8.1

Solution:

$$E + S \underset{k_2}{\overset{k_1}{\rightleftharpoons}} ES \xrightarrow{k_3} E + P$$

according to the law of mass action,

$$E: \quad \frac{d[E]}{dt} = (k_2 + k_3)[ES] - k_1[E][S]$$

$$S: \quad \frac{d[S]}{dt} = k_2[ES] - k_1[E][S]$$

$$ES: \quad \frac{d[ES]}{dt} = k_1[E][S] - k_2[ES] - k_3[ES]$$

$$P: \quad \frac{d[P]}{dt} = k_3[ES]$$

8.2&8.3

MATLAB Code:

```
h=1e-5;
t=0:h:1;
a=100;
b=600;
c=150;

N=length(t);
E=ones(1,N);
S=ones(1,N);
es=ones(1,N);
P=ones(1,N);
E(1)=1;
S(1)=10;
se(1)=0;
P(1)=0;

%RK4:
for i=2:N
t_n=t(i-1);
E_n=E(i-1);
S_n=S(i-1);
es_n=es(i-1);
P_n=P(i-1);

kE1=(b+c)*es_n-a*E_n*S_n;
kS1=-a*E_n*S_n+b*es_n;
kes1=a*E_n*S_n-(b+c)*es_n;
kP1=c*es_n;

kE2=(b+c)*(es_n+kes1*h/2)-a*(S_n+kS1*h/2)*(S_n+kS1*h/2);
kS2=-a*(S_n+kS1*h/2)*(S_n+kS1*h/2)+b*(es_n+kes1*h/2);
kes2=a*(S_n+kS1*h/2)*(S_n+kS1*h/2)-(b+c)*(es_n+kes1*h/2);
kP2=c*(es_n+kes1*h/2);
kE3=(b+c)*(es_n+kes2*h/2)-a*(S_n+kS2*h/2)*(S_n+kS2*h/2);
kS3=-a*(S_n+kS2*h/2)*(S_n+kS2*h/2)+b*(es_n+kes2*h/2);
kes3=a*(S_n+kS2*h/2)*(S_n+kS2*h/2)-(b+c)*(es_n+kes2*h/2);
kP3=c*(es_n+kes2*h/2);
kE4=(b+c)*(es_n+kes3*h)-a*(S_n+kS3*h)*(S_n+kS3*h);
kS4=-a*(S_n+kS3*h)*(S_n+kS3*h)+b*(es_n+kes3*h);
kes4=a*(S_n+kS3*h)*(S_n+kS3*h)-(b+c)*(es_n+kes3*h);
kP4=c*(es_n+kes3*h);
```

```
E(i)=E_n+h/6*(kE1+2*kE2+2*kE3+kE4);
S(i)=S_n+h/6*(kS1+2*kS2+2*kS3+kS4);
es(i)=es_n+h/6*(kes1+2*kes2+2*kes3+kes4);
P(i)=P_n+h/6*(kP1+2*kP2+2*kP3+kP4);
end

figure();
hold on;
plot(t,E,'r');
plot(t,S,'g');
plot(t,es,'b');
plot(t,P,'black');
legend('E','S','ES','P');
xlabel('t');
ylabel('Concentration')
title(' Changes in each component ');
hold off;
```

RESULT: