

Software for numerical simulation of terpolymerization process and state estimation methods for its identification.

(annexed to the paper of M. Basin and M.A. Alcorta-Garcia
“Optimal Filtering for Bilinear System States and Its Application to
Terpolymerization Process Identification”)

The software package written in MatLab 6.1 consists of three program-executors and three subordinated program modules. The pair **og1** (executor) and **ogun1** (module) simulates behavior of ten states of terpolymerization process, the ten estimates given by the optimal bilinear filter, and the 55 entries of the corresponding symmetric error covariance matrix. The pair **og1lin** (executor) and **ogun1lin** (module) simulates behavior of ten states of terpolymerization process, the ten estimates given by the Kalman-Bucy filter, and the 55 entries of the corresponding error covariance matrix. The pair **og1polylin** (executor) and **ogunpolylin** (module) simulates behavior of ten states of terpolymerization process, the ten estimates given by the mixed filter (please see the paper for definition), and the 55 entries of the corresponding error covariance matrix.

Each executor defines the final time of simulation (the default value $T = 40$), specifies the initial values of all 75 program variables, and calls for the corresponding module to be executed. The program variables are organized in an array, where $x(1), \dots, x(10)$ are ten states of the terpolymerization process, $x(11), \dots, x(20)$ are their ten estimates by the corresponding filter (bilinear, Kalman-Bucy, or mixed), and $x(21), \dots, x(75)$ are 55 entries of the corresponding error covariance matrix arranged by rows: $p_{11}, p_{12}, p_{1,10}, p_{22}, \dots, p_{10,10}$. The program codes are given below. Results of executing a code can be graphically viewed using the MatLab command **plot**. To make an example, the graphs of the variable $x(10)$ and its estimate $x(20)$ are given after each program pair. Using the zoom option in a MatLab figure, the exact values of each variable can be outlined. To make an example, the values of $x(10)$ and $x(20)$ are compared at the time moments $T = 1, 2, 3, 4, 5, 10, 20$.

All process equations and definitions of variables should be consulted in the paper mentioned in the poster title. Should you have any additional questions, please send e-mail at mbasin@fcfm.uanl.mx.

% Executor of ogun1.m

```
x=zeros(75,1)
a=0
x(1,1)=0
x(2,1)=0
x(3,1)=0
x(4,1)=0
x(5,1)=0
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x(6,1)=0
x(7,1)=0
x(8,1)=0
x(9,1)=0
x(10,1)=0
x(11,1)=0.5
x(12,1)=0.5
x(13,1)=0.5
x(14,1)=0.5
x(15,1)=0.5
x(16,1)=0.5
x(17,1)=0.5
x(18,1)=0.5
x(19,1)=0.5
x(20,1)=0.5
x(35,1)=1
x(42,1)=1
x(33,1)=1
x(44,1)=1
x(55,1)=1
x(65,1)=1
x(66,1)=1
x(70,1)=1
x(73,1)=1
x(75,1)=1
x(21,1)=a
x(22,1)=a
x(23,1)=a
x(24,1)=a
x(25,1)=a
x(26,1)=a
x(27,1)=a
x(28,1)=a
x(29,1)=a
x(30,1)=a
x(31,1)=a
x(32,1)=a
x(34,1)=a
x(36,1)=a
x(37,1)=a
x(38,1)=a
x(39,1)=a
x(40,1)=a
x(41,1)=a
x(43,1)=a
x(45,1)=a
x(46,1)=a

x(47,1)=a
x(48,1)=a
x(49,1)=a
x(50,1)=a
x(51,1)=a
x(52,1)=a
x(53,1)=a
x(54,1)=a
x(56,1)=a
x(57,1)=a
x(58,1)=a
x(59,1)=a
x(60,1)=a
x(61,1)=a
x(62,1)=a
x(63,1)=a
x(64,1)=a
x(67,1)=a
x(68,1)=a
x(69,1)=a
x(71,1)=a
x(72,1)=a
x(74,1)=a

[t,x] = ode23(@ogun1,[0 40],x);

