8.1 Applying the law of mass action, we define the rate of changes of E, S, ES, and P as V_E, V_S, V_{ES} and V_P, and the total concentration of enzyme E is $[E_t]$.

We have:

$$V_E = k_2[ES] + k_3[ES] - k_1([E_t] - [ES])[S]$$

$$V_S = k_2[ES] - k_1([E_t] - [ES])[S]$$

$$V_{ES} = k_1([E_t] - [ES])[S] - k_2[ES] - k_3[ES]$$

$$V_P = k_3[ES]$$

8.2

Let's first assume that the rate of ES is 0, and in these two plots, the first is the rate of change of S (substrate) and the second is the rate of change of P (product).

The main.m file

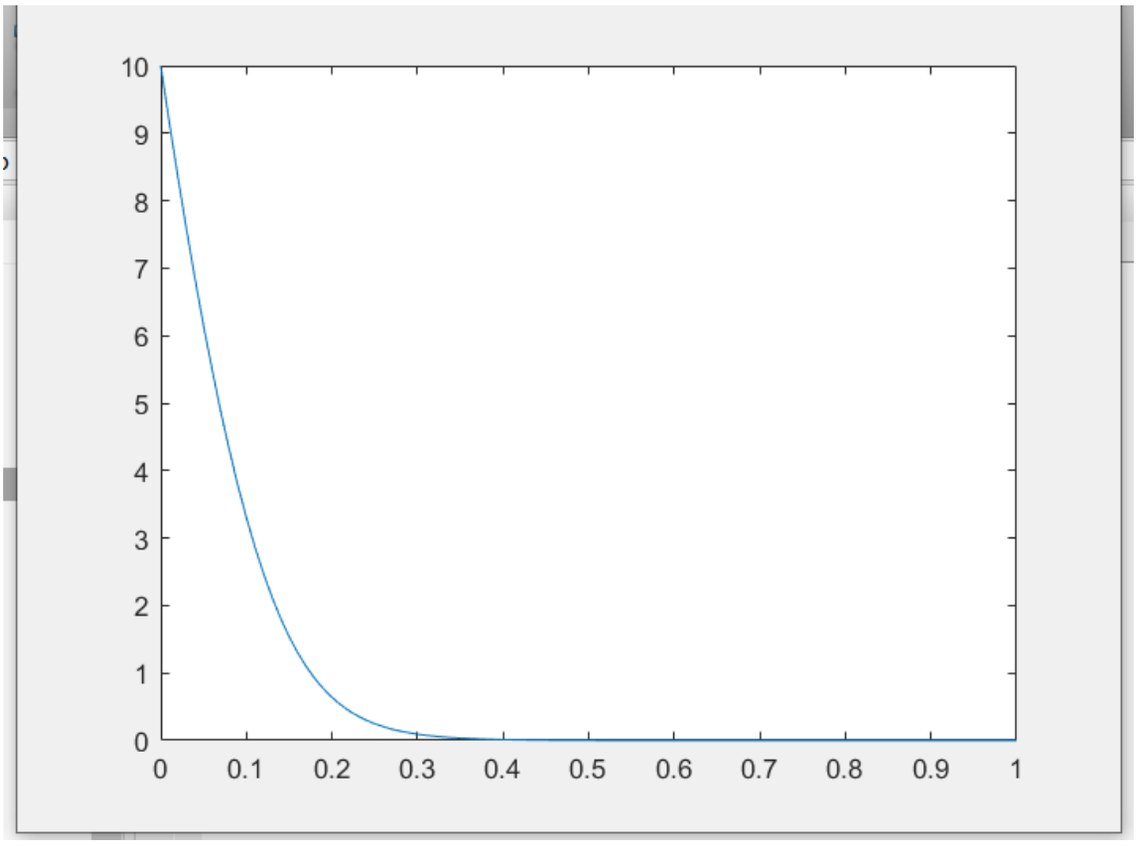
```
clc;clear all;close all;
h=0.01
x=0:h:1
n=length(x)
x(1)=0
y(1)=10
z(1)=0
for i=1:n-1
   k1=h*fun(x(i),y(i));
   k2=h*fun(x(i)+h/2,y(i)+k1*1/2)
   k3=h*fun(x(i)+h/2,y(i)+k2*1/2)
   k4=h*fun(x(i)+h,y(i)+k3)
   y(i+1)=y(i)+(k1+2*k2+2*k3+k4)/6
end
plot(x,y)
for i=1:n-1
   k1=h*fun1(y(i),z(i));
   k2=h*fun1(y(i)+h/2,z(i)+k1*1/2)
   k3=h*fun1(y(i)+h/2,z(i)+k2*1/2)
   k4=h*fun1(y(i)+h,z(i)+k3)
   z(i+1)=z(i)+(k1+2*k2+2*k3+k4)/6
end
plot(x,z)
```

