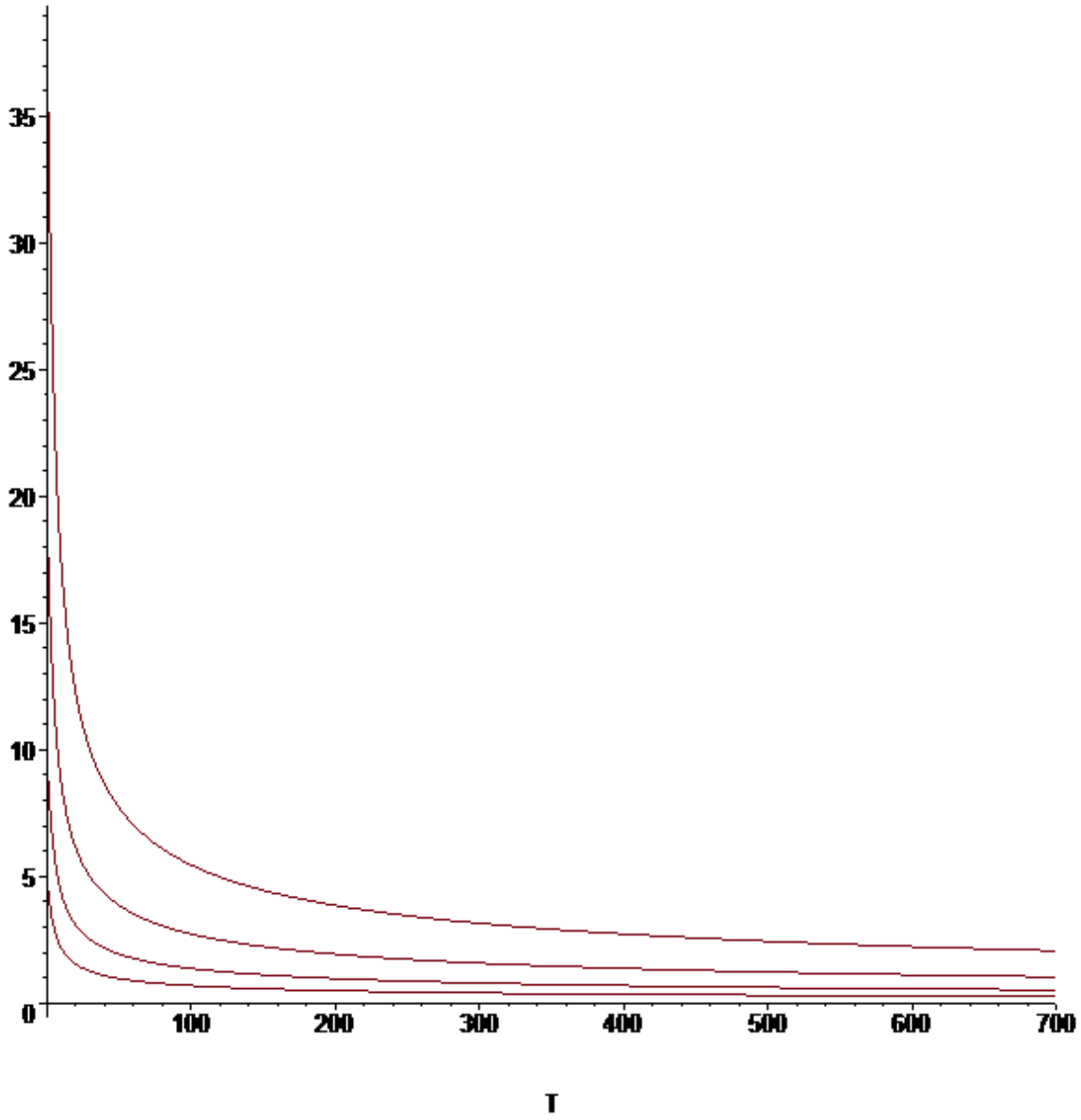
$$L := 0.000100$$

$$ci := 1000$$

$$ci := 2000$$

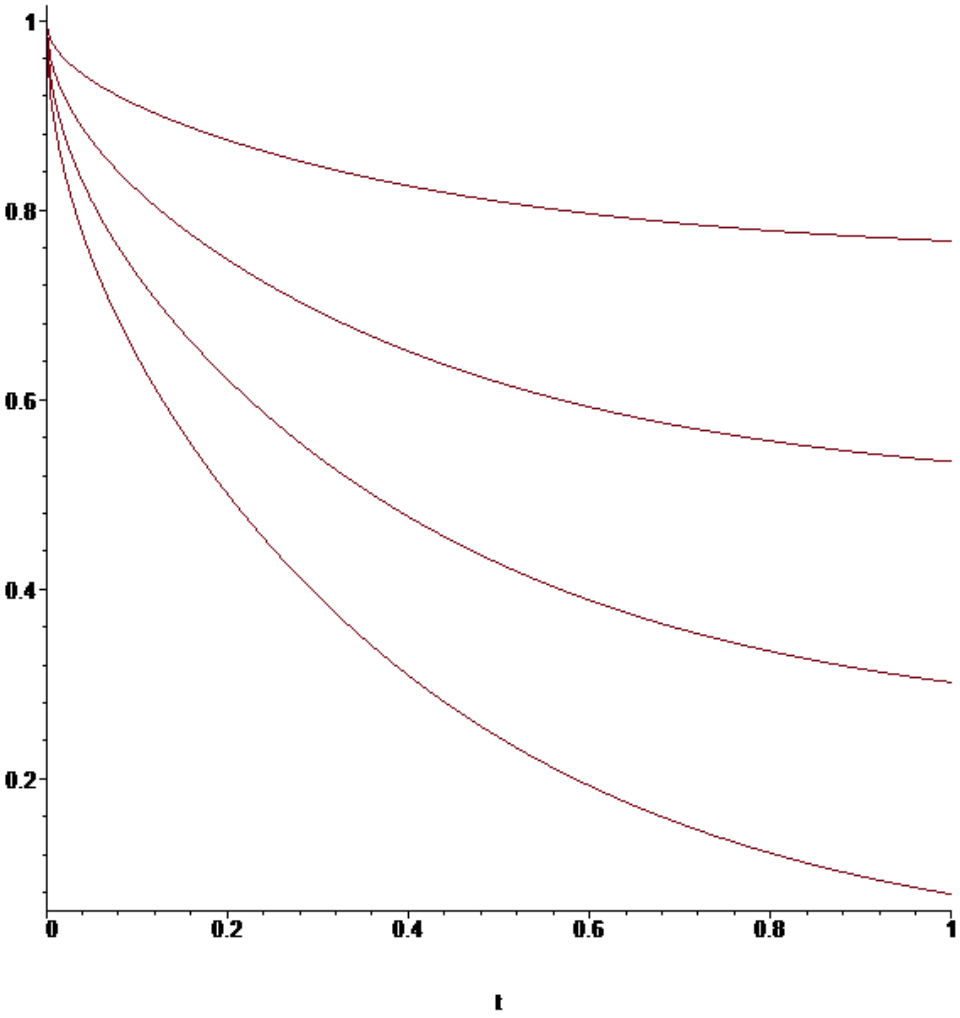
$$ci := 500$$

$$ci := 250$$




```
> SOC:=int(C,x=0..1):
p1:=plot(subs(Ceq=0.01,SOC),t=0..1):
p2:=plot(subs(Ceq=0.25,SOC),t=0..1):
p3:=plot(subs(Ceq=0.50,SOC),t=0..1):
p4:=plot(subs(Ceq=0.75,SOC),t=0..1):
```

```
display(p1,p2,p3,p4);
```




```
>
> restart:
################ P2 ##################
eq1:=diff(u(x,t),t)=diff(diff(u(x,t),x),x);
```

$$eq1 := \frac{\partial}{\partial t}\,\mathrm{u}(x,t) = \frac{\partial^2}{\partial x^2}\,\mathrm{u}(x,t)$$

```
> N:=20;
y:=(2*n-1)*Pi/2;
An:=int((0-Ceq)*cos(y*X),X=0..1)/int((cos(y*X))^2,X=0..1);
C:=Ceq+sum(An*cos(y*x)*exp(-y^2*t),n=1..N):
dC:=diff(C,x):
```

