Student Spring Break Behaviors and COVID-19 Transmission

In[ ]:= **Brenna Mehl, Dawson Brown, Leo Pang, Aidan Holland**

Initial Values :

In[ ]:=
```
au = 1 / 7.5; (*recovery rate for unvaccinated indiviuals 1/length of infection*)
av = 1 / 5.5; (*recovery rate for vaccinated indiviuals, 1/length of infection*)
covidCases = 838 / 7; (*use first day covid cases*)
numUndergrads = 19742; (*total undergraduates*)
vaxRate = .93; (*proportion vaccinated*)
days = 109; (*number of days in semester*)
p = 0.8;(*proportion who go to spring break environment 1*)
tD = .00001 ; (*difference in transmission rate
 between campus bu/bv and spring break transmission rates*)
campusBu = .000020; (*campus transmission rate to unvaccinated indiviuals*)
campusBv = .000012;(*campus transmission rate to vaccinated indiviuals*)
```

Campus Transmission Before Spring Break (Days 1-60)

In[ ]:=
```
(*Initialize SIR Tables*)
tabSu = Table[0, {i, days}];
tabSv = Table[0, {i, days}];
tabIu = Table[0, {i, days}];
tabIv = Table[0, {i, days}];
tabR = Table[0, {i, days}];
```

In[ ]:=
```
(*Iniialize Values*)
su = (numUndergrads - covidCases) (1 - vaxRate);
(*initial unvaccinated susceptible individuals*)
sv = (numUndergrads - covidCases) (vaxRate );
(*initial vaccinated susceptible individuals*)
iu = covidCases (1 - vaxRate); (*initial unvaccinated infected individuals*)
iv = covidCases (vaxRate); (*initial vaccinated infected individuals*)
r = 0; (*initial recovered indiviuals,
0 becasuse we assume all students can be infected*)
bu = campusBu; (*transmission rate to an unvaccinated individudal*)
bv = campusBv; (*transmission rate to a vaccinated individual*)
numDays = 60; (*number of days*)
```

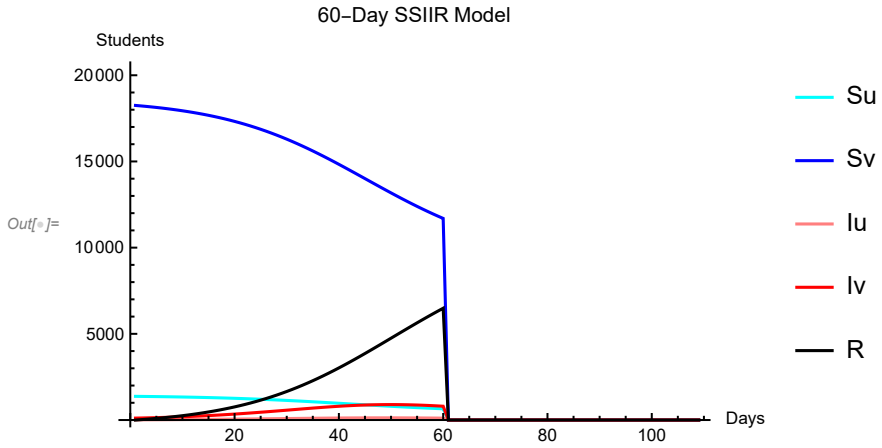
In[ ]:=
```
(*Run SIR Model*)
Do[
  tabSu[[i]] = su;
  tabSv[[i]] = sv;
  tabIu[[i]] = iu;
  tabIv[[i]] = iv;
  tabR[[i]] = r;
  s1u = su - bu su (iv + iu);
  s1v = sv - bv sv (iv + iu);
  i1u = iu + bu su (iv + iu) - au iu;
  i1v = iv + bv sv (iv + iu) - av iv;
  r1 = r + au iu + av iv;
  su = s1u;
  sv = s1v;
  iu = i1u;
  iv = i1v;
  r = r1,
  {i, numDays}];
```

SIR Plots Before Break

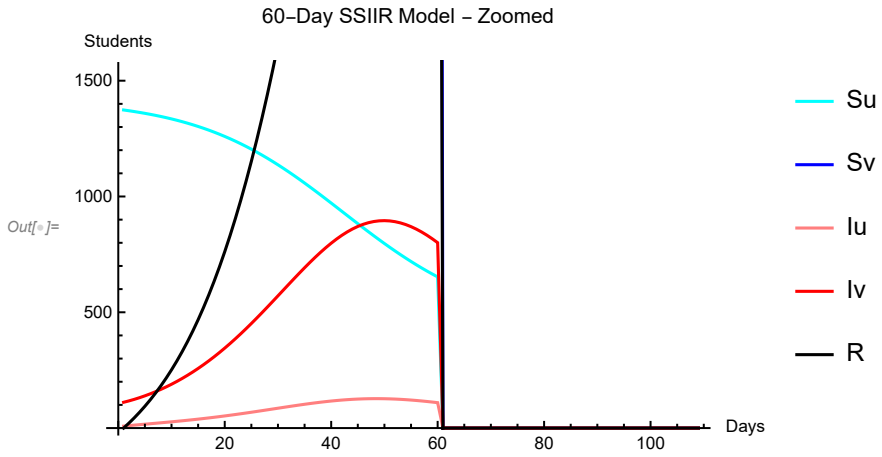
Create Plots:

In[ ]:=
```
plotSu = ListPlot[tabSu, Joined → True, PlotStyle → Cyan, PlotLegends → {"Su"}];
plotSv = ListPlot[tabSv, Joined → True, PlotStyle → Blue, PlotLegends → {"Sv"}];
plotIu = ListPlot[tabIu, Joined → True, PlotStyle → Pink, PlotLegends → {"Iu"}];
plotIv = ListPlot[tabIv, Joined → True, PlotStyle → Red, PlotLegends → {"Iv"}];
plotR = ListPlot[tabR, Joined → True, PlotStyle → Black, PlotLegends → {"R"}];
Show[plotSu, plotSv, plotIu, plotIv , plotR, PlotRange → {0, 19742},
 AxesLabel → {"Days", "Students"}, PlotLabel → "60-Day SSIIR Model"]
Show[plotSu, plotSv, plotIu, plotIv , plotR, PlotRange → {0, 1500},
 AxesLabel → {"Days", "Students"}, PlotLabel → "60-Day SSIIR Model - Zoomed"]
```

Out[•]=


60–Day SSIIR Model
Students
20000
15000
10000
5000
20
40
60
80
100
Days
Su
Sv
Iu
Iv
R

Out[•]=


60–Day SSIIR Model – Zoomed
Students
1500
1000
500
20
40
60
80
100
Days
Su
Sv
Iu
Iv
R

Spring Break Environment 1 (Days 61-69)

In[ ]:=
```
(*Initial Values*)
iTabSu = tabSu[[60]];
iTabSv = tabSv[[60]];
iTabIu = tabIu[[60]];
iTabIv = tabIv[[60]];
iTabR = tabR[[60]];
su = iTabSu (p); (*initial unvaccinated susceptible individuals*)
sv = iTabSv (p);(*initial vaccinated susceptible individuals*)
iu = iTabIu (p); (*initial unvaccinated infected individuals*)
iv = iTabIv (p) ;(*initial vaccinated infected individuals*)
r = iTabR (p); (*initial recovered indiviuals*)
bu = campusBu + tD; (*transmission rate to an unvaccinated individudal*)
bv = campusBv + tD ;(*transmission rate to a vaccinated individual*)
numDays = 9; (*number of days*)

(*SIR Model*)
Do[
  tabSu[[i + 59]] = su;
  tabSv[[i + 59]] = sv;
  tabIu[[i + 59]] = iu;
  tabIv[[i + 59]] = iv;
  tabR[[i + 59]] = r;
  s1u = su - bu su (iv + iu);
  s1v = sv - bv sv (iv + iu);
  i1u = iu + bu su (iv + iu) - au iu;
  i1v = iv + bv sv (iv + iu) - av iv;
  r1 = r + au iu + av iv;
  su = s1u;
  sv = s1v;
  iu = i1u;
  iv = i1v;
  r = r1,
  {i, numDays + 1}];
```

In[ ]:=

Spring Break Environment 2 (Days 61-69)

