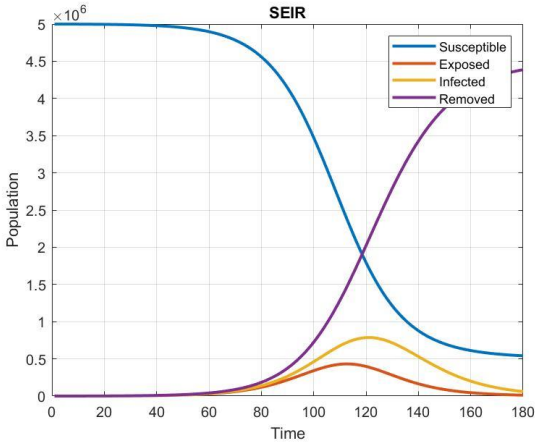
Q1.

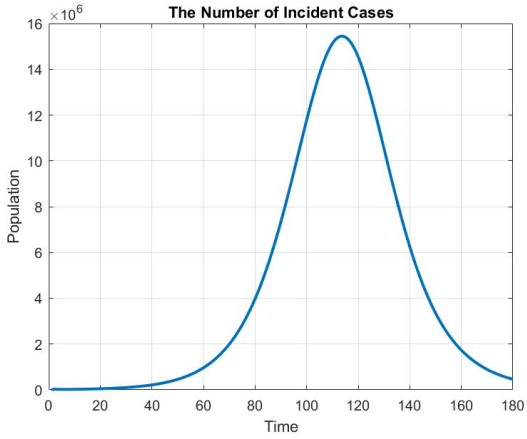
(a) Matlab code to solve the SEIR equation is provided last section of the paper.

(b) SEIR plot is shown in Left downside, Susceptible decreased after 80th day, on the other hand, removed individuals are increase after 80th day. Exposed and infected individuals are bell curved graphs.

(c) Graph that describes the number of incident case shown in below and it looks like bell curve which has maximum about 110th day.



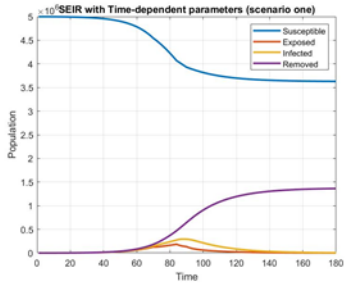
(b) SEIR

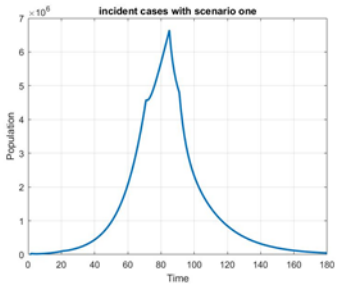


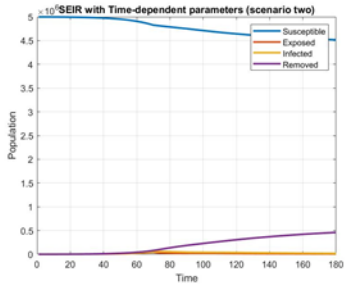
(c) The number of incident case

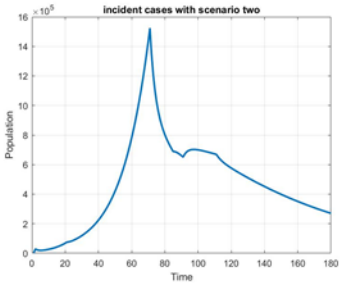
Q2.

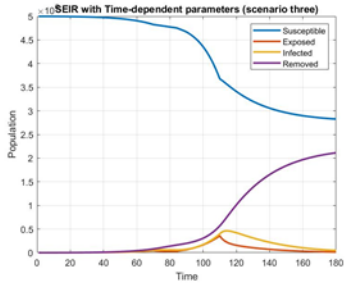
So, for the three scenario, 2nd one 3rd one have better situation than 1st one, 2nd one has smallest exposed individual, and 3rd one has the highest the removed(cured) individual. By far, 1st case has largest number of the new cases.

