Of Previous Question
Conclusion :- Blue Army wins as the number of soldiers of red army left after 30 days but red army has no soldiers after 30 days.

Section-f

Epidemic Model of influenza (basic epidemic model, contagious for life, disease with carriers) :-

3.1 Basic Epidemic Model :-

Example 1 :- Consider the Basic Epidemic Model Given by the differential equations :

$$\frac{dS}{dt} = -\beta SH$$

$$\frac{dH}{dt} = \beta SH - \gamma H,$$

where $\beta = 2.18 \times 10^{-3}$, $\gamma = 0.44$. The initial values of S & H are s_0=762 and H_0= 1.
Obtain the solution of the differential equations given above and plot their graphs. Here S denotes the number of susceptible and H denotes the number of invectives.

Solution :-

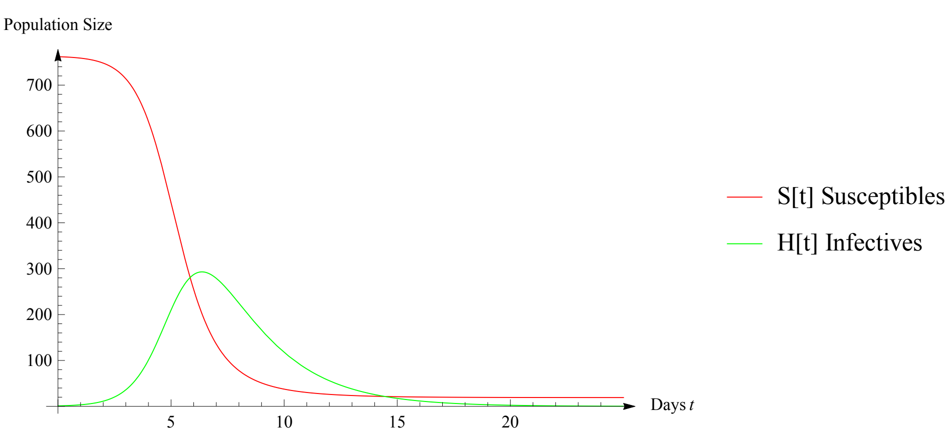
In[23]:=
```
β = 2.18 * 10^-3;
S0 = 762;
H0 = 1;
γ = 0.44;
eqn1 = S'[t] == -β S[t] H[t]
eqn2 = H'[t] == β S[t] H[t] - γ H[t]
soln = NDSolve[{eqn1, eqn2, S[0] == S0, H[0] == H0}, {S[t], H[t]}, {t, 0, 30}]

Plot[Evaluate[{S[t], H[t]} /. soln], {t, 0, 25},
 AxesLabel → {t (Days), "Population Size"}, PlotStyle → {Red, Green},
 PlotLegends → {"S[t] Susceptibles", "H[t] Infectives"},
 AxesStyle → Arrowheads[{0, 0.02}]]
```

Out[27]=
```
S′[t] == -0.00218 H[t] S[t]
```

Out[28]=
```
H′[t] == -0.44 H[t] + 0.00218 H[t] S[t]
```

Out[29]=
```
{{S[t] → InterpolatingFunction[{{0., 30.}}, <>][t],
  H[t] → InterpolatingFunction[{{0., 30.}}, <>][t]}}
```

Out[30]=



Conclusion :- We notice that the number of invectives start small and increases over days then decreases. The epidemic was started by 1 infective with number of susceptible 762. Number of susceptible is decreasing over days. In latter stages of epidemic there is a much smaller chance of any given infective coming into contact with someone who has yet been infected.

3.2 Epidemic Model (contagious for life) :-

Example 2 :- Consider the Epidemic Model with contagious for life given by the differential equations :