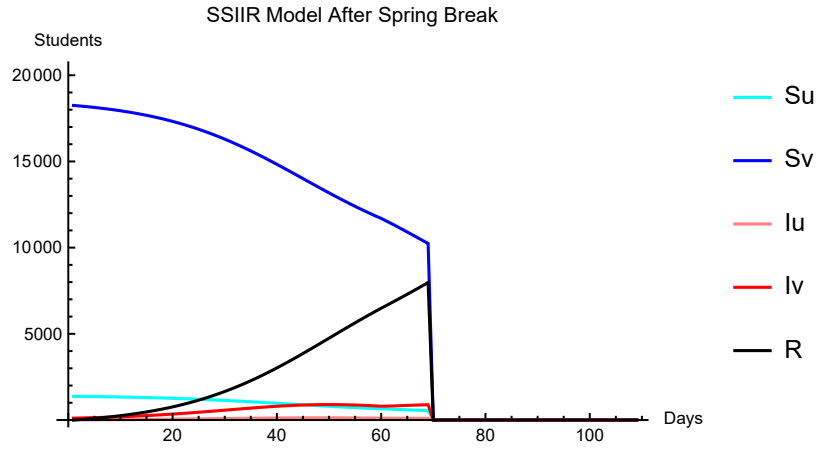
```
In[ ]:= (*Initial Values*)
su = iTabSu (1 - p); (*initial unvaccinated susceptible individuals*)
sv = iTabSv (1 - p);(*initial vaccinated susceptible individuals*)
iu = iTabIu (1 - p); (*initial unvaccinated infected individuals*)
iv = iTabIv (1 - p) ;(*initial vaccinated infected individuals*)
r = iTabR (1 - p); (*initial recovered indiviuals*)
bu = campusBu - tD; (*transmission rate to an unvaccinated individudal*)
bv = campusBv - tD; (*transmission rate to a vaccinated individual*)
numDays = 9; (*number of days*)

(*SIR Model*)
Do[
  tabSu[[i + 59]] = tabSu[[i + 59]] + su;
  tabSv[[i + 59]] = tabSv[[i + 59]] + sv;
  tabIu[[i + 59]] = tabIu[[i + 59]] + iu;
  tabIv[[i + 59]] = tabIv[[i + 59]] + iv;
  tabR[[i + 59]] = tabR[[i + 59]] + r;
  s1u = su - bu su (iv + iu);
  s1v = sv - bv sv (iv + iu);
  i1u = iu + bu su (iv + iu) - au iu;
  i1v = iv + bv sv (iv + iu) - av iv;
  r1 = r + au iu + av iv;
  su = s1u;
  sv = s1v;
  iu = i1u;
  iv = i1v;
  r = r1,
  {i, numDays + 1}];
```

SIR Plots After Break

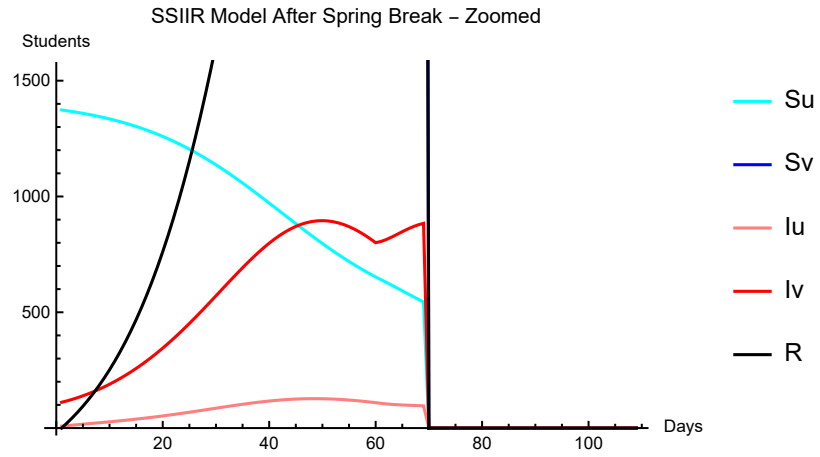
Create Plots:

```
In[ ]:= plotSu = ListPlot[tabSu, Joined → True, PlotStyle → Cyan, PlotLegends → {"Su"}];
plotSv = ListPlot[tabSv, Joined → True, PlotStyle → Blue, PlotLegends → {"Sv"}];
plotIu = ListPlot[tabIu, Joined → True, PlotStyle → Pink, PlotLegends → {"Iu"}];
plotIv = ListPlot[tabIv, Joined → True, PlotStyle → Red, PlotLegends → {"Iv"}];
plotR = ListPlot[tabR, Joined → True, PlotStyle → Black, PlotLegends → {"R"}];
Show[plotSu, plotSv, plotIu, plotIv , plotR, PlotRange → {0, 19742},
 AxesLabel → {"Days", "Students"}, PlotLabel → "SSIIR Model After Spring Break"]
Show[plotSu, plotSv, plotIu, plotIv , plotR, PlotRange → {0, 1500},
 AxesLabel → {"Days", "Students"}, PlotLabel → "SSIIR Model After Spring Break - Zoomed"]
```

Out[•]=


SSIIR Model After Spring Break
Students
20000
15000
10000
5000
20
40
60
80
100
Days
Su
Sv
Iu
Iv
R

Out[•]=


SSIIR Model After Spring Break – Zoomed
Students
1500
1000
500
20
40
60
80
100
Days
Su
Sv
Iu
Iv
R

Campus Transmission After Spring Break (Days 70-109)

