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> #ex1:
> ecdif1:= diff(x(t),t,t)+w__0^2*x(t)=0

$$ecdif1 := \frac{d^2}{dt^2} x(t) + w_0^2 x(t) = 0 \quad (1)$$

> sol1:=dsolve(ecdif1,x(t))

$$sol1 := x(t) = c_1 \sin(w_0 t) + c_2 \cos(w_0 t) \quad (2)$$

> sol2:=subs(c__1=R*cos(delta),c__2=R*sin(delta),sol1)

$$sol2 := x(t) = R \cos(\delta) \sin(w_0 t) + R \sin(\delta) \cos(w_0 t) \quad (3)$$

> cond_in1:=x(0)=x__0;cond_in2:=D(x)(0)=v__0

$$cond\_in1 := x(0) = x_0$$


$$cond\_in2 := D(x)(0) = v_0 \quad (4)$$

> sist:={ecdif1,cond_in1,cond_in2}

$$sist := \left\{ \frac{d^2}{dt^2} x(t) + w_0^2 x(t) = 0, x(0) = x_0, D(x)(0) = v_0 \right\} \quad (5)$$

> sol:=dsolve(sist)

$$sol := x(t) = \frac{v_0 \sin(w_0 t)}{w_0} + x_0 \cos(w_0 t) \quad (6)$$

> sist2:={sol2,sol}

$$sist2 := \left\{ x(t) = R \cos(\delta) \sin(w_0 t) + R \sin(\delta) \cos(w_0 t), x(t) = \frac{v_0 \sin(w_0 t)}{w_0} + x_0 \cos(w_0 t) \right\} \quad (7)$$

> ec1:=v__0/w__0=R*cos(delta)

$$ec1 := \frac{v_0}{w_0} = R \cos(\delta) \quad (8)$$

> ec2:=x__0=R*sin(delta)

$$ec2 := x_0 = R \sin(\delta) \quad (9)$$

> sistem:=ec1,ec2

$$sistem := \frac{v_0}{w_0} = R \cos(\delta), x_0 = R \sin(\delta) \quad (10)$$

> solf:=solve({sistem},{R,delta})

$$solf := \left\{ R = \frac{\text{RootOf}(-x_0^2 w_0^2 + \_Z^2 - v_0^2)}{w_0}, \delta = \arctan\left(\frac{x_0 w_0}{\text{RootOf}(-x_0^2 w_0^2 + \_Z^2 - v_0^2)}\right), \right. \\ \left. \frac{v_0}{\text{RootOf}(-x_0^2 w_0^2 + \_Z^2 - v_0^2)} \right\} \quad (11)$$

> simplify(solf[2])

$$\arctan\left(\frac{x_0 w_0}{v_0}\right) = \arctan\left(\frac{x_0 w_0}{\text{RootOf}(-x_0^2 w_0^2 + \_Z^2 - v_0^2)}, \frac{v_0}{\text{RootOf}(-x_0^2 w_0^2 + \_Z^2 - v_0^2)}\right) \quad (12)$$

> delta:=arctan(x__0*w__0/RootOf(-x__0^2*w__0^2-v__0^2+_Z^2)/
(v__0/RootOf(-x__0^2*w__0^2-v__0^2+_Z^2)))

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$$\delta := \arctan\left(\frac{x_0 w_0}{v_0}\right) \quad (13)$$

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> deltaL:=39.24;cond_in:=x(0)=15,D(x)(0)=0
      deltaL := 39.24
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$$cond_in := x(0) = 15, D(x)(0) = 0 \quad (14)$$

```
> sold:=dsolve({ecdif1,cond_in},x(t))
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$$sold := x(t) = 15 \cos(w_0 t) \quad (15)$$

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> R:=15
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$$R := 15 \quad (16)$$

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> w__0:=9.81/deltaL
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$$w_0 := 0.2500000000 \quad (17)$$

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> ecdif2:=diff(x(t), t$2)+w__0^2*x(t)=0
```

