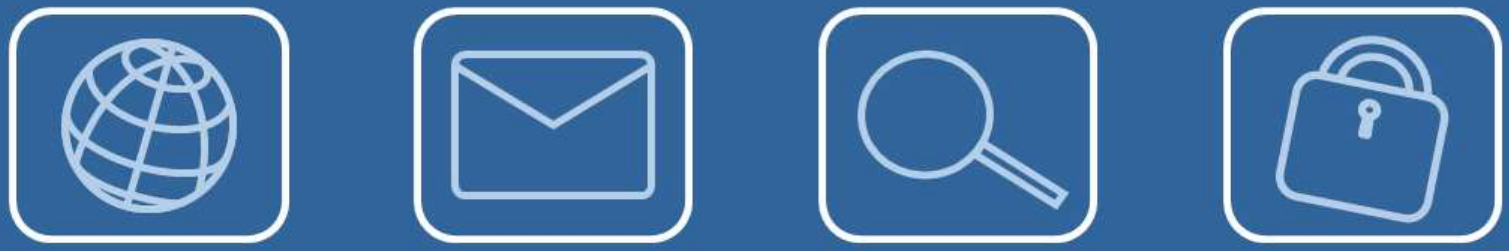


Turbidostat Response (TURBCON)

Contents




Dream CNU

Model

- Schematic diagram

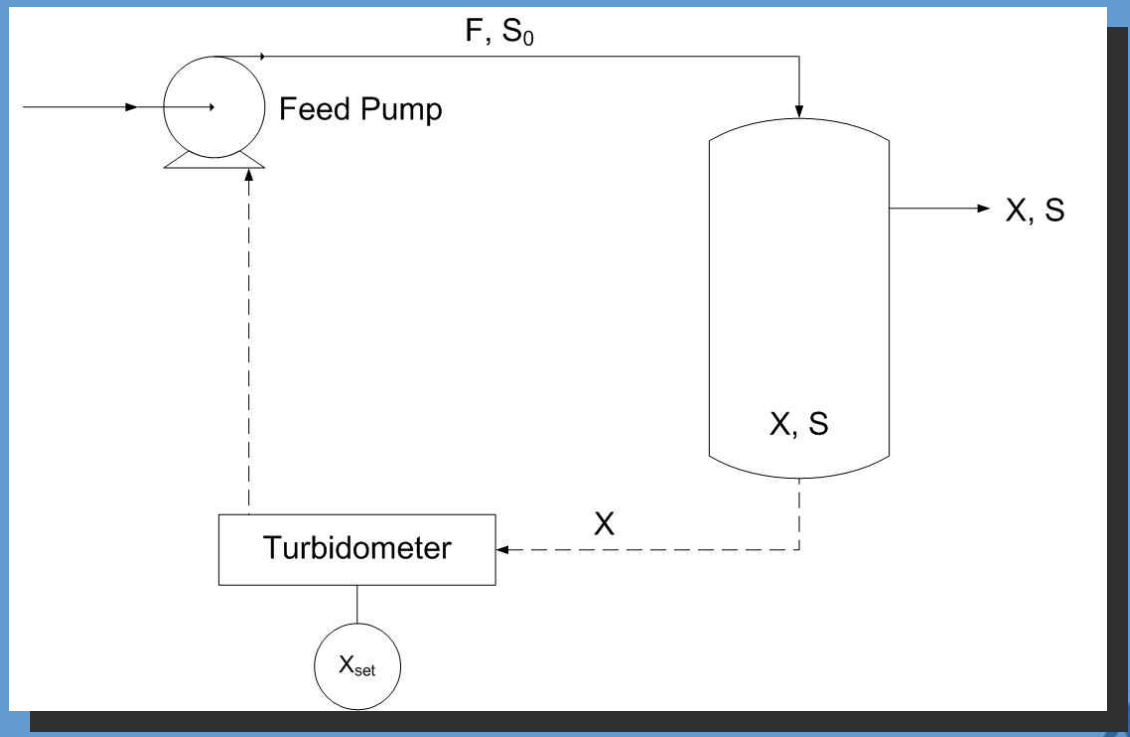


Fig. 1. Feedback control of the biomass concentration using a Turbidostat.