$$N := 20$$

$$y := \frac{(2\,n-1)\,\pi}{2}$$

$$An := \frac{4\,Ceq\cos(\pi\,n)}{2\,\pi\,n - 2\sin(\pi\,n)\cos(\pi\,n) - \pi}$$

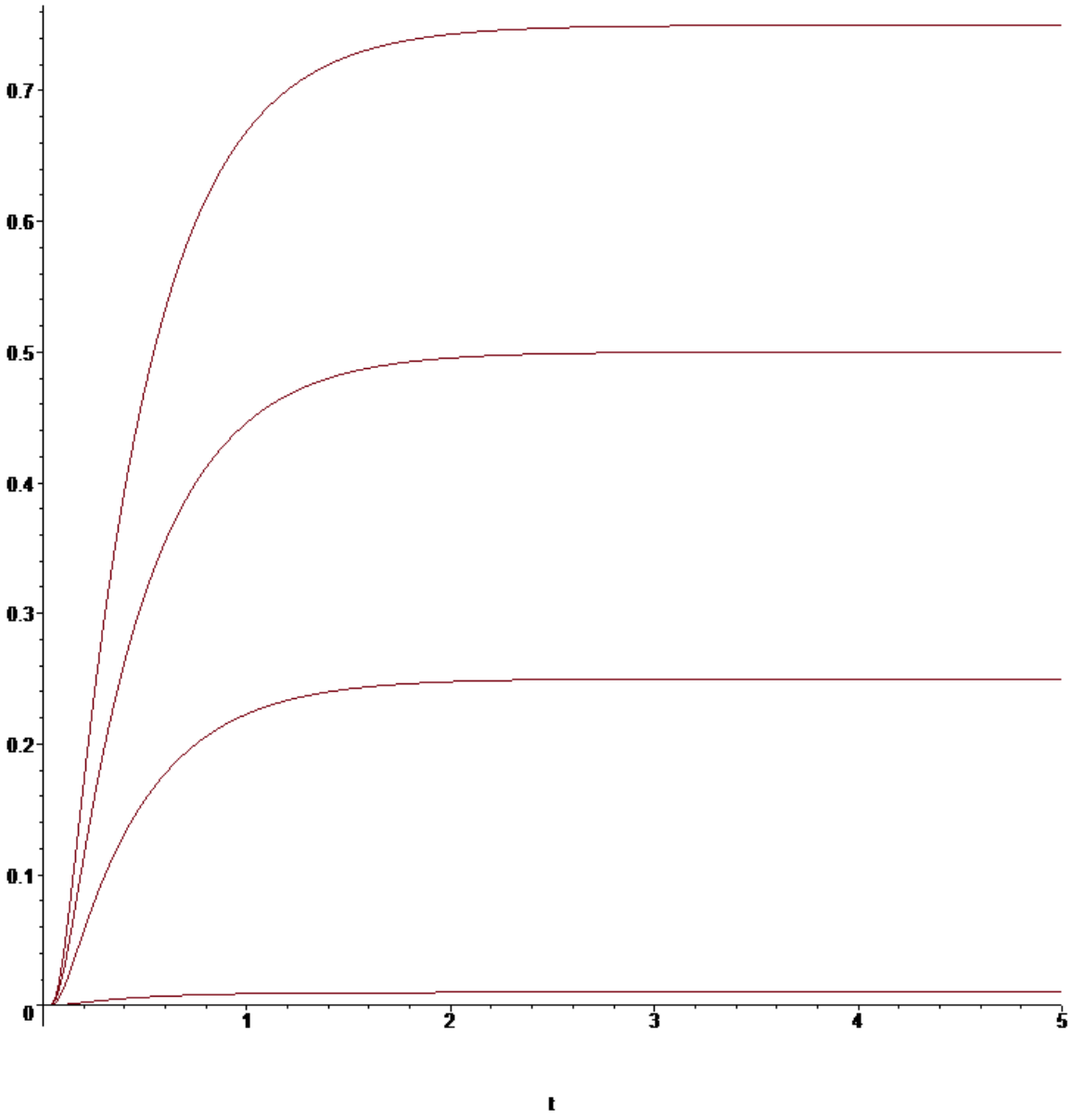
```
>
```

```
> Pi;
```

$$\pi$$

```
>
> ##################### varying Cea vs concentration
################
with(plots):
c_1:=subs(x=0.,C):
> p1:=plot(subs(Ceq=0.01,c_1),t=0..5):
p2:=plot(subs(Ceq=0.25,c_1),t=0..5):
p3:=plot(subs(Ceq=0.50,c_1),t=0..5):
p4:=plot(subs(Ceq=0.75,c_1),t=0..5):

display(p1,p2,p3,p4);
```



>

> ############### long times, varying Ceq ###############

```
with(plots):
m:=1;F:=96485;D1:=1e-12;L:=100e-6;ci:=1000;
ibatt:=subs(x=1,-m*F*D1*ci/L*dC):
p11:=plot(subs([Ceq=0.01,t=D1/L^2*T],ibatt),T=0..500):
p12:=plot(subs([Ceq=0.25,t=D1/L^2*T],ibatt),T=0..500):
p13:=plot(subs([Ceq=0.50,t=D1/L^2*T],ibatt),T=0..500):
p14:=plot(subs([Ceq=0.75,t=D1/L^2*T],ibatt),T=0..500):
display(p11,p12,p13,p14);
```

