Practical -1 (e,f,h)

Section : e
Predator-Prey Model

1.1 Predator-Prey Model (basic Volterra model)

<u>Example 1</u> :- The differrential equations describing the Predator Prey Model are

$$\frac{dx}{dt} = b_1 x - c_1 xy$$

$$\frac{dy}{dt} = c_2 xy - a_2 y$$

Generate time dependent graph of the population over the time with $b_1 = 1$, $a_2 = 0.5$, $c_1 = 0.01$, $c_2 = 0.005$. Initially with $[x_0, y_0] = [200, 80]$.

Solution :-

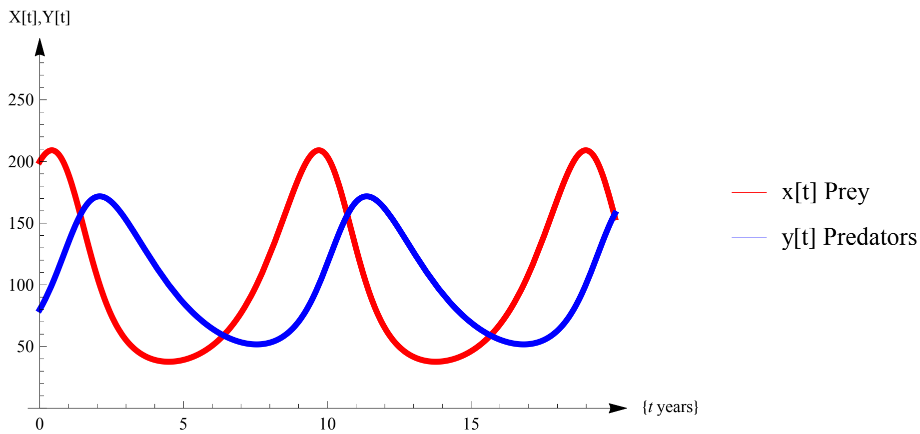
```
b1 = 1;
a2 = 0.5;
c1 = 0.01;
c2 = 0.005;
eqn1 = x'[t] == b1 x[t] - c1 x[t] y[t]
eqn2 = y'[t] == c2 x[t] y[t] - a2 y[t]
sol = NDSolve[{eqn1, eqn2, x[0] == 200, y[0] == 80}, {x, y}, {t, 0, 20}]

Plot[Evaluate[{x[t], y[t]} /. sol, {t, 0, 20}], PlotRange → {0, 300},
 PlotStyle → {{Red, Thickness[0.01]}, {Blue, Thickness[0.01]}},
 PlotLegends → {"x[t] Prey", "y[t] Predators"},
 AxesLabel → {t {years}, "X[t],Y[t]"}, AxesStyle → Arrowheads[{0, 0.03}]]
```

```
x'[t] == x[t] - 0.01 x[t] y[t]

y'[t] == -0.5 y[t] + 0.005 x[t] y[t]

{{x → InterpolatingFunction[{{0., 20.}}, <>],
  y → InterpolatingFunction[{{0., 20.}}, <>]}}
```



1.2 Predator-Prey Model with effect of DDT

<u>Example 2</u> :- The differential equations describing the Predator Prey Model with effect of DDT are

$$\frac{dx}{dt} = b_1 x - c_1 xy - p_1 x$$

$$\frac{dy}{dt} = c_2 xy - a_2 y - p_2 y$$

Generate time dependent graph of the population over time with $b_1 =$ 1, $a_2 = 0.5$, $c_1 = 0.01$ and $c_2 = 0.005$ and $p_1 = p_2 = 0.1$. Initially with $[x_0, y_0] = [200, 80]$.