Model

- For the well-mixed tank with Monod growth

$$\mu = \frac{\mu_m S}{K_S + S}$$

$$\frac{dS}{dt} = \frac{F(S_0 - S)}{V} - \frac{\mu X}{Y}$$

$$\frac{dX}{dt} = -\frac{FX}{V} + \mu X$$

  - Luedeking-Piret kinetics

$$\frac{dP}{dt} = -\frac{FP}{V} + (B + \mu A)X$$

  - PI control

$$F = F_0 + K_P \varepsilon + \frac{K_P}{\tau_I} \int \varepsilon dt$$

$$\varepsilon = (X - X_{set})$$





Model

Symbols			
	A	Growth-associated constant	-
	B	Nongrowth-associated constant	1/h
	F	Flow rate	m^3 /h
	F_0	Normal feed flow rate	m^3 /h
	K_P	Proportional controller constant	m^6 /(h·kg)
	K_S	Saturation constant	Kg/m^3
	P	Product concentration	Kg/m^3
	S	Substrate concentration	Kg/m^3
	V	Reactor Volume	m^3
	X	Biomass concentration	Kg/m^3
	Y	Yield coefficient	Kg /kg
	τ_I	Integral control time constant	h
Indices	m	Refers to maximum	
	P	Refers to proportional control	
	S and set	Refers to setpoint	
	0	Refers to inlet stream	

Dream CNU

Programming Source

M-file

```
function dydt=TURBCON(t,y)
clc;
UM=0.5;  KS=0.1;        Y=0.8;
V=1;     S0=5;          Tl=10;        %Constant
F0=0.2;  KP=0.25;       A=0.2;
B=0.15;  XS=2.0;
if (y(2)<0)
   y(2)=0;
   end;
U=UM*y(2)/(KS+y(2));
E=y(1)-XS;                            % Error
F=F0+KP*E+KP/Tl*E*t;
y1=y(1);                              % y1=X
y2=y(2);                              % y2=S
y3=y(3);                              % y3=P
dydt=[-F*y(1)/V+U*y(1);
   F*(S0-y(2))/V-U*y(1)/Y;
   -F*y(3)/V+A*U*y(1)+B*y(1)];
```

Command

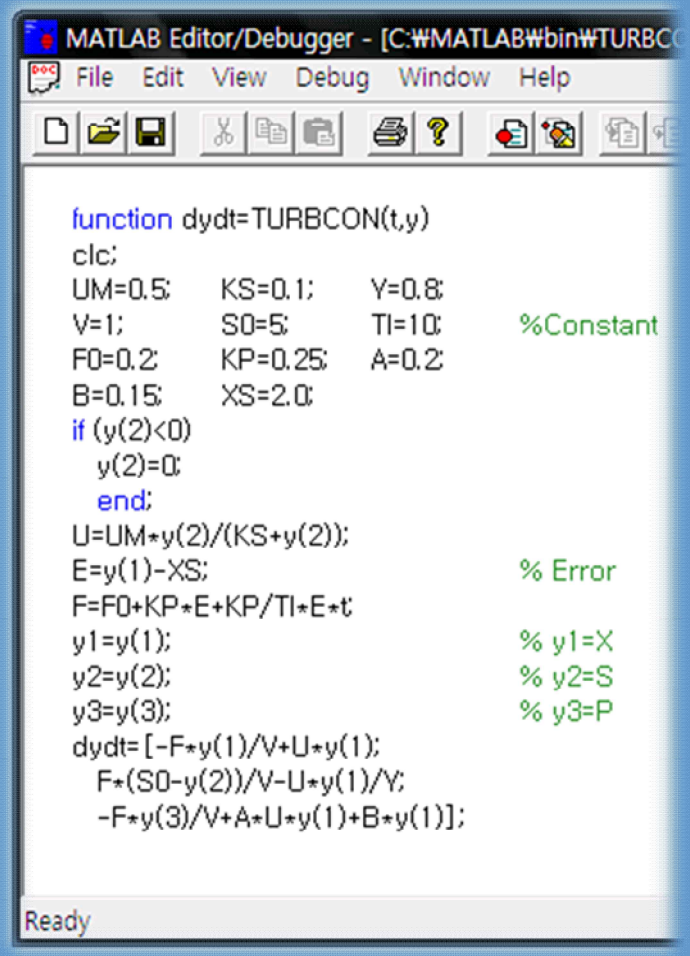
```
y0=[1,5,1];
t0=0;tf=20.0;
[t,y]=ode45('TURBCON',t0:0.01:tf,y0);
plot(t,y(:,1),'-r.',t,y(:,2),'-k.',t,y(:,3),'-b.');
title('TURBCON','fontsize',16,'fontweight','b');
xlabel('TIME','fontsize',12,'fontweight','b');
ylabel('X,S,P','fontsize',12,'fontweight','b');
h=legend('X','S','P',0);
set(h,'fontsize',8);
```