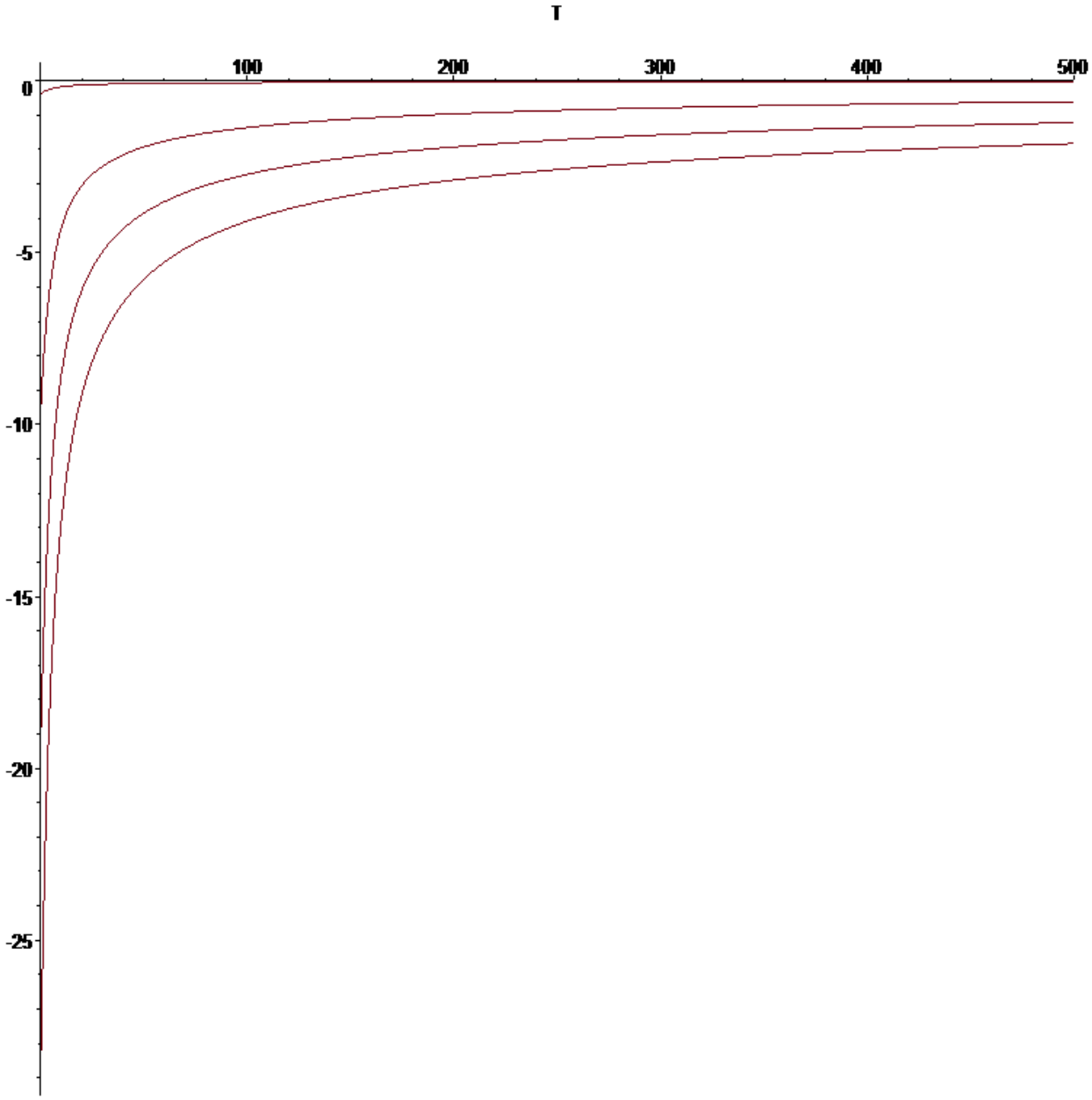
$$m := 1$$

$$F := 96485$$

$$D1 := 0.1\ 10^{-11}$$

$L := 0.000100$

$ci := 1000$




```
> ############## long times, varying L ##############
with(plots):
m:=1;F:=96485;D1:=1e-12;L:=100e-6;ci:=1000;
ibatt:=subs(x=1,-m*F*D1*ci/L*dC):
p21:=plot(subs([Ceq=0.25,t=D1/L^2*T],ibatt),T=0..700):
L:=50e-6;ibatt:=subs(x=1,-m*F*D1*ci/L*dC):
p22:=plot(subs([Ceq=0.25,t=D1/L^2*T],ibatt),T=0..700):
L:=25e-6;ibatt:=subs(x=1,-m*F*D1*ci/L*dC):
p23:=plot(subs([Ceq=0.25,t=D1/L^2*T],ibatt),T=0..700):
```

```
L:=10e-6;ibatt:=subs(x=1,-m*F*D1*ci/L*dC):
p24:=plot(subs([Ceq=0.25,t=D1/L^2*T],ibatt),T=0..700):
display(p21,p22,p23,p24);
```

$$m := 1$$

$$F := 96485$$

$$D1 := 0.1\ 10^{-11}$$

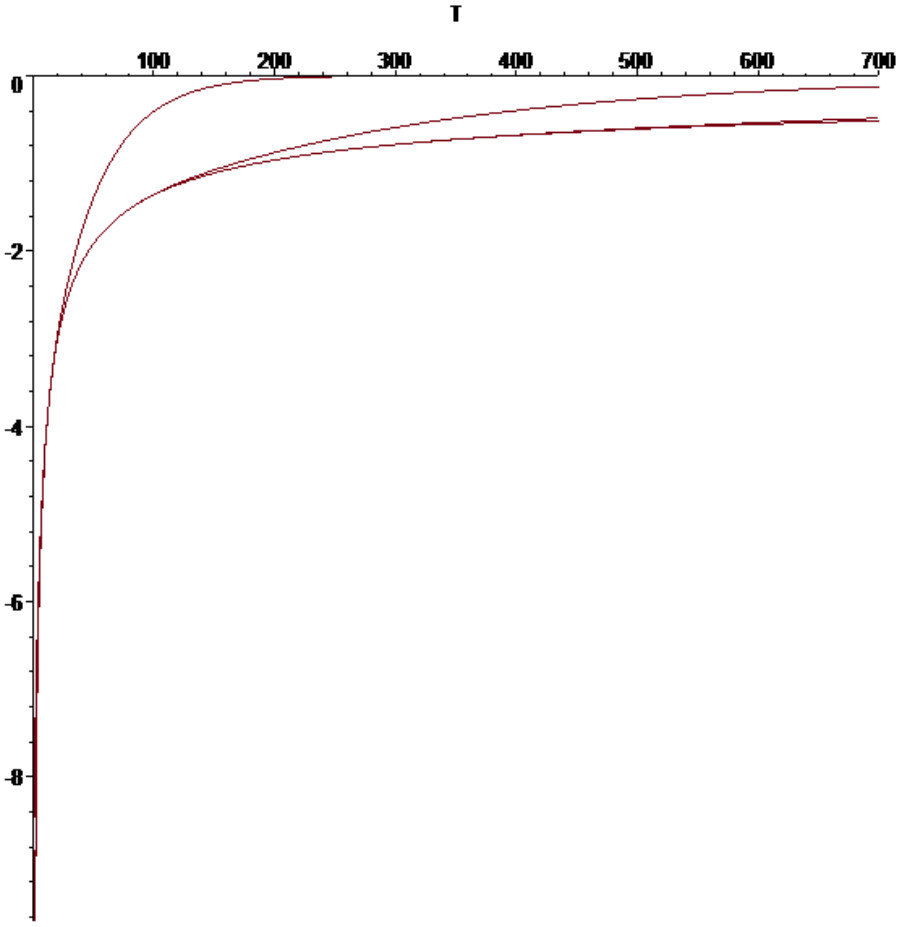
$$L := 0.000100$$

$$ci := 1000$$

$$L := 0.000050$$

$$L := 0.000025$$

$$L := 0.000010$$




```
> ###################### varying L, short times ################
with(plots):
m:=1;F:=96485;D1:=1e-12;L:=100e-6;ci:=1000;
ibatt:=subs(x=1,-m*F*D1*ci/L*dC):
p21:=plot(subs([Ceq=0.5,t=D1/L^2*T],ibatt),T=0..0.01):
L:=50e-6;ibatt:=subs(x=1,-m*F*D1*ci/L*dC):
```

```
p22:=plot(subs([Ceq=0.5,t=D1/L^2*T],ibatt),T=0..0.01):
L:=25e-6;ibatt:=subs(x=1,-m*F*D1*ci/L*dC):
p23:=plot(subs([Ceq=0.5,t=D1/L^2*T],ibatt),T=0..0.01):
L:=10e-6;ibatt:=subs(x=1,-m*F*D1*ci/L*dC):
p24:=plot(subs([Ceq=0.5,t=D1/L^2*T],ibatt),T=0..0.01):
display(p21,p22,p23,p24);
```

