## Note to new Mathematica users

To execute the cell you are currently in, press Shift-Enter. The cells in this notebook are intended to be executed in order, but you can also go back and modify earlier commands.

# Slope Fields

## Setup

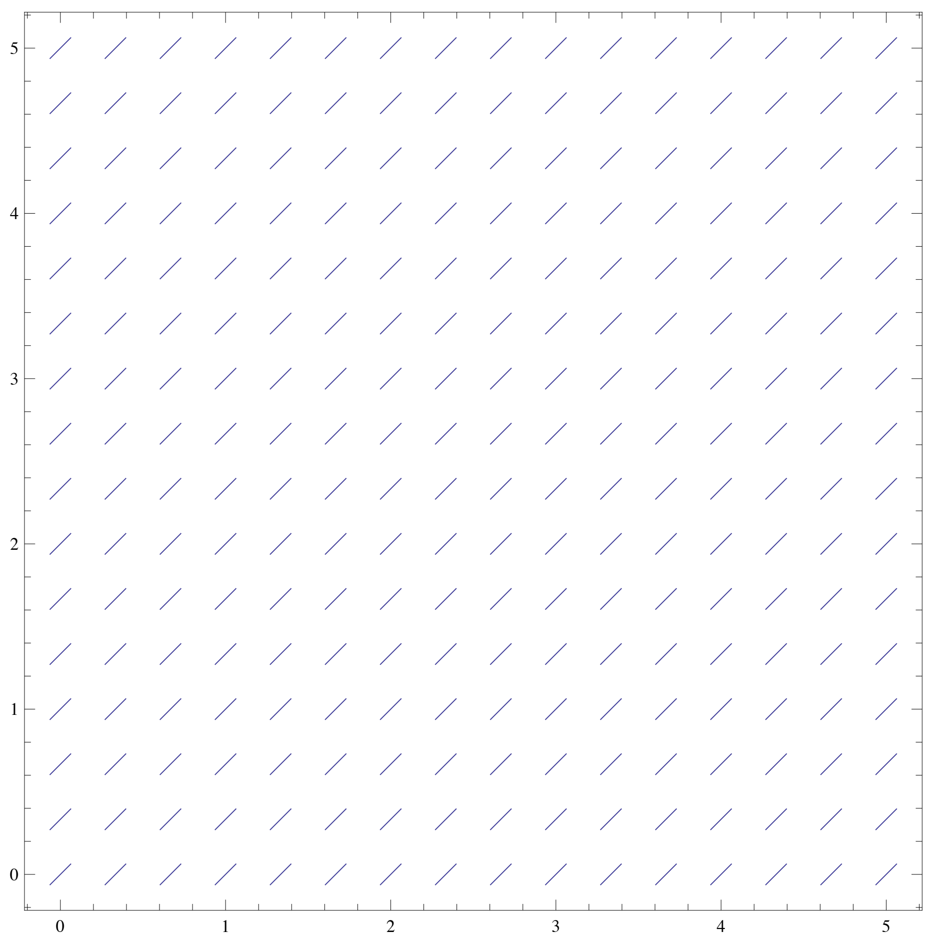
In[1]:=
```
NormalizeVector[{v_, w_}] = 1/Sqrt[v^2 + w^2] {v, w};
```

$$\text{NormalizeVector}[\{v\_, w\_\}] = \frac{1}{\sqrt{v\verb|^|2 + w\verb|^|2}} \{v, w\};$$

## Constant Slope

In[2]:=
```
constantSlopeField = VectorPlot[
  NormalizeVector[{1, 1}], {x, 0, 5}, {y, 0, 5},
  VectorPoints → 16, VectorStyle → "Segment", VectorScale → {0.025, Scaled[1], #5 &}
 ]
```