In[ ]:=
```
(*Initial Values*)
su = tabSu[[69]]; (*initial unvaccinated susceptible individuals*)
sv = tabSv[[69]]; (*initial vaccinated susceptible individuals*)
iu =  tabIu[[69]]; (*initial unvaccinated infected individuals*)
iv = tabIv[[69]]; (*initial vaccinated infected individuals*)
r = tabR[[69]]; (*initial recovered indiviuals*)
bu = campusBu; (*transmission rate to an unvaccinated individudal*)
bv = campusBv; (*transmission rate to a vaccinated individual*)
numDays = days - 9 - 60; (*number of days*)

(*SIRModel*)
(Do[
   tabSu[[i + 68]] = su;
   tabSv[[i + 68]] = sv;
   tabIu[[i + 68]] = iu;
   tabIv[[i + 68]] = iv;
   tabR[[i + 68]] = r;
   s1u = su - bu su (iv + iu);
   s1v = sv - bv sv (iv + iu);
   i1u = iu + bu su (iv + iu) - au iu;
   i1v = iv + bv sv (iv + iu) - av iv;
   r1 = r + au iu + av iv;
   su = s1u;
   sv = s1v;
   iu = i1u;
   iv = i1v;
   r = r1,
   {i, numDays + 1}];)
```

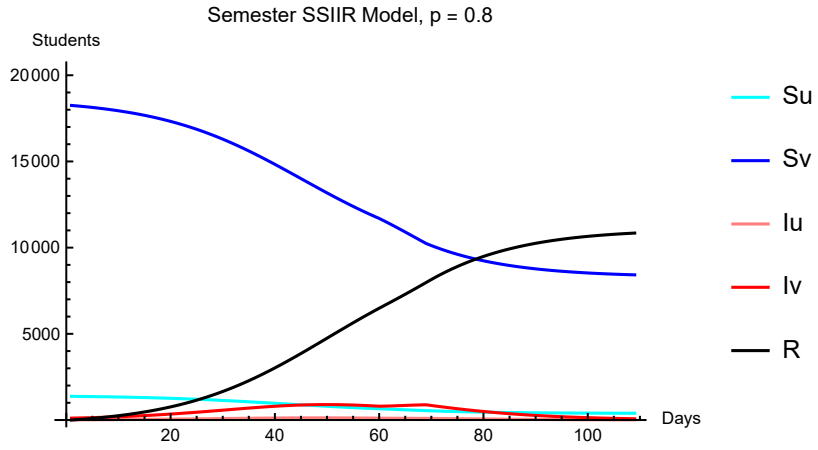
In[ ]:=

SIR Plots at End of Semester

Create Plots:

In[ ]:=
```
plotSu = ListPlot[tabSu, Joined → True, PlotStyle → Cyan, PlotLegends → {"Su"}];
plotSv = ListPlot[tabSv, Joined → True, PlotStyle → Blue, PlotLegends → {"Sv"}];
plotIu = ListPlot[tabIu, Joined → True, PlotStyle → Pink, PlotLegends → {"Iu"}];
plotIv = ListPlot[tabIv, Joined → True, PlotStyle → Red, PlotLegends → {"Iv"}];
plotR = ListPlot[tabR, Joined → True, PlotStyle → Black, PlotLegends → {"R"}];
Show[plotSu, plotSv, plotIu, plotIv , plotR, PlotRange → {0, 19742},
 AxesLabel → {"Days", "Students"}, PlotLabel → "Semester SSIIR Model, p = 0.8"]
Show[plotSu, plotSv, plotIu, plotIv , plotR, PlotRange → {0, 1500},
 AxesLabel → {"Days", "Students"}, PlotLabel → "Semester SSIIR Model, p = 0.8 - Zoomed"]
```

Out[ ]=



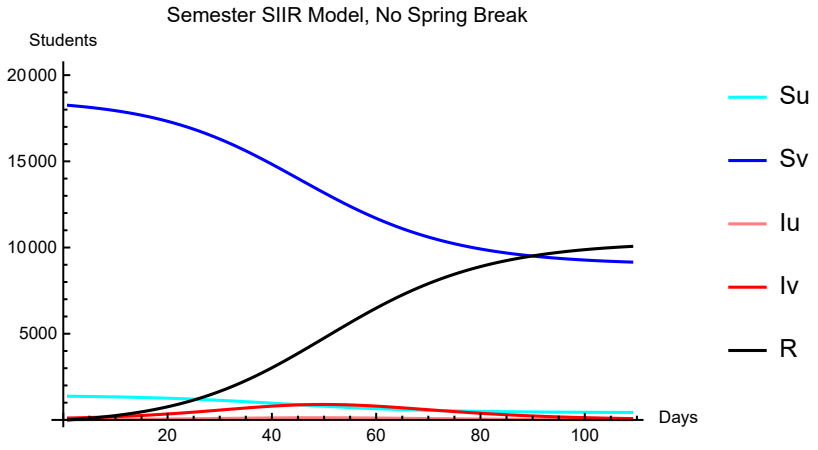
Out[ ]=

Compare to a Model Where No Spring Break Occurs:

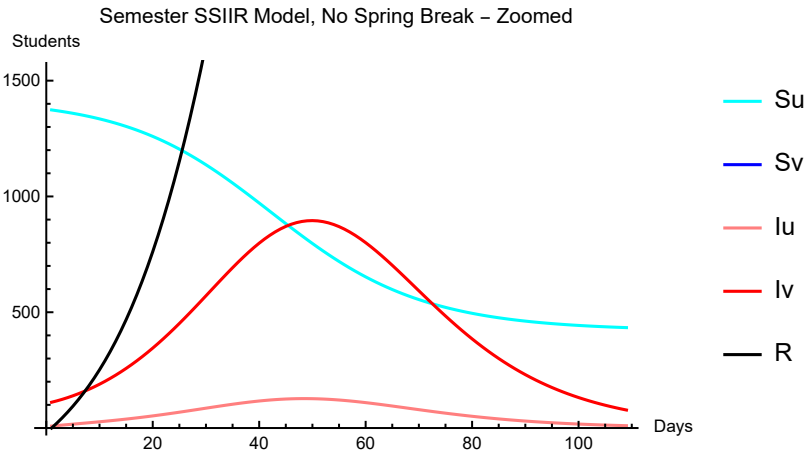
In[ ]:=
```
au = 1 / 7.5; (*recovery rate for unvaccinated indiviuals 1/length of infection*)
av = 1 / 5.5; (*recovery rate for vaccinated indiviuals, 1/length of infection*)
covidCases = 838 / 7; (*use first day covid cases*)
numUndergrads = 19742; (*total undergraduates*)
vaxRate = .93; (*proportion vaccinated*)
days = 109; (*number of days in semester*)
campusBu = .000020; (*campus transmission rate to unvaccinated indiviuals*)
campusBv = .000012;(*campus transmission rate to vaccinated indiviuals*)

(*Initialize SIR Tables*)
tabSu = Table[0, {i, days}];
tabSv = Table[0, {i, days}];
tabIu = Table[0, {i, days}];
tabIv = Table[0, {i, days}];
tabR = Table[0, {i, days}];

(*Initialize Values*)
su = (numUndergrads - covidCases) (1 - vaxRate);
(*initial unvaccinated susceptible individuals*)
sv = (numUndergrads - covidCases) (vaxRate );
(*initial vaccinated susceptible individuals*)
iu = covidCases (1 - vaxRate); (*initial unvaccinated infected individuals*)
iv = covidCases (vaxRate); (*initial vaccinated infected individuals*)
r = 0; (*initial recovered indiviuals,
0 becasuse we assume all students can be infected*)
bu = campusBu; (*transmission rate to an unvaccinated individudal*)
bv = campusBv; (*transmission rate to a vaccinated individual*)
numDays = 109; (*number of days*)
```

In[ ]:=
```
(*Run SIR Model*)
Do[
  tabSu[[i]] = su;
  tabSv[[i]] = sv;
  tabIu[[i]] = iu;
  tabIv[[i]] = iv;
  tabR[[i]] = r;
  s1u = su - bu su (iv + iu);
  s1v = sv - bv sv (iv + iu);
  i1u = iu + bu su (iv + iu) - au iu;
  i1v = iv + bv sv (iv + iu) - av iv;
  r1 = r + au iu + av iv;
  su = s1u;
  sv = s1v;
  iu = i1u;
  iv = i1v;
  r = r1,
  {i, numDays}];

plotSu = ListPlot[tabSu, Joined → True, PlotStyle → Cyan, PlotLegends → {"Su"}];
plotSv = ListPlot[tabSv, Joined → True, PlotStyle → Blue, PlotLegends → {"Sv"}];
plotIu = ListPlot[tabIu, Joined → True, PlotStyle → Pink, PlotLegends → {"Iu"}];
plotIv = ListPlot[tabIv, Joined → True, PlotStyle → Red, PlotLegends → {"Iv"}];
plotR = ListPlot[tabR, Joined → True, PlotStyle → Black, PlotLegends → {"R"}];
Show[plotSu, plotSv, plotIu, plotIv , plotR, PlotRange → {0, 19742},
 AxesLabel → {"Days", "Students"}, PlotLabel → "Semester SIIR Model, No Spring Break"]
rNoBreak = tabR[[109]];
Show[plotSu, plotSv, plotIu, plotIv , plotR,
 PlotRange → {0, 1500}, AxesLabel → {"Days", "Students"},
 PlotLabel → "Semester SSIIR Model, No Spring Break - Zoomed"]
```