$$m := 1$$

$$F := 96485$$

$$D1 := 0.1\ 10^{-11}$$

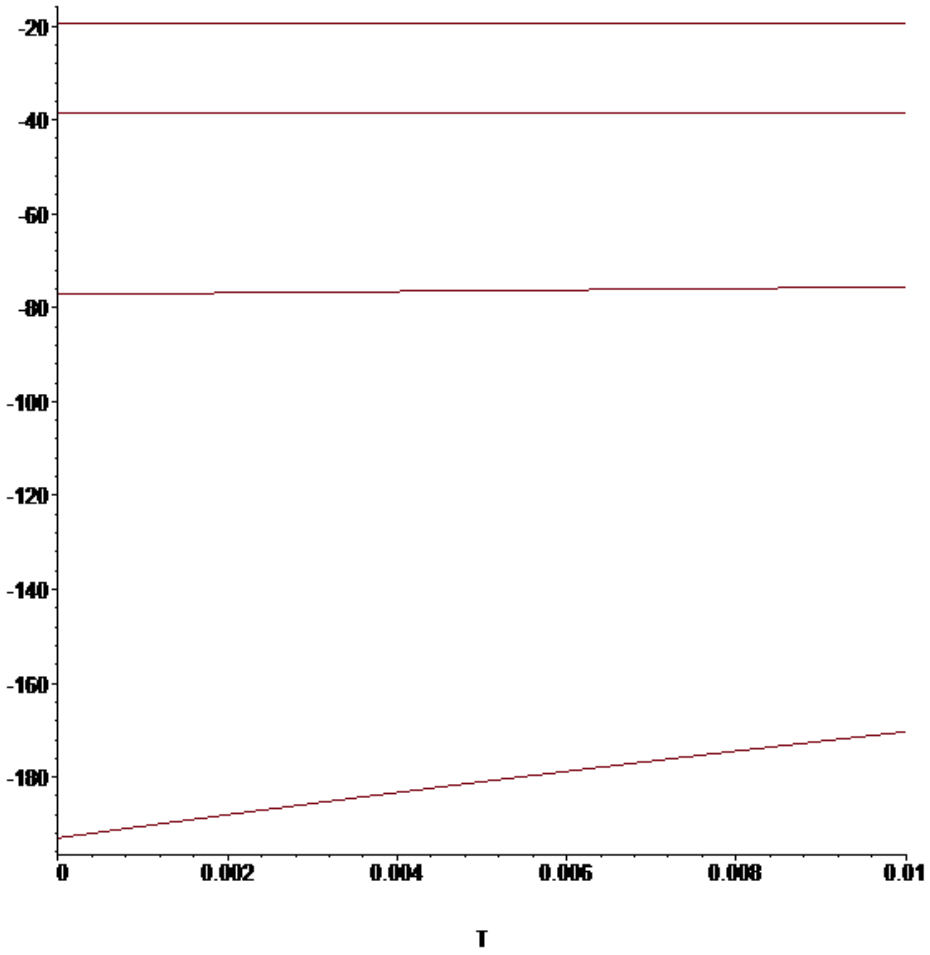
$$L := 0.000100$$

$$ci := 1000$$

$$L := 0.000050$$

$$L := 0.000025$$

$$L := 0.000010$$




```
> ###################### varying D, long time ################
with(plots):
```

```
m:=1;F:=96485;D1:=1e-12;L:=100e-6;ci:=1000;
ibatt:=subs(x=1,-m*F*D1*ci/L*dC):
p41:=plot(subs([Ceq=0.5,t=D1/L^2*T],ibatt),T=0..700):
D1:=1e-11;ibatt:=subs(x=1,-m*F*D1*ci/L*dC):
p42:=plot(subs([Ceq=0.5,t=D1/L^2*T],ibatt),T=0..700):
D1:=1e-13;ibatt:=subs(x=1,-m*F*D1*ci/L*dC):
p43:=plot(subs([Ceq=0.5,t=D1/L^2*T],ibatt),T=0..700):
D1:=1e-14;ibatt:=subs(x=1,-m*F*D1*ci/L*dC):
p44:=plot(subs([Ceq=0.5,t=D1/L^2*T],ibatt),T=0..700):
display(p41,p42,p43,p44);
```

$$m := 1$$

$$F := 96485$$

$$D1 := 0.1\ 10^{-11}$$

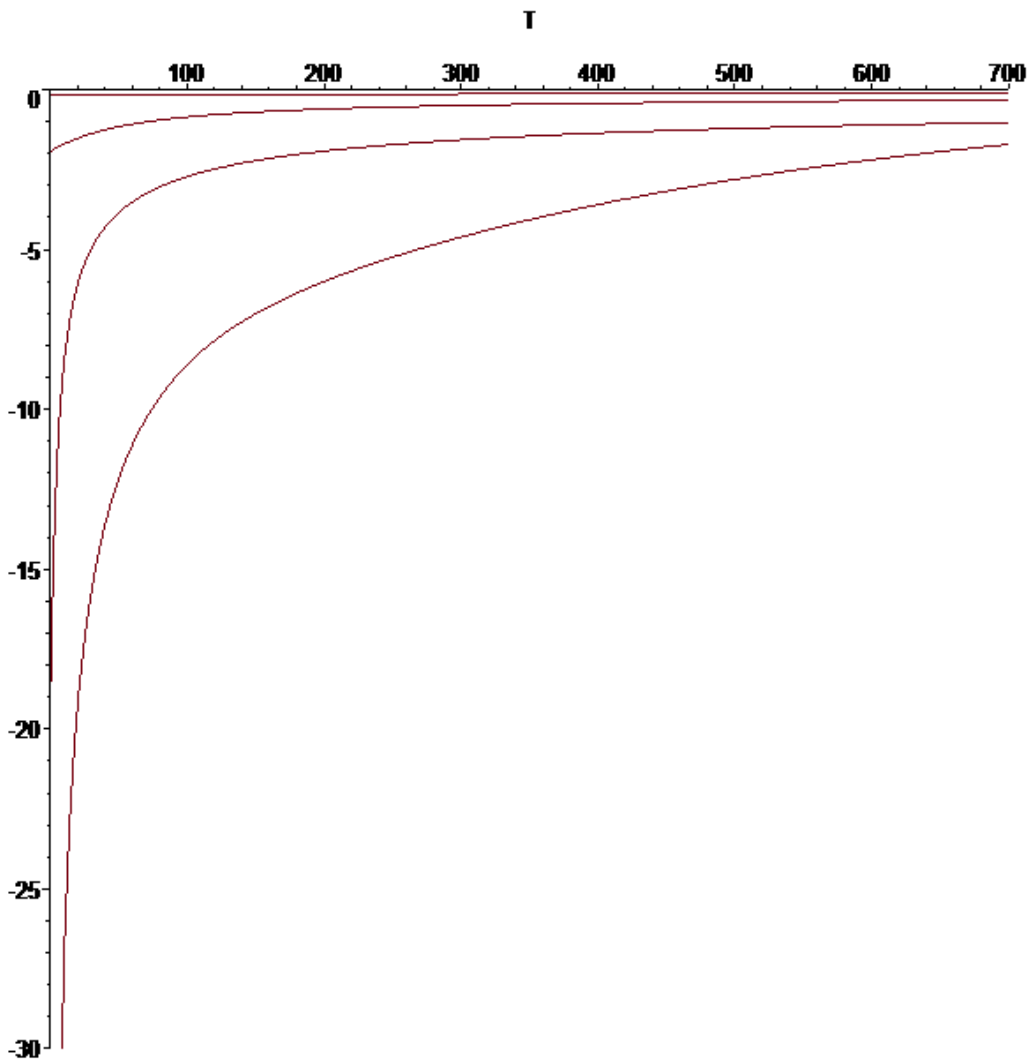
$$L := 0.000100$$

$$ci := 1000$$

$$D1 := 0.1\ 10^{-10}$$

$$D1 := 0.1\ 10^{-12}$$

$$D1 := 0.1\ 10^{-13}$$




```
> ###################### varying ci, long time ################
with(plots):
m:=1;F:=96485;D1:=1e-12;L:=100e-6;ci:=1000;
ibatt:=subs(x=1,-m*F*D1*ci/L*dC):
p41:=plot(subs([Ceq=0.5,t=D1/L^2*T],ibatt),T=0..700):
ci:=2000;ibatt:=subs(x=1,-m*F*D1*ci/L*dC):
p42:=plot(subs([Ceq=0.5,t=D1/L^2*T],ibatt),T=0..700):
ci:=500;ibatt:=subs(x=1,-m*F*D1*ci/L*dC):
p43:=plot(subs([Ceq=0.5,t=D1/L^2*T],ibatt),T=0..700):
ci:=250;ibatt:=subs(x=1,-m*F*D1*ci/L*dC):
p44:=plot(subs([Ceq=0.5,t=D1/L^2*T],ibatt),T=0..700):
display(p41,p42,p43,p44);
```