```
function dx=ogun1(t,x)
V = 1;
DM1 = 1; % Delta M1
KL1 = 1;
K11 = 1;
K21 = 1;
K31 = 1;
K32 = 1;
DM2 = 1;
DM3 = 1;
DMAST = 1; %Delta m asterisk
KL2 = 1;
KL3 = 1;
K12 = 1;
K13 = 1;
K22 = 1;
Kd = 1;
Kt1 = 1;
Kt2 = 1;
Kt3 = 1;
```

$\theta = 1;$
 $dx = [(1/V)*DM1 - ((1/\theta) + KL1*x(4) + K11*x(5) + K21*x(6) + K31*x(7))*x(1);$
 $(1/V)*DM2 - ((1/\theta) + KL2*x(4) + K12*x(5) + K22*x(6))*x(2);$
 $(1/V)*DM3 - ((1/\theta) + K13*x(5))*x(3);$
 $(1/V)*DMAST - ((1/\theta) + Kd + KL1*x(1) + KL2*x(2))*x(4);$
 $(-1/\theta - Kt1)*x(5) + KL1*x(1)*x(4) -$
 $(K12*x(2) + K13*x(3))*x(5) + K21*x(1)*x(6) + K31*x(1)*x(7);$
 $(-1/\theta)*x(6) + KL2*x(2)*x(4) - (K21*x(1) + Kt2)*x(6) + K12*x(2)*x(5);$
 $(-1/\theta)*x(7) - (K31*x(1) + Kt3)*x(7) + K13*x(3)*x(5);$
 $(-1/\theta)*x(8) + KL1*x(1)*x(4) + KL2*x(2)*x(4) +$
 $K11*x(1)*x(5) + K21*x(1)*x(6) + K31*x(1)*x(7);$
 $(-1/\theta)*x(9) + KL1*x(1)*x(4) + KL2*x(2)*x(4) + K12*x(2)*x(5) + K22*x(2)*x(6);$
 $(-1/\theta)*x(10) + (KL1*x(1) + KL2*x(2))*x(4) + K13*x(3)*x(5);$ % *****system
 $(1/V)*DM1 - ((1/\theta) + KL1*x(14) + K11*x(15) + K21*x(16) + K31*x(17))*x(11) -$
 $KL1*x(21) - K11*x(22) - K21*x(23) - K31*x(24) + x(35)*(x(1) + \sin(t) -$
 $x(11)) + x(52)*(x(2) + \sin(t) - x(12)) + x(31)*(x(3) + \sin(t) - x(13)) + x(21)*(x(4) + \sin(t) -$
 $x(14)) + x(22)*(x(5) + \sin(t) - x(15)) + x(23)*(x(6) + \sin(t) - x(16)) + x(24)*(x(7) + \sin(t) -$
 $x(17)) + x(41)*(x(8) + \sin(t) - x(18)) + x(43)*(x(9) + \sin(t) - x(19)) + x(51)*(x(10) + \sin(t) - x(20));$
 $(1/V)*DM2 - ((1/\theta) + KL2*x(14) + K12*x(15) + K22*x(16))*x(12) - KL2*x(25) -$
 $K12*x(26) - K22*x(27) + x(52)*(x(1) + \sin(t) - x(11)) + x(42)*(x(2) + \sin(t) -$
 $x(12)) + x(32)*(x(3) + \sin(t) - x(13)) + x(25)*(x(4) + \sin(t) - x(14)) + x(26)*(x(5) + \sin(t) -$
 $x(15)) + x(27)*(x(6) + \sin(t) - x(16)) + x(53)*(x(7) + \sin(t) - x(17)) + x(54)*(x(8) + \sin(t) -$
 $x(18)) + x(29)*(x(9) + \sin(t) - x(19)) + x(61)*(x(10) + \sin(t) - x(20));$
 $(1/V)*DM3 - ((1/\theta) + K13*x(15))*x(13) - K13*x(28) + x(31)*(x(1) + \sin(t) -$
 $x(11)) + x(32)*(x(2) + \sin(t) - x(12)) + x(33)*(x(3) + \sin(t) - x(13)) + x(34)*(x(4) + \sin(t) -$
 $x(14)) + x(28)*(x(5) + \sin(t) - x(15)) + x(36)*(x(6) + \sin(t) - x(16)) + x(37)*(x(7) + \sin(t) -$
 $x(17)) + x(38)*(x(8) + \sin(t) - x(18)) + x(39)*(x(9) + \sin(t) - x(19)) + x(30)*(x(10) + \sin(t) - x(20));$
 $(1/V)*DMAST - ((1/\theta) + Kd + KL1*x(11) + K12*x(12))*x(14) - KL1*x(21) -$
 $K12*x(25) + x(21)*(x(1) + \sin(t) - x(11)) + x(25)*(x(2) + \sin(t) - x(12)) + x(34)*(x(3) + \sin(t) -$
 $x(13)) + x(44)*(x(4) + \sin(t) - x(14)) + x(45)*(x(5) + \sin(t) - x(15)) + x(46)*(x(6) + \sin(t) -$
 $x(16)) + x(47)*(x(7) + \sin(t) - x(17)) + x(48)*(x(8) + \sin(t) - x(18)) + x(49)*(x(9) + \sin(t) -$
 $x(19)) + x(40)*(x(10) + \sin(t) - x(20));$
 $(-1/\theta - Kt1)*x(15) + KL1*x(14)*x(11) -$
 $K12*x(12)*x(15) + K21*x(16)*x(11) + K31*x(17)*x(11) -$
 $K13*x(15)*x(13) + KL1*x(21) + K21*x(23) + K31*x(24) - K12*x(26) -$
 $K13*x(28) + x(22)*(x(1) + \sin(t) - x(11)) + x(26)*(x(2) + \sin(t) - x(12)) + x(28)*(x(3) + \sin(t) -$
 $x(13)) + x(45)*(x(4) + \sin(t) - x(14)) + x(55)*(x(5) + \sin(t) - x(15)) + x(56)*(x(6) + \sin(t) -$
 $x(16)) + x(57)*(x(7) + \sin(t) - x(17)) + x(58)*(x(8) + \sin(t) - x(18)) + x(59)*(x(9) + \sin(t) -$
 $x(19)) + x(50)*(x(10) + \sin(t) - x(20));$
 $(-1/\theta - Kt2 - K21*x(11))*x(16) + KL2*x(14)*x(12) + K12*x(15)*x(12) -$
 $K21*x(23) + KL2*x(25) + K12*x(26) + x(23)*(x(1) + \sin(t) - x(11)) + x(27)*(x(2) + \sin(t) -$
 $x(12)) + x(36)*(x(3) + \sin(t) - x(13)) + x(46)*(x(4) + \sin(t) - x(14)) + x(56)*(x(5) + \sin(t) -$
 $x(15)) + x(65)*(x(6) + \sin(t) - x(16)) + x(64)*(x(7) + \sin(t) - x(17)) + x(63)*(x(8) + \sin(t) -$
 $x(18)) + x(62)*(x(9) + \sin(t) - x(19)) + x(60)*(x(10) + \sin(t) - x(20));$
 $(-1/\theta - Kt3 - K31*x(11))*x(17) + K13*x(15)*x(13) -$
 $K31*x(24) + K13*x(28) + x(24)*(x(1) + \sin(t) - x(11)) + x(53)*(x(2) + \sin(t) -$
 $x(12)) + x(37)*(x(3) + \sin(t) - x(13)) + x(47)*(x(4) + \sin(t) - x(14)) + x(57)*(x(5) + \sin(t) -$

$x(15))+x(64)*(x(6)+\sin(t)-x(16))+x(66)*(x(7)+\sin(t)-x(17))+x(67)*(x(8)+\sin(t)-x(18))+x(68)*(x(9)+\sin(t)-x(19))+x(69)*(x(10)+\sin(t)-x(20));$
 $(-1/\theta)*x(18)+(KL1*x(14)+K11*x(15)+K21*x(16)+$
 $K31*x(17))*x(11)+KL2*x(14)*x(12)+KL1*x(21)+K11*x(22)+K21*x(23)+K31*x(24)+K$
 $L2*x(25)+x(41)*(x(1)+\sin(t)-x(11))+x(54)*(x(2)+\sin(t)-x(12))+x(38)*(x(3)+\sin(t)-$
 $x(13))+x(48)*(x(4)+\sin(t)-x(14))+x(58)*(x(5)+\sin(t)-x(15))+x(63)*(x(6)+\sin(t)-$
 $x(16))+x(67)*(x(7)+\sin(t)-x(17))+x(70)*(x(8)+\sin(t)-x(18))+x(71)*(x(9)+\sin(t)-$
 $x(19))+x(72)*(x(10)+\sin(t)-x(20));$
 $(-1/\theta)*x(19)+KL1*x(14)*x(11)+KL2*x(14)*x(12)+$
 $K12*x(15)*x(12)+K22*x(16)*x(12)+KL1*x(21)+KL2*x(25)*K12*x(26)+K22*x(27)+x(4$
 $3)*(x(1)+\sin(t)-x(11))+x(29)*(x(2)+\sin(t)-x(12))+x(39)*(x(3)+\sin(t)-$
 $x(13))+x(49)*(x(4)+\sin(t)-x(14))+x(59)*(x(5)+\sin(t)-x(15))+x(62)*(x(6)+\sin(t)-$
 $x(16))+x(68)*(x(7)+\sin(t)-x(17))+x(71)*(x(8)+\sin(t)-x(18))+x(73)*(x(9)+\sin(t)-$
 $x(19))+x(74)*(x(10)+\sin(t)-x(20));$
 $(-1/\theta)*x(20)+KL1*x(14)*x(11)+KL2*x(14)*x(12)+$
 $K13*x(15)*x(13)+KL1*x(21)+KL2*x(25)+K13*x(28)+x(51)*(x(1)+\sin(t)-$
 $x(11))+x(61)*(x(2)+\sin(t)-x(12))+x(30)*(x(3)+\sin(t)-x(13))+x(40)*(x(4)+\sin(t)-$
 $x(14))+x(50)*(x(5)+\sin(t)-x(15))+x(60)*(x(6)+\sin(t)-x(16))+x(69)*(x(7)+\sin(t)-$
 $x(17))+x(72)*(x(8)+\sin(t)-x(18))+x(74)*(x(9)+\sin(t)-x(19))+x(75)*(x(10)+\sin(t)-$
 $x(20));\%*****estimate$
 $((-2/\theta)-2*(2*KL1*x(14)+K11*x(15)+K21*x(16)+K31*x(17)))*x(21)-$
 $2*K12*x(14)*x(25)-x(35)*x(21)-x(52)*x(25)-x(31)*x(34)-x(21)*x(44)-x(22)*x(45)-$
 $x(23)*x(46)-x(24)*x(47)-x(41)*x(48)-x(43)*x(49)-x(51)*x(40);\%P14$
 $((-2/\theta)+2*(KL1*x(14)+K21*x(16)+K31*x(17)-KL1*x(14)-K11*x(15)-K21*x(16)-$
 $K32*x(17)))*x(22)-K12*x(15)*x(26)-K13*x(15)*x(28)-x(35)*x(22)-x(52)*x(26)-$
 $x(31)*x(28)-x(21)*x(45)-x(22)*x(55)-x(23)*x(56)-x(24)*x(57)-x(41)*x(58)-x(43)*x(59)-$
 $x(51)*x(50);\%P15$
 $((-2/\theta)+2*(-2*K21*x(16)-KL1*x(14)-K11*x(15)-$
 $K31*x(17)))*x(23)+(KL2*x(14)+K12*x(15))*x(27)-x(35)*x(23)-x(52)*x(27)-$
 $x(31)*x(36)-x(21)*x(46)-x(22)*x(56)-x(23)*x(65)-x(24)*x(64)-x(41)*x(63)-x(43)*x(62)-$
 $x(51)*x(60);\%P16$
 $((-2/\theta)-2*(2*K31*x(17)+KL1*x(14)+K11*x(15)+$
 $K21*x(16)))*x(24)+2*K13*x(15)*x(24)-x(35)*x(24)-x(52)*x(53)-x(31)*x(37)-$
 $x(21)*x(47)-x(22)*x(57)-x(23)*x(64)-x(24)*x(66)-x(41)*x(67)-x(43)*x(68)-$
 $x(51)*x(69);\%P17$
 $((-2/\theta)-2*(K12*x(14)+KL2*x(14)+K12*x(15)+K22*x(16)))*x(25)-$
 $2*KL1*x(14)*x(21)-x(52)*x(21)-x(42)*x(25)-x(32)*x(34)-x(25)*x(44)-x(26)*x(45)-$
 $x(27)*x(46)-x(53)*x(47)-x(54)*x(48)-x(29)*x(49)-x(61)*x(40);\%P24$
 $((-2/\theta)-2*(KL2*x(14)+K22*x(16)))*x(26)+2*(KL1*x(14)+$
 $K21*x(16)+K31*x(17))*x(22)-K13*x(15)*x(28)-x(52)*x(22)-x(42)*x(26)-x(32)*x(28)-$
 $x(25)*x(45)-x(26)*x(55)-x(27)*x(56)-x(53)*x(57)-x(54)*x(58)-x(29)*x(59)-$
 $x(61)*x(50);\%P25$
 $((-2/\theta)+(4*K12*x(15)-2*K22*x(16)))*x(27)-2*K21*x(16)*x(23)-x(52)*x(23)-$
 $x(42)*x(27)-x(32)*x(36)-x(25)*x(46)-x(26)*x(56)-x(27)*x(65)-x(53)*x(64)-x(54)*x(63)-$
 $x(29)*x(62)-x(61)*x(60);\%P26$

$$(-2/\theta)*x(28)+2*(KL1*x(14)+K21*x(16)+K31*x(17))*x(22)-4*(K13*x(15))*x(28)-2*K12*x(15)*x(26)-x(31)*x(22)-x(32)*x(26)-x(33)*x(28)-x(34)*x(45)-x(28)*x(55)-x(36)*x(56)-x(37)*x(57)-x(38)*x(58)-x(39)*x(59)-x(30)*x(50);%P35$$

$$((-2/\theta))*x(29)+2*(KL1*x(14))*x(43)-x(52)*x(43)-x(42)*x(29)-x(32)*x(39)-x(25)*x(49)-x(26)*x(59)-x(27)*x(62)-x(53)*x(68)-x(54)*x(71)-x(29)*x(73)-x(61)*x(74);%P29$$

$$(-2/\theta)*x(30)+2*(KL1*x(14)*x(51)+KL2*x(14)*x(61)+K13*x(15)*x(30)-K13*x(15)*x(30))-x(31)*x(51)-x(32)*x(61)-x(33)*x(30)-x(34)*x(40)-x(28)*x(50)-x(36)*x(60)-x(37)*x(69)-x(38)*x(72)-x(39)*x(74)-x(30)*x(75);%P310$$

$$((-2/\theta)-2*(K13*x(15)+KL1*x(14)+K11*x(15)+K21*x(16)-K31*x(17)))*x(31)-x(35)*x(31)-x(52)*x(32)-x(31)*x(33)-x(21)*x(34)-x(22)*x(28)-x(23)*x(36)-x(24)*x(37)-x(41)*x(38)-x(43)*x(39)-x(51)*x(30);%P13$$

$$((-2/\theta)-2*(KL2*x(14)+K12*x(15)+K22*x(16)))*x(32)-2*K13*x(15)*x(28)-x(52)*x(31)-x(42)*x(32)-x(32)*x(33)-x(25)*x(34)-x(26)*x(28)-x(27)*x(36)-x(53)*x(37)-x(54)*x(38)-x(29)*x(39)-x(61)*x(30);%P23$$

$$(-2/\theta-4*(K13*x(15)))*x(33)-x(31)^2-x(32)^2-x(33)^2-x(34)^2-x(28)^2-x(36)^2-x(37)^2-x(38)^2-x(39)^2-x(30)^2;%P33$$

$$(-2/\theta)*x(34)-2*(KL1*x(14)*x(21)+K12*x(14)*x(25)+K13*x(15)*x(34))-x(31)*x(21)-x(32)*x(25)-x(33)*x(34)-x(34)*x(44)-x(28)*x(54)-x(36)*x(46)-x(37)*x(47)-x(38)*x(48)-x(39)*x(49)-x(30)*x(40);%P34$$

$$((-2/\theta)-4*(KL1*x(14)+K11*x(15)+K21*x(16)+K31*x(17)))*x(35)-x(35)^2-x(52)^2-x(31)^2-x(21)^2-x(22)^2-x(23)^2-x(24)^2-x(41)^2-x(43)^2-x(51)^2;%P11$$

$$(-2/\theta)*x(36)+2*(-K21*x(16)*x(23)+(KL2*x(14)+K12*x(15)))*x(27)-K13*x(15)*x(36)-x(31)*x(23)-x(32)*x(27)-x(33)*x(36)-x(34)*x(46)-x(28)*x(56)-x(36)*x(65)-x(37)*x(64)-x(38)*x(63)-x(39)*x(62)-x(30)*x(60);%P36$$

$$(-2/\theta)*x(37)-2*K31*x(17)*x(24)-x(31)*x(24)-x(32)*x(53)-x(33)*x(37)-x(34)*x(47)-x(28)*x(57)-x(36)*x(64)-x(37)*x(66)-x(38)*x(67)-x(39)*x(68)-x(30)*x(69);%P37$$

$$(-2/\theta)*x(38)+2*(KL1*x(14)+K11*x(15)+K21*x(16)+K31*x(17))*x(41)+2*KL2*x(14)*x(54)-2*K13*x(15)*x(38)-x(31)*x(41)-x(32)*x(54)-x(33)*x(38)-x(34)*x(48)-x(28)*x(58)-x(36)*x(63)-x(37)*x(67)-x(38)*x(70)-x(39)*x(71)-x(30)*x(72);%P38$$