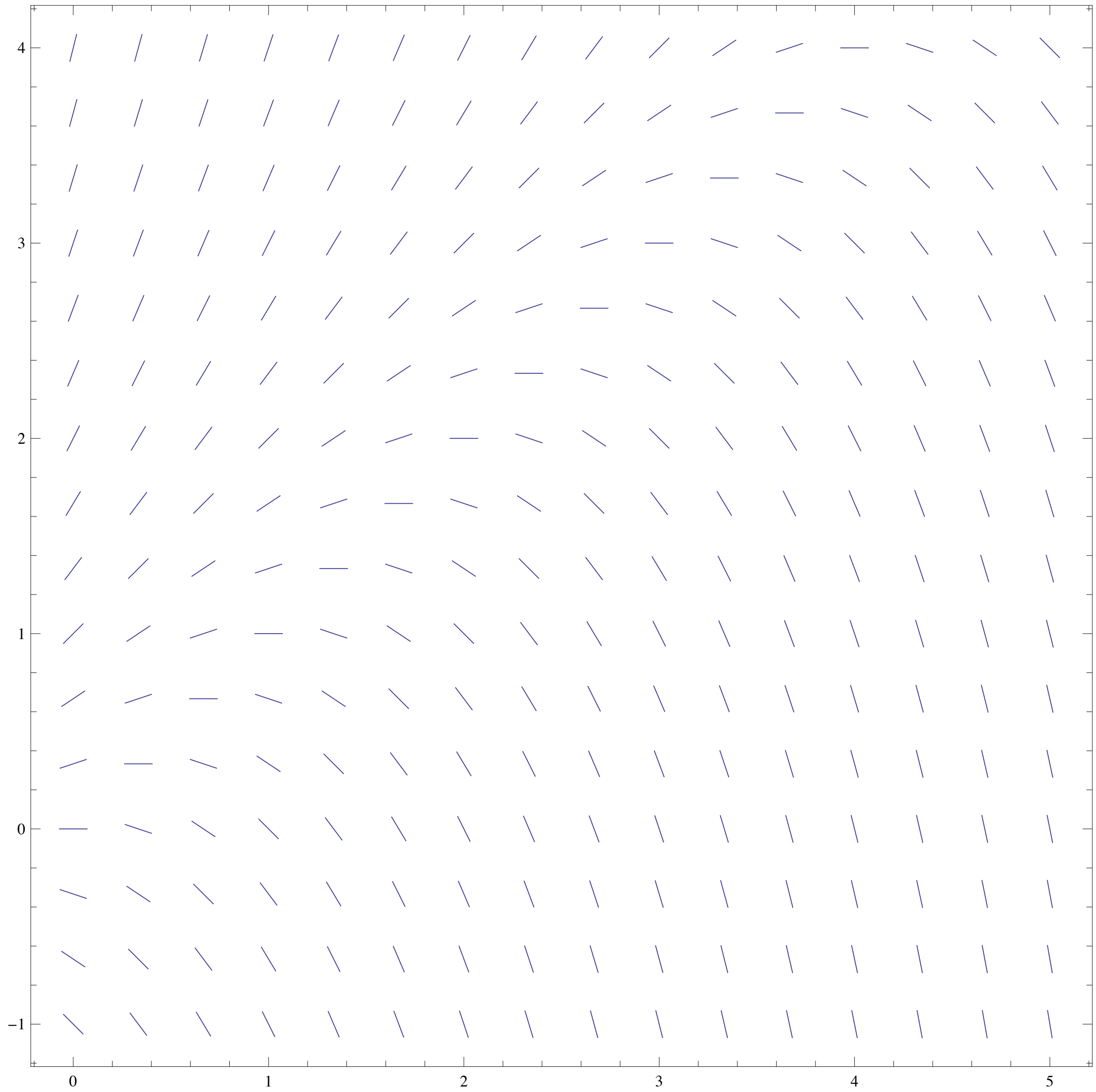
Out[2]=



## Linear DE

In[3]:=
```
linearDESlopeField = VectorPlot[
  NormalizeVector[{1, y - x}], {x, 0, 5}, {y, -1, 4},
  VectorPoints → 16, VectorStyle → "Segment", VectorScale → {0.02, Scaled[1], #5 &}
 ]
```