$$ecdif2 := \frac{d^2}{dt^2} x(t) + 0.06250000000 x(t) = 0 \quad (18)$$

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> sold:=dsolve({ecdif2,cond_in},x(t));v__0=0;x__0=15
```

$$sold := x(t) = 15 \cos\left(\frac{t}{4}\right)$$

$$v_0 = 0$$

$$x_0 = 15$$

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> delta:=Pi/2
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$$\delta := \frac{\pi}{2}$$

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> evalf(%)
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$$1.570796327$$

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> T:=2*Pi/w__0
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$$T := 25.13274124$$

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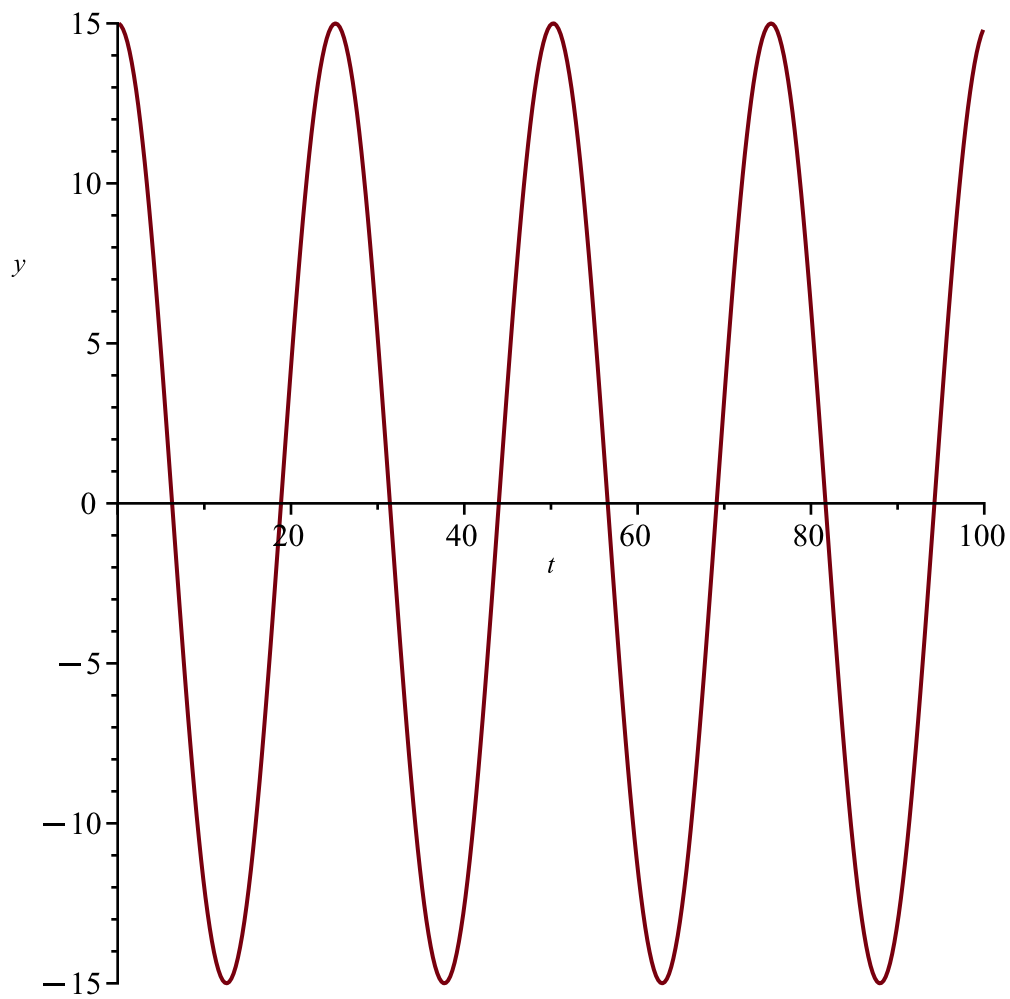
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> xx:=unapply(rhs(sold),t)
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$$xx := t \mapsto 15 \cdot \cos\left(\frac{t}{4}\right)$$

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> with(plots):
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> plot(xx(t),t=0..100, y)
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> #ex2
> restart;with(plots):
> ecdif:=diff(x(t),t,t)+lambda*diff(x(t),t)+omega__0^2*x(t)=0