$$(-2/\theta)*x(39)+2*(KL2*x(14)+K12*x(15)+K22*x(16))*x(29)+KL1*x(14)*x(43)-2*K13*x(15)*x(39)-x(31)*x(43)-x(32)*x(29)-x(33)*x(39)-x(34)*x(49)-x(28)*x(59)-x(36)*x(62)-x(37)*x(68)-x(38)*x(71)-x(39)*x(73)-x(30)*x(74);%P39$$

$$(-2*(1/\theta+Kd)*x(40))+2*(KL1*x(14)*x(51)+KL2*x(14)*x(61)+K13*x(15)*x(30))-2*(KL1*x(14)+K12*x(14))*x(40)-x(21)*x(51)-x(25)*x(61)-x(34)*x(30)-x(44)*x(40)-x(45)*x(50)-x(46)*x(60)-x(47)*x(69)-x(48)*x(72)-x(49)*x(74)-x(40)*x(75);%P410$$

$$(-2/\theta)*x(41)+2*KL1*x(14)*x(54)-x(35)*x(41)-x(52)*x(54)-x(31)*x(38)-x(21)*x(48)-x(22)*x(58)-x(23)*x(63)-x(24)*x(67)-x(41)*x(70)-x(43)*x(71)-x(51)*x(72);%P18$$

$$((-2/\theta)+4*(-KL2*x(14)-K12*x(15)-K22*x(16)))*x(42)-x(52)^2-x(42)^2-x(32)^2-x(25)^2-x(26)^2-x(27)^2-x(53)^2-x(54)^2-x(29)^2-x(61)^2;%P22$$

$$((-2/\theta)-2*(K11*x(15)+K21*x(16)+K31*x(17)))*x(43)+2*(KL2*x(14)+K12*x(15)+K22*x(16))*x(29)-x(35)*x(43)-x(52)*x(29)-x(31)*x(39)-x(21)*x(49)-x(22)*x(59)-x(23)*x(62)-x(24)*x(68)-x(41)*x(71)-x(43)*x(73)-x(51)*x(74);%P19$$

$$(-2*(1/\theta+K_d))*x(44)-4*(K_{L1}*x(14)*x(21)+K_{12}*x(14)*x(25))-x(21)^2-x(25)^2-x(34)^2-x(44)^2-x(45)^2-x(46)^2-x(47)^2-x(48)^2-x(49)^2-x(40)^2;\%P44$$

$$(-2*(1/\theta+K_d)*x(45))+2*(K_{L1}*x(14)+K_{21}*x(16)+K_{31}*x(17))*x(22)-2*K_{12}*x(15)*x(26)-2*K_{13}*x(15)*x(28)-2*(K_{L1}*x(14)+K_{12}*x(14))*x(45)-x(21)*x(22)-x(25)*x(26)-x(34)*x(28)-x(44)*x(45)-x(45)*x(55)-x(46)*x(56)-x(47)*x(57)-x(48)*x(58)-x(49)*x(59)-x(40)*x(50);\%P45$$

$$(-2*(1/\theta+K_d)*x(46))+2*(-K_{21}*x(16)*x(23)+K_{L2}*x(14)*x(27)+K_{12}*x(15)*x(27)-K_{L1}*x(14)*x(46)-K_{12}*x(14)*x(46))-x(21)*x(23)-x(25)*x(27)-x(34)*x(36)-x(44)*x(46)-x(45)*x(56)-x(46)*x(65)-x(47)*x(64)-x(48)*x(63)-x(49)*x(62)-x(40)*x(60);\%P46$$

$$(-2*(1/\theta+K_d)*x(47))+2*(-K_{31}*x(17)*x(24)+K_{13}*x(15)*x(37)-K_{L1}*x(14)*x(47)-K_{12}*x(14)*x(47))-x(21)*x(24)-x(25)*x(53)-x(34)*x(37)-x(44)*x(47)-x(45)*x(57)-x(46)*x(64)-x(47)*x(66)-x(48)*x(67)-x(49)*x(68)-x(40)*x(69);\%P47$$

$$(-2*(1/\theta+K_d)*x(48))+2*(K_{L1}*x(14)+K_{11}*x(15)+K_{21}*x(16)+K_{31}*x(17))*x(41)-2*(K_{L1}*x(14)+K_{12}*x(14))*x(48)+2*K_{L2}*x(14)*x(54)-x(21)*x(41)-x(25)*x(54)-x(34)*x(38)-x(44)*x(48)-x(45)*x(58)-x(46)*x(63)-x(47)*x(67)-x(48)*x(70)-x(49)*x(71)-x(40)*x(72);\%P48$$

$$(-2*(1/\theta+K_d)*x(49))+2*(K_{L2}*x(14)+K_{12}*x(15)+K_{22}*x(16))*x(29)+2*K_{L1}*x(14)*x(43)-2*(K_{L1}*x(14)+K_{12}*x(14))*x(49)-x(21)*x(43)-x(25)*x(29)-x(34)*x(39)-x(44)*x(49)-x(45)*x(59)-x(46)*x(62)-x(47)*x(68)-x(48)*x(71)-x(49)*x(73)-x(40)*x(74);\%P49$$

$$2*(-1/\theta+K_{t1})*x(50)+2*(K_{L1}*x(14)*x(51)+K_{12}*x(14)*x(61)+K_{13}*x(15)*x(30))+2*(K_{L1}*x(14)+K_{21}*x(16)+K_{31}*x(17)-K_{12}*x(15)-K_{13}*x(15))*x(50)-x(22)*x(51)-x(26)*x(61)-x(28)*x(30)-x(45)*x(40)-x(55)*x(50)-x(56)*x(60)-x(57)*x(69)-x(58)*x(72)-x(59)*x(74)-x(50)*x(75);\%P510$$

$$((-2/\theta)-2*(K_{11}*x(15)+K_{21}*x(16)+K_{31}*x(17)))*x(51)+2*(K_{L2}*x(14))*x(61)+2*(K_{13}*x(15))*x(30)-x(35)*x(51)-x(52)*x(61)-x(31)*x(30)-x(21)*x(40)-x(22)*x(50)-x(23)*x(60)-x(24)*x(69)-x(41)*x(72)-x(43)*x(74)-x(51)*x(75);\%P110$$

$$((-2/\theta)-2*(K_{L2}*x(14)+K_{12}*x(15)+K_{22}*x(16)+K_{L1}+x(14)+K_{11}*x(15)+K_{31}*x(17)))*x(52)-x(35)*x(52)-x(52)*x(42)-x(31)*x(32)-x(21)*x(25)-x(22)*x(26)-x(23)*x(27)-x(24)*x(53)-x(41)*x(54)-x(43)*x(29)-x(51)*x(61);\%P12$$

$$((-2/\theta)-2*(K_{31}*x(17)+K_{L2}*x(14)+K_{12}*x(15)+K_{22}*x(16)))*x(53)+2*K_{13}*x(15)*x(37)-x(52)*x(24)-x(42)*x(53)-x(32)*x(37)-x(25)*x(47)-x(26)*x(57)-x(27)*x(64)-x(53)*x(66)-x(54)*x(67)-x(29)*x(68)-x(61)*x(69);\%P27$$

$$((-2/\theta)-2*(K_{12}*x(15)+K_{22}*x(16)))*x(54)+2*(K_{L1}*x(14)+K_{11}*x(15)+K_{21}*x(16)+K_{31}*x(17))*x(41)-x(52)*x(41)-x(42)*x(54)-x(32)*x(38)-x(25)*x(48)-x(26)*x(58)-x(27)*x(63)-x(53)*x(67)-x(54)*x(70)-x(29)*x(71)-x(61)*x(72);\%P28$$

$$2*(-1/\theta+K_{t1})*x(55)+4*(K_{L1}*x(14)*x(22)+K_{21}*x(16)*x(22)+K_{31}*x(17)*x(22)-K_{12}*x(15)*x(26)-K_{13}*x(15)*x(28))-x(22)^2-x(26)^2-x(28)^2-x(45)^2-x(55)^2-x(56)^2-x(57)^2-x(58)^2-x(59)^2-x(50)^2;\%P55$$

$$2*(-1/\theta+K_{t1})*x(56)+2*(K_{L1}*x(14)+K_{21}*x(16)+K_{31}*x(17)-K_{12}*x(15)-K_{13}*x(15))*x(56)+2*(-K_{21}*x(16)*x(23)+K_{L2}*x(14)*x(27)+K_{12}*x(15)*x(27))-x(22)*x(23)-x(26)*x(27)-x(28)*x(36)-x(45)*x(46)-x(55)*x(56)-x(56)*x(65)-x(57)*x(64)-x(58)*x(63)-x(59)*x(62)-x(50)*x(60);\%P56$$

$$2*(-1/\theta+K_{t1})*x(57)+2*(-K_{31}*x(17)*x(24)+K_{13}*x(15)*x(37)+$$

$$(KL1*x(14)+K21*x(16)-K12*x(15)-K13*x(15))*x(57))-x(22)*x(24)-x(26)*x(53)-x(28)*x(37)-x(45)*x(47)-x(55)*x(57)-x(56)*x(64)-x(57)*x(66)-x(58)*x(67)-x(59)*x(68)-x(50)*x(69);%P57$$

$$2*(-1/theta+Kt1)*x(58)+2*(KL1*x(14)+K11*x(15)+K21*x(16)+K31*x(17))*x(41)+2*(KL1*x(14)+K21*x(16)+K31*x(17)-K12*x(15)-K13*x(15))*x(58)+2*KL2*x(14)*x(54)-x(22)*x(41)-x(26)*x(54)-x(28)*x(38)-x(45)*x(48)-x(55)*x(58)-x(56)*x(63)-x(57)*x(67)-x(58)*x(70)-x(59)*x(71)-x(50)*x(72);%P58$$

$$2*(-1/theta+Kt1)*x(59)+2*(KL2*x(14)+K12*x(15)+K22*x(16))*x(29)+2*(KL1*x(14)+K21*x(16)+K31*x(17)-K12*x(15)-K13*x(15))*x(59)+2*KL1*x(14)*x(43)-x(22)*x(43)-x(26)*x(29)-x(28)*x(39)-x(45)*x(49)-x(55)*x(59)-x(56)*x(62)-x(57)*x(68)-x(58)*x(71)-x(59)*x(73)-x(50)*x(74);%P59$$

$$2*(-1/theta+Kt2)*x(60)+2*(KL1*x(14)*x(51)+KL2*x(14)*x(61)+K13*x(15)*x(30)-K21*x(16)*x(60)+KL2*x(14)*x(62)+K12*x(15)*x(62))-x(23)*x(51)-x(27)*x(61)-x(36)*x(30)-x(46)*x(40)-x(56)*x(50)-x(65)*x(60)-x(64)*x(69)-x(63)*x(72)-x(62)*x(74)-x(60)*x(75);%P610$$

$$((-2/theta)*x(61)+2*(K12*x(15)-K22*x(16))*x(61)+KL1*x(14)*x(51)+K13*x(15)*x(30)-x(52)*x(51)-x(42)*x(61)-x(32)*x(30)-x(25)*x(40)-x(26)*x(50)-x(27)*x(60)-x(53)*x(69)-x(54)*x(72)-x(29)*x(74)-x(61)*x(75);%P210$$

$$2*(-1/theta+Kt2)*x(62)+2*(KL1*x(14)*x(43)+KL2*x(14)*x(29)+K12*x(15)*x(29)+K22*x(16)*x(29)-K21*x(16)*x(62)+KL2*x(14)*x(62)+K12*x(15)*x(62))-x(23)*x(43)-x(27)*x(29)-x(36)*x(39)-x(46)*x(49)-x(56)*x(59)-x(65)*x(62)-x(64)*x(68)-x(63)*x(71)-x(62)*x(73)-x(60)*x(74);%P69$$

$$2*(-1/theta+Kt2)*x(63)+2*(KL1*x(14)*x(41)+K11*x(15)*x(41)+K21*x(16)*x(41)+K31*x(17)*x(41)+KL2*x(14)*x(54)-K21*x(16)*x(63)+KL2*x(14)*x(63)+K12*x(15)*x(63))-x(23)*x(41)-x(27)*x(54)-x(36)*x(38)-x(46)*x(48)-x(56)*x(58)-x(65)*x(63)-x(64)*x(67)-x(63)*x(70)-x(62)*x(71)-x(60)*x(72);%P68$$

$$2*(-1/theta+Kt2)*x(64)+2*(-K31*x(17)*x(24)+KL2*x(14)*x(64)+K12*x(15)*x(64)+K13*x(15)*x(37)-K21*x(16)*x(64))-x(23)*x(24)-x(27)*x(53)-x(36)*x(37)-x(46)*x(47)-x(56)*x(57)-x(65)*x(64)-x(64)*x(66)-x(63)*x(67)-x(62)*x(68)-x(60)*x(69);%P67$$

$$2*(-1/theta+Kt2)*x(65)+4*(-K21*x(16)*x(23)+KL2*x(14)*x(27)+K12*x(15)*x(27))-x(23)^2-x(27)^2-x(36)^2-x(46)^2-x(56)^2-x(65)^2-x(64)^2-x(63)^2-x(62)^2-x(60)^2;%P66$$

$$2*(-1/theta+Kt3)*x(66)+4*(-K31*x(17)*x(24)+K13*x(15)*x(37))-x(24)^2-x(53)^2-x(37)^2-x(47)^2-x(57)^2-x(64)^2-x(66)^2-x(67)^2-x(68)^2-x(69)^2;%P77$$

$$2*(-1/theta+Kt3)*x(67)+2*(KL1*x(14)*x(41)+K11*x(15)*x(41)+K21*x(16)*x(41)+K31*x(17)*x(41)+KL2*x(14)*x(54)-K31*x(17)*x(67)+K13*x(15)*x(67))-x(24)*x(41)-x(53)*x(54)-x(37)*x(38)-x(47)*x(48)-x(57)*x(58)-x(64)*x(63)-x(66)*x(67)-x(67)*x(70)-x(68)*x(71)-x(69)*x(72);%P78$$

$$2*(-1/theta+Kt3)*x(68)+2*(KL1*x(14)*x(43)+KL2*x(14)*x(29)+K12*x(15)*x(29)+K22*x(16)*x(29)+K31*x(17)*x(68)+K13*x(15)*x(68))-x(24)*x(43)-x(53)*x(29)-x(37)*x(39)-x(47)*x(49)-x(57)*x(59)-x(64)*x(62)-x(66)*x(68)-x(67)*x(71)-x(68)*x(73)-x(69)*x(74);%P79$$

$$2*(-1/\theta+Kt3)*x(69)+2*(KL1*x(14)*x(51)+KL2*x(14)*x(61)+K13*x(15)*x(30)-K31*x(17)*x(69)+K13*x(15)*x(69))-x(24)*x(51)-x(53)*x(61)-x(37)*x(30)-x(47)*x(40)-x(57)*x(50)-x(64)*x(60)-x(66)*x(69)-x(67)*x(72)-x(68)*x(74)-x(69)*x(75);%P710$$

$$2*(-1/\theta)*x(70)+4*(KL1*x(14)*x(41)+K11*x(15)*x(41)+K21*x(16)*x(41)+K31*x(17)*x(41)+KL2*x(14)*x(54))-x(41)^2-x(54)^2-x(38)^2-x(48)^2-x(58)^2-x(63)^2-x(67)^2-x(70)^2-x(71)^2-x(72)^2;%P88$$

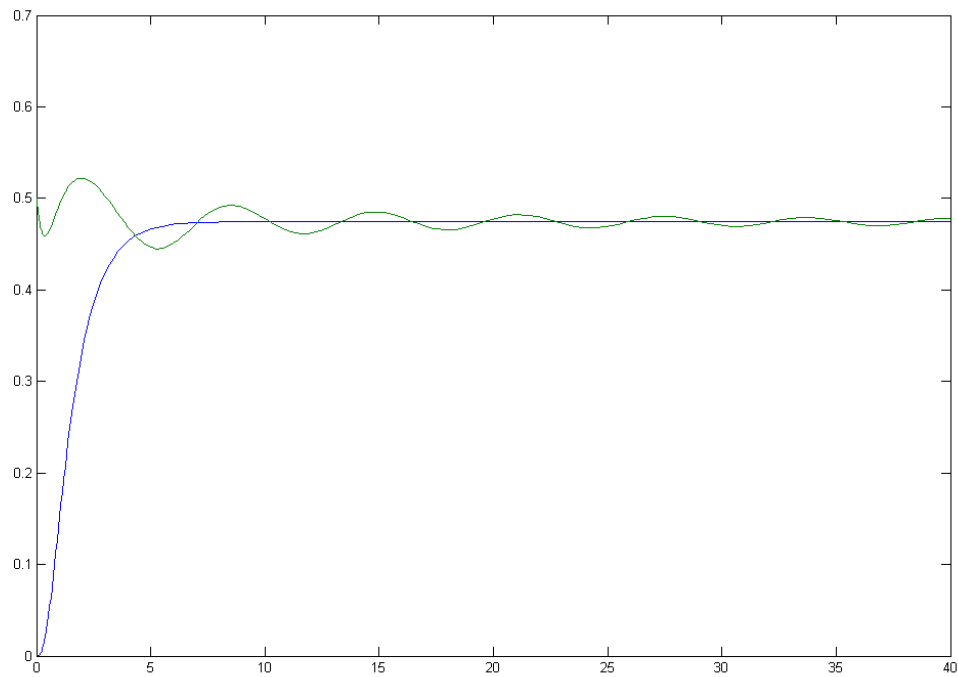
$$2*(-1/\theta)*x(71)+2*(KL1*x(14)*x(43)+KL2*x(14)*x(29)+K12*x(15)*x(29)+K22*x(16)*x(29)+KL1*x(14)*x(71)-K11*x(15)*x(71)+K21*x(16)*x(71)+K31*x(17)*x(71)+KL2*x(14)*x(71))-x(41)*x(43)-x(54)*x(29)-x(38)*x(39)-x(48)*x(49)-x(58)*x(59)-x(63)*x(62)-x(67)*x(68)-x(70)*x(71)-x(71)*x(73)-x(72)*x(74);%P89$$

$$2*(-1/\theta)*x(72)+2*(KL1*x(14)*x(51)+KL2*x(14)*x(61)+K13*x(15)*x(30)+KL1*x(14)*x(72)+K11*x(15)*x(72)+K21*x(16)*x(72)+K31*x(17)*x(72)+KL2*x(14)*x(72))-x(41)*x(51)-x(54)*x(61)-x(38)*x(30)-x(48)*x(40)-x(58)*x(50)-x(63)*x(60)-x(67)*x(69)-x(70)*x(72)-x(71)*x(74)-x(72)*x(75);%P810$$

$$2*(-1/\theta)*x(73)+4*(KL1*x(14)*x(43)+KL2*x(14)*x(29)+K12*x(15)*x(29)+K22*x(16)*x(29))-x(43)^2-x(29)^2-x(39)^2-x(49)^2-x(59)^2-x(62)^2-x(68)^2-x(71)^2-x(73)^2-x(74)^2;%P99$$

$$2*(-1/\theta)*x(74)+2*(KL1*x(14)*x(51)+KL2*x(14)*x(61)+K13*x(15)*x(30)+KL1*x(14)*x(74)+KL2*x(14)*x(74)+K12*x(15)*x(74)+K22*x(16)*x(74))-x(43)*x(51)-x(29)*x(61)-x(39)*x(30)-x(49)*x(40)-x(59)*x(50)-x(62)*x(60)-x(68)*x(69)-x(71)*x(72)-x(73)*x(74)-x(74)*x(75);%P910$$

$$2*(-1/\theta)*x(75)+4*(KL1*x(14)*x(51)+KL2*x(14)*x(61)+K13*x(15)*x(30))-x(51)^2-x(61)^2-x(30)^2-x(40)^2-x(50)^2-x(60)^2-x(69)^2-x(72)^2-x(74)^2-x(75)^2;%P1010$$



Numerical Table

$x_{10}(0)=0$ $x_{10}(1)=0.15$ $x_{10}(2)=0.334$ $x_{10}(3)=0.419$ $x_{10}(4)=0.453$ $x_{10}(5)=0.466$
 $x_{10}(10)=0.475$ $x_{10}(20)=0.475$

$x_{20}(0)=0.5$ $x_{20}(1)=0.493$ $x_{20}(2)=0.522$ $x_{20}(3)=0.503$ $x_{20}(4)=0.469$ $x_{20}(5)=0.447$
 $x_{20}(10)=0.478$ $x_{20}(20)=0.477$

% Executor of ogun1lin.m