Out[3]=

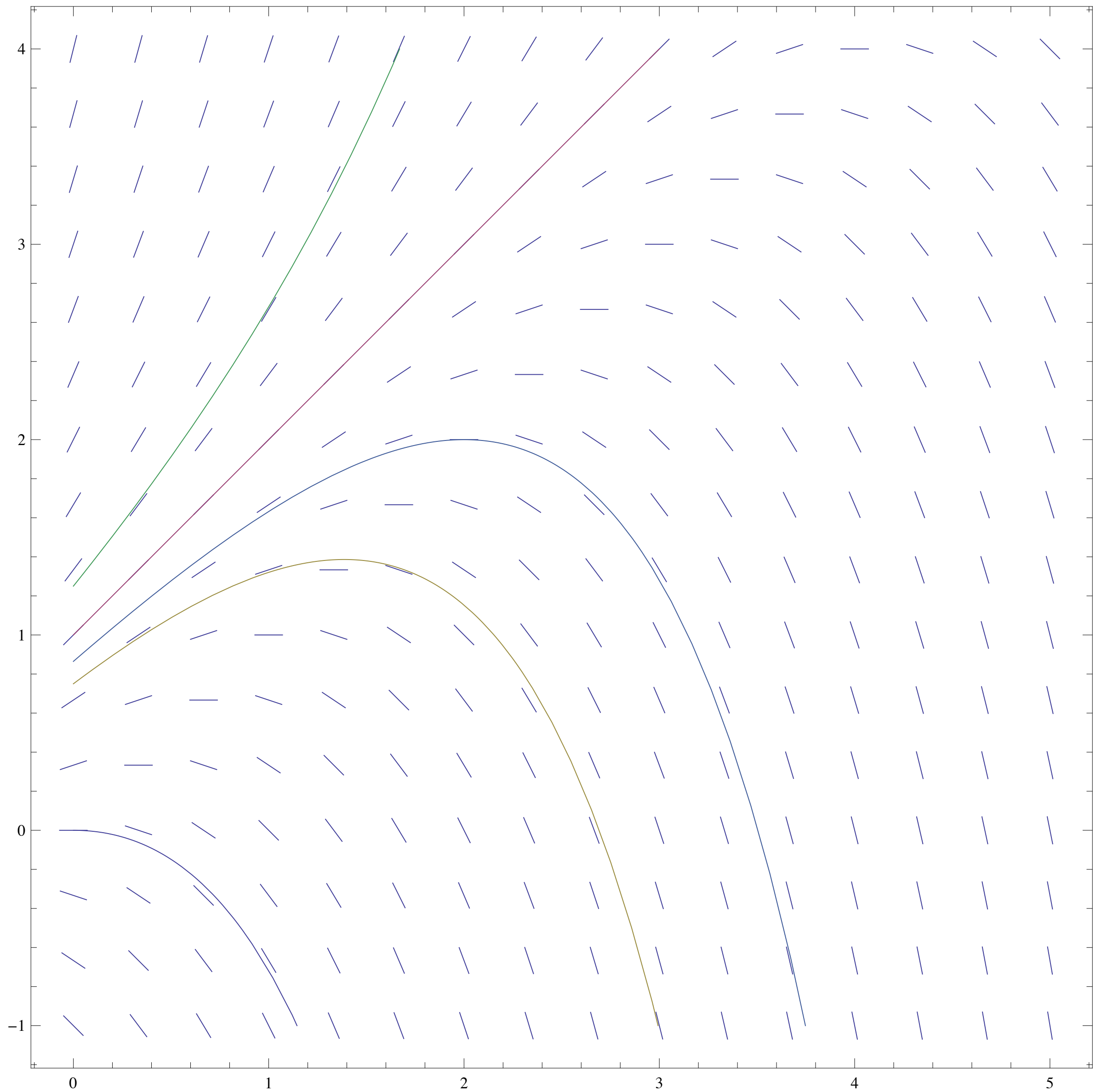



Solution to this DE through the point (x0, y0) :

In[4]:=
```
linearDESolution[x0_, y0_, x_] = x + 1 + (y0 - x0 - 1) e^(x-x0);
```

In[5]:=
```
linearDEPlots = Plot[{
    linearDESolution[0, 0, x],
    linearDESolution[0, 1, x],
    linearDESolution[0, 0.75, x],
    linearDESolution[0, 1.25, x],
    linearDESolution[2, 2, x]
   }, {x, 0, 5}, PlotRange → {-1, 4}];
Show[linearDESlopeField, linearDEPlots]
```