Out[ ]=



Out[ ]=



Analysis

Creating a Function

In[ ]:=

```
(*Creating a Function*)
PModel := (
      p = 0; (*proportion who go to spring break environment 1*)
      tabFinal = Table[0, {i, 101}, {j, 2}] ;
  (*table to hold the p and r values of each run*)
  Do[
       p = (i - 1) / 100;
   (*Campus Transmission Before Spring Break (Days 1-60)*)
    (*Initialize SIR Tables*)
    tabSu = Table[0, {i, days}];
   tabSv = Table[0, {i, days}];
   tabIu = Table[0, {i, days}];
   tabIv = Table[0, {i, days}];
   tabR = Table[0, {i, days}];

(*Initialize Values*)
    su = (numUndergrads - covidCases) (1 - vaxRate);
   (*initial unvaccinated susceptible individuals*)
   sv = (numUndergrads - covidCases) (vaxRate );
   (*initial vaccinated susceptible individuals*)
   iu = covidCases (1 - vaxRate); (*initial unvaccinated infected individuals*)
   iv = covidCases (vaxRate); (*initial vaccinated infected individuals*)
   r = 0; (*initial recovered indiviuals,
   0 becasuse we assume all students can be infected*)
   bu = campusBu; (*transmission rate to an unvaccinated individudal*)
   bv = campusBv; (*transmission rate to a vaccinated individual*)
   numDays = 60; (*number of days*)
```

```
(*SIRModel*)
    Do[
     tabSu[[i]] = su;
     tabSv[[i]] = sv;
     tabIu[[i]] = iu;
     tabIv[[i]] = iv;
     tabR[[i]] = r;
     s1u = su - bu su (iv + iu);
     s1v = sv - bv sv (iv + iu);
     i1u = iu + bu su (iv + iu) - au iu;
     i1v = iv + bv sv (iv + iu) - av iv;
     r1 = r + au iu + av iv;
     su = s1u;
     sv = s1v;
     iu = i1u;
     iv = i1v;
     r = r1,
     {i, numDays}];

(*Spring Break Environment 1 (Days 61-69)*)
(*Initial Values*)
    su = tabSu[[60]] (p); (*initial unvaccinated susceptible individuals*)
   sv = tabSv[[60]] (p); (*initial vaccinated susceptible individuals*)
   iu = tabIu[[60]] (p); (*initial unvaccinated infected individuals*)
   iv = tabIv[[60]] (p) ; (*initial vaccinated infected individuals*)
   r = r (p); (*initial recovered indiviuals*)
   bu = campusBu + tD; (*transmission rate to an unvaccinated individudal*)
   bv = campusBv + tD ; (*transmission rate to a vaccinated individual*)
   numDays = 9; (*number of days*)

   (*SIR Model*)
   Do[
    tabSu[[i + 60]] = su;
    tabSv[[i + 60]] = sv;
    tabIu[[i + 60]] = iu;
    tabIv[[i + 60]] = iv;
    tabR[[i + 60]] = r;
    s1u = su - bu su (iv + iu);
    s1v = sv - bv sv (iv + iu);
    i1u = iu + bu su (iv + iu) - au iu;
    i1v = iv + bv sv (iv + iu) - av iv;
    r1 = r + au iu + av iv;
    su = s1u;
    sv = s1v;
    iu = i1u;
    iv = i1v;
    r = r1,
```

```
    {i, numDays}];


(*Spring Break Environment 2 (Days 61-69)*)
(*Initial Values*)
   su = tabSu[[60]] (1 - p); (*initial unvaccinated susceptible individuals*)
   sv = tabSv[[60]] (1 - p); (*initial vaccinated susceptible individuals*)
   iu =  tabIu[[60]] (1 - p); (*initial unvaccinated infected individuals*)
   iv = tabIv[[60]] (1 - p); (*initial vaccinated infected individuals*)
   r = tabR[[60]] (1 - p); (*initial recovered indiviuals*)
   bu = campusBu - tD; (*transmission rate to an unvaccinated individudal*)
   bv = campusBv - tD; (*transmission rate to a vaccinated individual*)
   numDays = 9; (*number of days*)

   (*SIR Model*)
   Do[
    tabSu[[i + 60]] = tabSu[[i + 60]] + su;
    tabSv[[i + 60]] = tabSv[[i + 60]] + sv;
    tabIu[[i + 60]] = tabIu[[i + 60]] + iu;
    tabIv[[i + 60]] = tabIv[[i + 60]] + iv;
    tabR[[i + 60]] = tabR[[i + 60]] + r;
    s1u = su - bu su (iv + iu);
    s1v = sv - bv sv (iv + iu);
    i1u = iu + bu su (iv + iu) - au iu;
    i1v = iv + bv sv (iv + iu) - av iv;
    r1 = r + au iu + av iv;
    su = s1u;
    sv = s1v;
    iu = i1u;
    iv = i1v;
    r = r1,
    {i, numDays}];

(*Campus Transmission After Spring Break (Days 70-109)*)
   (*Initial Values*)
    su = tabSu[[69]]; (*initial unvaccinated susceptible individuals*)
   sv = tabSv[[69]]; (*initial vaccinated susceptible individuals*)
   iu =  tabIu[[69]]; (*initial unvaccinated infected individuals*)
   iv = tabIv[[69]]; (*initial vaccinated infected individuals*)
   r = tabR[[69]]; (*initial recovered indiviuals*)
   bu = campusBu; (*transmission rate to an unvaccinated individudal*)
   bv = campusBv; (*transmission rate to a vaccinated individual*)
   numDays = days - 9 - 60; (*number of days*)

   (*SIRModel*)
   Do[
    tabSu[[i + 69]] = su;
```

```
    tabSv[[i + 69]] = sv;
    tabIu[[i + 69]] = iu;
    tabIv[[i + 69]] = iv;
    tabR[[i + 69]] = r;
    s1u = su - bu su (iv + iu);
    s1v = sv - bv sv (iv + iu);
    i1u = iu + bu su (iv + iu) - au iu;
    i1v = iv + bv sv (iv + iu) - av iv;
    r1 = r + au iu + av iv;
    su = s1u;
    sv = s1v;
    iu = i1u;
    iv = i1v;
    r = r1,
    {i, numDays}];

   tabFinal[[i, 1]] = p;
  tabFinal[[i, 2]] = tabR[[109]],
  {i, 101}];
)
```

