Question 2: Enzyme Kinetics

8.1.

$$\frac{dS}{dx} = -k1 * S * E + K2 * ES$$

$$\frac{dE}{dx} = -k1 * S * E + (K2 + K3) * ES$$

$$\frac{dES}{dx} = +k1 * S * E - (K2 + K3) * ES$$

$$\frac{dP}{dx} = +K2 * ES$$

8.2.

1st script (runge_kutta) definide the fourth-order Runge-Kutta method

```
function [x,y]=runge_kutta(ufunc,y0,h,a,b)
n=floor((b-a)/h);        %steps
x(1)=a;                  %time0
y(:,1)=y0;
for i=1:n
    x(i+1)=x(i)+h;
    k1=ufunc(x(i),y(:,i));
    k2=ufunc(x(i)+h/2,y(:,i)+h*k1/2);
    k3=ufunc(x(i)+h/2,y(:,i)+h*k2/2);
    k4=ufunc(x(i)+h,y(:,i)+h*k3);
    y(:,i+1)=y(:,i)+h*(k1+2*k2+2*k3+k4)/6;
end
```

2nd script (test_fun) definide the equations
```
%equation
function dydt=test_fun(t,y)
m1=100;
m2=600;
m3=150;

dydt=[-m1*y(1)*y(2)+m2*y(3);
    -m1*y(1)*y(2)+(m2+m3)*y(3);
    m1*y(1)*y(2)-(m2+m3)*y(3);
    m2*y(3)];
```