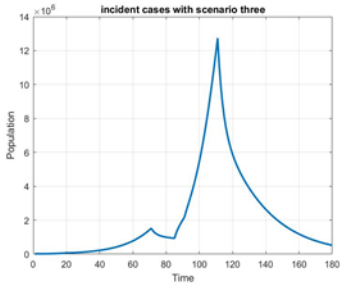








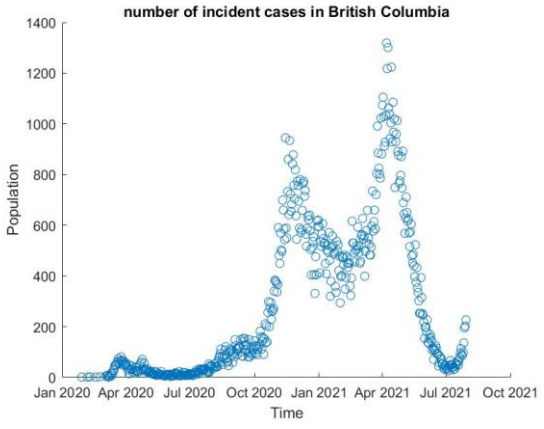




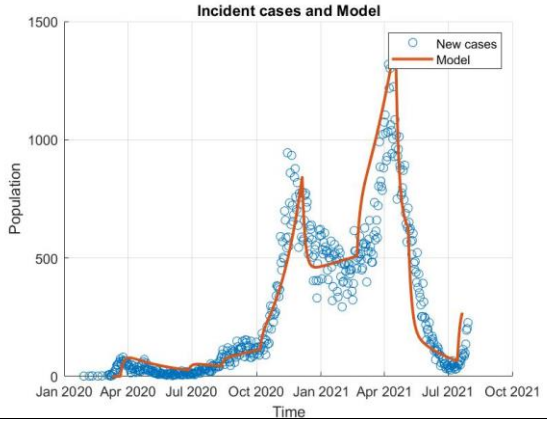
Q3

So by changing R0 parameter, model was fitted to the incident data.

(a)



