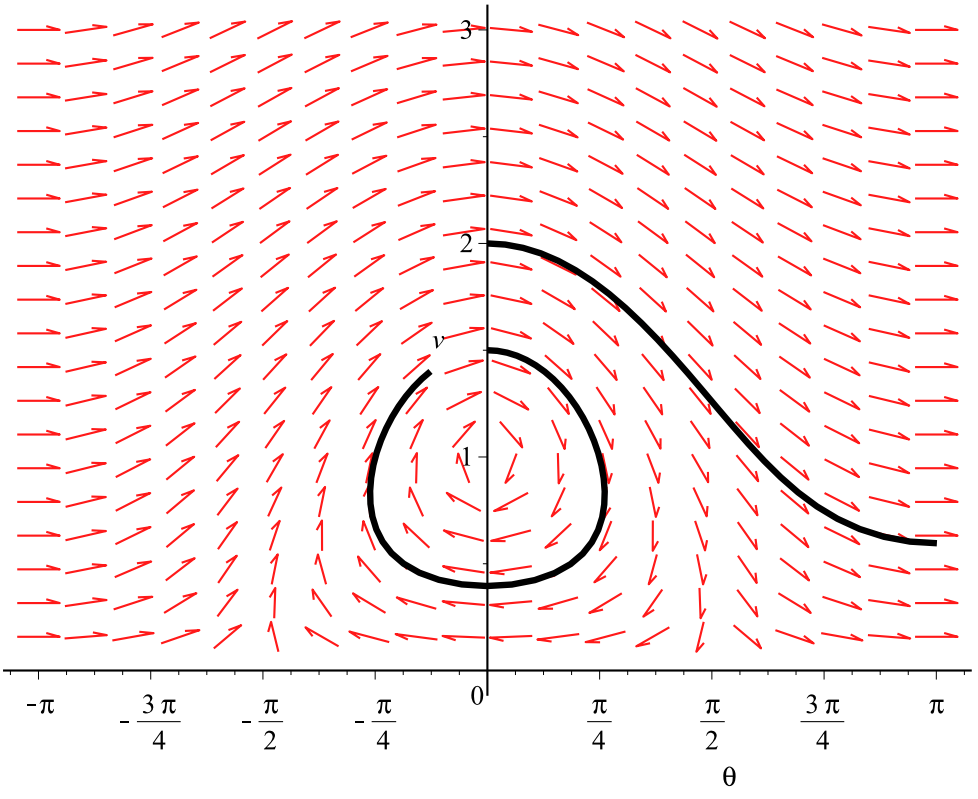
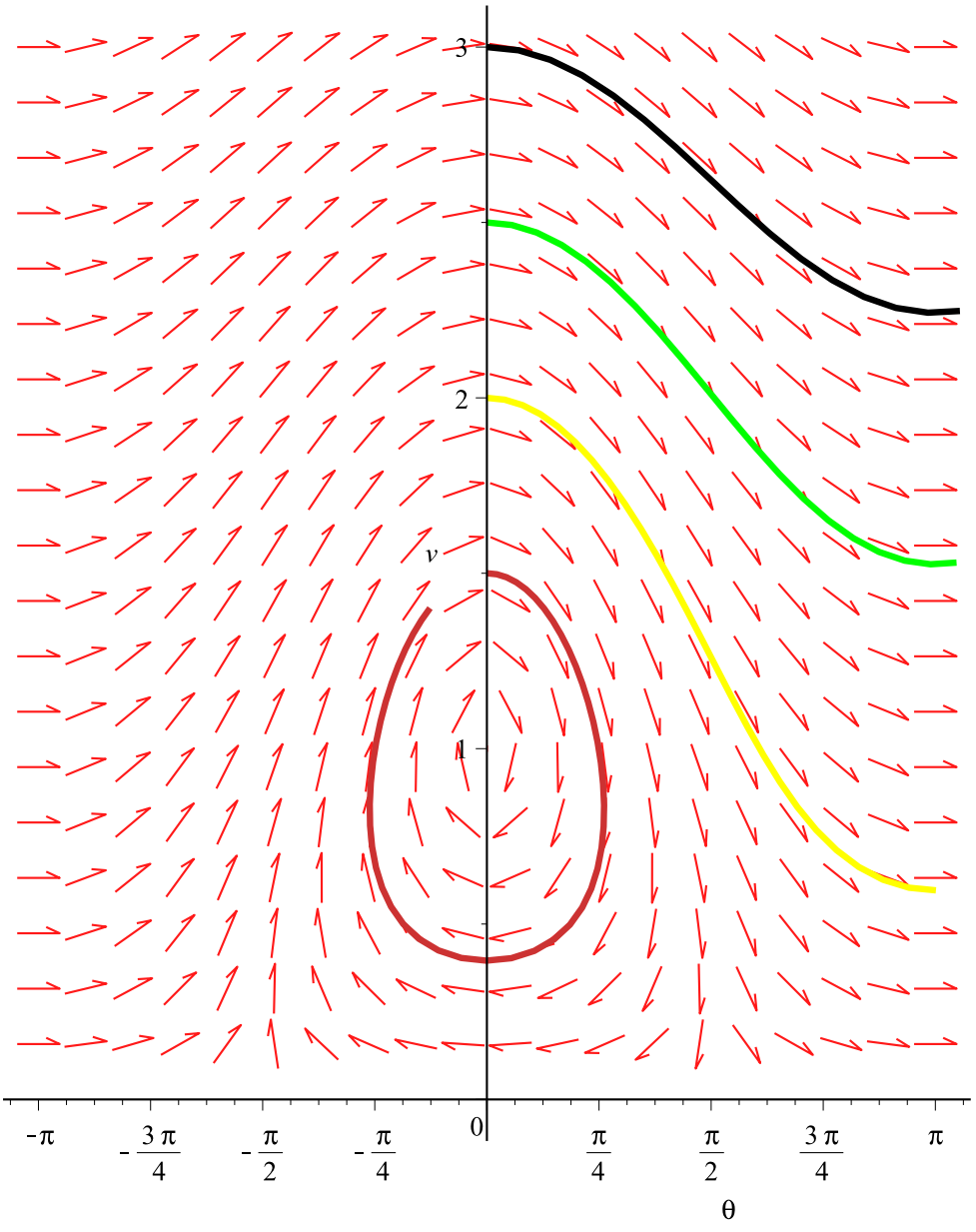
```
> with(DEtools):
> phug:=R-> [ diff(theta(t),t)=v(t)-cos(theta(t))/v(t),
              diff(v(t),t)    = -sin(theta(t)) - R*(v(t))^2 ];
```

$$phug := R \rightarrow \left[\frac{d}{dt}\,\theta(t) = v(t) - \frac{\cos(\theta(t))}{v(t)},\ \frac{d}{dt}\,v(t) = -\sin(\theta(t)) - R\,v(t)^2 \right] \quad (1)$$

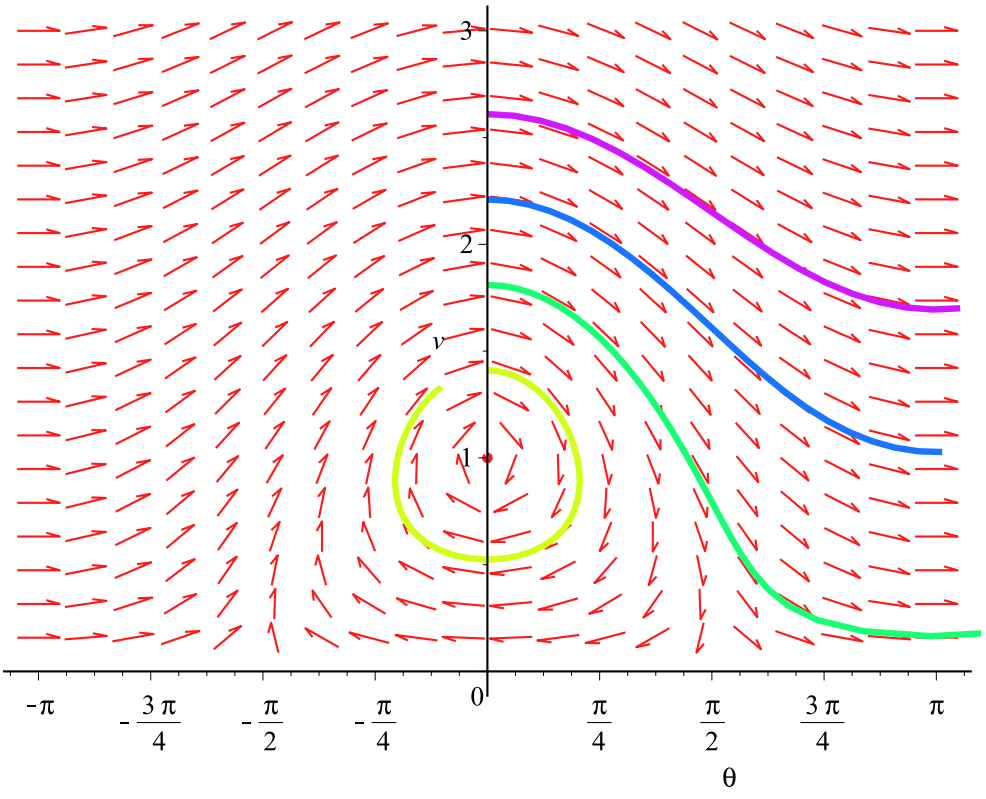
```
> DEplot( phug(0), [theta,v], t=0..4, theta=-Pi..Pi, v=0..3,
  [[theta(0)=0, v(0)=2], [theta(0)=0, v(0)=1.5]],