```

x=zeros(75,1)
a=0
x(1,1)=0
x(2,1)=0
x(3,1)=0
x(4,1)=0
x(5,1)=0
x(6,1)=0
x(7,1)=0
x(8,1)=0
x(9,1)=0

```

x(10,1)=0
x(11,1)=0.5
x(12,1)=0.5
x(13,1)=0.5
x(14,1)=0.5
x(15,1)=0.5
x(16,1)=0.5
x(17,1)=0.5
x(18,1)=0.5
x(19,1)=0.5
x(20,1)=0.5
x(35,1)=1
x(42,1)=1
x(33,1)=1
x(44,1)=1
x(55,1)=1
x(65,1)=1
x(66,1)=1
x(70,1)=1
x(73,1)=1
x(75,1)=1
x(21,1)=a
x(22,1)=a
x(23,1)=a
x(24,1)=a
x(25,1)=a
x(26,1)=a
x(27,1)=a
x(28,1)=a
x(29,1)=a
x(30,1)=a
x(31,1)=a
x(32,1)=a
x(34,1)=a
x(36,1)=a
x(37,1)=a
x(38,1)=a
x(39,1)=a
x(40,1)=a
x(41,1)=a
x(43,1)=a
x(45,1)=a
x(46,1)=a
x(47,1)=a
x(48,1)=a
x(49,1)=a
x(50,1)=a

```
x(51,1)=a
x(52,1)=a
x(53,1)=a
x(54,1)=a
x(56,1)=a
x(57,1)=a
x(58,1)=a
x(59,1)=a
x(60,1)=a
x(61,1)=a
x(62,1)=a
x(63,1)=a
x(64,1)=a
x(67,1)=a
x(68,1)=a
x(69,1)=a
x(71,1)=a
x(72,1)=a
x(74,1)=a
```

```
[t,x] = ode23(@ogun1lin,[0, 40],x);
```

```
function dx=ogun1lin(t,x)
V = 1;
DM1 = 1; % Delta M1
KL1 = 1;
%CAST = 1; % C asterisk
%CM1 = 1;
%CM2 = 1;
%CM3 = 1;
K11 = 1;
K21 = 1;
K31 = 1;
K32 = 1;
DM2 = 1;
DM3 = 1;
DMAST = 1; %Delta m asterisk
KL2 = 1;
KL3 = 1;
K12 = 1;
K13 = 1;
K22 = 1;
Kd = 1;
Kt1 = 1;
Kt2 = 1;
Kt3 = 1;
```