```

$$ecdif := \frac{d^2}{dt^2} x(t) + 25 \frac{d}{dt} x(t) + 100 x(t) = 0 \quad (24)$$

```

> assume(lambda^2>4*omega__0^2)
> sol1:=dsolve(ecdif,x(t))

```

$$sol1 := x(t) = c_1 e^{\frac{(-\lambda + \sqrt{\lambda^2 - 4 \omega_{0\sim}^2}) t}{2}} + c_2 e^{-\frac{(\lambda + \sqrt{\lambda^2 - 4 \omega_{0\sim}^2}) t}{2}} \quad (25)$$

```

> cond_inb:=x(0)=1;cond_inb1:=D(x)(0)=5

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$$cond_inb := x(0) = 1$$

$$cond_inb1 := D(x)(0) = 5 \quad (26)$$

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> lambda:=25;omega__0:=10

```

$$\lambda := 25$$

$$\omega_0 := 10 \quad (27)$$

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> sist:={ecdif,cond_inb,cond_inb1}

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$$sist := \left\{ \frac{d^2}{dt^2} x(t) + 25 \frac{d}{dt} x(t) + 100 x(t) = 0, x(0) = 1, D(x)(0) = 5 \right\} \quad (28)$$

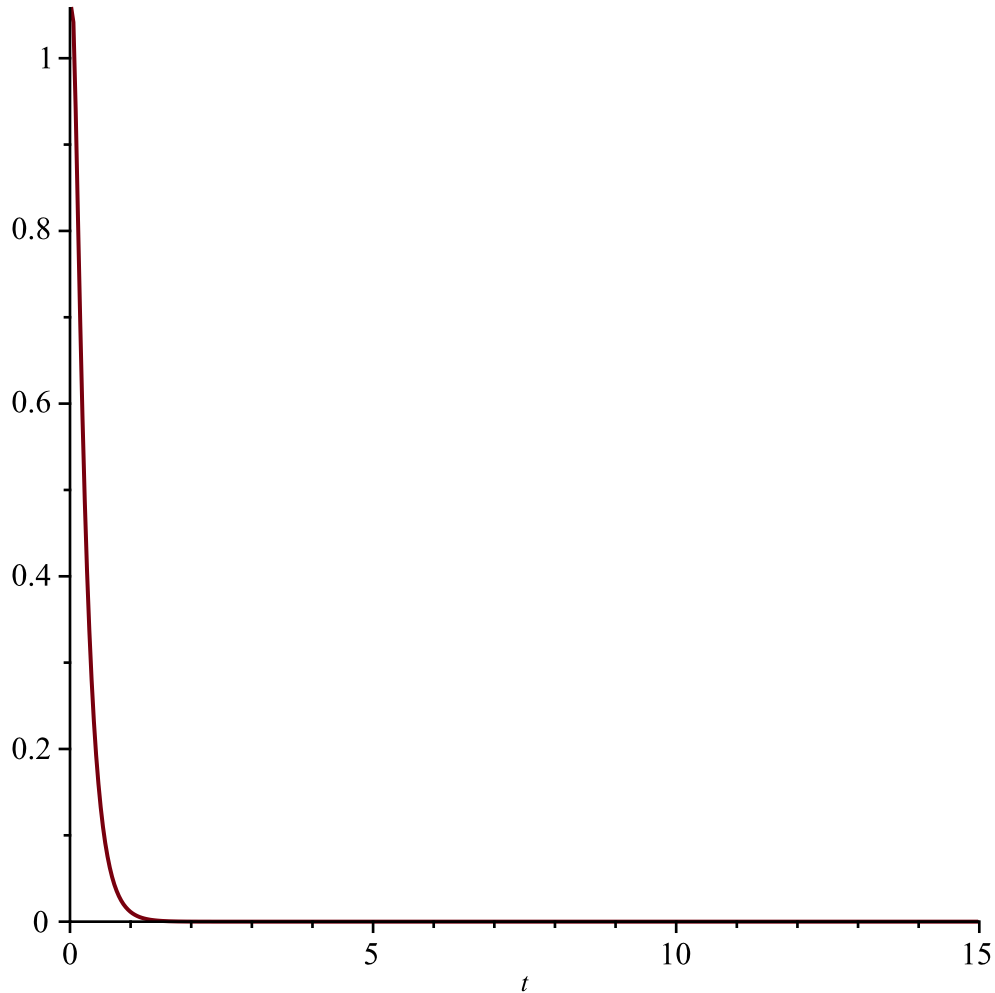
> solb:=dsolve(sist)