$$\frac{dS}{dt} = -\beta\, SH$$

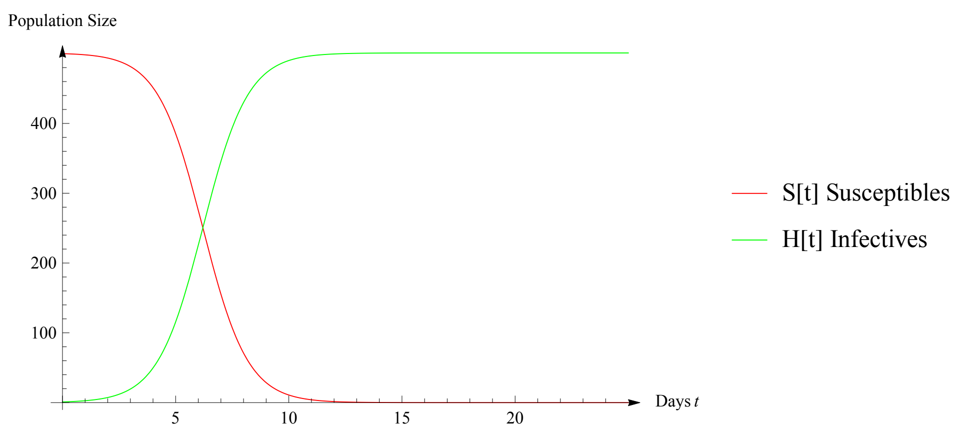
$$\frac{dH}{dt} = \beta\, SH,$$

where $\beta = 0.002$. The initial values of S & H are $S_0 = 500$ and $H_0 = 1$.
Obtain the solution of the differential equations given above and plot their graphs.
Solution :-

```
In[37]:= β = 0.002;
S0 = 500;
H0 = 1;
eqn1 = S'[t] == -β S[t] H[t]
eqn2 = H'[t] == β S[t] H[t]
soln = NDSolve[{eqn1, eqn2, S[0] == S0, H[0] == H0}, {S[t], H[t]}, {t, 0, 30}]

Plot[Evaluate[{S[t], H[t]} /. soln], {t, 0, 25},
 AxesLabel → {t (Days), "Population Size"}, PlotStyle → {Red, Green},
 PlotLegends → {"S[t] Susceptibles", "H[t] Infectives"},
 AxesStyle → Arrowheads[{0, 0.02}]]
```

```
Out[40]= S'[t] == -0.002 H[t] S[t]

Out[41]= H'[t] == 0.002 H[t] S[t]

Out[42]= {{S[t] → InterpolatingFunction[{{0., 30.}}, <>][t],
  H[t] → InterpolatingFunction[{{0., 30.}}, <>][t]}}
```

Out[43]=



Conclusion :- We notice that the number of invectives start small and increase over days and then after 10 days all susceptible are infective.

3.3 Epidemic Model (Disease with carriers) :-

Example 3 :- Consider the Epidemic Model (Disease with carriers) given by the differential equations :

$$\frac{dS}{dt} = -\beta\, SH + \gamma H$$

$$\frac{dH}{dt} = \beta\, SH - \gamma H,$$

where $\beta = 0.002$, $\gamma = 0.4$. The initial values of S & H are S_0=500 and H_0=1.
Obtain the solution of the differential equations given above and plot their graphs.

Solution :-

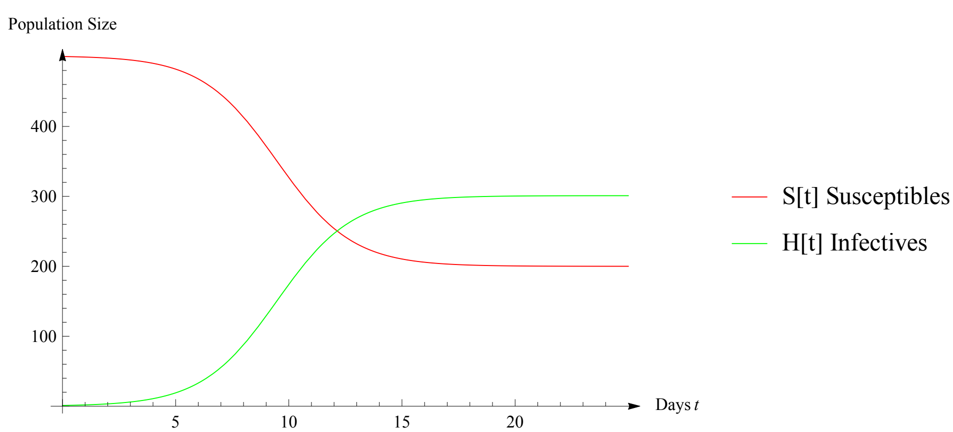
In[65]:=
```
β = 0.002;
S0 = 500;
H0 = 1;
γ = 0.4;
eqn1 = S'[t] == -β S[t] H[t] + γ H[t]
eqn2 = H'[t] == β S[t] H[t] - γ H[t]
soln = NDSolve[{eqn1, eqn2, S[0] == S0, H[0] == H0}, {S[t], H[t]}, {t, 0, 30}]

Plot[Evaluate[{S[t], H[t]} /. soln], {t, 0, 25},
 AxesLabel → {t (Days), "Population Size"}, PlotStyle → {Red, Green},
 PlotLegends → {"S[t] Susceptibles", "H[t] Infectives"},
 AxesStyle → Arrowheads[{0, 0.02}]]
```

Out[69]= `S'[t] == 0.4 H[t] - 0.002 H[t] S[t]`

Out[70]= `H'[t] == -0.4 H[t] + 0.002 H[t] S[t]`

Out[71]=
```
{{S[t] → InterpolatingFunction[{{0., 30.}}, <>][t],
  H[t] → InterpolatingFunction[{{0., 30.}}, <>][t]}}
```

Out[72]=



Conclusion :- We notice that the number of invectives start small and increases over days then becomes constant once the value crosses 300. At least 100 susceptible never get infected to disease.