3rd script (mainQ2) to resolve equation with fourth-order Runge-Kutta method and ode45
```
clear all;
close all;
```

```matlab
%ode45
[t,h] = ode45(@test_fun,[0 1],[10 1 0 0]);
figure;
hold on
plot(t(:),h(:,1),'g')
plot(t(:),h(:,2),'r')
plot(t(:),h(:,3),'c')
plot(t(:),h(:,4),'b')
xlabel('Time (min)')
ylabel('Concentration (¬µg)')
title('Evolution of Enzyme Kinetics (resolution with ode45)')
legend('S','E','ES','P')
hold off
grid on;

figure;
hold on
plot(t(:),h(:,4),'g')
xlabel('Time (min)')
ylabel('Concentration (¬µg)')
title('Evolution of S (resolution with ode45)')
hold off
grid on;

% runge kutta
[t1,h1] = runge_kutta(@test_fun,[10 1 0 0],0.0005,0,1);
figure
hold on
plot(t1(:),h1(1,:),'g')
plot(t1(:),h1(2,:),'r')
plot(t1(:),h1(3,:),'c')
plot(t1(:),h1(4,:),'b')
xlabel('Time (min)')
ylabel('Concentration (¬µg)')
title('Evolution of Enzyme Kinetics (resolution with runge
kutta)')
legend('S','E','ES','P')
hold off
grid on;

figure;
hold on
plot(t1(:),h1(4,:),'g')
xlabel('Time (min)')
ylabel('Concentration (¬µg)')
title('Evolution of S (resolution with runge kutta)')
hold off
grid on;
```
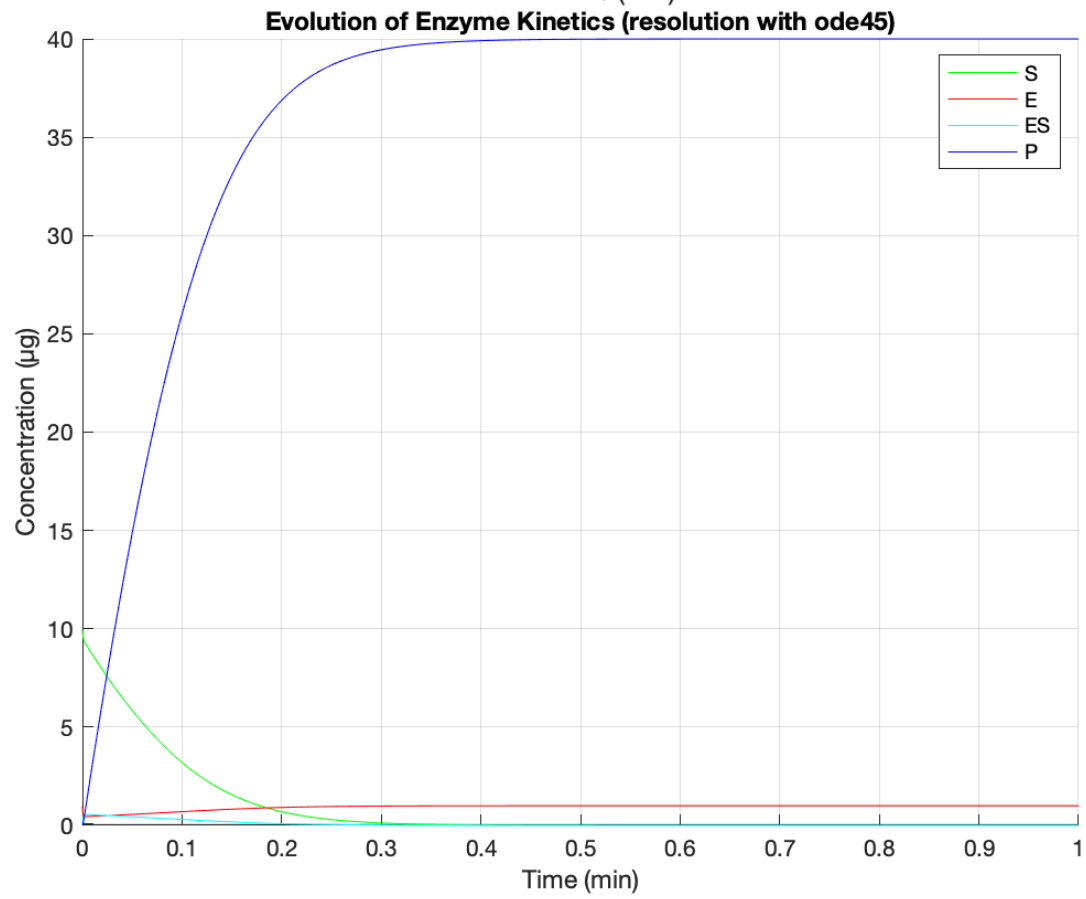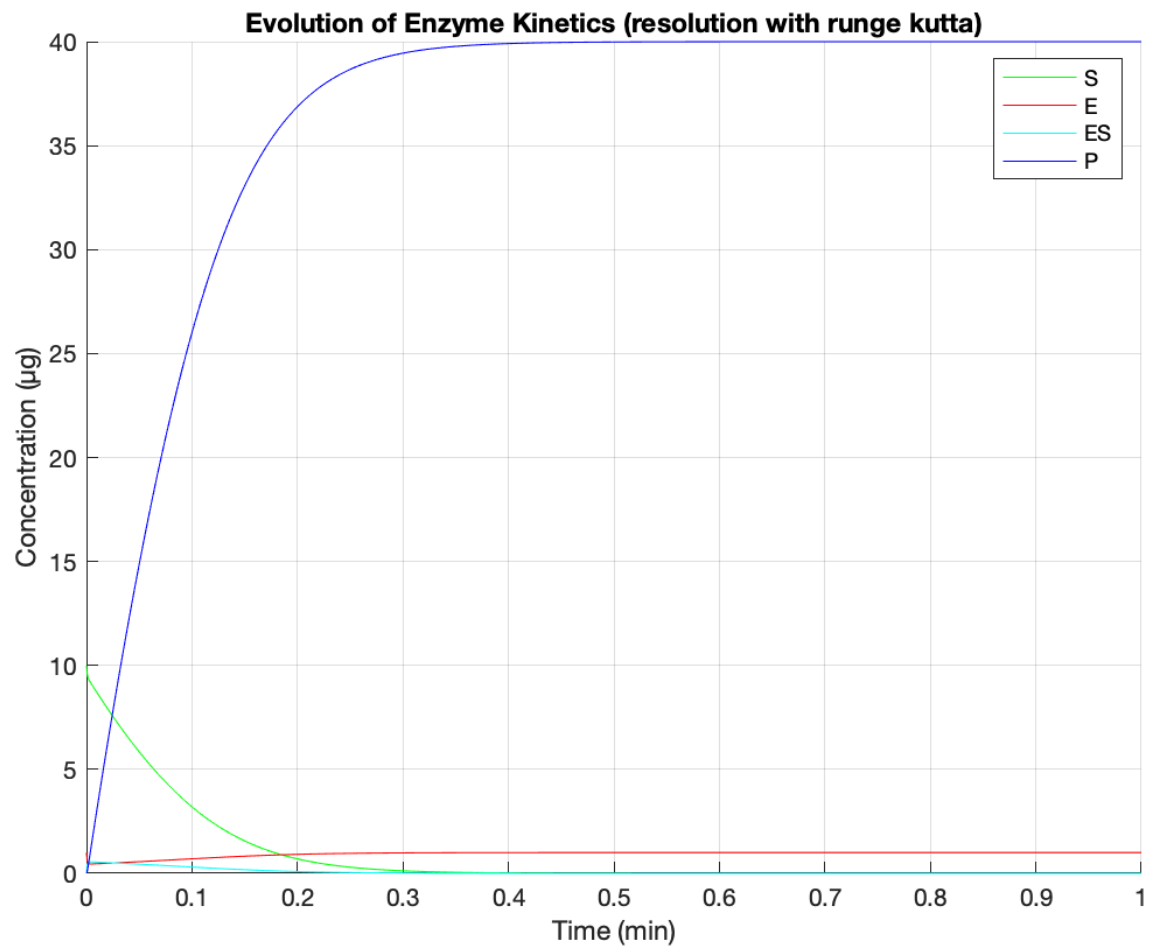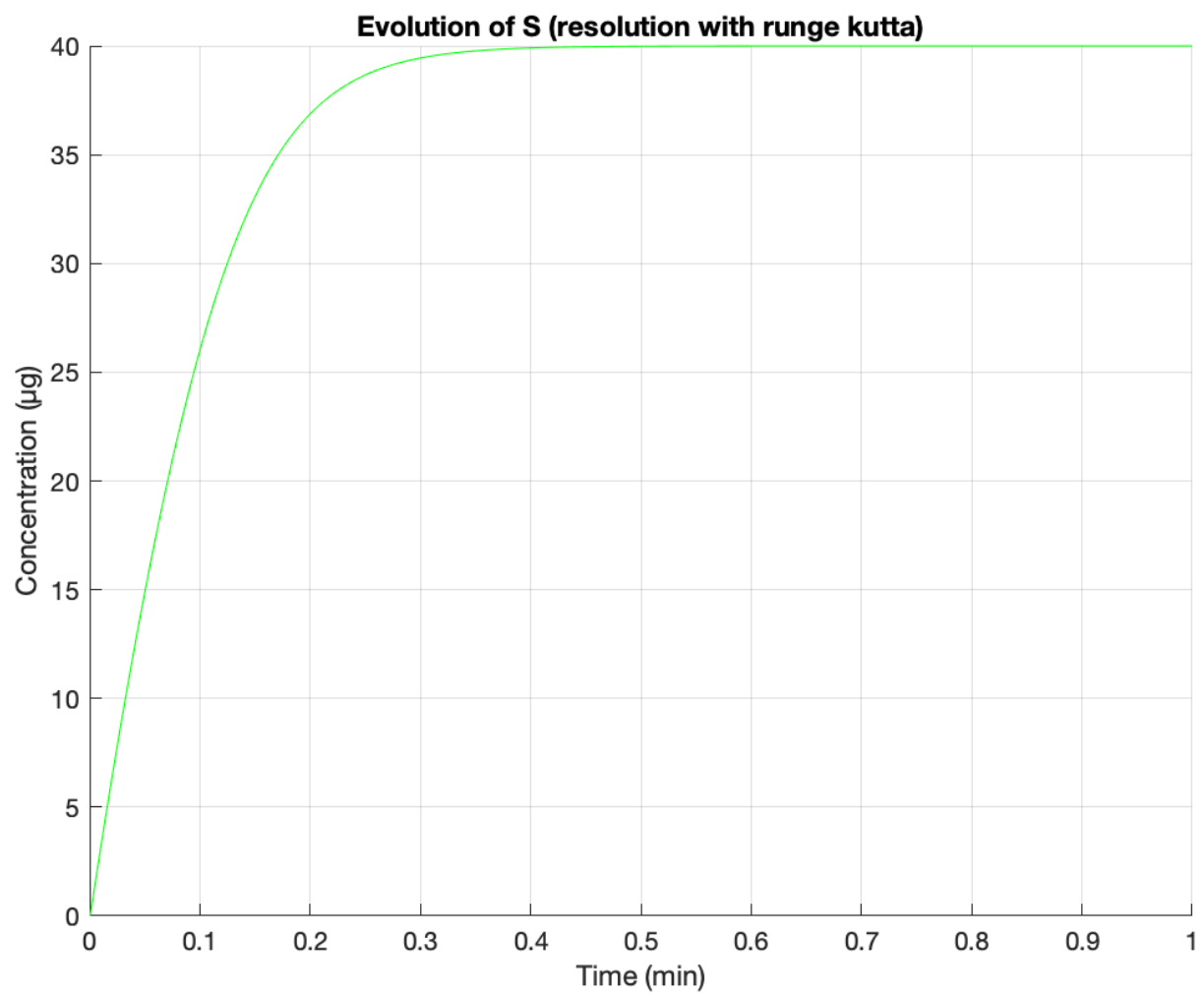
Graph:

Evolution of Enzyme Kinetics (resolution with runge kutta)

Evolution of Enzyme Kinetics (resolution with ode45)

8.3.

Vm=40µg/0.35min = 114,29 µg/min
Vm=1,90 µg/s