  tickmarks=[piticks,default], linecolor=black);
```



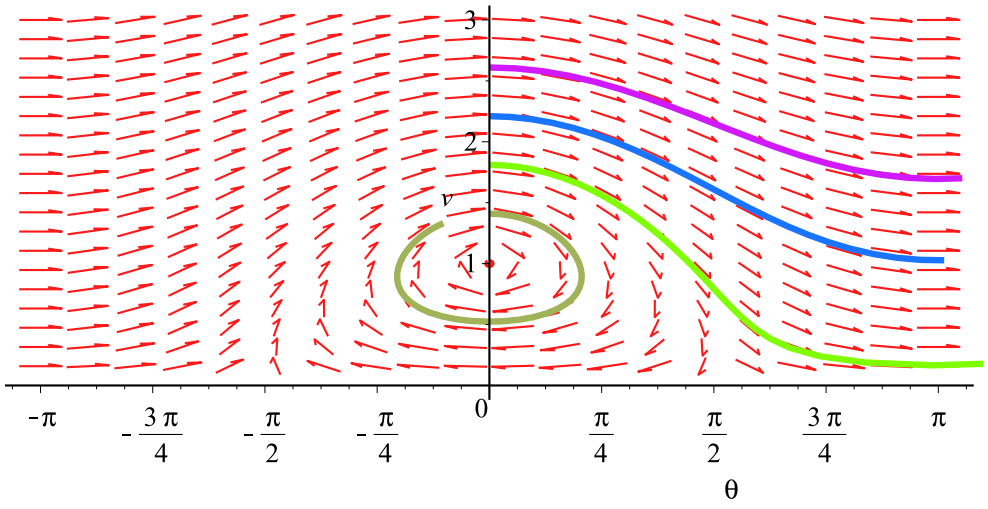

```
> DEplot( phug(0), [theta,v], t=0..4, theta=-Pi..Pi, v=0..3,
  [seq([theta(0)=0, v(0)=vel], vel=1..3, .5)],
  tickmarks=[piticks,default], linecolor=[red,orange,yellow,green,
  black]);
```



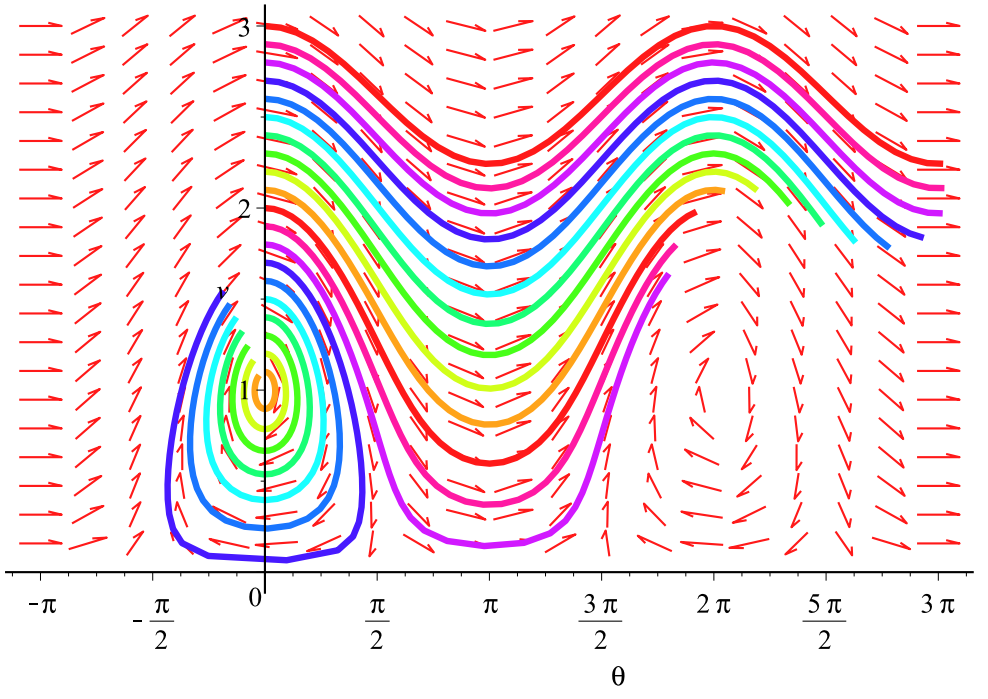

```
> DEplot( phug(0), [theta,v], t=0..4, theta=-Pi..Pi, v=0..3,
  [seq([theta(0)=0, v(0)=vel], vel=1.01..3, .4)],
  tickmarks=[piticks,default], linecolor=[COLOR(HUE,0.0), COLOR