```

theta = 1;
dx=[(1/V)*DM1-((1/theta)+KL1*x(4)+K11*x(5)+K21*x(6)+K31*x(7))*x(1);
(1/V)*DM2-((1/theta)+KL2*x(4)+K12*x(5)+K22*x(6))*x(2);
(1/V)*DM3-((1/theta)+K13*x(5))*x(3);
(1/V)*DMAST-((1/theta)+Kd+KL1*x(1)+KL2*x(2))*x(4);
(-1/theta-Kt1)*x(5)+KL1*x(1)*x(4)-
(K12*x(2)+K13*x(3))*x(5)+K21*x(1)*x(6)+K31*x(1)*x(7);
(-1/theta)*x(6)+KL2*x(2)*x(4)-(K21*x(1)+Kt2)*x(6)+K12*x(2)*x(5);
(-1/theta)*x(7)-(K31*x(1)+Kt3)*x(7)+K13*x(3)*x(5);
(-1/theta)*x(8)+KL1*x(1)*x(4)+KL2*x(2)*x(4)+
K11*x(1)*x(5)+K21*x(1)*x(6)+K31*x(1)*x(7);
(-1/theta)*x(9)+KL1*x(1)*x(4)+KL2*x(2)*x(4)+K12*x(2)*x(5)+K22*x(2)*x(6);
(-1/theta)*x(10)+(KL1*x(1)+KL2*x(2))*x(4)+K13*x(3)*x(5);% *****system
(1/V)*DM1-((1/theta))*x(11)+x(35)*(x(1)+sin(t)-x(11))+x(52)*(x(2)+sin(t)-
x(12))+x(31)*(x(3)+sin(t)-x(13))+x(21)*(x(4)+sin(t)-x(14))+x(22)*(x(5)+sin(t)-
x(15))+x(23)*(x(6)+sin(t)-x(16))+x(24)*(x(7)+sin(t)-x(17))+x(41)*(x(8)+sin(t)-
x(18))+x(43)*(x(9)+sin(t)-x(19))+x(51)*(x(10)+sin(t)-x(20));
(1/V)*DM2-((1/theta))*x(12)+x(52)*(x(1)+sin(t)-x(11))+x(42)*(x(2)+sin(t)-
x(12))+x(32)*(x(3)+sin(t)-x(13))+x(25)*(x(4)+sin(t)-x(14))+x(26)*(x(5)+sin(t)-
x(15))+x(27)*(x(6)+sin(t)-x(16))+x(53)*(x(7)+sin(t)-x(17))+x(54)*(x(8)+sin(t)-
x(18))+x(29)*(x(9)+sin(t)-x(19))+x(61)*(x(10)+sin(t)-x(20));
(1/V)*DM3-((1/theta))*x(13)+x(31)*(x(1)+sin(t)-x(11))+x(32)*(x(2)+sin(t)-
x(12))+x(33)*(x(3)+sin(t)-x(13))+x(34)*(x(4)+sin(t)-x(14))+x(28)*(x(5)+sin(t)-
x(15))+x(36)*(x(6)+sin(t)-x(16))+x(37)*(x(7)+sin(t)-x(17))+x(38)*(x(8)+sin(t)-
x(18))+x(39)*(x(9)+sin(t)-x(19))+x(30)*(x(10)+sin(t)-x(20));
(1/V)*DMAST-((1/theta)+Kd)*x(14)+x(21)*(x(1)+sin(t)-x(11))+x(25)*(x(2)+sin(t)-
x(12))+x(34)*(x(3)+sin(t)-x(13))+x(44)*(x(4)+sin(t)-x(14))+x(45)*(x(5)+sin(t)-
x(15))+x(46)*(x(6)+sin(t)-x(16))+x(47)*(x(7)+sin(t)-x(17))+x(48)*(x(8)+sin(t)-
x(18))+x(49)*(x(9)+sin(t)-x(19))+x(40)*(x(10)+sin(t)-x(20));
(-1/theta-Kt1)*x(15)+x(22)*(x(1)+sin(t)-x(11))+x(26)*(x(2)+sin(t)-
x(12))+x(28)*(x(3)+sin(t)-x(13))+x(45)*(x(4)+sin(t)-x(14))+x(55)*(x(5)+sin(t)-
x(15))+x(56)*(x(6)+sin(t)-x(16))+x(57)*(x(7)+sin(t)-x(17))+x(58)*(x(8)+sin(t)-
x(18))+x(59)*(x(9)+sin(t)-x(19))+x(50)*(x(10)+sin(t)-x(20));
(-1/theta+Kt2)*x(16)+x(23)*(x(1)+sin(t)-x(11))+x(27)*(x(2)+sin(t)-
x(12))+x(36)*(x(3)+sin(t)-x(13))+x(46)*(x(4)+sin(t)-x(14))+x(56)*(x(5)+sin(t)-
x(15))+x(65)*(x(6)+sin(t)-x(16))+x(64)*(x(7)+sin(t)-x(17))+x(63)*(x(8)+sin(t)-
x(18))+x(62)*(x(9)+sin(t)-x(19))+x(60)*(x(10)+sin(t)-x(20));
(-1/theta-Kt3)*x(17)+x(24)*(x(1)+sin(t)-x(11))+x(53)*(x(2)+sin(t)-
x(12))+x(37)*(x(3)+sin(t)-x(13))+x(47)*(x(4)+sin(t)-x(14))+x(57)*(x(5)+sin(t)-
x(15))+x(64)*(x(6)+sin(t)-x(16))+x(66)*(x(7)+sin(t)-x(17))+x(67)*(x(8)+sin(t)-
x(18))+x(68)*(x(9)+sin(t)-x(19))+x(69)*(x(10)+sin(t)-x(20));
(-1/theta)*x(18)+x(41)*(x(1)+sin(t)-x(11))+x(54)*(x(2)+sin(t)-
x(12))+x(38)*(x(3)+sin(t)-x(13))+x(48)*(x(4)+sin(t)-x(14))+x(58)*(x(5)+sin(t)-
x(15))+x(63)*(x(6)+sin(t)-x(16))+x(67)*(x(7)+sin(t)-x(17))+x(70)*(x(8)+sin(t)-
x(18))+x(71)*(x(9)+sin(t)-x(19))+x(72)*(x(10)+sin(t)-x(20));
(-1/theta)*x(19)+x(43)*(x(1)+sin(t)-x(11))+x(29)*(x(2)+sin(t)-
x(12))+x(39)*(x(3)+sin(t)-x(13))+x(49)*(x(4)+sin(t)-x(14))+x(59)*(x(5)+sin(t)-

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$x(15))+x(62)*(x(6)+\sin(t)-x(16))+x(68)*(x(7)+\sin(t)-x(17))+x(71)*(x(8)+\sin(t)-x(18))+x(73)*(x(9)+\sin(t)-x(19))+x(74)*(x(10)+\sin(t)-x(20));$
 $(-1/\theta)*x(20)+x(51)*(x(1)+\sin(t)-x(11))+x(61)*(x(2)+\sin(t)-x(12))+x(30)*(x(3)+\sin(t)-x(13))+x(40)*(x(4)+\sin(t)-x(14))+x(50)*(x(5)+\sin(t)-x(15))+x(60)*(x(6)+\sin(t)-x(16))+x(69)*(x(7)+\sin(t)-x(17))+x(72)*(x(8)+\sin(t)-x(18))+x(74)*(x(9)+\sin(t)-x(19))+x(75)*(x(10)+\sin(t)-x(20));\%*****estimate$
 $((-2/\theta)*x(21)-x(35)*x(21)-x(52)*x(25)-x(31)*x(34)-x(21)*x(44)-x(22)*x(45)-x(23)*x(46)-x(24)*x(47)-x(41)*x(48)-x(43)*x(49)-x(51)*x(40);\%P14$
 $((-2/\theta)*x(22)-x(35)*x(22)-x(52)*x(26)-x(31)*x(28)-x(21)*x(45)-x(22)*x(55)-x(23)*x(56)-x(24)*x(57)-x(41)*x(58)-x(43)*x(59)-x(51)*x(50);\%P15$
 $((-2/\theta)*x(23)-x(35)*x(23)-x(52)*x(27)-x(31)*x(36)-x(21)*x(46)-x(22)*x(56)-x(23)*x(65)-x(24)*x(64)-x(41)*x(63)-x(43)*x(62)-x(51)*x(60);\%P16$
 $((-2/\theta)*x(24)-x(35)*x(24)-x(52)*x(53)-x(31)*x(37)-x(21)*x(47)-x(22)*x(57)-x(23)*x(64)-x(24)*x(66)-x(41)*x(67)-x(43)*x(68)-x(51)*x(69);\%P17$
 $((-2/\theta)*x(25)-x(52)*x(21)-x(42)*x(25)-x(32)*x(34)-x(25)*x(44)-x(26)*x(45)-x(27)*x(46)-x(53)*x(47)-x(54)*x(48)-x(29)*x(49)-x(61)*x(40);\%P24$
 $((-2/\theta)*x(26)-x(52)*x(22)-x(42)*x(26)-x(32)*x(28)-x(25)*x(45)-x(26)*x(55)-x(27)*x(56)-x(53)*x(57)-x(54)*x(58)-x(29)*x(59)-x(61)*x(50);\%P25$
 $((-2/\theta)*x(27)-x(52)*x(23)-x(42)*x(27)-x(32)*x(36)-x(25)*x(46)-x(26)*x(56)-x(27)*x(65)-x(53)*x(64)-x(54)*x(63)-x(29)*x(62)-x(61)*x(60);\%P26$
 $(-2/\theta)*x(28)-x(31)*x(22)-x(32)*x(26)-x(33)*x(28)-x(34)*x(45)-x(28)*x(55)-x(36)*x(56)-x(37)*x(57)-x(38)*x(58)-x(39)*x(59)-x(30)*x(50);\%P35$
 $((-2/\theta)*x(29)-x(52)*x(43)-x(42)*x(29)-x(32)*x(39)-x(25)*x(49)-x(26)*x(59)-x(27)*x(62)-x(53)*x(68)-x(54)*x(71)-x(29)*x(73)-x(61)*x(74);\%P29$
 $(-2/\theta)*x(30)-x(31)*x(51)-x(32)*x(61)-x(33)*x(30)-x(34)*x(40)-x(28)*x(50)-x(36)*x(60)-x(37)*x(69)-x(38)*x(72)-x(39)*x(74)-x(30)*x(75);\%P310$
 $((-2/\theta)*x(31)-x(35)*x(31)-x(52)*x(32)-x(31)*x(33)-x(21)*x(34)-x(22)*x(28)-x(23)*x(36)-x(24)*x(37)-x(41)*x(38)-x(43)*x(39)-x(51)*x(30);\%P13$
 $((-2/\theta)*x(32)-x(52)*x(31)-x(42)*x(32)-x(32)*x(33)-x(25)*x(34)-x(26)*x(28)-x(27)*x(36)-x(53)*x(37)-x(54)*x(38)-x(29)*x(39)-x(61)*x(30);\%P23$
 $(-2/\theta)*x(33)-x(31)^2-x(32)^2-x(33)^2-x(34)^2-x(28)^2-x(36)^2-x(37)^2-x(38)^2-x(39)^2-x(30)^2;\%P33$
 $(-2/\theta)*x(34)-x(31)*x(21)-x(32)*x(25)-x(33)*x(34)-x(34)*x(44)-x(28)*x(54)-x(36)*x(46)-x(37)*x(47)-x(38)*x(48)-x(39)*x(49)-x(30)*x(40);\%P34$
 $(-2/\theta)*x(35)-x(35)^2-x(52)^2-x(31)^2-x(21)^2-x(22)^2-x(23)^2-x(24)^2-x(41)^2-x(43)^2-x(51)^2;\%P11$
 $(-2/\theta)*x(36)-x(31)*x(23)-x(32)*x(27)-x(33)*x(36)-x(34)*x(46)-x(28)*x(56)-x(36)*x(65)-x(37)*x(64)-x(38)*x(63)-x(39)*x(62)-x(30)*x(60);\%P36$
 $(-2/\theta)*x(37)-x(31)*x(24)-x(32)*x(53)-x(33)*x(37)-x(34)*x(47)-x(28)*x(57)-x(36)*x(64)-x(37)*x(66)-x(38)*x(67)-x(39)*x(68)-x(30)*x(69);\%P37$
 $(-2/\theta)*x(38)-x(31)*x(41)-x(32)*x(54)-x(33)*x(38)-x(34)*x(48)-x(28)*x(58)-x(36)*x(63)-x(37)*x(67)-x(38)*x(70)-x(39)*x(71)-x(30)*x(72);\%P38$
 $(-2/\theta)*x(39)-x(31)*x(43)-x(32)*x(29)-x(33)*x(39)-x(34)*x(49)-x(28)*x(59)-x(36)*x(62)-x(37)*x(68)-x(38)*x(71)-x(39)*x(73)-x(30)*x(74);\%P39$
 $(-2*(1/\theta+Kd)*x(40))-x(21)*x(51)-x(25)*x(61)-x(34)*x(30)-x(44)*x(40)-x(45)*x(50)-x(46)*x(60)-x(47)*x(69)-x(48)*x(72)-x(49)*x(74)-x(40)*x(75);\%P410$

