Многоуровневое управление в простейшей линейной системе
Multilevel control in simplest linear systems

```
> restart;
```

```
> with(plots);
```

[*animate*, *animate3d*, *animatecurve*, *arrow*, *changecoords*, *complexplot*, *complexplot3d*, *conformal*, *conformal3d*, *contourplot*, *contourplot3d*, *coordplot*, *coordplot3d*, *densityplot*, *display*, *dualaxisplot*, *fieldplot*, *fieldplot3d*, *gradplot*, *gradplot3d*, *implicitplot*, *implicitplot3d*, *inequal*, *interactive*, *interactiveparams*, *intersectplot*, *listcontplot*, *listcontplot3d*, *listdensityplot*, *listplot*, *listplot3d*, *loglogplot*, *logplot*, *matrixplot*, *multiple*, *odeplot*, *pareto*, *plotcompare*, *pointplot*, *pointplot3d*, *polarplot*, *polygonplot*, *polygonplot3d*, *polyhedra_supported*, *polyhedraplot*, *rootlocus*, *semilogplot*, *setcolors*, *setoptions*, *setoptions3d*, *shadebetween*, *spacecurve*, *sparsematrixplot*, *surfdata*, *textplot*, *textplot3d*, *tubeplot*] **(1)**

```
> X:=100;
```

$$X := 100 \quad \textbf{(2)}$$

```
> k:=0.3;
```

$$k := 0.3 \quad \textbf{(3)}$$

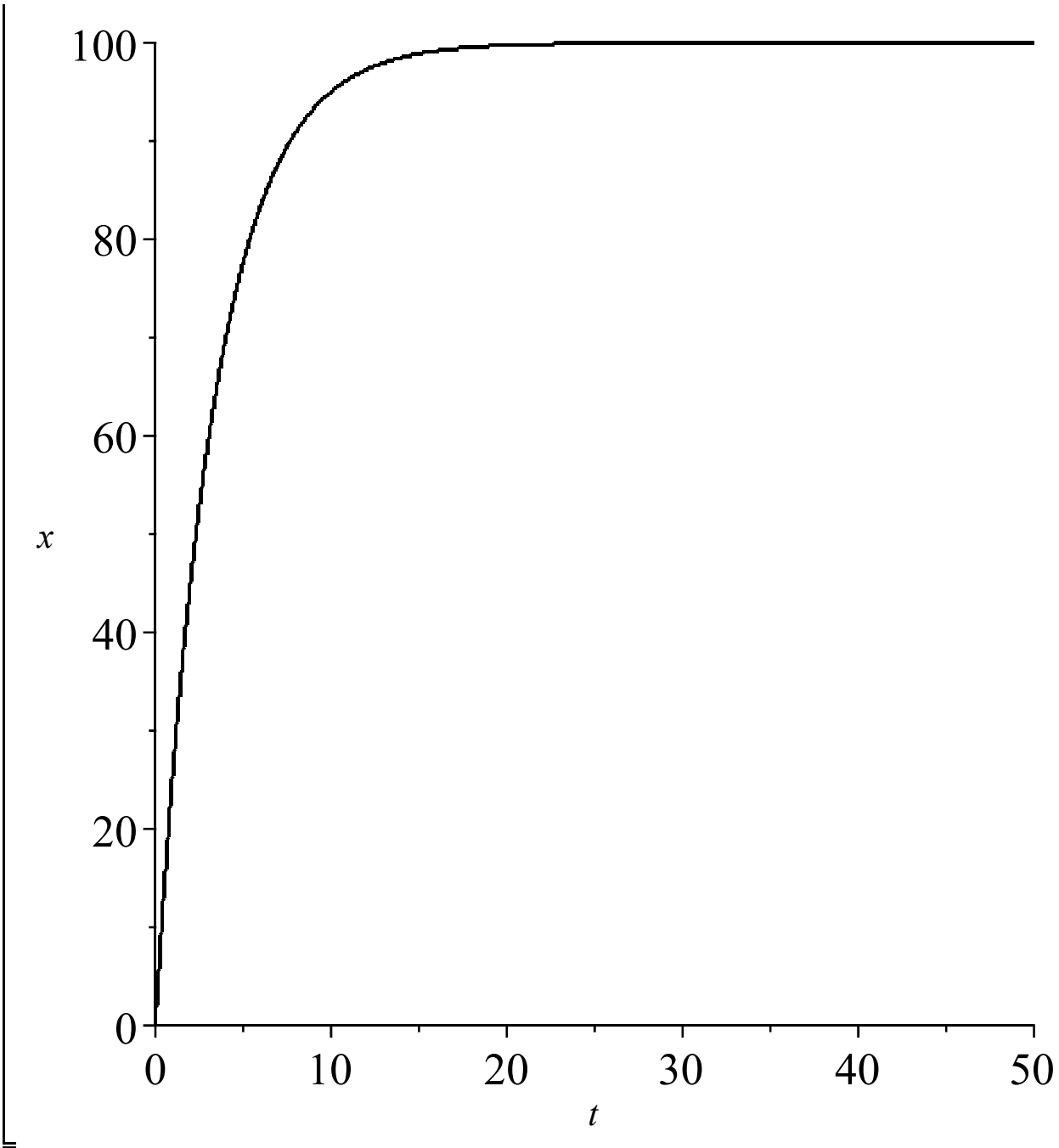
```
> ur1:=diff(x(t),t)=-k*(x(t)-X);
```