  (HUE,.2), COLOR(HUE,.4), COLOR(HUE,.6), COLOR(HUE,.8)]);
```



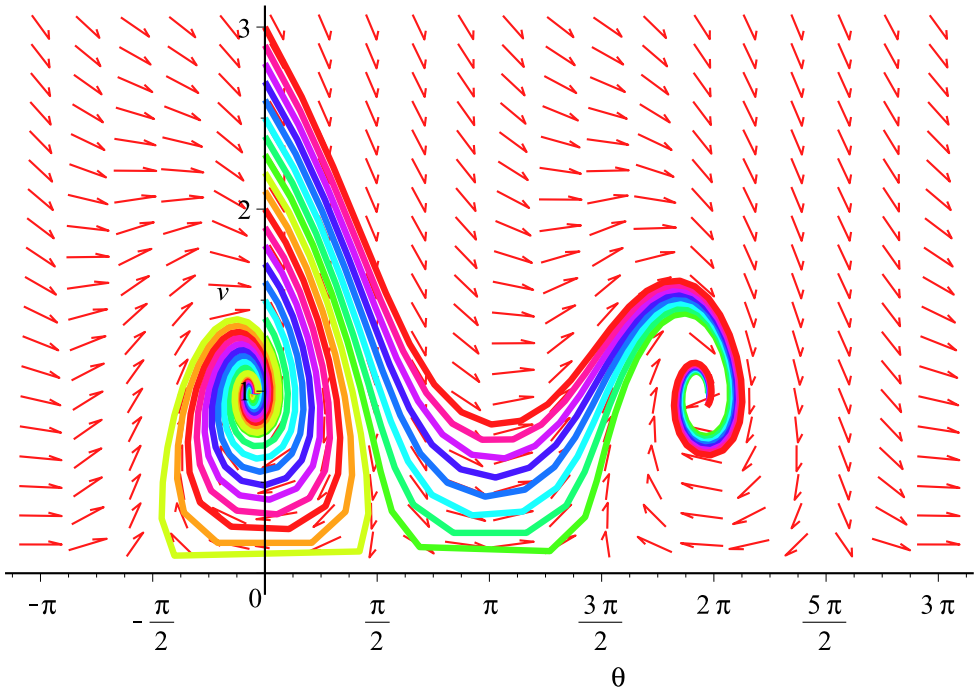

```
> DEplot( phug(0), [theta, v], t = 0..4, theta = -Pi..Pi, v = 0..3,
  [seq( [theta(0) = 0, v(0) = vel], vel = 1.01..3, .4) ],
  tickmarks = [piticks, default], linecolor = [COLOR(HUE, 0.0), COLOR(HSV, .2, .5, .7),
        COLOR(RGB, .5, 1, 0), COLOR(HUE, .6), COLOR(HUE, .8) ]);
```



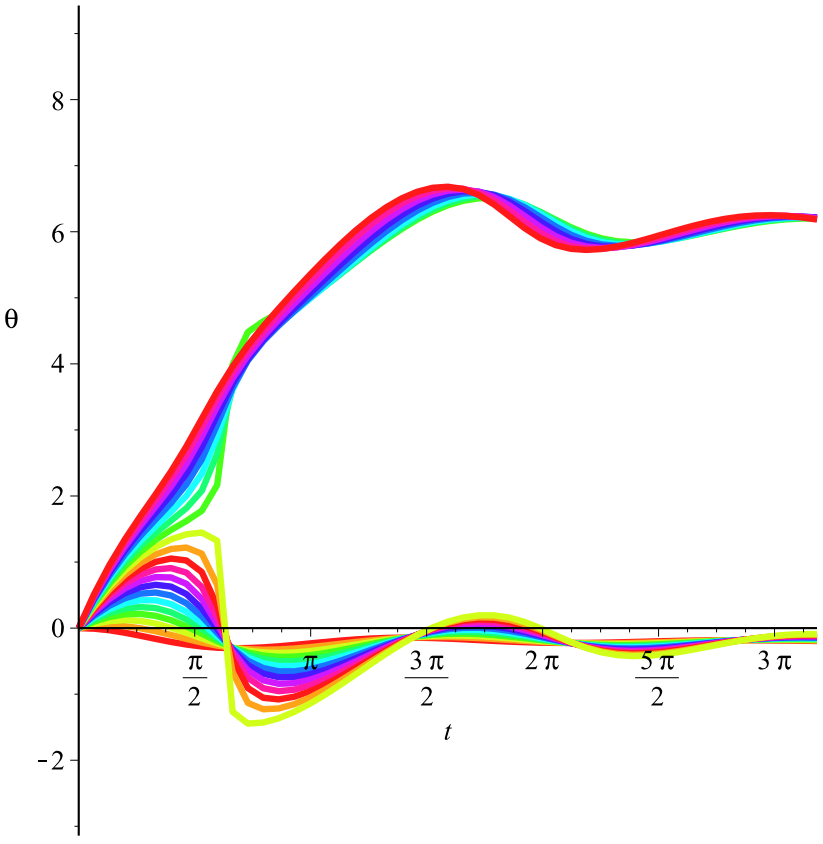

```
> DEplot(phug(0), [theta, v], t = 0 .. 4, theta = -Pi .. 3*Pi, v =
  0 .. 3, [seq([theta(0) = 0, v(0) = vel], vel = 1 .. 3, .1)],