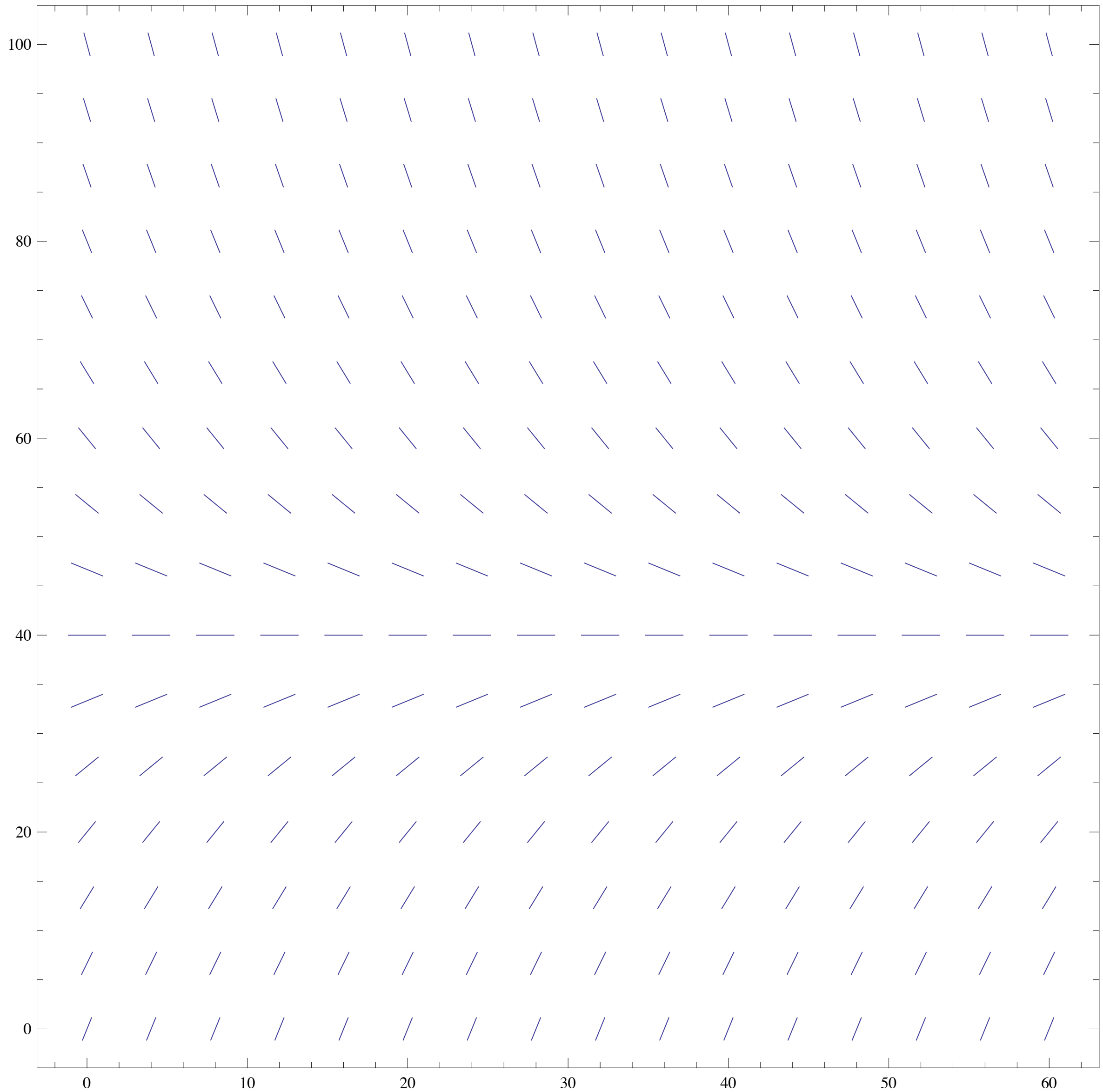
Out[6]=



## Newton' s Law of Cooling

In[8]:=
```
newtonSlopeField = VectorPlot[
  NormalizeVector[{1, 0.1 (40 - T)}], {t, 0, 60}, {T, 0, 100},
  VectorPoints → 16, VectorStyle → "Segment", VectorScale → {0.02, Scaled[1], #5 &}
 ]
```