$$ur1 := \frac{d}{dt} x(t) = -0.3\, x(t) + 30.0 \quad \textbf{(4)}$$

```
> resh1:=dsolve({ur1,x(0)=0},{x(t)},type=numeric,method=rosenbrock,
  abserr=1e-4, relerr=1e-4,output=listprocedure);
```

$$resh1 := [t = \textbf{proc}(t) \ \ldots \ \textbf{end proc}, x(t) = \textbf{proc}(t) \ \ldots \ \textbf{end proc}] \quad \textbf{(5)}$$

```
> pic_ch_1:=odeplot(resh1,[t,x(t)],0..50,numpoints=5000,color=
  black,thickness=1):
> display(pic_ch_1);
```




```
> #-------------------------------------------------------------
  ---------------------
```

```
> ur2:=diff(x(t),t)=y(t);
```

$$ur2 := \frac{d}{dt} x(t) = y(t) \tag{6}$$

```
> ur3:=diff(y(t),t)=-k*(x(t)-X);
```

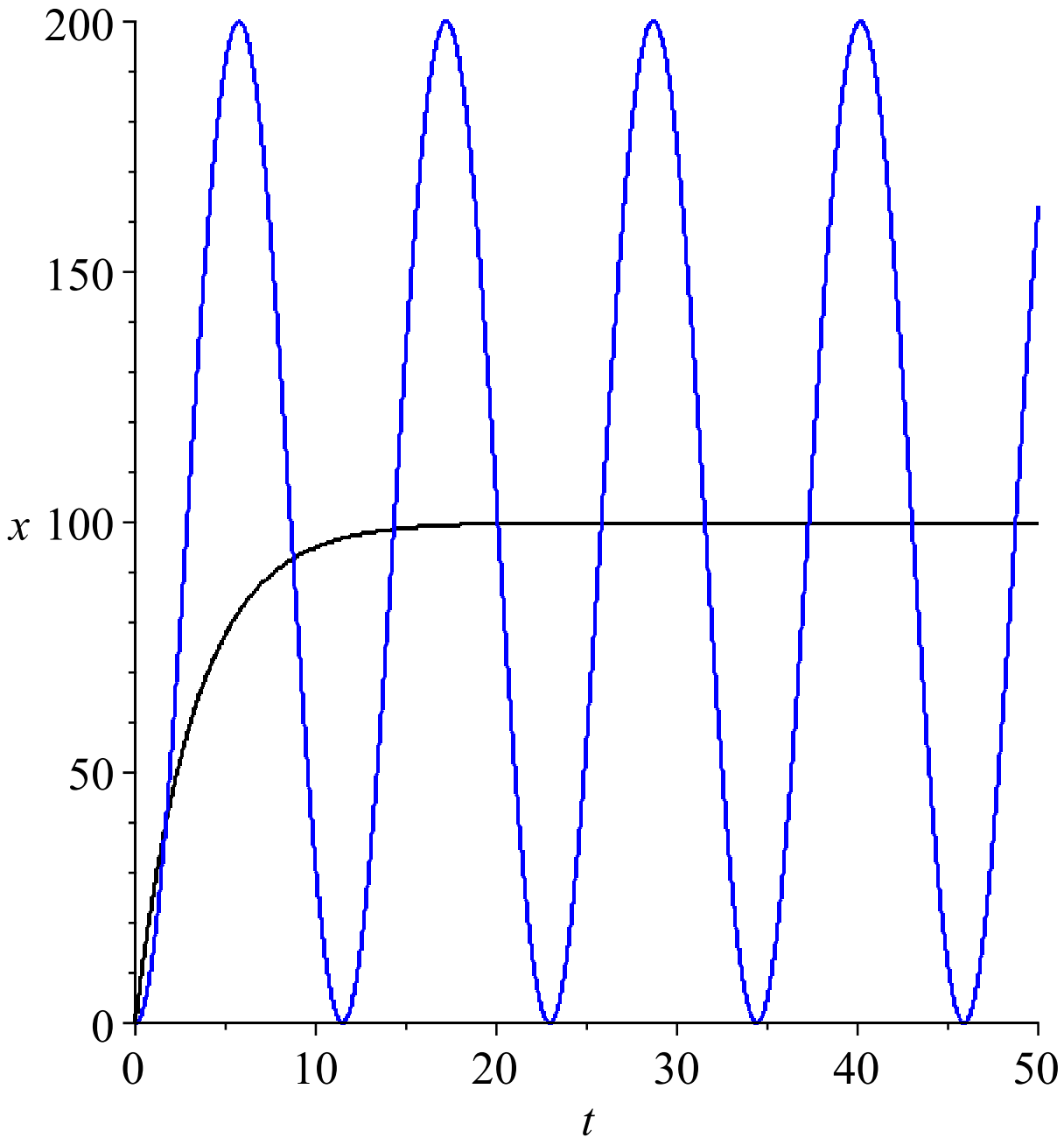
$$ur3 := \frac{d}{dt} y(t) = -0.3\, x(t) + 30.0 \tag{7}$$

```
> resh2:=dsolve({ur2,ur3,x(0)=0,y(0)=0},{x(t),y(t)},type=numeric,
```

```
  method=rosenbrock,abserr=1e-4, relerr=1e-4,output=listprocedure);
```

$$resh2 := [t = \mathbf{proc}(t) \ \ldots \ \mathbf{end\ proc}, x(t) = \mathbf{proc}(t) \ \ldots \ \mathbf{end\ proc}, y(t) = \mathbf{proc}(t) \ \ldots \ \mathbf{end\ proc}] \quad (8)$$

```
> pic_ch_2:=odeplot(resh2,[t,x(t)],0..50,numpoints=5000,color=blue,
  thickness=1):
> display(pic_ch_1,pic_ch_2);
```




```
> #-------------------------------------------------------------
  ---------------------
```

```
> ur4:=diff(x(t),t)=y(t);
```

(9)