$$m := 1$$

$$F := 96485$$

$$D1 := 0.1\ 10^{-11}$$

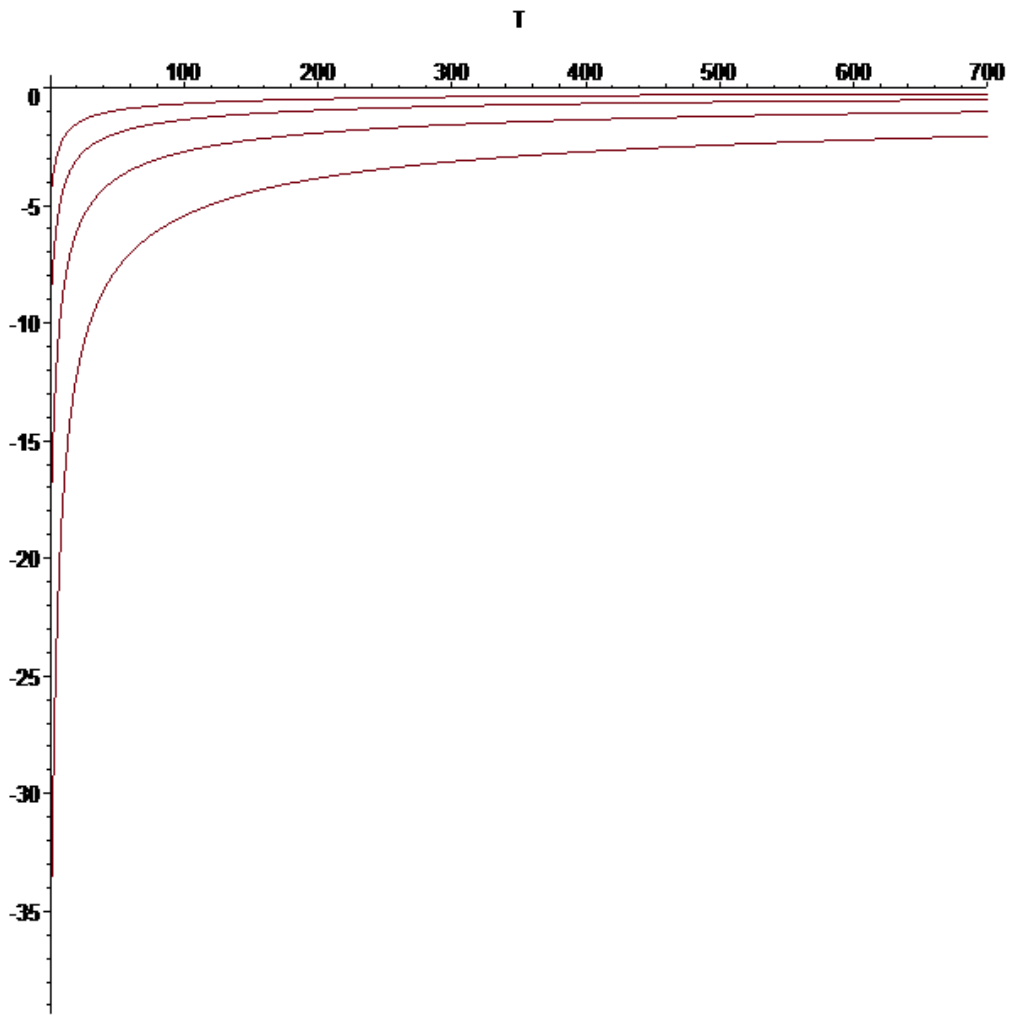
$$L := 0.000100$$

$ci := 1000$

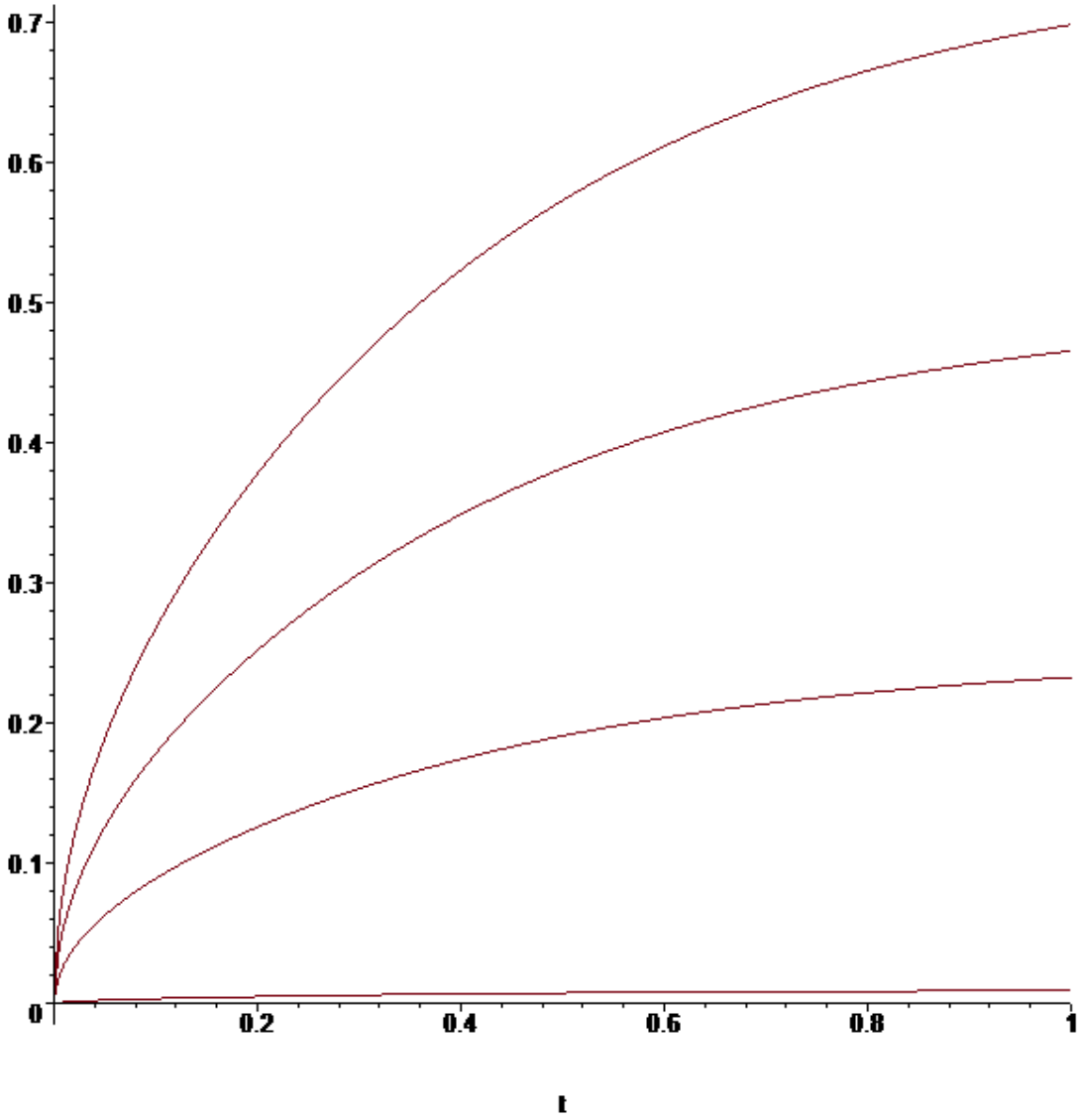
$ci := 2000$

$ci := 500$

$ci := 250$




```
> SOC:=int(C,x=0..1):
p1:=plot(subs(Ceq=0.01,SOC),t=0..1):
p2:=plot(subs(Ceq=0.25,SOC),t=0..1):
p3:=plot(subs(Ceq=0.50,SOC),t=0..1):
p4:=plot(subs(Ceq=0.75,SOC),t=0..1):
display(p1,p2,p3,p4);
```




```
>
>
>
>
> ############### P3.1 ###############
restart:
> Digits:=15;
```

$$Digits := 15$$

```
> N:=10;
```

$$N := 10$$

```
> eq[0]:=u[0](t)=0;
```

$$eq_0 := u_0(t) = 0$$

```
> h:=1/(N+1):
```

```
> for i from 1 to N do eq[i]:=diff(u[i](t),t)=(u[i-1](t)-
2*u[i](t)+u[i+1](t))/h^2;od;
```

$$eq_1 := \frac{d}{dt} u_1(t) = 121\, u_0(t) - 242\, u_1(t) + 121\, u_2(t)$$

$$eq_2 := \frac{d}{dt} u_2(t) = 121\, u_1(t) - 242\, u_2(t) + 121\, u_3(t)$$

$$eq_3 := \frac{d}{dt} u_3(t) = 121\, u_2(t) - 242\, u_3(t) + 121\, u_4(t)$$

$$eq_4 := \frac{d}{dt} u_4(t) = 121\, u_3(t) - 242\, u_4(t) + 121\, u_5(t)$$

$$eq_5 := \frac{d}{dt} u_5(t) = 121\, u_4(t) - 242\, u_5(t) + 121\, u_6(t)$$

$$eq_6 := \frac{d}{dt} u_6(t) = 121\, u_5(t) - 242\, u_6(t) + 121\, u_7(t)$$

$$eq_7 := \frac{d}{dt} u_7(t) = 121\, u_6(t) - 242\, u_7(t) + 121\, u_8(t)$$

$$eq_8 := \frac{d}{dt} u_8(t) = 121\, u_7(t) - 242\, u_8(t) + 121\, u_9(t)$$

$$eq_9 := \frac{d}{dt} u_9(t) = 121\, u_8(t) - 242\, u_9(t) + 121\, u_{10}(t)$$

$$eq_{10} := \frac{d}{dt} u_{10}(t) = 121\, u_9(t) - 242\, u_{10}(t) + 121\, u_{11}(t)$$

```
> eq[N+1]:=u[N+1](t)=0;
```