(b)



```
%Q1-A,B

t = 180;

R0 = 2.5;
N = 5*10^6;
alpha = 0.2;
gamma = 0.1;
beta = R0 *gamma;


S = zeros(t,1);
E = zeros(t,1);
I = zeros(t,1);
R = zeros(t,1);

R(1) = 0;
I(1) = 40;
E(1) = 20*I(1);
S(1) = N-I(1)-E(1)-R(1);

for i = 2:t
    S(i) = S(i-1) - beta*I(i-1)*S(i-1)/N;
    E(i) = E(i-1) + beta*I(i-1)*S(i-1)/N - alpha*E(i-1);
    I(i) = I(i-1) + alpha*E(i-1) - gamma*I(i-1);
    R(i) = R(i-1) + gamma*I(i-1);

end

plot(1:t,S,'LineWidth',2)
hold on
plot(1:t,E,'LineWidth',2)
hold on
plot(1:t,I,'LineWidth',2)
hold on
plot(1:t,R,'LineWidth',2)
grid on


title('SEIR')
legend("Susceptible","Exposed","Infected","Removed")
xlabel("Time")
ylabel("Population")
```

```
%Q1-C
t = 180;

R0 = 2.5;
N = 5*10^6;
alpha = 0.2;
gamma = 0.1;
beta = R0 *gamma;


S = zeros(t,1);
E = zeros(t,1);
I = zeros(t,1);
R = zeros(t,1);
New = zeros(t,1);

R(1) = 0;
I(1) = 40;
E(1) = 20*I(1);
S(1) = N-I(1)-E(1)-R(1);


for i = 2:t
    S(i) = S(i-1) - beta*I(i-1)*S(i-1)/N;
    E(i) = E(i-1) + beta*I(i-1)*S(i-1)/N - alpha*E(i-1);
    I(i) = I(i-1) + alpha*E(i-1) - gamma*I(i-1);
    R(i) = R(i-1) + gamma*I(i-1);
    New(i) = alpha*E(i-1)*(t-1);
end

% %plot(1:t,S,'LineWidth',2)
% hold on
% %plot(1:t,E,'LineWidth',2)
% hold on
% %plot(1:t,I,'LineWidth',2)
% hold on
% plot(1:t,R,'LineWidth',2)
plot(1:t,New,'LineWidth',2)
grid on


title('The number of incident cases')
% legend("Susceptible","Exposed","Infected","Removed")
xlabel("Time")
ylabel("Population")
```

```
%Q2- 1st case commented part(a) , uncommented plot (b)
t = 180;


N = 5*10^6;
alpha = 0.2;
gamma = 0.1;



S = zeros(t,1);
E = zeros(t,1);
I = zeros(t,1);
R = zeros(t,1);
New = zeros(t,1);

R(1) = 0;
I(1) = 40;
E(1) = 20*I(1);
S(1) = N-I(1)-E(1)-R(1);


for i = 2:t
    if i >=2 & i <= 20;
        R0 = 3.5;
    end
    if i >= 21 & i <= 70;
        R0 = 2.6;
    end
    if i >= 71 & i <= 84;
        R0 = 1.9;
    end
    if i >= 85 & i <= 90;
        R0 = 1.0;
    end
    if i >= 91 & i <= 110;
        R0 = 0.55;
    end
    if i >= 111 & i <= 180;
        R0 = 0.55;

    end
    if i >= 181;
        R0 = 0.5;
    end
    beta = R0 *gamma;

    S(i) = S(i-1) - beta*I(i-1)*S(i-1)/N;
    E(i) = E(i-1) + beta*I(i-1)*S(i-1)/N - alpha*E(i-1);
    I(i) = I(i-1) + alpha*E(i-1) - gamma*I(i-1);
    R(i) = R(i-1) + gamma*I(i-1);
    New(i) = alpha*E(i-1)*(t-1);
End

%(a)

% plot(1:t,S,'LineWidth',2)
% hold on
% plot(1:t,E,'LineWidth',2)
% hold on
% plot(1:t,I,'LineWidth',2)
% hold on
% plot(1:t,R,'LineWidth',2)
plot(1:t,New,'LineWidth',2)

grid on


title('incident cases with scenario one')
%legend("Susceptible","Exposed","Infected","Removed")
xlabel("Time")
ylabel("Population")
```

```
%Q2- 2nd case commented part(a) , uncommented plot (b)
t = 180;


N = 5*10^6;
alpha = 0.2;
gamma = 0.1;



S = zeros(t,1);
E = zeros(t,1);
I = zeros(t,1);
R = zeros(t,1);
New = zeros(t,1);

R(1) = 0;
I(1) = 40;
E(1) = 20*I(1);
S(1) = N-I(1)-E(1)-R(1);


for i = 2:t
    if i >=2 & i <= 20;
        R0 = 3 ;
    end
    if i >= 21 & i <= 70;
        R0 = 2.2;
    end
    if i >= 71 & i <= 84;
        R0 = 0.7;
    end
    if i >= 85 & i <= 90;
        R0 = 0.8;
    end
    if i >= 91 & i <= 110;
        R0 = 1.0;
    end
    if i >= 111 & i <= 180;
        R0 = 0.90;
    end
    if i >= 181;
        R0 = 0.5;
    end
    beta = R0 *gamma;

    S(i) = S(i-1) - beta*I(i-1)*S(i-1)/N;