  tickmarks = [piticks, default], linecolor = [seq(COLOR(HUE, h),h=
  1..3, .1)]);
```




```
> DEplot(phug(0.2), [theta, v], t = 0 .. 10, theta = -Pi .. 3*Pi, v
  = 0 .. 3, [seq([theta(0) = 0, v(0) = vel], vel = 1 .. 3, .1)],
  tickmarks = [piticks, default], linecolor = [seq(COLOR(HUE, h),h=
  1..3, .1)]);
```



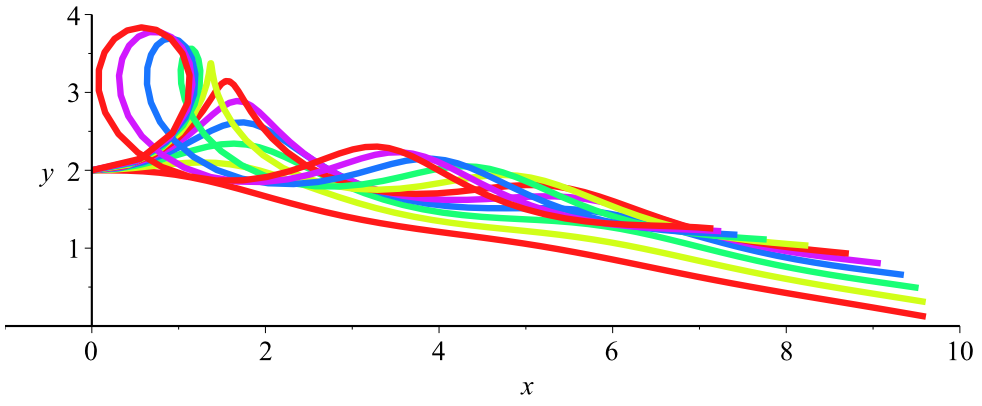

```
> DEplot(phug(0.2), [theta, v], t = 0 .. 10, theta = -Pi .. 3*Pi, v
  = 0 .. 3, [seq([theta(0) = 0, v(0) = vel], vel = 1 .. 3, .1)],
  tickmarks = [piticks, default], linecolor = [seq(COLOR(HUE, h),h=