$$eq_{11} := u_{11}(t) = 0$$

```
> ics:=seq(u[i](0)=1,i=0..N+1);
```

$$ics := u_0(0) = 1, u_1(0) = 1, u_2(0) = 1, u_3(0) = 1, u_4(0) = 1, u_5(0) = 1, u_6(0) = 1,$$
$$u_7(0) = 1, u_8(0) = 1, u_9(0) = 1, u_{10}(0) = 1, u_{11}(0) = 1$$

```
> Eqs:=seq(eq[i],i=0..N+1);
```

$$Eqs := u_0(t) = 0, \frac{d}{dt} u_1(t) = 121\, u_0(t) - 242\, u_1(t) + 121\, u_2(t),$$

$$\frac{d}{dt} u_2(t) = 121\, u_1(t) - 242\, u_2(t) + 121\, u_3(t),$$

$$\frac{d}{dt} u_3(t) = 121\, u_2(t) - 242\, u_3(t) + 121\, u_4(t),$$

$$\frac{d}{dt} u_4(t) = 121\, u_3(t) - 242\, u_4(t) + 121\, u_5(t),$$

$$\frac{d}{dt}u_5(t) = 121\,u_4(t) - 242\,u_5(t) + 121\,u_6(t),$$

$$\frac{d}{dt}u_6(t) = 121\,u_5(t) - 242\,u_6(t) + 121\,u_7(t),$$

$$\frac{d}{dt}u_7(t) = 121\,u_6(t) - 242\,u_7(t) + 121\,u_8(t),$$

$$\frac{d}{dt}u_8(t) = 121\,u_7(t) - 242\,u_8(t) + 121\,u_9(t),$$

$$\frac{d}{dt}u_9(t) = 121\,u_8(t) - 242\,u_9(t) + 121\,u_{10}(t),$$

$$\frac{d}{dt}u_{10}(t) = 121\,u_9(t) - 242\,u_{10}(t) + 121\,u_{11}(t),\ u_{11}(t) = 0$$

```
> infolevel[all]:=0;
```

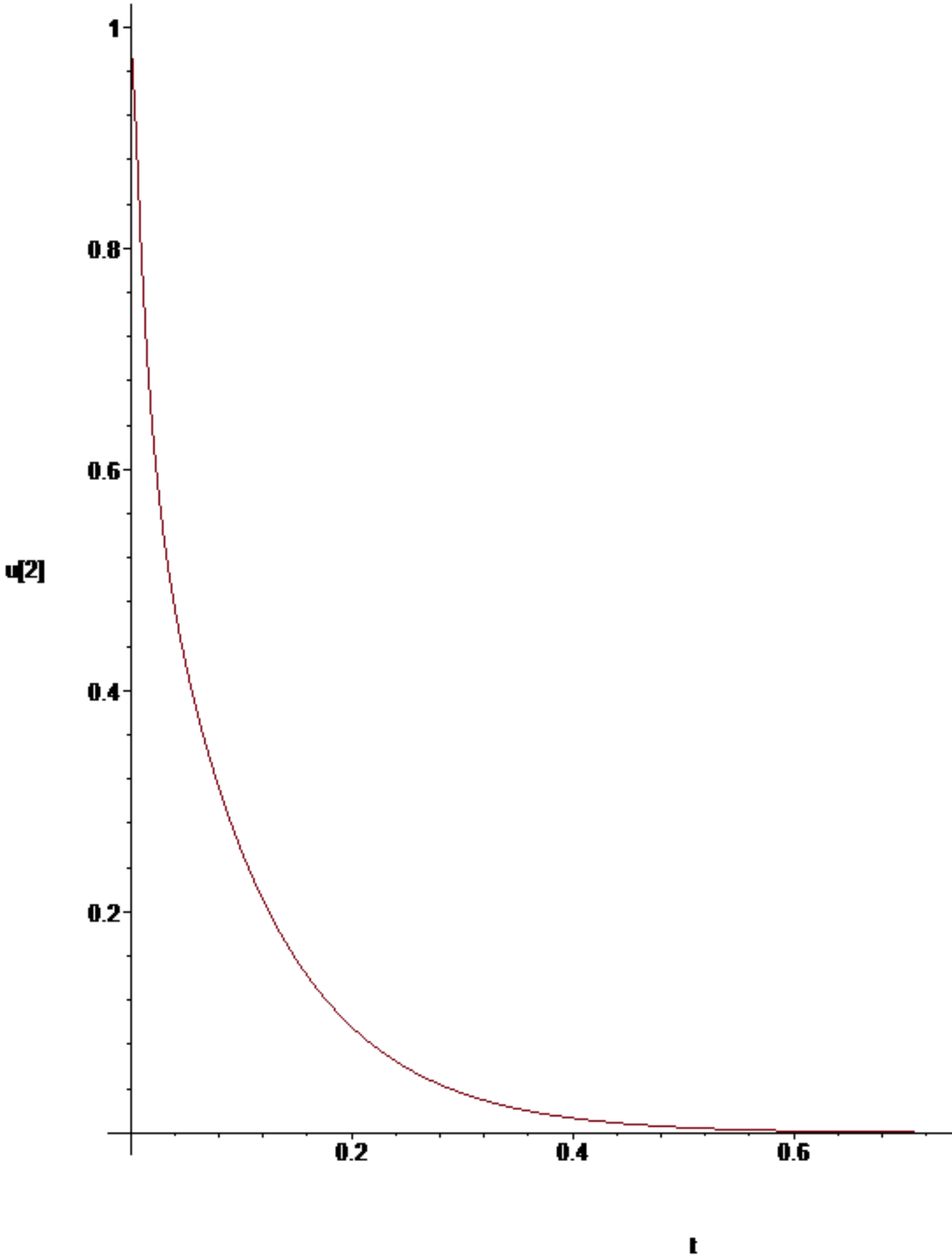
$$infolevel_{all} := 0$$

```
> sol:=dsolve({Eqs,ics},type=numeric,stiff=true):
> infolevel[all]:=0;
sol(1);
```

$$infolevel_{all} := 0$$

$$[t = 1.,\ u_0(t) = 0.,\ u_1(t) = 0.0000197128030461880,\ u_2(t) = 0.0000378285920261276,$$
$$u_3(t) = 0.0000528797334554097,\ u_4(t) = 0.0000636468733680186,$$
$$u_5(t) = 0.0000692577221228813,\ u_6(t) = 0.0000692577221228813,$$
$$u_7(t) = 0.0000636468733680186,\ u_8(t) = 0.0000528797334554097,$$
$$u_9(t) = 0.0000378285920261276,\ u_{10}(t) = 0.0000197128030461880,\ u_{11}(t) = 0.]$$

```
> with(plots):
> odeplot(sol,[t,u[2](t)],0..1);
```