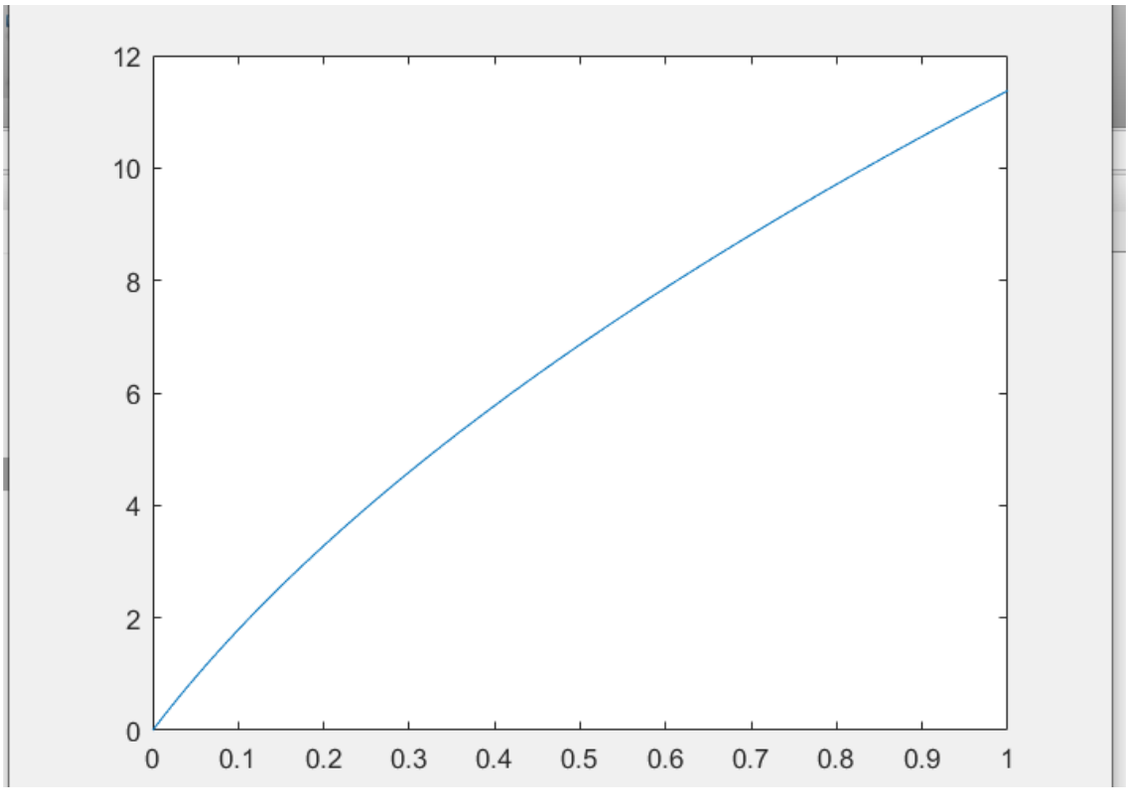
the fun1.m file

```
function dy=fun1(y,z)
dy=150*(100*1)/(100*z+600+150)
```

The fun.m file

```
function dy=fun(x,y)
dy=(600+100*y)*100*1*y/(100*y+600+150)-100*1*y
```


10
9
8
7
6
5
4
3
2
1
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


12
10
8
6
4
2
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

8.3 For the enzyme reaction $E+S \underset{k_3}{\overset{k_2}{\rightleftharpoons}} ES \xrightarrow{k_3} E+P$ the first step is fast, and the second step is slow. We Assum that the concentration of Es, that is $[ES]$ is stable. $V_{ES}=0$ then.

$$k_1([E_t]-[ES])[S] = k_2[ES]+k_3[ES]$$

$$\frac{([E_t]-[ES])[S]}{[ES]} = \frac{k_2+k_3}{k_1}$$

define $\frac{k_2+k_3}{k_1} = k_m$

$$([E_t]-[ES])[S] = k_m[ES]$$

$$[ES] = \frac{[E_t][S]}{k_m+[S]}$$

$$\therefore V = V_p = k_3[ES]$$

$$\therefore V = \frac{k_3[E_t][S]}{K_m + [S]}$$

When the concentration of S, $[S]$ is large, the active centers of the enzyme are saturated by the substrate, then

$[E_t] = [ES]$ $\quad V_m = k_3[ES]$

$= k_3[E_t]$