$$solb := x(t) = -\frac{2 e^{-20 t}}{3} + \frac{5 e^{-5 t}}{3} \quad (29)$$

> xb:=unapply(rhs(solb), t)

$$xb := t \mapsto -\frac{2 \cdot e^{-20 \cdot t}}{3} + \frac{5 \cdot e^{-5 \cdot t}}{3} \quad (30)$$

> plot(xb(t), t=0..15)



> restart;ecdifc:=diff(x(t),t,t)+4*omega__0^2*diff(x(t),t)+
omega__0^2*x(t)=0

$$ecdifc := \frac{d^2}{dt^2} x(t) + 4 \omega_0^2 \left(\frac{d}{dt} x(t) \right) + \omega_0^2 x(t) = 0 \quad (31)$$

> solc:=dsolve(ecdifc,x(t))

$$solc := x(t) = c_1 e^{\left(-2 \omega_0 + \sqrt{4 \omega_0^2 - 1}\right) \omega_0 t} + c_2 e^{\left(-2 \omega_0 + \sqrt{4 \omega_0^2 - 1}\right) \omega_0 t} \quad (32)$$

> cond_ind:=x(0)=1;cond_ind1:=D(x)(0)=5

$$cond_ind := x(0) = 1$$

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$$\text{cond_ind1} := D(x)(0) = 5 \quad (33)$$

> **ecdifc1:=diff(x(t),t,t)+4*10^2*diff(x(t),t)+10^2*x(t)=0**

$$\text{ecdifc1} := \frac{d^2}{dt^2} x(t) + 400 \frac{d}{dt} x(t) + 100 x(t) = 0 \quad (34)$$

> **sistd:={ecdifc1,cond_ind,cond_ind1}**

$$\text{sistd} := \left\{ \frac{d^2}{dt^2} x(t) + 400 \frac{d}{dt} x(t) + 100 x(t) = 0, x(0) = 1, D(x)(0) = 5 \right\} \quad (35)$$