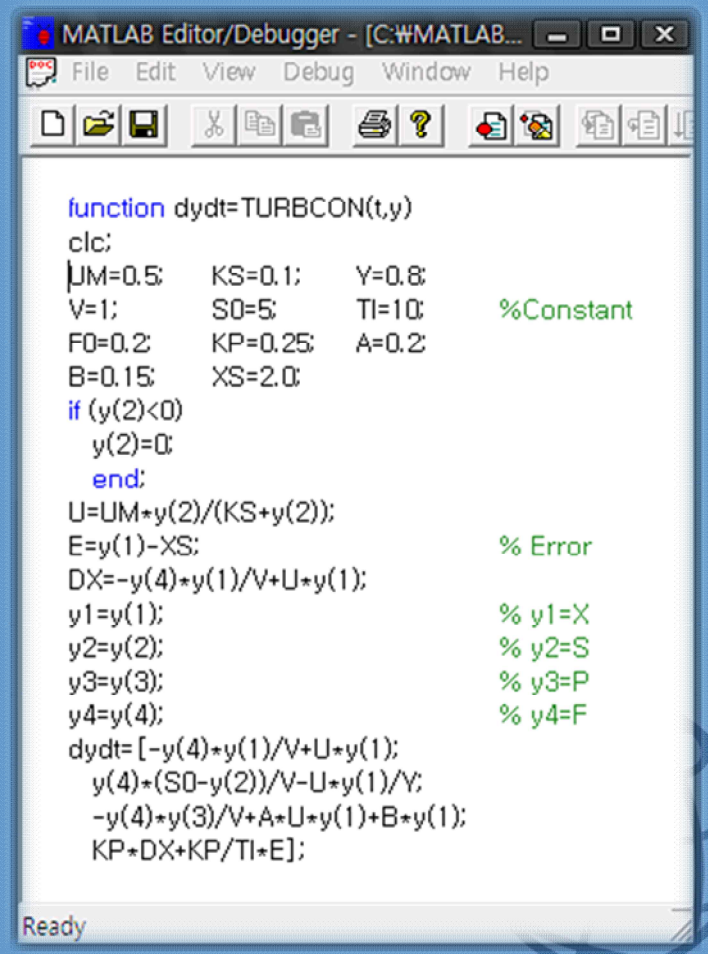
```
y0=[1,5,1,0.2];
t0=0;tf=40.0;
[t,y]=ode45('TURBCON',t0:0.01:tf,y0);
plot(t,y(:,1),'-r.',t,y(:,2),'-k.',t,y(:,3),'-b.',t,y(:,4),'-g.');
title('TURBCON','fontsize',16,'fontweight','b');
xlabel('TIME','fontsize',12,'fontweight','b');
ylabel('X,S,P,F','fontsize',12,'fontweight','b');
h=legend('X','S','P','F',0);
set(h,'fontsize',8);
```