$(-2/\theta) * x(41) - x(35) * x(41) - x(52) * x(54) - x(31) * x(38) - x(21) * x(48) - x(22) * x(58) -$
 $x(23) * x(63) - x(24) * x(67) - x(41) * x(70) - x(43) * x(71) - x(51) * x(72); \%P18$

$((-2/\theta)) * x(42) - x(52)^2 - x(42)^2 - x(32)^2 - x(25)^2 - x(26)^2 - x(27)^2 - x(53)^2 - x(54)^2 -$
 $x(29)^2 - x(61)^2; \%P22$

$((-2/\theta)) * x(43) - x(35) * x(43) - x(52) * x(29) - x(31) * x(39) - x(21) * x(49) - x(22) * x(59) -$
 $x(23) * x(62) - x(24) * x(68) - x(41) * x(71) - x(43) * x(73) - x(51) * x(74); \%P19$

$(-2 * (1/\theta + Kd)) * x(44) - x(21)^2 - x(25)^2 - x(34)^2 - x(44)^2 - x(45)^2 - x(46)^2 - x(47)^2 -$
 $x(48)^2 - x(49)^2 - x(40)^2; \%P44$

$(-2 * (1/\theta + Kd) * x(45)) - x(21) * x(22) - x(25) * x(26) - x(34) * x(28) - x(44) * x(45) -$
 $x(45) * x(55) - x(46) * x(56) - x(47) * x(57) - x(48) * x(58) - x(49) * x(59) - x(40) * x(50); \%P45$

$(-2 * (1/\theta + Kd) * x(46)) - x(21) * x(23) - x(25) * x(27) - x(34) * x(36) - x(44) * x(46) -$
 $x(45) * x(56) - x(46) * x(65) - x(47) * x(64) - x(48) * x(63) - x(49) * x(62) - x(40) * x(60); \%P46$

$(-2 * (1/\theta + Kd) * x(47)) - x(21) * x(24) - x(25) * x(53) - x(34) * x(37) - x(44) * x(47) -$
 $x(45) * x(57) - x(46) * x(64) - x(47) * x(66) - x(48) * x(67) - x(49) * x(68) - x(40) * x(69); \%P47$

$(-2 * (1/\theta + Kd) * x(48)) - x(21) * x(41) - x(25) * x(54) - x(34) * x(38) - x(44) * x(48) -$
 $x(45) * x(58) - x(46) * x(63) - x(47) * x(67) - x(48) * x(70) - x(49) * x(71) - x(40) * x(72); \%P48$

$(-2 * (1/\theta + Kd) * x(49)) - x(21) * x(43) - x(25) * x(29) - x(34) * x(39) - x(44) * x(49) -$
 $x(45) * x(59) - x(46) * x(62) - x(47) * x(68) - x(48) * x(71) - x(49) * x(73) - x(40) * x(74); \%P49$

$2 * (-1/\theta + Kt1) * x(50) - x(22) * x(51) - x(26) * x(61) - x(28) * x(30) - x(45) * x(40) -$
 $x(55) * x(50) - x(56) * x(60) - x(57) * x(69) - x(58) * x(72) - x(59) * x(74) - x(50) * x(75); \%P510$

$((-2/\theta)) * x(51) - x(35) * x(51) - x(52) * x(61) - x(31) * x(30) - x(21) * x(40) - x(22) * x(50) -$
 $x(23) * x(60) - x(24) * x(69) - x(41) * x(72) - x(43) * x(74) - x(51) * x(75); \%P110$

$((-2/\theta)) * x(52) - x(35) * x(52) - x(52) * x(42) - x(31) * x(32) - x(21) * x(25) - x(22) * x(26) -$
 $x(23) * x(27) - x(24) * x(53) - x(41) * x(54) - x(43) * x(29) - x(51) * x(61); \%P12$

$((-2/\theta)) * x(53) - x(52) * x(24) - x(42) * x(53) - x(32) * x(37) - x(25) * x(47) - x(26) * x(57) -$
 $x(27) * x(64) - x(53) * x(66) - x(54) * x(67) - x(29) * x(68) - x(61) * x(69); \%P27$

$((-2/\theta)) * x(54) - x(52) * x(41) - x(42) * x(54) - x(32) * x(38) - x(25) * x(48) - x(26) * x(58) -$
 $x(27) * x(63) - x(53) * x(67) - x(54) * x(70) - x(29) * x(71) - x(61) * x(72); \%P28$

$2 * (-1/\theta + Kt1) * x(55) - x(22)^2 - x(26)^2 - x(28)^2 - x(45)^2 - x(55)^2 - x(56)^2 - x(57)^2 -$
 $x(58)^2 - x(59)^2 - x(50)^2; \%P55$

$2 * (-1/\theta + Kt1) * x(56) - x(22) * x(23) - x(26) * x(27) - x(28) * x(36) - x(45) * x(46) -$
 $x(55) * x(56) - x(56) * x(65) - x(57) * x(64) - x(58) * x(63) - x(59) * x(62) - x(50) * x(60); \%P56$

$2 * (-1/\theta + Kt1) * x(57) - x(22) * x(24) - x(26) * x(53) - x(28) * x(37) - x(45) * x(47) -$
 $x(55) * x(57) - x(56) * x(64) - x(57) * x(66) - x(58) * x(67) - x(59) * x(68) - x(50) * x(69); \%P57$

$2 * (-1/\theta + Kt1) * x(58) - x(22) * x(41) - x(26) * x(54) - x(28) * x(38) - x(45) * x(48) -$
 $x(55) * x(58) - x(56) * x(63) - x(57) * x(67) - x(58) * x(70) - x(59) * x(71) - x(50) * x(72); \%P58$

$2 * (-1/\theta + Kt1) * x(59) - x(22) * x(43) - x(26) * x(29) - x(28) * x(39) - x(45) * x(49) -$
 $x(55) * x(59) - x(56) * x(62) - x(57) * x(68) - x(58) * x(71) - x(59) * x(73) - x(50) * x(74); \%P59$

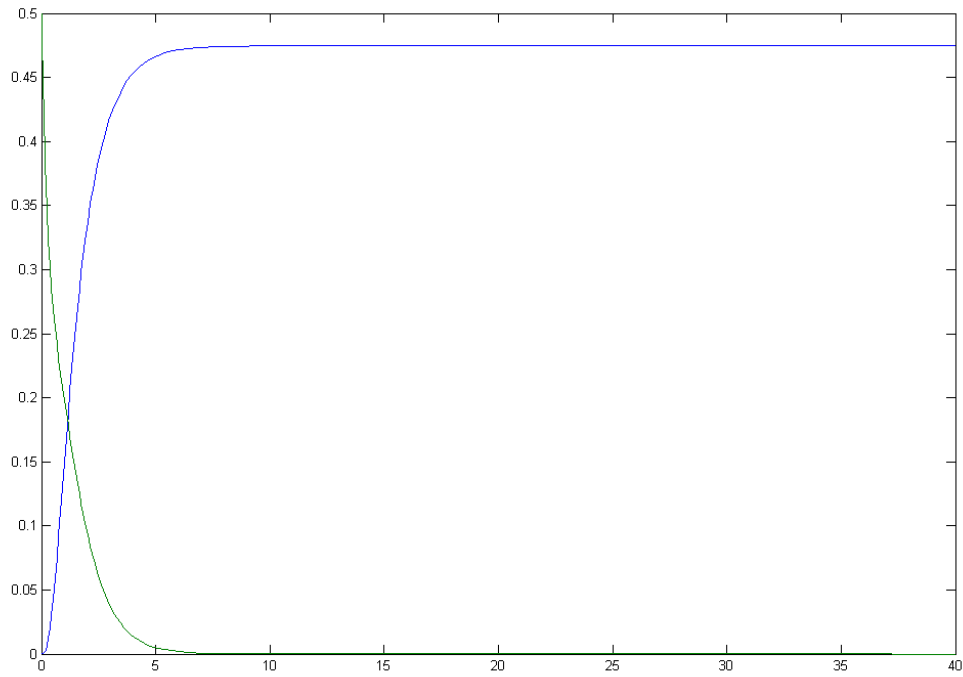
$2 * (-1/\theta + Kt2) * x(60) - x(23) * x(51) - x(27) * x(61) - x(36) * x(30) - x(46) * x(40) -$
 $x(56) * x(50) - x(65) * x(60) - x(64) * x(69) - x(63) * x(72) - x(62) * x(74) - x(60) * x(75); \%P610$

$((-2/\theta)) * x(61) - x(52) * x(51) - x(42) * x(61) - x(32) * x(30) - x(25) * x(40) - x(26) * x(50) -$
 $x(27) * x(60) - x(53) * x(69) - x(54) * x(72) - x(29) * x(74) - x(61) * x(75); \%P210$

$2 * (-1/\theta + Kt2) * x(62) - x(23) * x(43) - x(27) * x(29) - x(36) * x(39) - x(46) * x(49) -$
 $x(56) * x(59) - x(65) * x(62) - x(64) * x(68) - x(63) * x(71) - x(62) * x(73) - x(60) * x(74); \%P69$

$2 * (-1/\theta + Kt2) * x(63) - x(23) * x(41) - x(27) * x(54) - x(36) * x(38) - x(46) * x(48) -$
 $x(56) * x(58) - x(65) * x(63) - x(64) * x(67) - x(63) * x(70) - x(62) * x(71) - x(60) * x(72); \%P68$