Running Function, tD = 0.0000100

In[ ]:=
```
(*Set Initial Values*)
au = 1 / 7.5; (*recovery rate for unvaccinated indiviuals*)
av = 1 / 5.5; (*recovery rate for vaccinated indiviuals*)
covidCases = 838 / 7; (*seven day average of covid cases the first week*)
numUndergrads = 19742; (*total undergraduates*)
vaxRate = .93; (*proportion vaccinated*)
days = 109; (*number of days in semester*)
tD = .00001 ; (*difference in transmission rate
 between campus bu/bv and spring break transmission rates*)
campusBu = .000020; (*campus transmission rate to unvaccinated indiviuals*)
campusBv = .000012;(*campus transmission rate to vaccinated indiviuals*)

PModel
plotTD1 = ListPlot[tabFinal, Joined → True, PlotStyle → Blue,  PlotRange → {0, 19742},
   AxesLabel → {"p", "students"}, PlotLegends → {"tD = 0.00001"}];
```

Running Function, tD = 0.0000075

In[ ]:=
```
(*Set Initial Values*)
au = 1 / 7.5; (*recovery rate for unvaccinated indiviuals*)
av = 1 / 5.5; (*recovery rate for vaccinated indiviuals*)
covidCases = 838 / 7; (*seven day average of covid cases the first week*)
numUndergrads = 19742; (*total undergraduates*)
vaxRate = .93; (*proportion vaccinated*)
days = 109; (*number of days in semester*)
tD = .0000075 ; (*difference in transmission rate
 between campus bu/bv and spring break transmission rates*)
campusBu = .000020; (*campus transmission rate to unvaccinated indiviuals*)
campusBv = .000012;(*campus transmission rate to vaccinated indiviuals*)

PModel
plotTD75 = ListPlot[tabFinal, Joined → True, PlotStyle → Green,  PlotRange → {0, 19742},
   AxesLabel → {"p", "students"}, PlotLegends → {"tD = 0.0000075"}];
```

Running Function, tD = 0.0000050

In[ ]:=
```
(*Set Initial Values*)
au = 1 / 7.5; (*recovery rate for unvaccinated indiviuals*)
av = 1 / 5.5; (*recovery rate for vaccinated indiviuals*)
covidCases = 838 / 7; (*seven day average of covid cases the first week*)
numUndergrads = 19742; (*total undergraduates*)
vaxRate = .93; (*proportion vaccinated*)
days = 109; (*number of days in semester*)
tD = .000005 ; (*difference in transmission rate
 between campus bu/bv and spring break transmission rates*)
campusBu = .000020; (*campus transmission rate to unvaccinated indiviuals*)
campusBv = .000012;(*campus transmission rate to vaccinated indiviuals*)

PModel
plotTD5 = ListPlot[tabFinal, Joined → True, PlotStyle → Red,  PlotRange → {0, 19742},
   AxesLabel → {"p", "students"},  PlotLegends → {"tD = 0.000005"}];
```