Dream CNU

Matlab Programming

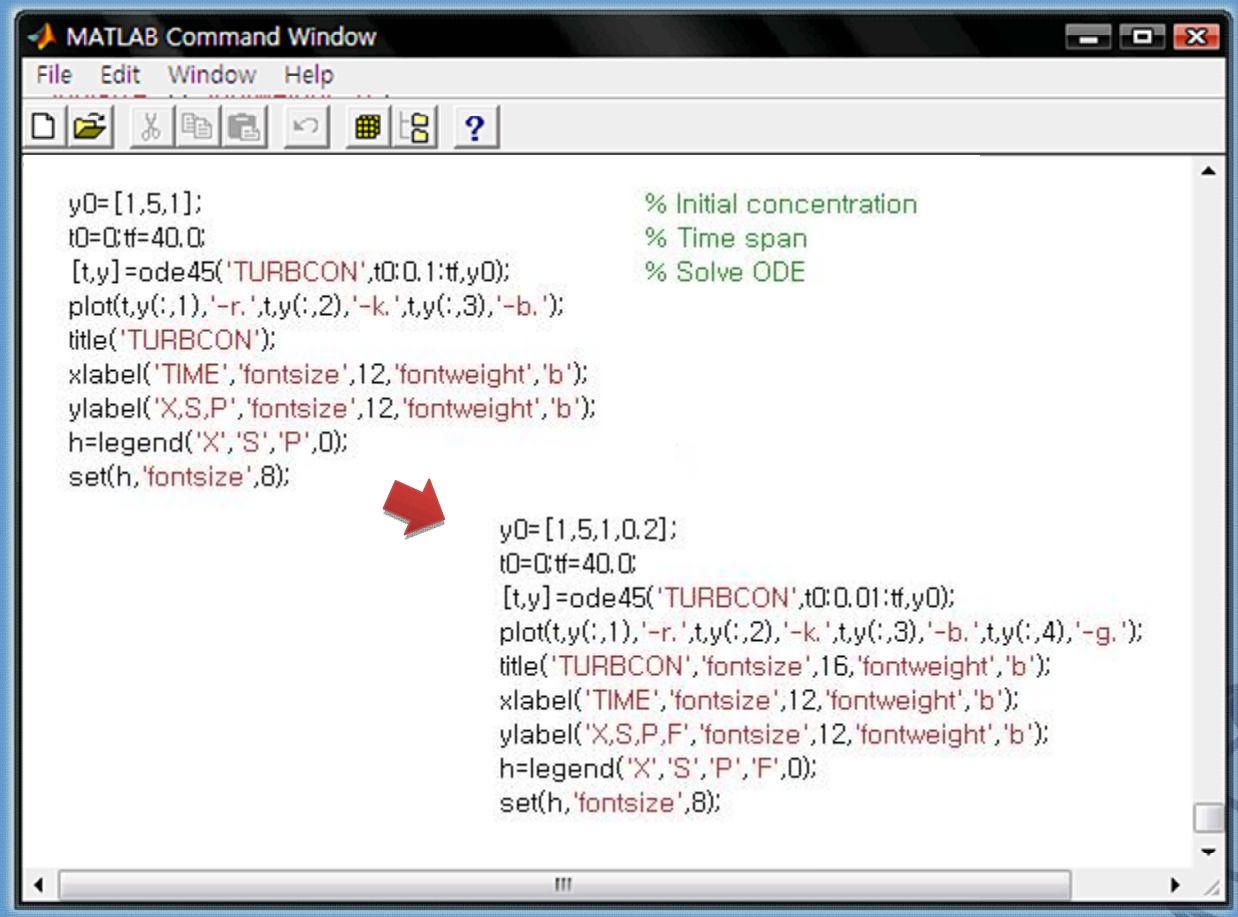
- M-file





Matlab Programming

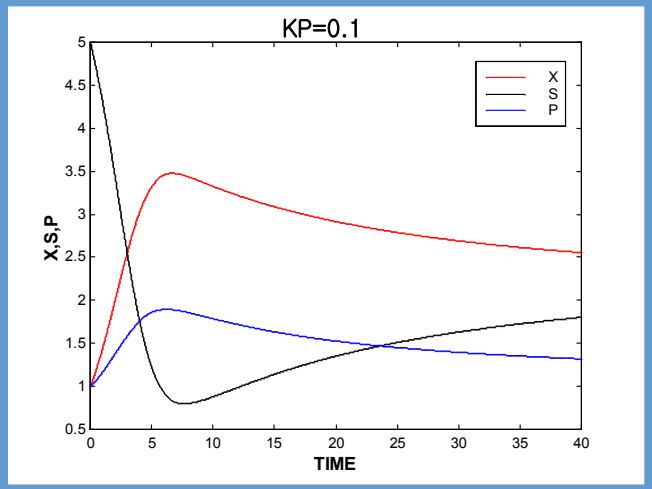
- Command

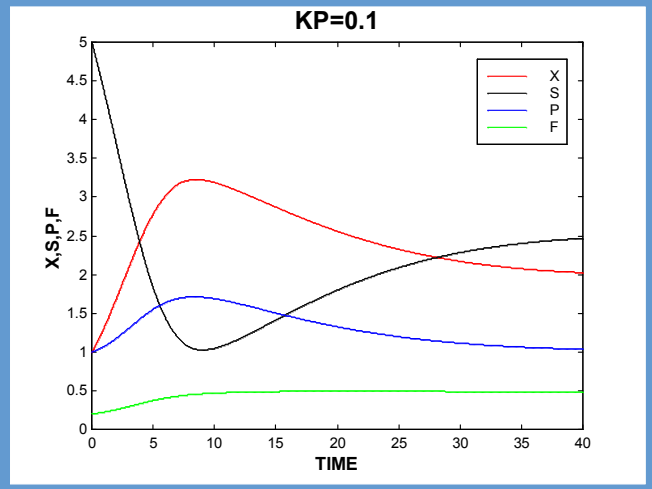


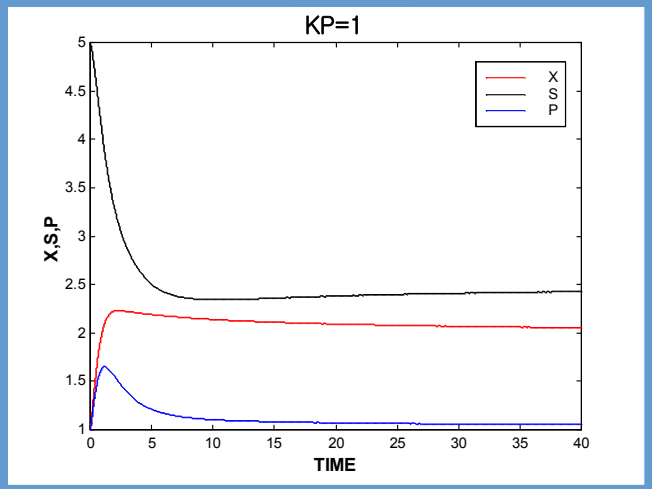