$$ur4 := \frac{d}{dt}\,x(t) = y(t) \tag{9}$$

```
> ur5:=diff(y(t),t)=z(t);
```

$$ur5 := \frac{d}{dt}\,y(t) = z(t) \tag{10}$$

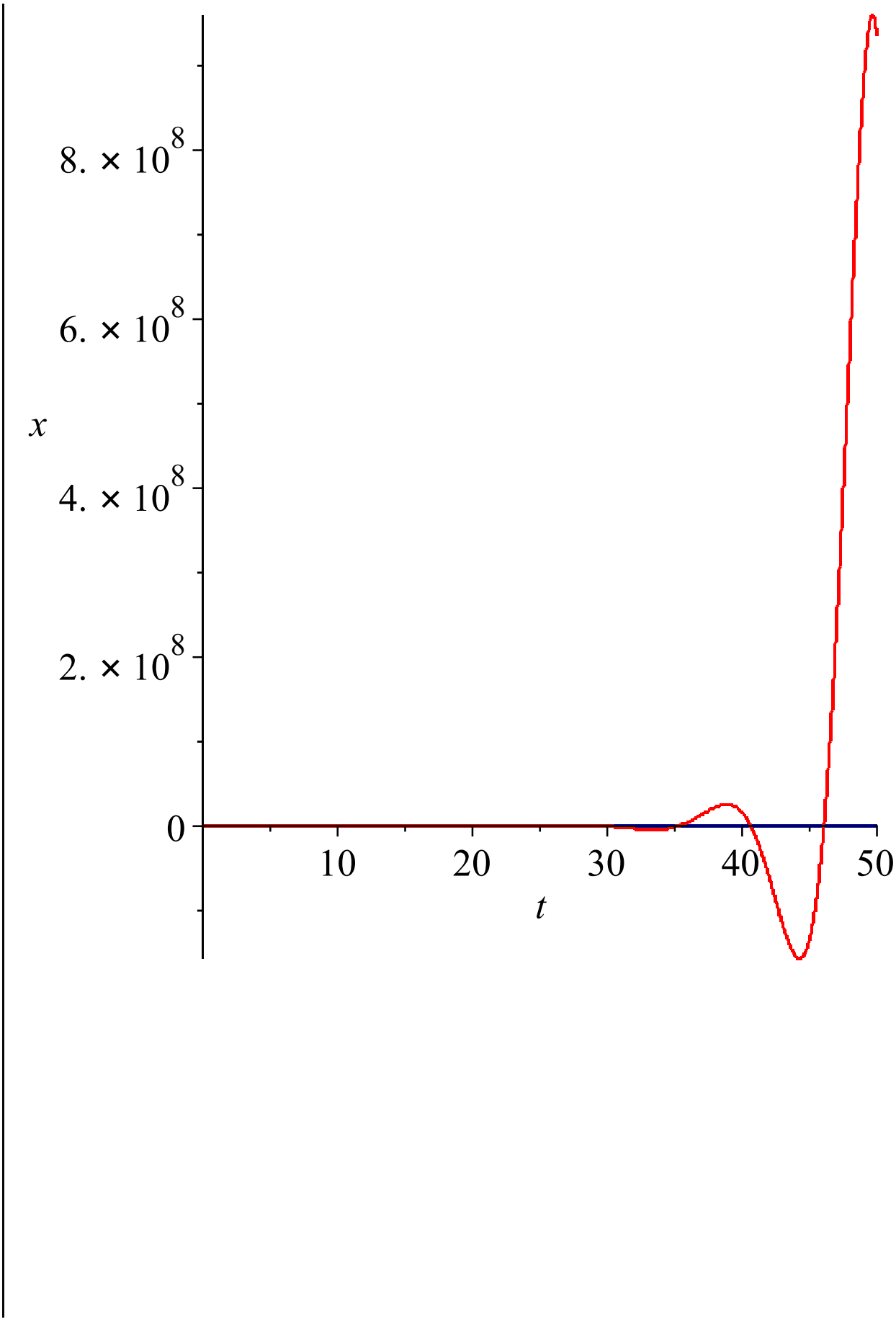
```
> ur6:=diff(z(t),t)=-k*(x(t)-X);
```