  1..3, .1)], scene=[t,theta]);
```



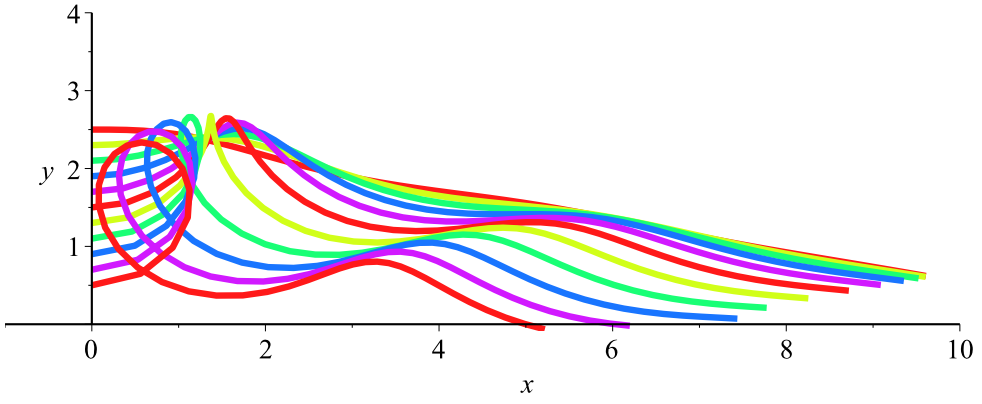

```
> xphug:=R-> [diff(theta(t),t)=v(t)-cos(theta(t))/v(t),
              diff(v(t),t)    = -sin(theta(t)) - R*(v(t))^2,
              diff(x(t),t)    =v(t)*cos(theta(t)),
              diff(y(t),t)    =v(t)*sin(theta(t))];
```

$$xphug := R \rightarrow \left[\frac{d}{dt}\,\theta(t) = v(t) - \frac{\cos(\theta(t))}{v(t)}, \frac{d}{dt}\,v(t) = -\sin(\theta(t)) - R\,v(t)^2, \frac{d}{dt}\,x(t) = v(t)\cos(\theta(t)), \frac{d}{dt}\,y(t) = v(t)\sin(\theta(t)) \right] \quad (2)$$

```
> DEplot(xphug(0.2), [theta, v, x, y],
    t = 0..10, theta = -Pi..3*Pi, v = 0..3, x=-1..10, y=0..4,
   [seq([theta(0)=0, v(0)=vel, x(0)=0, y(0)=2], vel = 1..3, .2)],
   linecolor = [seq(COLOR(HUE, h),h=1..3, .2)],
   scene=[x,y]);
```




```
> DEplot(xphug(0.2), [theta, v, x, y],
    t = 0..10, theta = -Pi..3*Pi, v = 0..3, x=-1..10, y=0..4,
   [seq([theta(0)=0, v(0)=vel, x(0)=0, y(0)=3.5-vel], vel = 1..3,
   .2)],
    linecolor = [seq(COLOR(HUE, h),h=1..3, .2)],
    scene=[x,y]);
```




```
>
```