Dream CNU

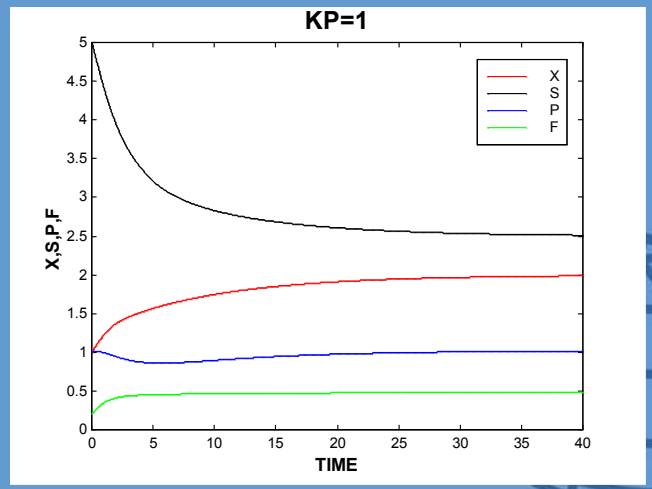
Changing Parameters

- Set K_p in the range 0.1 to 1



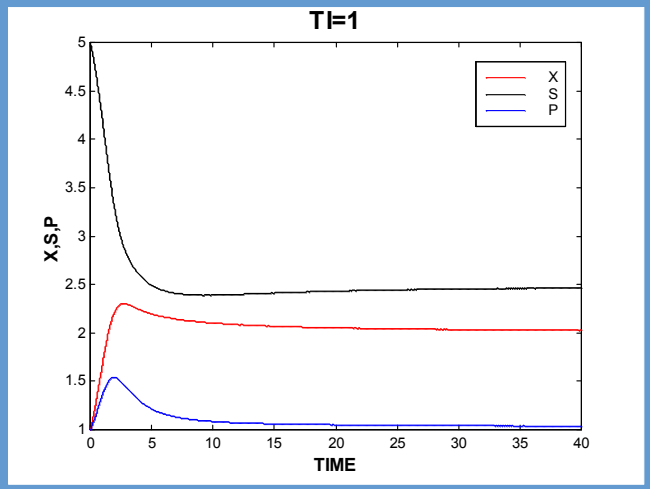


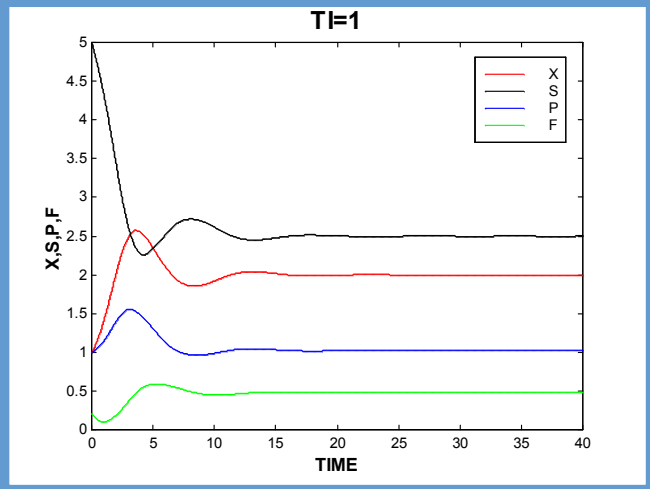


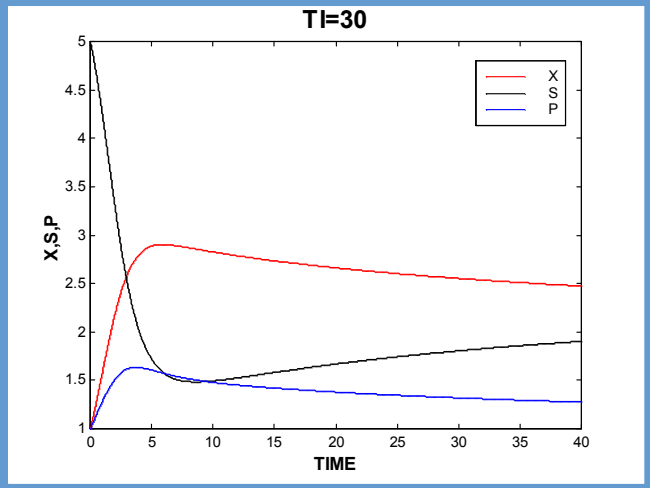