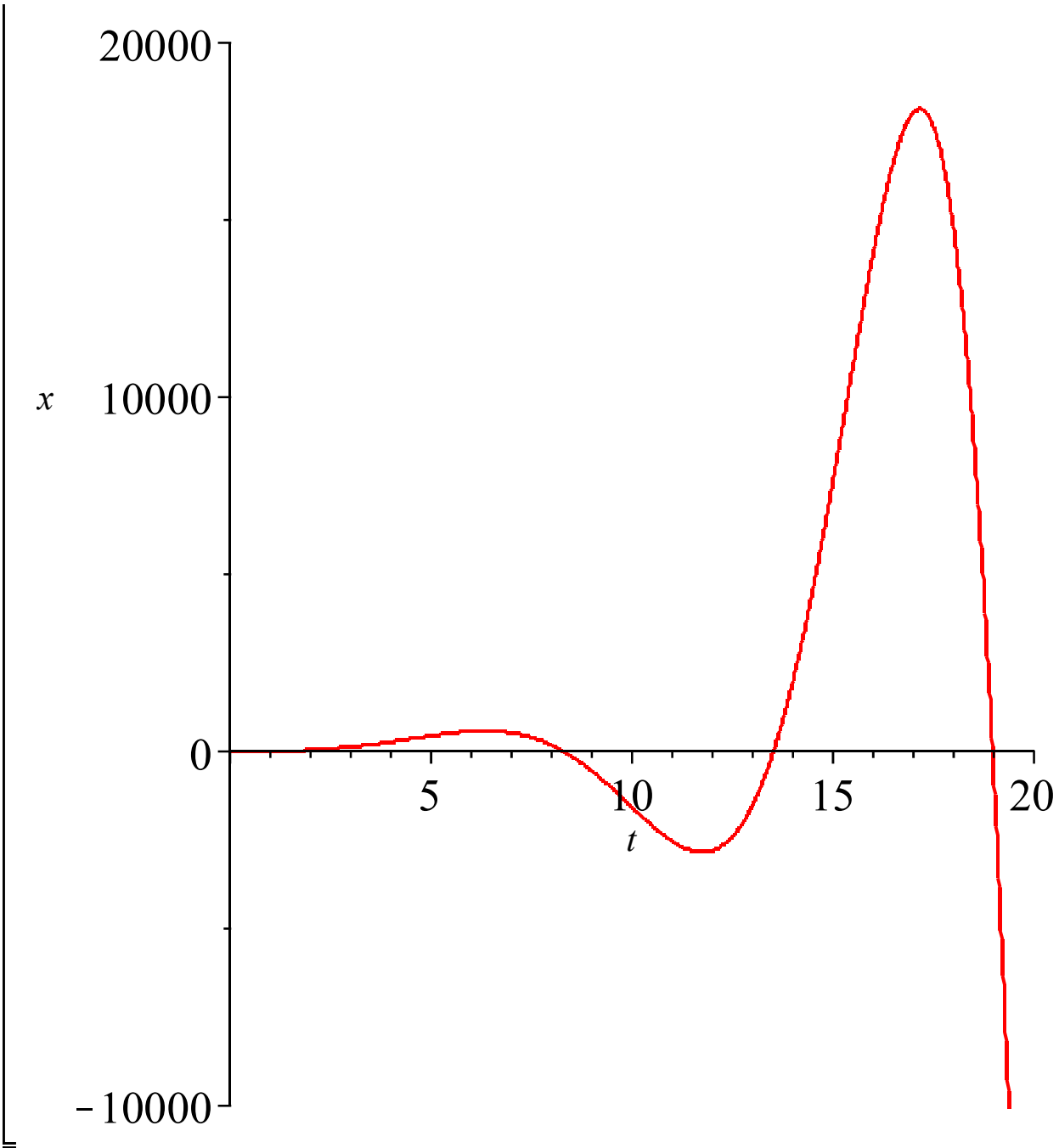
$$ur6 := \frac{d}{dt}\,z(t) = -0.3\,x(t) + 30.0 \tag{11}$$

```
> resh3:=dsolve({ur4,ur5,ur6,x(0)=0,y(0)=0,z(0)=0},{x(t),y(t),z(t)}
  ,type=numeric,method=rosenbrock,abserr=1e-4, relerr=1e-4,output=
  listprocedure);
```