> **sold:=dsolve(sistd)**

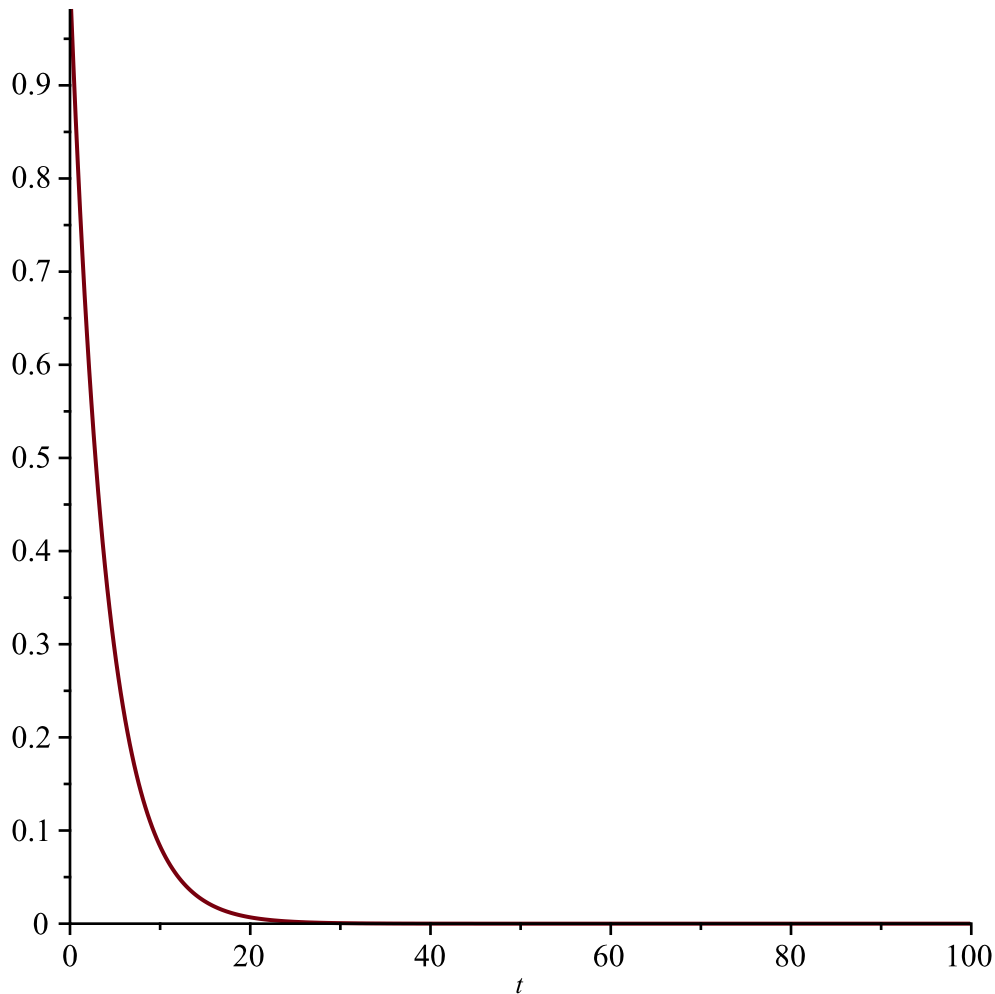
$$\text{sold} := x(t) = \left(\frac{1}{2} + \frac{41\sqrt{399}}{1596} \right) e^{10(-20+\sqrt{399})t} + \left(\frac{1}{2} - \frac{41\sqrt{399}}{1596} \right) e^{-10(20+\sqrt{399})t} \quad (36)$$

> **with(plots):**

> **xd:=unapply(rhs(sold),t)**

$$\text{xd} := t \mapsto \left(\frac{1}{2} + \frac{41\sqrt{399}}{1596} \right) \cdot e^{10 \cdot (-20 + \sqrt{399}) \cdot t} + \left(\frac{1}{2} - \frac{41\sqrt{399}}{1596} \right) \cdot e^{-10 \cdot (20 + \sqrt{399}) \cdot t} \quad (37)$$

> **plot(xd(t),t=0..100)**



> **ecdifd:=diff(x(t),t,t)+lambda*diff(x(t),t)+omega__0^2*x(t)=0**

$$\text{ecdifd} := \frac{d^2}{dt^2} x(t) + \lambda \left(\frac{d}{dt} x(t) \right) + \omega_0^2 x(t) = 0 \quad (38)$$

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> assume(lambda<4*omega__0^2)
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> sole:=dsolve(ecdifd,x(t))
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$$sole := x(t) = c_1 e^{\left(-\frac{\lambda}{2} + \frac{\sqrt{\lambda^2 - 4\omega_0^2}}{2}\right)t} + c_2 e^{\left(-\frac{\lambda}{2} - \frac{\sqrt{\lambda^2 - 4\omega_0^2}}{2}\right)t} \quad (39)$$

```
> cond_ine:=x(0)=1;cond_ine1:=D(x)(0)=5
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$$cond_ine := x(0) = 1$$

$$cond_ine1 := D(x)(0) = 5 \quad (40)$$

```
> lambda:=5;omega__0:=10
```

$$\lambda := 5$$

$$\omega_0 := 10 \quad (41)$$