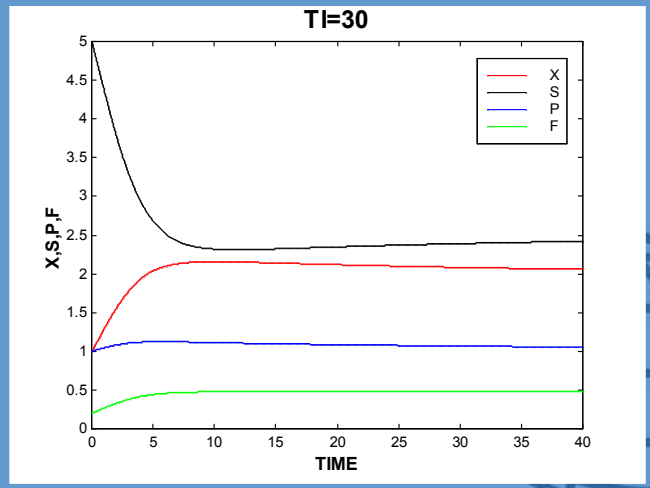
Changing Parameters

- Vary τ_I in the range 1 to 30





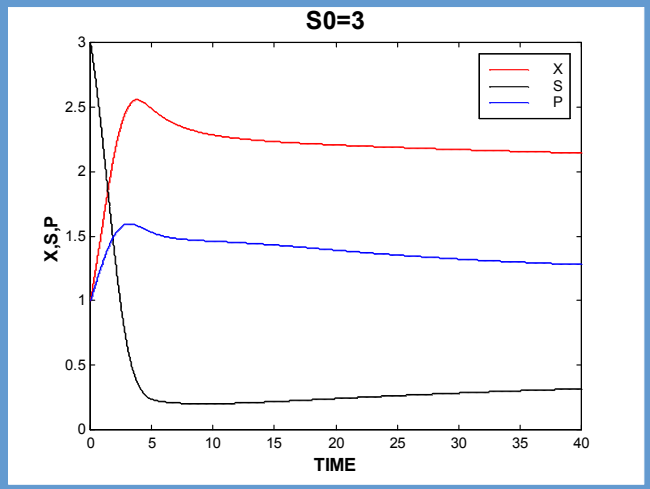


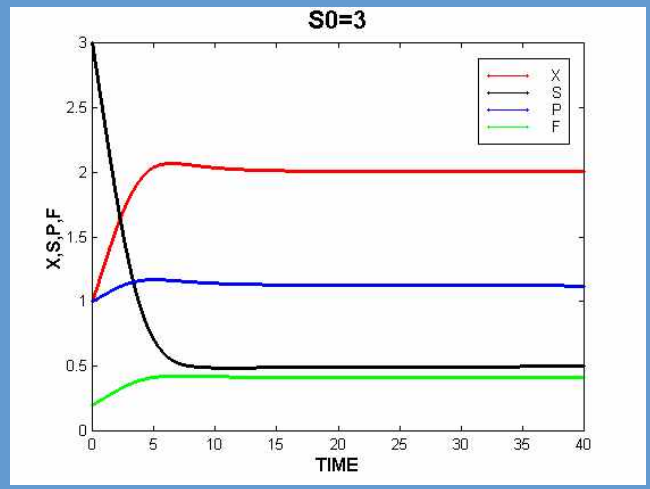


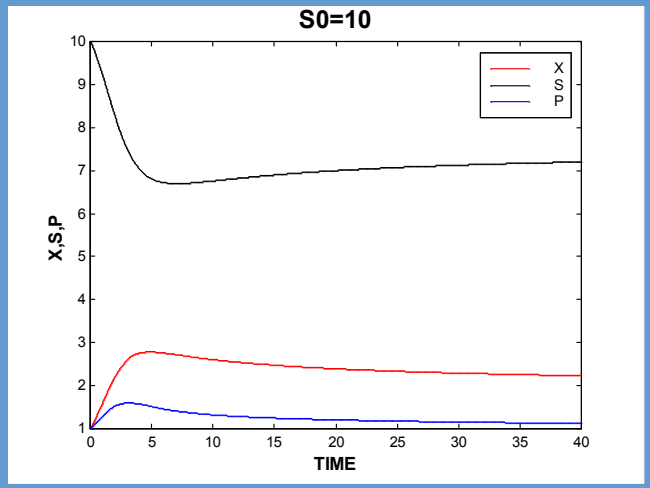
Dream CNU