$2^{*}(-1/\theta+Kt2)^{*}x(64)-x(23)^{*}x(24)-x(27)^{*}x(53)-x(36)^{*}x(37)-x(46)^{*}x(47)-$
 $x(56)^{*}x(57)-x(65)^{*}x(64)-x(64)^{*}x(66)-x(63)^{*}x(67)-x(62)^{*}x(68)-x(60)^{*}x(69); \%P67$
 $2^{*}(-1/\theta+Kt2)^{*}x(65)-x(23)^{\wedge}2-x(27)^{\wedge}2-x(36)^{\wedge}2-x(46)^{\wedge}2-x(56)^{\wedge}2-x(65)^{\wedge}2-x(64)^{\wedge}2-$
 $x(63)^{\wedge}2-x(62)^{\wedge}2-x(60)^{\wedge}2; \%P66$
 $2^{*}(-1/\theta+Kt3)^{*}x(66)-x(24)^{\wedge}2-x(53)^{\wedge}2-x(37)^{\wedge}2-x(47)^{\wedge}2-x(57)^{\wedge}2-x(64)^{\wedge}2-x(66)^{\wedge}2-$
 $x(67)^{\wedge}2-x(68)^{\wedge}2-x(69)^{\wedge}2; \%P77$
 $2^{*}(-1/\theta+Kt3)^{*}x(67)-x(24)^{*}x(41)-x(53)^{*}x(54)-x(37)^{*}x(38)-x(47)^{*}x(48)-$
 $x(57)^{*}x(58)-x(64)^{*}x(63)-x(66)^{*}x(67)-x(67)^{*}x(70)-x(68)^{*}x(71)-x(69)^{*}x(72); \%P78$
 $2^{*}(-1/\theta+Kt3)^{*}x(68)-x(24)^{*}x(43)-x(53)^{*}x(29)-x(37)^{*}x(39)-x(47)^{*}x(49)-$
 $x(57)^{*}x(59)-x(64)^{*}x(62)-x(66)^{*}x(68)-x(67)^{*}x(71)-x(68)^{*}x(73)-x(69)^{*}x(74); \%P79$
 $2^{*}(-1/\theta+Kt3)^{*}x(69)-x(24)^{*}x(51)-x(53)^{*}x(61)-x(37)^{*}x(30)-x(47)^{*}x(40)-$
 $x(57)^{*}x(50)-x(64)^{*}x(60)-x(66)^{*}x(69)-x(67)^{*}x(72)-x(68)^{*}x(74)-x(69)^{*}x(75); \%P710$
 $2^{*}(-1/\theta)^{*}x(70)-x(41)^{\wedge}2-x(54)^{\wedge}2-x(38)^{\wedge}2-x(48)^{\wedge}2-x(58)^{\wedge}2-x(63)^{\wedge}2-x(67)^{\wedge}2-x(70)^{\wedge}2-$
 $x(71)^{\wedge}2-x(72)^{\wedge}2; \%P88$
 $2^{*}(-1/\theta)^{*}x(71)-x(41)^{*}x(43)-x(54)^{*}x(29)-x(38)^{*}x(39)-x(48)^{*}x(49)-x(58)^{*}x(59)-$
 $x(63)^{*}x(62)-x(67)^{*}x(68)-x(70)^{*}x(71)-x(71)^{*}x(73)-x(72)^{*}x(74); \%P89$
 $2^{*}(-1/\theta)^{*}x(72)-x(41)^{*}x(51)-x(54)^{*}x(61)-x(38)^{*}x(30)-x(48)^{*}x(40)-x(58)^{*}x(50)-$
 $x(63)^{*}x(60)-x(67)^{*}x(69)-x(70)^{*}x(72)-x(71)^{*}x(74)-x(72)^{*}x(75); \%P810$
 $2^{*}(-1/\theta)^{*}x(73)-x(43)^{\wedge}2-x(29)^{\wedge}2-x(39)^{\wedge}2-x(49)^{\wedge}2-x(59)^{\wedge}2-x(62)^{\wedge}2-x(68)^{\wedge}2-x(71)^{\wedge}2-$
 $x(73)^{\wedge}2-x(74)^{\wedge}2; \%P99$
 $2^{*}(-1/\theta)^{*}x(74)-x(43)^{*}x(51)-x(29)^{*}x(61)-x(39)^{*}x(30)-x(49)^{*}x(40)-x(59)^{*}x(50)-$
 $x(62)^{*}x(60)-x(68)^{*}x(69)-x(71)^{*}x(72)-x(73)^{*}x(74)-x(74)^{*}x(75); \%P910$
 $2^{*}(-1/\theta)^{*}x(75)-x(51)^{\wedge}2-x(61)^{\wedge}2-x(30)^{\wedge}2-x(40)^{\wedge}2-x(50)^{\wedge}2-x(60)^{\wedge}2-x(69)^{\wedge}2-x(72)^{\wedge}2-$
 $x(74)^{\wedge}2-x(75)^{\wedge}2]; \%P1010$



Numerical Table

$x_{10}(0)=0$ $x_{10}(1)=0.15$ $x_{10}(2)=0.334$ $x_{10}(3)=0.419$ $x_{10}(4)=0.453$ $x_{10}(5)=0.466$
 $x_{10}(10)=0.475$ $x_{10}(20)=0.475$

$x_{20}(0)=0.5$ $x_{20}(1)=0.198$ $x_{20}(2)=0.095$ $x_{20}(3)=0.038$ $x_{20}(4)=0.014$ $x_{20}(5)=0.005$
 $x_{20}(10)=0$ $x_{20}(20)=0$

% Executor of ogunpolylin.m

```
x=zeros(75,1)
a=0
x(1,1)=0
x(2,1)=0
x(3,1)=0
x(4,1)=0
x(5,1)=0
x(6,1)=0
x(7,1)=0
x(8,1)=0
```

x(9,1)=0
x(10,1)=0
x(11,1)=0.5
x(12,1)=0.5
x(13,1)=0.5
x(14,1)=0.5
x(15,1)=0.5
x(16,1)=0.5
x(17,1)=0.5
x(18,1)=0.5
x(19,1)=0.5
x(20,1)=0.5
x(35,1)=1
x(42,1)=1
x(33,1)=1
x(44,1)=1
x(55,1)=1
x(65,1)=1
x(66,1)=1
x(70,1)=1
x(73,1)=1
x(75,1)=1
x(21,1)=a
x(22,1)=a
x(23,1)=a
x(24,1)=a
x(25,1)=a
x(26,1)=a
x(27,1)=a
x(28,1)=a
x(29,1)=a
x(30,1)=a
x(31,1)=a
x(32,1)=a
x(34,1)=a
x(36,1)=a
x(37,1)=a
x(38,1)=a
x(39,1)=a
x(40,1)=a
x(41,1)=a
x(43,1)=a
x(45,1)=a
x(46,1)=a
x(47,1)=a
x(48,1)=a
x(49,1)=a

```
x(50,1)=a
x(51,1)=a
x(52,1)=a
x(53,1)=a
x(54,1)=a
x(56,1)=a
x(57,1)=a
x(58,1)=a
x(59,1)=a
x(60,1)=a
x(61,1)=a
x(62,1)=a
x(63,1)=a
x(64,1)=a
x(67,1)=a
x(68,1)=a
x(69,1)=a
x(71,1)=a
x(72,1)=a
x(74,1)=a
```

```
[t,x] = ode23(@ogunpolylin,[0 40],x);
```

```
function dx=ogunpolylin(t,x)
V = 1;
DM1 = 1; % Delta M1
KL1 = 1;
K11 = 1;
K21 = 1;
K31 = 1;
K32 = 1;
DM2 = 1;
DM3 = 1;
DMAST = 1; %Delta m asterisk
KL2 = 1;
KL3 = 1;
K12 = 1;
K13 = 1;
K22 = 1;
Kd = 1;
Kt1 = 1;
Kt2 = 1;
Kt3 = 1;
theta = 1;
dx=[(1/V)*DM1-((1/theta)+KL1*x(4)+K11*x(5)+K21*x(6)+K31*x(7))*x(1);
    (1/V)*DM2-((1/theta)+KL2*x(4)+K12*x(5)+K22*x(6))*x(2);
```

$(1/V)*DM3-((1/\theta)+K13*x(5))*x(3);$
 $(1/V)*DMAST-((1/\theta)+Kd+KL1*x(1)+KL2*x(2))*x(4);$
 $(-1/\theta-Kt1)*x(5)+KL1*x(1)*x(4)-$
 $(K12*x(2)+K13*x(3))*x(5)+K21*x(1)*x(6)+K31*x(1)*x(7);$
 $(-1/\theta)*x(6)+KL2*x(2)*x(4)-(K21*x(1)+Kt2)*x(6)+K12*x(2)*x(5);$
 $(-1/\theta)*x(7)-(K31*x(1)+Kt3)*x(7)+K13*x(3)*x(5);$
 $(-1/\theta)*x(8)+KL1*x(1)*x(4)+KL2*x(2)*x(4)+$
 $K11*x(1)*x(5)+K21*x(1)*x(6)+K31*x(1)*x(7);$
 $(-1/\theta)*x(9)+KL1*x(1)*x(4)+KL2*x(2)*x(4)+K12*x(2)*x(5)+K22*x(2)*x(6);$
 $(-1/\theta)*x(10)+(KL1*x(1)+KL2*x(2))*x(4)+K13*x(3)*x(5);$
 $(1/V)*DM1-((1/\theta)+KL1*x(14)+K11*x(15)+K21*x(16)+K31*x(17))*x(11)-$
 $KL1*x(21)-K11*x(22)-K21*x(23)-K31*x(24)+x(35)*(x(1)+\sin(t)-$
 $x(11))+x(52)*(x(2)+\sin(t)-x(12))+x(31)*(x(3)+\sin(t)-x(13))+x(21)*(x(4)+\sin(t)-$
 $x(14))+x(22)*(x(5)+\sin(t)-x(15))+x(23)*(x(6)+\sin(t)-x(16))+x(24)*(x(7)+\sin(t)-$
 $x(17))+x(41)*(x(8)+\sin(t)-x(18))+x(43)*(x(9)+\sin(t)-x(19))+x(51)*(x(10)+\sin(t)-x(20));$
 $(1/V)*DM2-((1/\theta)+KL2*x(14)+K12*x(15)+K22*x(16))*x(12)-KL2*x(25)-$
 $K12*x(26)-K22*x(27)+x(52)*(x(1)+\sin(t)-x(11))+x(42)*(x(2)+\sin(t)-$
 $x(12))+x(32)*(x(3)+\sin(t)-x(13))+x(25)*(x(4)+\sin(t)-x(14))+x(26)*(x(5)+\sin(t)-$
 $x(15))+x(27)*(x(6)+\sin(t)-x(16))+x(53)*(x(7)+\sin(t)-x(17))+x(54)*(x(8)+\sin(t)-$
 $x(18))+x(29)*(x(9)+\sin(t)-x(19))+x(61)*(x(10)+\sin(t)-x(20));$
 $(1/V)*DM3-((1/\theta)+K13*x(15))*x(13)-K13*x(28)+x(31)*(x(1)+\sin(t)-$
 $x(11))+x(32)*(x(2)+\sin(t)-x(12))+x(33)*(x(3)+\sin(t)-x(13))+x(34)*(x(4)+\sin(t)-$
 $x(14))+x(28)*(x(5)+\sin(t)-x(15))+x(36)*(x(6)+\sin(t)-x(16))+x(37)*(x(7)+\sin(t)-$
 $x(17))+x(38)*(x(8)+\sin(t)-x(18))+x(39)*(x(9)+\sin(t)-x(19))+x(30)*(x(10)+\sin(t)-x(20));$
 $(1/V)*DMAST-((1/\theta)+Kd+KL1*x(11)+K12*x(12))*x(14)-KL1*x(21)-$
 $K12*x(25)+x(21)*(x(1)+\sin(t)-x(11))+x(25)*(x(2)+\sin(t)-x(12))+x(34)*(x(3)+\sin(t)-$
 $x(13))+x(44)*(x(4)+\sin(t)-x(14))+x(45)*(x(5)+\sin(t)-x(15))+x(46)*(x(6)+\sin(t)-$
 $x(16))+x(47)*(x(7)+\sin(t)-x(17))+x(48)*(x(8)+\sin(t)-x(18))+x(49)*(x(9)+\sin(t)-$
 $x(19))+x(40)*(x(10)+\sin(t)-x(20));$
 $(-1/\theta-Kt1)*x(15)+KL1*x(14)*x(11)-$
 $K12*x(12)*x(15)+K21*x(16)*x(11)+K31*x(17)*x(11)-$
 $K13*x(15)*x(13)+KL1*x(21)+K21*x(23)+K31*x(24)-K12*x(26)-$
 $K13*x(28)+x(22)*(x(1)+\sin(t)-x(11))+x(26)*(x(2)+\sin(t)-x(12))+x(28)*(x(3)+\sin(t)-$
 $x(13))+x(45)*(x(4)+\sin(t)-x(14))+x(55)*(x(5)+\sin(t)-x(15))+x(56)*(x(6)+\sin(t)-$
 $x(16))+x(57)*(x(7)+\sin(t)-x(17))+x(58)*(x(8)+\sin(t)-x(18))+x(59)*(x(9)+\sin(t)-$
 $x(19))+x(50)*(x(10)+\sin(t)-x(20));$
 $(-1/\theta-Kt2-K21*x(11))*x(16)+KL2*x(14)*x(12)+K12*x(15)*x(12)-$
 $K21*x(23)+KL2*x(25)+K12*x(26)+x(23)*(x(1)+\sin(t)-x(11))+x(27)*(x(2)+\sin(t)-$
 $x(12))+x(36)*(x(3)+\sin(t)-x(13))+x(46)*(x(4)+\sin(t)-x(14))+x(56)*(x(5)+\sin(t)-$
 $x(15))+x(65)*(x(6)+\sin(t)-x(16))+x(64)*(x(7)+\sin(t)-x(17))+x(63)*(x(8)+\sin(t)-$
 $x(18))+x(62)*(x(9)+\sin(t)-x(19))+x(60)*(x(10)+\sin(t)-x(20));$
 $(-1/\theta-Kt3-K31*x(11))*x(17)+K13*x(15)*x(13)-$
 $K31*x(24)+K13*x(28)+x(24)*(x(1)+\sin(t)-x(11))+x(53)*(x(2)+\sin(t)-$
 $x(12))+x(37)*(x(3)+\sin(t)-x(13))+x(47)*(x(4)+\sin(t)-x(14))+x(57)*(x(5)+\sin(t)-$
 $x(15))+x(64)*(x(6)+\sin(t)-x(16))+x(66)*(x(7)+\sin(t)-x(17))+x(67)*(x(8)+\sin(t)-$
 $x(18))+x(68)*(x(9)+\sin(t)-x(19))+x(69)*(x(10)+\sin(t)-x(20));$
 $(-1/\theta)*x(18)+(KL1*x(14)+K11*x(15)+$