```
> sistem:={ecdifd,cond_ine,cond_ine1}
```

$$sistem := \left\{ \frac{d^2}{dt^2} x(t) + 5 \frac{d}{dt} x(t) + 100 x(t) = 0, x(0) = 1, D(x)(0) = 5 \right\} \quad (42)$$

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> solf:=dsolve(sistem)
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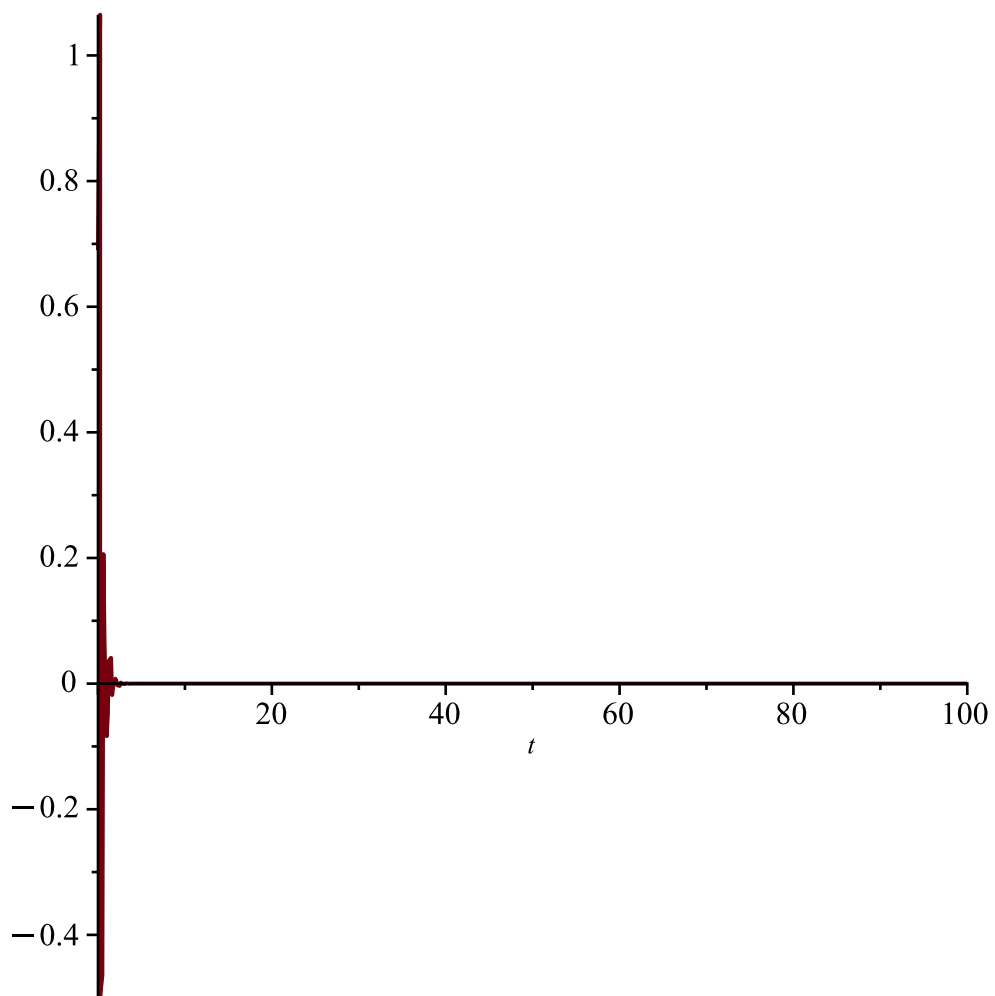
$$solf := x(t) = \frac{e^{-\frac{5t}{2}} \left(\sqrt{15} \sin\left(\frac{5\sqrt{15}t}{2}\right) + 5 \cos\left(\frac{5\sqrt{15}t}{2}\right) \right)}{5} \quad (43)$$

```
> xe:=unapply(rhs(solf))
```

$$xe := () \mapsto \frac{e^{-\frac{5 \cdot t}{2}} \cdot \left(\sqrt{15} \cdot \sin\left(\frac{5 \cdot \sqrt{15} \cdot t}{2}\right) + 5 \cdot \cos\left(\frac{5 \cdot \sqrt{15} \cdot t}{2}\right) \right)}{5} \quad (44)$$

```
> with(plots):
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> plot(xe(t),t=0..100)
```



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> #ex3:  
> restaer
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restaer

(45)