Phase Plane Plot of the Van der Pol Differential Equation

```
Manipulate[process[λ, k, pt],
 Row[{Control[ {{λ, .2, Style["λ"]}, 0, 2, .1, Appearance → "Labeled", ImageSize → Normal}],
   Control[
    {{k, 1, Style["k", Italic]}, .1, 3, .1, Appearance → "Labeled", ImageSize → Normal}] }],
 {{pt, {1, 3}}, {-5, -5}, {5, 5}, ControlType → Locator},
 ControlPlacement → {Top},

 Initialization ⧴ {
   process[λ_, k_, pt_] := Module[{eq, x, t, tmax = 100, sol, paramPlot,
     solPlot, vData, x0, v0, lableSize = 14, initialConditionsString},
    eq = x''[t] - λ (1 - x[t]^2) x'[t] + k x[t] == 0;
    sol = First[NDSolve[{eq, x[0] == pt[[1]], x'[0] == pt[[2]]}, x, {t, 0, tmax}]];

    initialConditionsString = Style[Row[{Style["x", Italic], "(0)  = ",
       NumberForm[pt[[1]], {3, 2}, NumberSigns → {"-", "+"}], "    ", Style["x", Italic]',
       "(0)  = ", NumberForm[pt[[2]], {3, 2}, NumberSigns → {"-", "+"}]
      }], lableSize, TextAlignment → Center];

    paramPlot = ParametricPlot[Evaluate[{x[t], x'[t]} /. sol], {t, 0, tmax},
      AspectRatio → Automatic,
      PlotRange → {{-5, 5}, {-5, 5}},
      PlotPoints → 100,
      Frame → True,
      FrameLabel → {
        {Style[Row[{Style["x", Italic]', "(", Style["t", Italic], ")"}], lableSize], None},
        {Style[Row[{Style["x", Italic], "(", Style["t", Italic], ")"}], lableSize],
         Column[ { Style["phase plane plot", lableSize], initialConditionsString
           }, Alignment -> Center]}},
      ImageSize → {270, 220},
      ImagePadding → 40,
      PlotStyle -> Red];

    solPlot = Plot[Evaluate[x[t] /. sol], {t, 0, tmax},
      PlotRange → All,
      FrameLabel → {
        {Style[Row[{Style["x", Italic], "(", Style["t", Italic], ")"}], lableSize], None},
        {Style["time", lableSize], Style[Row[{Style["x", Italic],
            "(", Style["t", Italic], ") versus time"}], lableSize]}},
      AspectRatio → 1,
      Frame → True,
      ImageSize → {270, 220},
      ImagePadding → 40,
      PlotStyle -> Red];

    Grid[{ {paramPlot, solPlot }}, Frame → None, Spacings → 0]
   ]}
]
```
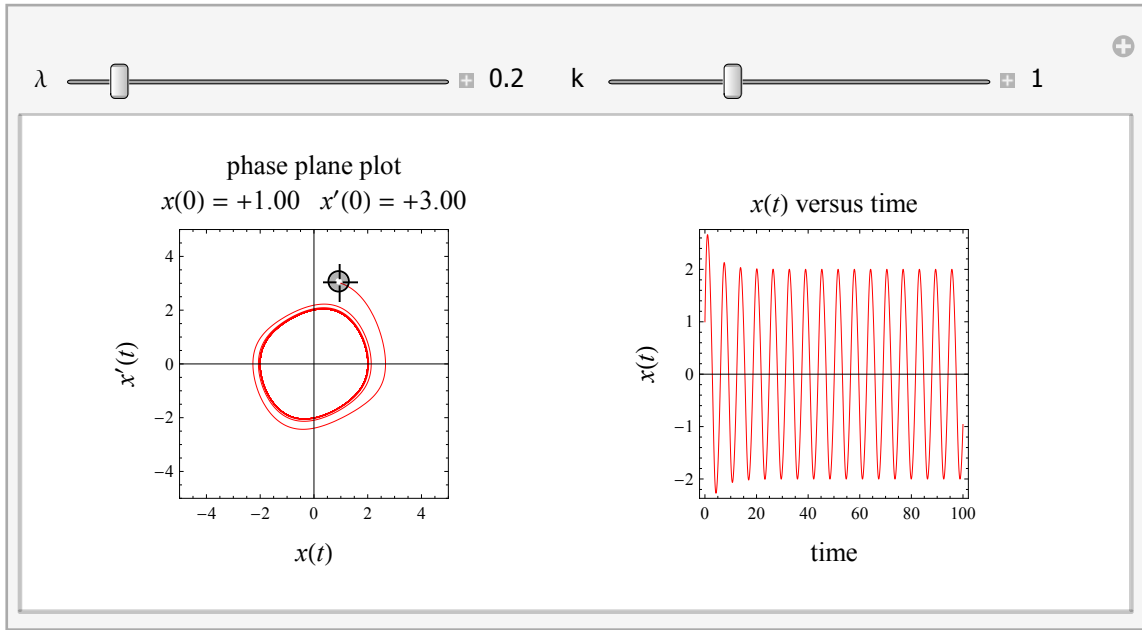
- Contributed by: Nasser Abbasi

A full-function Wolfram *Mathematica* system (Version 6 or higher) is required to edit this notebook.

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