    E(i) = E(i-1) + beta*I(i-1)*S(i-1)/N - alpha*E(i-1);
    I(i) = I(i-1) + alpha*E(i-1) - gamma*I(i-1);
    R(i) = R(i-1) + gamma*I(i-1);
    New(i) = alpha*E(i-1)*(t-1);
end
%(a)

% plot(1:t,S,'LineWidth',2)
% hold on
% plot(1:t,E,'LineWidth',2)
% hold on
% plot(1:t,I,'LineWidth',2)
% hold on
% plot(1:t,R,'LineWidth',2)
%hold on
plot(1:t,New,'LineWidth',2)

grid on


title('incident cases with scenario two')
%legend("Susceptible","Exposed","Infected","Removed")
xlabel("Time")
ylabel("Population")
```

```
%Q2- 3rd case commented part(a) , uncommented plot (b)
t = 180;


N = 5*10^6;
alpha = 0.2;
gamma = 0.1;



S = zeros(t,1);
E = zeros(t,1);
I = zeros(t,1);
R = zeros(t,1);
New = zeros(t,1);

R(1) = 0;
I(1) = 40;
E(1) = 20*I(1);
S(1) = N-I(1)-E(1)-R(1);


for i = 2:t
    if i >=2 & i <= 20;
        R0 = 3 ;
    end
    if i >= 21 & i <= 70;
        R0 = 2.2;
    end
    if i >= 71 & i <= 84;
        R0 = 0.9;
    end
    if i >= 85 & i <= 90;
        R0 = 2.5;
    end
    if i >= 91 & i <= 110;
        R0 = 3.2;
    end
    if i >= 111 & i <= 180;
        R0 = 0.85;
    end
    if i >= 181;
        R0 = 0.5;
    end
    beta = R0 *gamma;

    S(i) = S(i-1) - beta*I(i-1)*S(i-1)/N;
    E(i) = E(i-1) + beta*I(i-1)*S(i-1)/N - alpha*E(i-1);
    I(i) = I(i-1) + alpha*E(i-1) - gamma*I(i-1);
    R(i) = R(i-1) + gamma*I(i-1);
    New(i) = alpha*E(i-1)*(t-1);
end
%(a)
% plot(1:t,S,'LineWidth',2)
% hold on
% plot(1:t,E,'LineWidth',2)
% hold on
% plot(1:t,I,'LineWidth',2)
% hold on
% plot(1:t,R,'LineWidth',2)
plot(1:t,New,'LineWidth',2)

grid on


title('incident cases with scenario three')
%legend("Susceptible","Exposed","Infected","Removed")
xlabel("Time")
ylabel("Population")
```

```
%Q4

%(a)

T = readtable('BCCDC_COVID19_Dashboard_Case_Details.csv');

time = T(:,1);
date = unique(time);
date = table2array(date);
time = table2array(time);

c = groupsummary(table(time),1);
count = c(:,2);
count = table2array(count);
scatter(date,count)
hold on

%(b)
t = 500;


N = 200000;
alpha = 0.2;
gamma = 0.02;



S = zeros(t,1);
E = zeros(t,1);
I = zeros(t,1);
R = zeros(t,1);
New = zeros(t,1);

R(1) = 0;
I(1) = 40;
E(1) = 0*I(1);
S(1) = N-I(1)-E(1)-R(1);


for i = 2:t
    if i >=2 & i <= 12;
        R0 = 0.0;
    end
    if i >= 13 & i <= 22;
        R0 = 0.3;
    end
    if i >= 23 & i <= 109;
        R0 = 0.3;
    end
    if i >= 110 & i <= 156;
        R0 = 0.7;
    end
    if i >= 157 & i <= 212;
        R0 = 1.4;
    end
    if i >= 212 & i <= 271;
        R0 = 2.6;
    end
    if i >= 272 & i  <= 349;
        R0 = 1.1;
    end
    if i >= 350 & i <= 404;
        R0 = 1.72;
    end
    if i >= 405 & i <= 423;
        R0 = 0.7;
    end
    if i >= 423 & i <= 491;
        R0 = 0.2;
    end
    if i >= 493
        R0 = 1.12;
    end
    beta = R0 *gamma;

    S(i) = S(i-1) - beta*I(i-1)*S(i-1)/N;
    E(i) = E(i-1) + beta*I(i-1)*S(i-1)/N - alpha*E(i-1);
    I(i) = I(i-1) + alpha*E(i-1) - gamma*I(i-1);
    R(i) = R(i-1) + gamma*I(i-1);
    New(i) = alpha*E(i-1)*(t-1);
end
```

```
% plot(1:t,S,'LineWidth',2)
% hold on
% plot(1:t,E,'LineWidth',2)
% hold on
% plot(1:t,I,'LineWidth',2)
% hold on
% plot(1:t,R,'LineWidth',2)
plot(40:t+39,New,'LineWidth',2)
%35:t+34
grid on


title('Incident cases and Model')
legend("New cases","Model")
xlabel("Time")
ylabel("Population")
```