Out[8]=

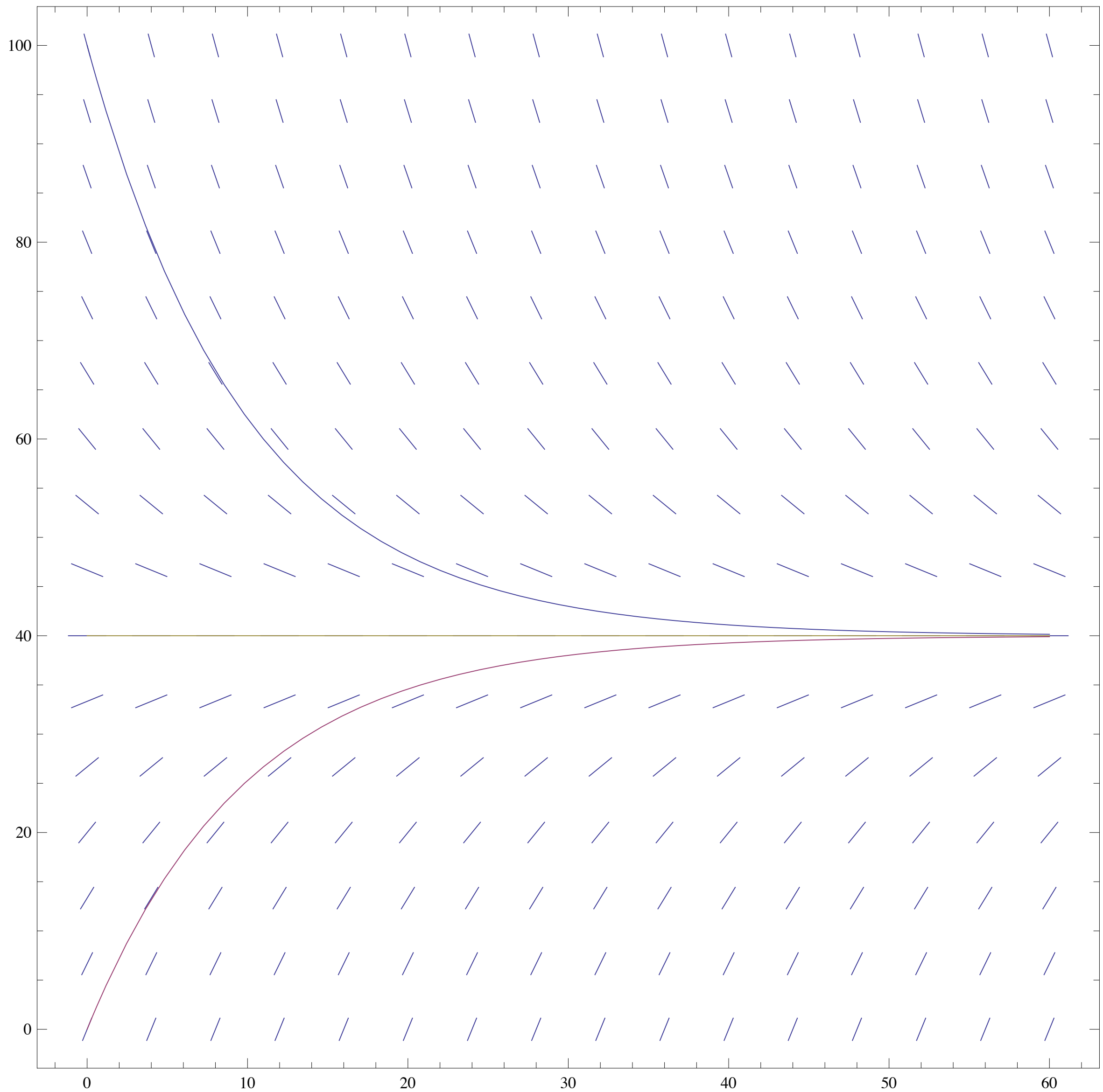



In[11]:=
```
NewtonCool[k_, A_, T0_, t_] = A + (T0 - A) ⅇ^(-k t)
```

Out[11]= $A + e^{-k t} (-A + T0)$

In[12]:=
```
newtonPlots = Plot[
    {
     NewtonCool[0.1, 40, 100, t],
     NewtonCool[0.1, 40, 0, t],
     NewtonCool[0.1, 40, 40, t]
    }, {t, 0, 60}, PlotRange -> {0, 100}
   ];
Show[newtonSlopeField, newtonPlots]
```