Running Function, tD = 0.0000025

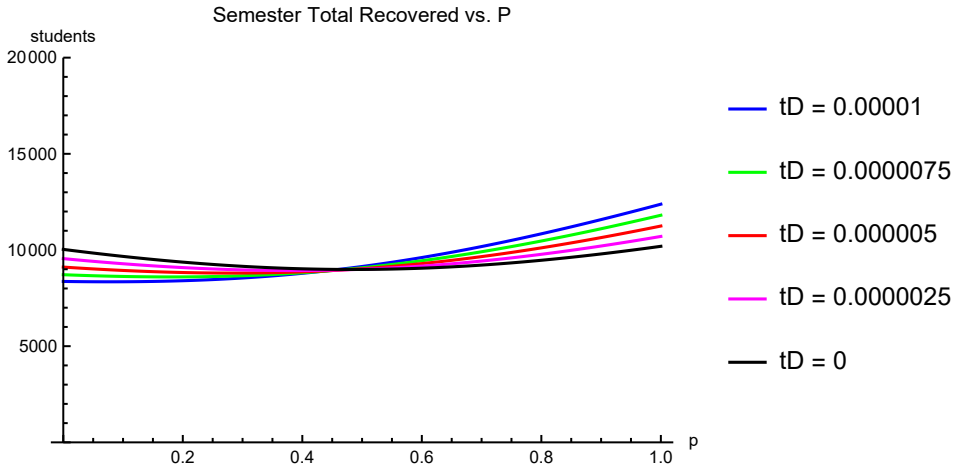
In[ ]:=
```
(*Set Initial Values*)
au = 1 / 7.5; (*recovery rate for unvaccinated indiviuals*)
av = 1 / 5.5; (*recovery rate for vaccinated indiviuals*)
covidCases = 838 / 7; (*seven day average of covid cases the first week*)
numUndergrads = 19742; (*total undergraduates*)
vaxRate = .93; (*proportion vaccinated*)
days = 109; (*number of days in semester*)
tD = .0000025 ; (*difference in transmission rate
 between campus bu/bv and spring break transmission rates*)
campusBu = .000020; (*campus transmission rate to unvaccinated indiviuals*)
campusBv = .000012;(*campus transmission rate to vaccinated indiviuals*)

PModel
plotTD25 =
  ListPlot[tabFinal, Joined → True, PlotStyle → Magenta,  PlotRange → {0, 19742},
   AxesLabel → {"p", "students"}, PlotLegends → {"tD = 0.0000025"}];
```

Running Function, tD = 0:

In[ ]:=
```
(*Set Initial Values*)
au = 1 / 7.5; (*recovery rate for unvaccinated indiviuals*)
av = 1 / 5.5; (*recovery rate for vaccinated indiviuals*)
covidCases = 838 / 7; (*seven day average of covid cases the first week*)
numUndergrads = 19742; (*total undergraduates*)
vaxRate = .93; (*proportion vaccinated*)
days = 109; (*number of days in semester*)
tD = 0 ; (*difference in transmission rate
 between campus bu/bv and spring break transmission rates*)
campusBu = .000020; (*campus transmission rate to unvaccinated indiviuals*)
campusBv = .000012;(*campus transmission rate to vaccinated indiviuals*)

PModel
plotTD0 = ListPlot[tabFinal, Joined → True, PlotStyle → Black,
   PlotRange → {0, 19742},  AxesLabel → {"p", "students"}, PlotLegends → {"tD = 0"}];
```

In[ ]:=
```
Show[plotTD1, plotTD75, plotTD5, plotTD25,
 plotTD0, PlotLabel → "Semester Total Recovered vs. P",
 AxesLabel → {"p", "students"}, PlotRange → {0, 20000}]
```

Out[ ]=



In[ ]:=
```
plotNoBreak =
  Plot[rNoBreak, {x, 0, 1}, PlotStyle → Dashed, PlotLegends → {"No Spring Break"}];
```

In[ ]:=
```
Show[plotTD1, plotTD75, plotTD5, plotTD25, plotTD0,
 plotNoBreak, PlotLabel → "Semester Total Recovered vs. P (zoomed)",
 AxesLabel → {"p", "students"}, PlotRange → {8000, 13000}]
```

Out[ ]=