Solution :-

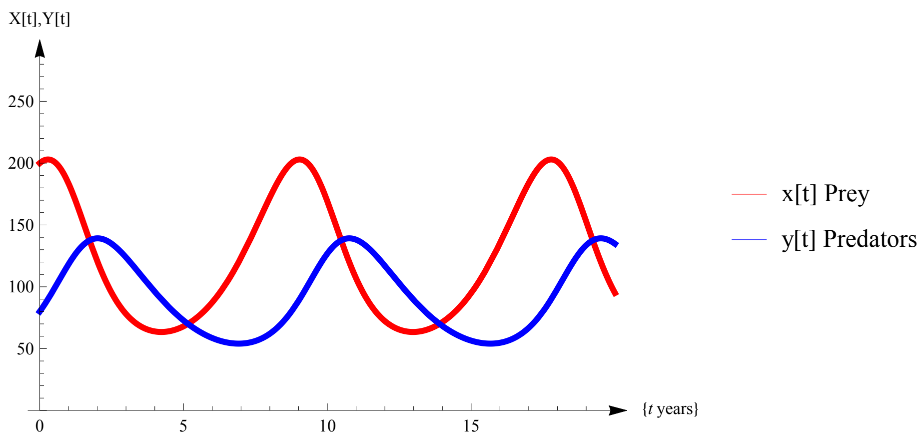
```
b1 = 1;
a2 = 0.5;
c1 = 0.01;
c2 = 0.005;
p1 = 0.1;
p2 = 0.1;
eqn1 = x'[t] == b1 x[t] - c1 x[t] y[t] - p1 x[t]
eqn2 = y'[t] == c2 x[t] y[t] - a2 y[t] - p2 y[t]
sol = NDSolve[{eqn1, eqn2, x[0] == 200, y[0] == 80}, {x, y}, {t, 0, 20}]

Plot[Evaluate[{x[t], y[t]} /. sol, {t, 0, 20}], PlotRange → {0, 300},
 PlotStyle → {{Red, Thickness[0.01]}, {Blue, Thickness[0.01]}},
 PlotLegends → {"x[t] Prey", "y[t] Predators"},
 AxesLabel → {t {years}, "X[t],Y[t]"}, AxesStyle → Arrowheads[{0, 0.03}]]
```

```
x′[t] == 0.9 x[t] - 0.01 x[t] y[t]

y′[t] == -0.6 y[t] + 0.005 x[t] y[t]

{{x → InterpolatingFunction[{{0., 20.}}, <>],
  y → InterpolatingFunction[{{0., 20.}}, <>]}}
```



1.3 Predator-Prey Model with Density Dependent

Example 3 :- The differential equations describing the Predator Prey Model with density dependence are

$$\frac{dx}{dt} = b_1\, x\left(1 - \frac{x}{k}\right) - c_1\, xy$$

$$\frac{dy}{dt} = c_2 xy - a_2\, y$$

Generate time dependent graph of the population over time with $b_1 = 1$, $a_2 = 0.5$, $c_1 = 0.01$ and $c_2 = 0.005$ and $k = 1000$. Initially with $[x_0, y_0] = [200, 80]$.

Solution :-

In[9]:=

```
b1 = 1;
a2 = 0.5;
c1 = 0.01;
c2 = 0.005;
k = 1000;
```

$$\text{eqn1} = x'[t] == b_1\, x[t] \left(1 - \frac{x[t]}{k}\right) - c_1\, x[t]\, y[t]$$

$$\text{eqn2} = y'[t] == c_2\, x[t]\, y[t] - a_2\, y[t]$$

```
sol = NDSolve[{eqn1, eqn2, x[0] == 200, y[0] == 80}, {x, y}, {t, 0, 20}]

Plot[Evaluate[{x[t], y[t]} /. sol, {t, 0, 20}], PlotRange → {0, 300},
 PlotStyle → {{Red, Thickness[0.01]}, {Blue, Thickness[0.01]}},
 PlotLegends → {"x[t] Prey", "y[t] Predators"},
 AxesLabel → {t {years}, "X[t],Y[t]"}, AxesStyle → Arrowheads[{0, 0.03}]]
```

Out[14]= $x'[t] == \left(1 - \frac{x[t]}{1000}\right) x[t] - 0.01\, x[t]\, y[t]$

Out[15]= $y'[t] == -0.5\, y[t] + 0.005\, x[t]\, y[t]$

Out[16]=

```
{{x → InterpolatingFunction[{{0., 20.}}, <>],
  y → InterpolatingFunction[{{0., 20.}}, <>]}}
```

Out[17]=