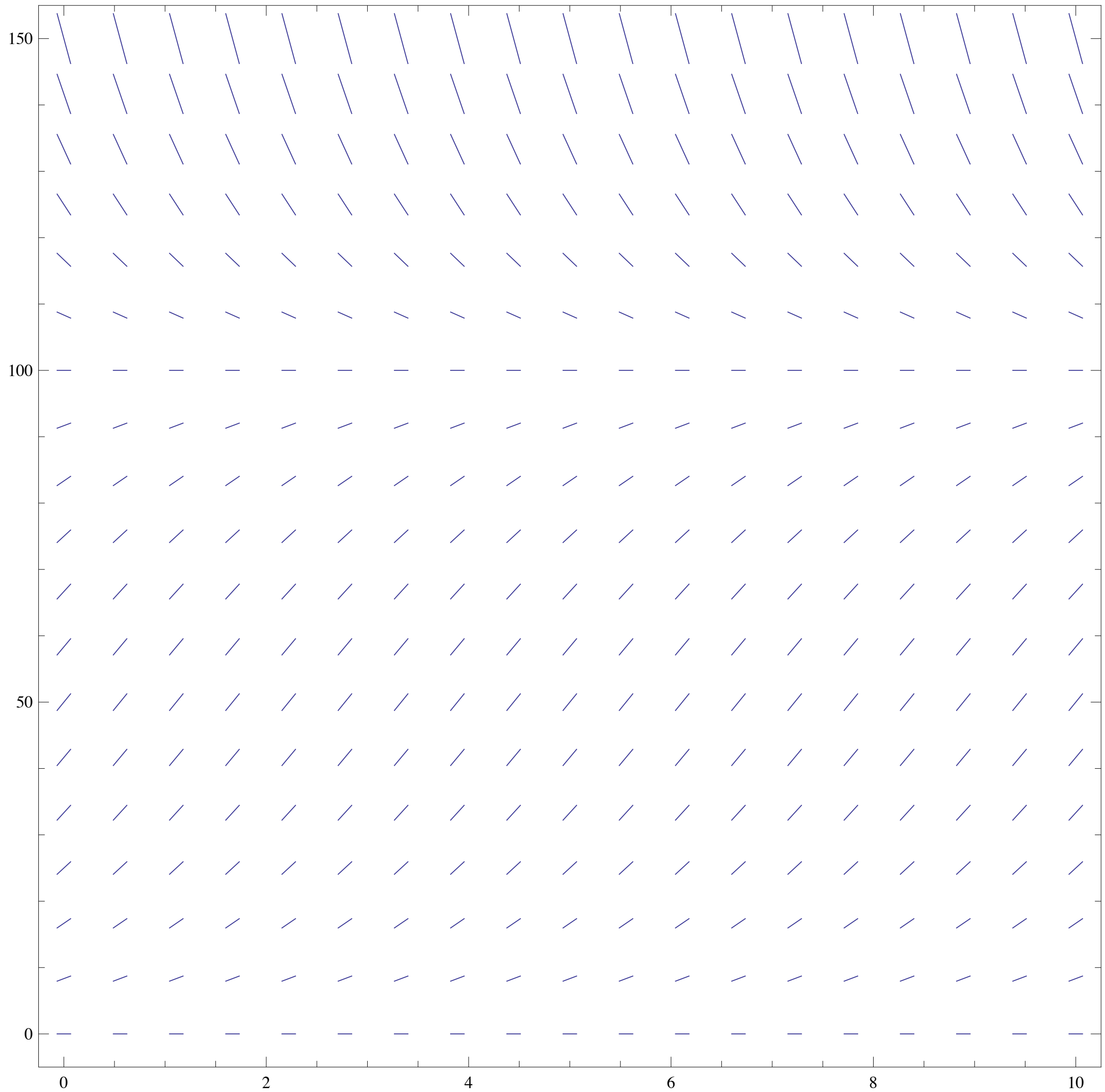
Out[13]=



## Logistic Growth

In[14]:=
```
logisticSlopeField = VectorPlot[
  {1, 0.0075 P (100 - P)}, {t, 0, 10}, {P, 0, 150},
  VectorPoints → 19, VectorStyle → "Segment",
  VectorScale → {0.05, Automatic, #5 &}, PlotRange → {{-0.25, 10.25}, {-5, 155}}
 ]
```

Out[14]=




In[15]:=
$$\text{logistic}[k\_, M\_, P0\_, t\_] = \frac{M\,P0}{P0 + (M - P0)\,e^{-k M t}};$$

In[16]:=
```
logisticPlots = Plot[{
    logistic[0.0075, 100, 10, t],
    logistic[0.0075, 100, 150, t],
    logistic[0.0075, 100, 100, t]
   }, {t, 0, 10}, PlotRange → {0, 150}];
Show[logisticSlopeField, logisticPlots]
```

Out[17]=