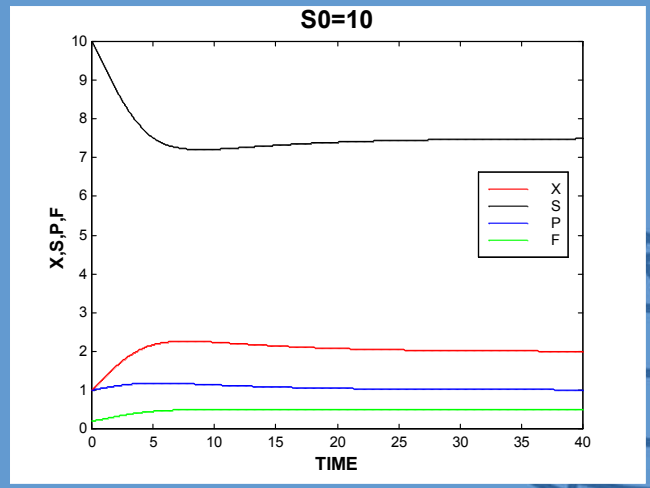
Changing Parameters

- Vary S_0 in the range 3 to 10









Dream CNU

Conclusion

- K_p 의 값이 클수록, τ_I 값이 작을 수록 최종값에 빨리 도달한다.
- S_0의 양이 많아질수록 반응 용기의 기질의 농도는 증가하나 생성물 농도(P)와 생장 농도(X) 변화에는 거의 영향을 미치지 않는다.