1
0.8
0.6
0.4
0.2
u[2]
0.2
0.4
0.6
t

```
> restart:
Digits:=15;
N:=10;
h:=1/N;
eq[0]:=u[1](t)-u[0](t)=0;
for i from 1 to N do eq[i]:=diff(u[i](t),t)=(u[i-1](t)-
2*u[i](t)+u[i+1](t))/h^2;od;
eq[N+1]:=(u[N+1](t)-u[N](t))/h=-1;
ics:=seq(u[i](0)=1,i=0..N+1);
Eqs:=seq(eq[i],i=0..N+1);
sol:=dsolve({Eqs,ics},type=numeric,stiff=true):
with(plots):
odeplot(sol,[t,u[2](t)],0..1);
```

$$Digits := 15$$

$$N := 10$$

$$h := \frac{1}{10}$$

$$eq_0 := u_1(t) - u_0(t) = 0$$

$$eq_1 := \frac{d}{dt} u_1(t) = 100\, u_0(t) - 200\, u_1(t) + 100\, u_2(t)$$

$$eq_2 := \frac{d}{dt} u_2(t) = 100\, u_1(t) - 200\, u_2(t) + 100\, u_3(t)$$

$$eq_3 := \frac{d}{dt} u_3(t) = 100\, u_2(t) - 200\, u_3(t) + 100\, u_4(t)$$

$$eq_4 := \frac{d}{dt} u_4(t) = 100\, u_3(t) - 200\, u_4(t) + 100\, u_5(t)$$

$$eq_5 := \frac{d}{dt} u_5(t) = 100\, u_4(t) - 200\, u_5(t) + 100\, u_6(t)$$

$$eq_6 := \frac{d}{dt} u_6(t) = 100\, u_5(t) - 200\, u_6(t) + 100\, u_7(t)$$

$$eq_7 := \frac{d}{dt} u_7(t) = 100\, u_6(t) - 200\, u_7(t) + 100\, u_8(t)$$

$$eq_8 := \frac{d}{dt} u_8(t) = 100\, u_7(t) - 200\, u_8(t) + 100\, u_9(t)$$

$$eq_9 := \frac{d}{dt} u_9(t) = 100\, u_8(t) - 200\, u_9(t) + 100\, u_{10}(t)$$

$$eq_{10} := \frac{d}{dt} u_{10}(t) = 100\, u_9(t) - 200\, u_{10}(t) + 100\, u_{11}(t)$$

$$eq_{11} := 10\,u_{11}(t) - 10\,u_{10}(t) = -1$$

$$ics := u_0(0) = 1,\ u_1(0) = 1,\ u_2(0) = 1,\ u_3(0) = 1,\ u_4(0) = 1,\ u_5(0) = 1,\ u_6(0) = 1,$$
$$u_7(0) = 1,\ u_8(0) = 1,\ u_9(0) = 1,\ u_{10}(0) = 1,\ u_{11}(0) = 1$$

$$Eqs := u_1(t) - u_0(t) = 0,\ \frac{d}{dt}u_1(t) = 100\,u_0(t) - 200\,u_1(t) + 100\,u_2(t),$$

$$\frac{d}{dt}u_2(t) = 100\,u_1(t) - 200\,u_2(t) + 100\,u_3(t),$$

$$\frac{d}{dt}u_3(t) = 100\,u_2(t) - 200\,u_3(t) + 100\,u_4(t),$$

$$\frac{d}{dt}u_4(t) = 100\,u_3(t) - 200\,u_4(t) + 100\,u_5(t),$$

$$\frac{d}{dt}u_5(t) = 100\,u_4(t) - 200\,u_5(t) + 100\,u_6(t),$$

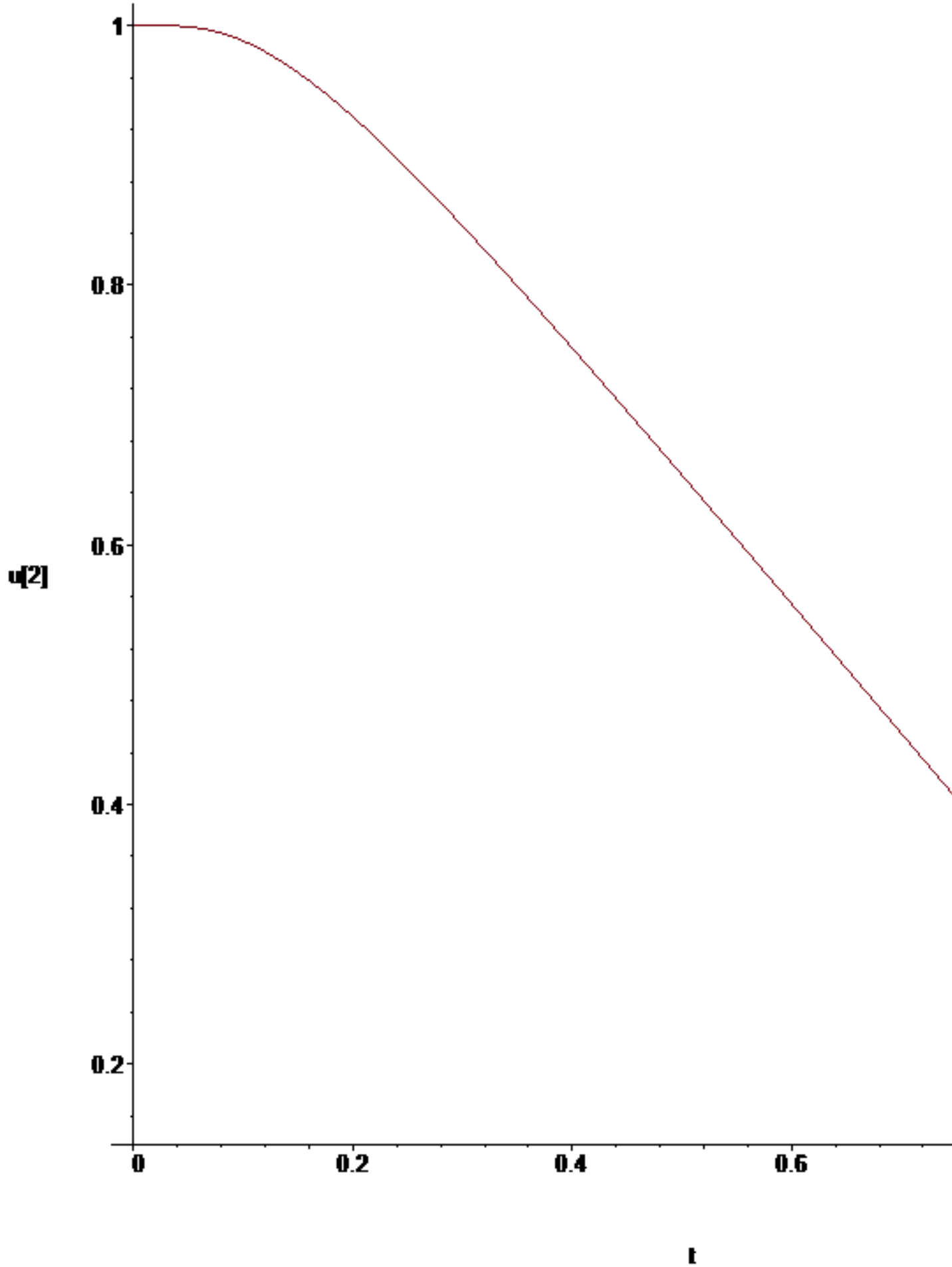
$$\frac{d}{dt}u_6(t) = 100\,u_5(t) - 200\,u_6(t) + 100\,u_7(t),$$

$$\frac{d}{dt}u_7(t) = 100\,u_6(t) - 200\,u_7(t) + 100\,u_8(t),$$

$$\frac{d}{dt}u_8(t) = 100\,u_7(t) - 200\,u_8(t) + 100\,u_9(t),$$

$$\frac{d}{dt}u_9(t) = 100\,u_8(t) - 200\,u_9(t) + 100\,u_{10}(t),$$

$$\frac{d}{dt}u_{10}(t) = 100\,u_9(t) - 200\,u_{10}(t) + 100\,u_{11}(t),\ 10\,u_{11}(t) - 10\,u_{10}(t) = -1$$