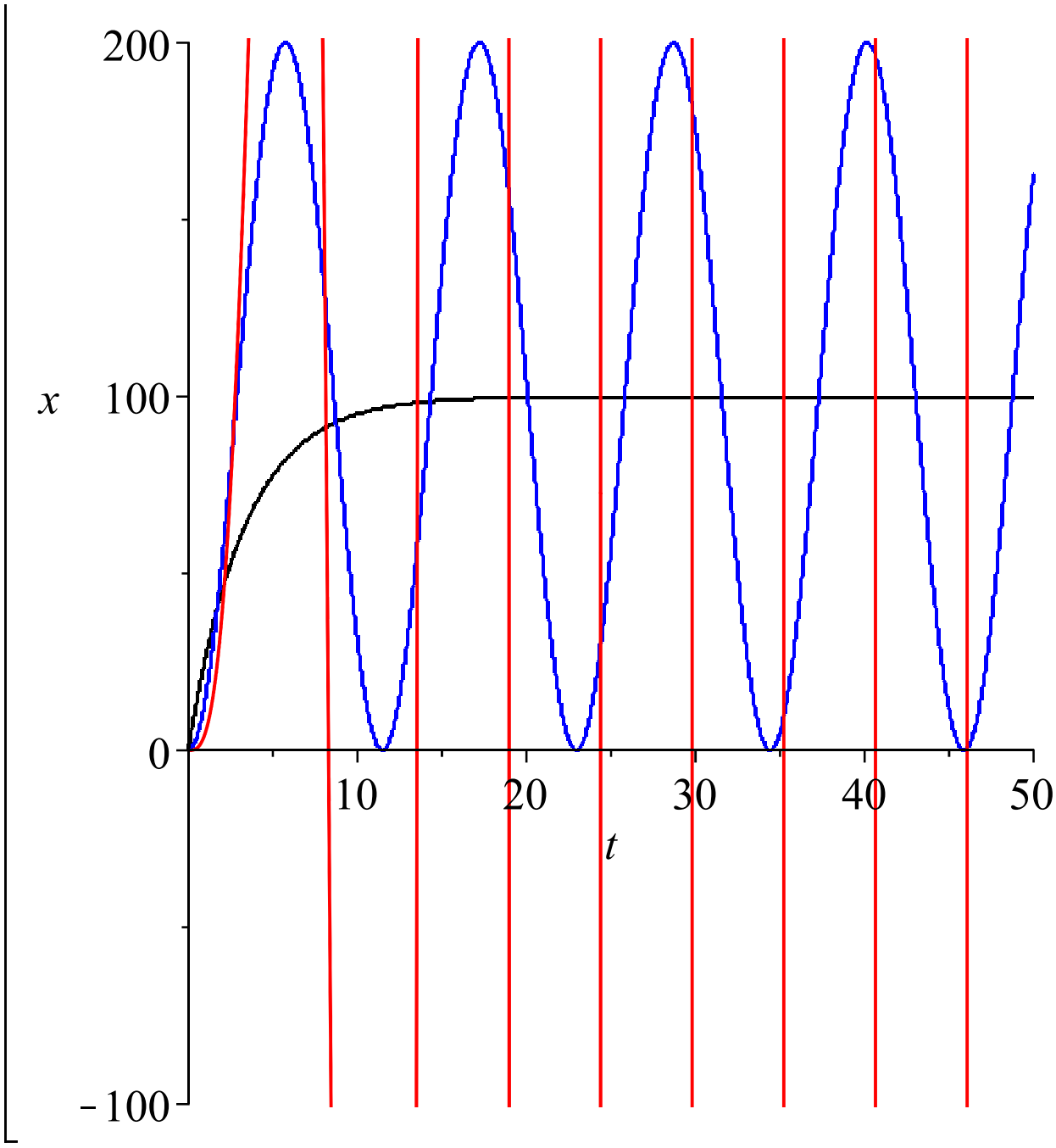
$$resh3 := [t = \mathbf{proc}(t)\ \ldots\ \mathbf{end\ proc}, x(t) = \mathbf{proc}(t)\ \ldots\ \mathbf{end\ proc}, y(t) = \mathbf{proc}(t)\ \ldots\ \mathbf{end\ proc}, \tag{12}$$
$$z(t) = \mathbf{proc}(t)\ \ldots\ \mathbf{end\ proc}]$$

```
> pic_ch_3:=odeplot(resh3,[t,x(t)],0..50,numpoints=5000,color=red,
  thickness=1):
> display(pic_ch_1,pic_ch_2,pic_ch_3);display(pic_ch_3,view=[0..20,
  -10000..20000]);
```


8. × 10^8
6. × 10^8
4. × 10^8
2. × 10^8
0
x
10
20
30
40
50
t




```
> display(pic_ch_1,pic_ch_2,pic_ch_3, view=[0..50,-100..200]);
```


200
100
0
-100
x
10
20
30
40
50
t