1
0.8
0.6
0.4
0.2
u[2]
0
0.2
0.4
0.6
t

```
> restart:
Digits:=15;
N:=10;
h:=1/N;
eq[0]:=u[1](t)-u[0](t)=0;# u0
for i from 1 to N do eq[i]:=diff(u[i](t),t)=(u[i-1](t)-
2*u[i](t)+u[i+1](t))/h^2+2/(i*h)*(u[i+1](t)-u[i-1](t))/(2*h)-
u[i](t)^2;od; #eqn
eq[N+1]:=(u[N+1](t)-u[N](t))/h=-1; #uN+1
ics:=seq(u[i](0)=1,i=0..N+1);
Eqs:=seq(eq[i],i=0..N+1);
sol:=dsolve({Eqs,ics},type=numeric,stiff=true):
with(plots):
odeplot(sol,[t,u[2](t)],0..1);
```

$$Digits := 15$$

$$N := 10$$

$$h := \frac{1}{10}$$

$$eq_0 := u_1(t) - u_0(t) = 0$$

$$eq_1 := \frac{d}{dt} u_1(t) = -200\, u_1(t) + 200\, u_2(t) - u_1(t)^2$$

$$eq_2 := \frac{d}{dt} u_2(t) = 50\, u_1(t) - 200\, u_2(t) + 150\, u_3(t) - u_2(t)^2$$

$$eq_3 := \frac{d}{dt} u_3(t) = \frac{200}{3} u_2(t) - 200\, u_3(t) + \frac{400}{3} u_4(t) - u_3(t)^2$$

$$eq_4 := \frac{d}{dt} u_4(t) = 75\, u_3(t) - 200\, u_4(t) + 125\, u_5(t) - u_4(t)^2$$

$$eq_5 := \frac{d}{dt} u_5(t) = 80\, u_4(t) - 200\, u_5(t) + 120\, u_6(t) - u_5(t)^2$$

$$eq_6 := \frac{d}{dt} u_6(t) = \frac{250}{3} u_5(t) - 200\, u_6(t) + \frac{350}{3} u_7(t) - u_6(t)^2$$

$$eq_7 := \frac{d}{dt} u_7(t) = \frac{600}{7} u_6(t) - 200\, u_7(t) + \frac{800}{7} u_8(t) - u_7(t)^2$$

$$eq_8 := \frac{d}{dt} u_8(t) = \frac{175}{2} u_7(t) - 200\, u_8(t) + \frac{225}{2} u_9(t) - u_8(t)^2$$

$$eq_9 := \frac{d}{dt} u_9(t) = \frac{800}{9} u_8(t) - 200\, u_9(t) + \frac{1000}{9} u_{10}(t) - u_9(t)^2$$

$$eq_{10} := \frac{d}{dt} u_{10}(t) = 90\, u_9(t) - 200\, u_{10}(t) + 110\, u_{11}(t) - u_{10}(t)^2$$

$$eq_{11} := 10\, u_{11}(t) - 10\, u_{10}(t) = -1$$

$$ics := u_0(0) = 1,\ u_1(0) = 1,\ u_2(0) = 1,\ u_3(0) = 1,\ u_4(0) = 1,\ u_5(0) = 1,\ u_6(0) = 1,$$
$$u_7(0) = 1,\ u_8(0) = 1,\ u_9(0) = 1,\ u_{10}(0) = 1,\ u_{11}(0) = 1$$

$$Eqs := u_1(t) - u_0(t) = 0,\ \frac{d}{dt} u_1(t) = -200\, u_1(t) + 200\, u_2(t) - u_1(t)^2,$$

$$\frac{d}{dt} u_2(t) = 50\, u_1(t) - 200\, u_2(t) + 150\, u_3(t) - u_2(t)^2,$$

$$\frac{d}{dt} u_3(t) = \frac{200}{3} u_2(t) - 200\, u_3(t) + \frac{400}{3} u_4(t) - u_3(t)^2,$$

$$\frac{d}{dt} u_4(t) = 75\, u_3(t) - 200\, u_4(t) + 125\, u_5(t) - u_4(t)^2,$$

$$\frac{d}{dt} u_5(t) = 80\, u_4(t) - 200\, u_5(t) + 120\, u_6(t) - u_5(t)^2,$$

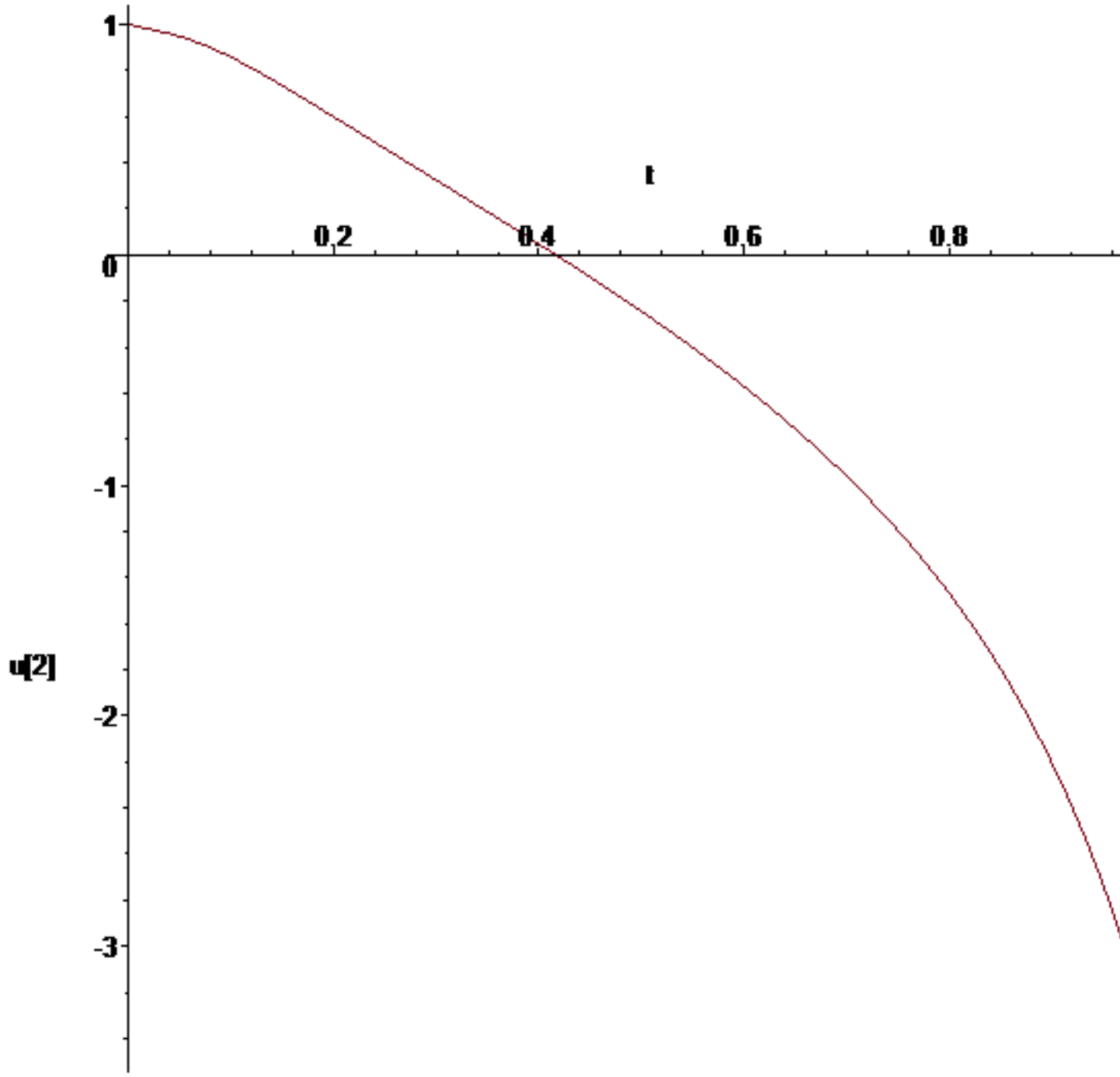
$$\frac{d}{dt} u_6(t) = \frac{250}{3} u_5(t) - 200\, u_6(t) + \frac{350}{3} u_7(t) - u_6(t)^2,$$

$$\frac{d}{dt} u_7(t) = \frac{600}{7} u_6(t) - 200\, u_7(t) + \frac{800}{7} u_8(t) - u_7(t)^2,$$

$$\frac{d}{dt} u_8(t) = \frac{175}{2} u_7(t) - 200\, u_8(t) + \frac{225}{2} u_9(t) - u_8(t)^2,$$

$$\frac{d}{dt} u_9(t) = \frac{800}{9} u_8(t) - 200\, u_9(t) + \frac{1000}{9} u_{10}(t) - u_9(t)^2,$$

$$\frac{d}{dt} u_{10}(t) = 90\, u_9(t) - 200\, u_{10}(t) + 110\, u_{11}(t) - u_{10}(t)^2,\ 10\, u_{11}(t) - 10\, u_{10}(t) = -1$$


1
0
-1
-2
-3
0.2
0.4
0.6
0.8
t
u[2]

>