$K21*x(16)+K31*x(17))*x(11)+KL2*x(14)*x(12)+KL1*x(21)+K11*x(22)+K21*x(23)+K31*x(24)+KL2*x(25)+x(41)*(x(1)+\sin(t)-x(11))+x(54)*(x(2)+\sin(t)-x(12))+x(38)*(x(3)+\sin(t)-x(13))+x(48)*(x(4)+\sin(t)-x(14))+x(58)*(x(5)+\sin(t)-x(15))+x(63)*(x(6)+\sin(t)-x(16))+x(67)*(x(7)+\sin(t)-x(17))+x(70)*(x(8)+\sin(t)-x(18))+x(71)*(x(9)+\sin(t)-x(19))+x(72)*(x(10)+\sin(t)-x(20));$
 $(-1/\theta)*x(19)+KL1*x(14)*x(11)+KL2*x(14)*x(12)+K12*x(15)*x(12)+K22*x(16)*x(12)+KL1*x(21)+KL2*x(25)*K12*x(26)+K22*x(27)+x(43)*(x(1)+\sin(t)-x(11))+x(29)*(x(2)+\sin(t)-x(12))+x(39)*(x(3)+\sin(t)-x(13))+x(49)*(x(4)+\sin(t)-x(14))+x(59)*(x(5)+\sin(t)-x(15))+x(62)*(x(6)+\sin(t)-x(16))+x(68)*(x(7)+\sin(t)-x(17))+x(71)*(x(8)+\sin(t)-x(18))+x(73)*(x(9)+\sin(t)-x(19))+x(74)*(x(10)+\sin(t)-x(20));$
 $(-1/\theta)*x(20)+KL1*x(14)*x(11)+KL2*x(14)*x(12)+K13*x(15)*x(13)+KL1*x(21)+KL2*x(25)+K13*x(28)+x(51)*(x(1)+\sin(t)-x(11))+x(61)*(x(2)+\sin(t)-x(12))+x(30)*(x(3)+\sin(t)-x(13))+x(40)*(x(4)+\sin(t)-x(14))+x(50)*(x(5)+\sin(t)-x(15))+x(60)*(x(6)+\sin(t)-x(16))+x(69)*(x(7)+\sin(t)-x(17))+x(72)*(x(8)+\sin(t)-x(18))+x(74)*(x(9)+\sin(t)-x(19))+x(75)*(x(10)+\sin(t)-x(20));$
 $\%*****estimate$
 $((-2/\theta)*x(21)-x(35)*x(21)-x(52)*x(25)-x(31)*x(34)-x(21)*x(44)-x(22)*x(45)-x(23)*x(46)-x(24)*x(47)-x(41)*x(48)-x(43)*x(49)-x(51)*x(40));\%P14$
 $((-2/\theta)*x(22)-x(35)*x(22)-x(52)*x(26)-x(31)*x(28)-x(21)*x(45)-x(22)*x(55)-x(23)*x(56)-x(24)*x(57)-x(41)*x(58)-x(43)*x(59)-x(51)*x(50));\%P15$
 $((-2/\theta)*x(23)-x(35)*x(23)-x(52)*x(27)-x(31)*x(36)-x(21)*x(46)-x(22)*x(56)-x(23)*x(65)-x(24)*x(64)-x(41)*x(63)-x(43)*x(62)-x(51)*x(60));\%P16$
 $((-2/\theta)*x(24)-x(35)*x(24)-x(52)*x(53)-x(31)*x(37)-x(21)*x(47)-x(22)*x(57)-x(23)*x(64)-x(24)*x(66)-x(41)*x(67)-x(43)*x(68)-x(51)*x(69));\%P17$
 $((-2/\theta)*x(25)-x(52)*x(21)-x(42)*x(25)-x(32)*x(34)-x(25)*x(44)-x(26)*x(45)-x(27)*x(46)-x(53)*x(47)-x(54)*x(48)-x(29)*x(49)-x(61)*x(40));\%P24$
 $((-2/\theta)*x(26)-x(52)*x(22)-x(42)*x(26)-x(32)*x(28)-x(25)*x(45)-x(26)*x(55)-x(27)*x(56)-x(53)*x(57)-x(54)*x(58)-x(29)*x(59)-x(61)*x(50));\%P25$
 $((-2/\theta)*x(27)-x(52)*x(23)-x(42)*x(27)-x(32)*x(36)-x(25)*x(46)-x(26)*x(56)-x(27)*x(65)-x(53)*x(64)-x(54)*x(63)-x(29)*x(62)-x(61)*x(60));\%P26$
 $(-2/\theta)*x(28)-x(31)*x(22)-x(32)*x(26)-x(33)*x(28)-x(34)*x(45)-x(28)*x(55)-x(36)*x(56)-x(37)*x(57)-x(38)*x(58)-x(39)*x(59)-x(30)*x(50));\%P35$
 $((-2/\theta)*x(29)-x(52)*x(43)-x(42)*x(29)-x(32)*x(39)-x(25)*x(49)-x(26)*x(59)-x(27)*x(62)-x(53)*x(68)-x(54)*x(71)-x(29)*x(73)-x(61)*x(74));\%P29$
 $(-2/\theta)*x(30)-x(31)*x(51)-x(32)*x(61)-x(33)*x(30)-x(34)*x(40)-x(28)*x(50)-x(36)*x(60)-x(37)*x(69)-x(38)*x(72)-x(39)*x(74)-x(30)*x(75));\%P310$
 $((-2/\theta)*x(31)-x(35)*x(31)-x(52)*x(32)-x(31)*x(33)-x(21)*x(34)-x(22)*x(28)-x(23)*x(36)-x(24)*x(37)-x(41)*x(38)-x(43)*x(39)-x(51)*x(30));\%P13$
 $((-2/\theta)*x(32)-x(52)*x(31)-x(42)*x(32)-x(32)*x(33)-x(25)*x(34)-x(26)*x(28)-x(27)*x(36)-x(53)*x(37)-x(54)*x(38)-x(29)*x(39)-x(61)*x(30));\%P23$
 $(-2/\theta)*x(33)-x(31)^2-x(32)^2-x(33)^2-x(34)^2-x(28)^2-x(36)^2-x(37)^2-x(38)^2-x(39)^2-x(30)^2;\%P33$
 $(-2/\theta)*x(34)-x(31)*x(21)-x(32)*x(25)-x(33)*x(34)-x(34)*x(44)-x(28)*x(54)-x(36)*x(46)-x(37)*x(47)-x(38)*x(48)-x(39)*x(49)-x(30)*x(40));\%P34$
 $(-2/\theta)*x(35)-x(35)^2-x(52)^2-x(31)^2-x(21)^2-x(22)^2-x(23)^2-x(24)^2-x(41)^2-x(43)^2-x(51)^2;\%P11$

$(-2/\theta) * x(36) - x(31) * x(23) - x(32) * x(27) - x(33) * x(36) - x(34) * x(46) - x(28) * x(56) - x(36) * x(65) - x(37) * x(64) - x(38) * x(63) - x(39) * x(62) - x(30) * x(60); \%P36$
 $(-2/\theta) * x(37) - x(31) * x(24) - x(32) * x(53) - x(33) * x(37) - x(34) * x(47) - x(28) * x(57) - x(36) * x(64) - x(37) * x(66) - x(38) * x(67) - x(39) * x(68) - x(30) * x(69); \%P37$
 $(-2/\theta) * x(38) - x(31) * x(41) - x(32) * x(54) - x(33) * x(38) - x(34) * x(48) - x(28) * x(58) - x(36) * x(63) - x(37) * x(67) - x(38) * x(70) - x(39) * x(71) - x(30) * x(72); \%P38$
 $(-2/\theta) * x(39) - x(31) * x(43) - x(32) * x(29) - x(33) * x(39) - x(34) * x(49) - x(28) * x(59) - x(36) * x(62) - x(37) * x(68) - x(38) * x(71) - x(39) * x(73) - x(30) * x(74); \%P39$
 $(-2 * (1/\theta + Kd) * x(40)) - x(21) * x(51) - x(25) * x(61) - x(34) * x(30) - x(44) * x(40) - x(45) * x(50) - x(46) * x(60) - x(47) * x(69) - x(48) * x(72) - x(49) * x(74) - x(40) * x(75); \%P410$
 $(-2/\theta) * x(41) - x(35) * x(41) - x(52) * x(54) - x(31) * x(38) - x(21) * x(48) - x(22) * x(58) - x(23) * x(63) - x(24) * x(67) - x(41) * x(70) - x(43) * x(71) - x(51) * x(72); \%P18$
 $((-2/\theta)) * x(42) - x(52)^2 - x(42)^2 - x(32)^2 - x(25)^2 - x(26)^2 - x(27)^2 - x(53)^2 - x(54)^2 - x(29)^2 - x(61)^2; \%P22$
 $((-2/\theta)) * x(43) - x(35) * x(43) - x(52) * x(29) - x(31) * x(39) - x(21) * x(49) - x(22) * x(59) - x(23) * x(62) - x(24) * x(68) - x(41) * x(71) - x(43) * x(73) - x(51) * x(74); \%P19$
 $(-2 * (1/\theta + Kd)) * x(44) - x(21)^2 - x(25)^2 - x(34)^2 - x(44)^2 - x(45)^2 - x(46)^2 - x(47)^2 - x(48)^2 - x(49)^2 - x(40)^2; \%P44$
 $(-2 * (1/\theta + Kd) * x(45)) - x(21) * x(22) - x(25) * x(26) - x(34) * x(28) - x(44) * x(45) - x(45) * x(55) - x(46) * x(56) - x(47) * x(57) - x(48) * x(58) - x(49) * x(59) - x(40) * x(50); \%P45$
 $(-2 * (1/\theta + Kd) * x(46)) - x(21) * x(23) - x(25) * x(27) - x(34) * x(36) - x(44) * x(46) - x(45) * x(56) - x(46) * x(65) - x(47) * x(64) - x(48) * x(63) - x(49) * x(62) - x(40) * x(60); \%P46$
 $(-2 * (1/\theta + Kd) * x(47)) - x(21) * x(24) - x(25) * x(53) - x(34) * x(37) - x(44) * x(47) - x(45) * x(57) - x(46) * x(64) - x(47) * x(66) - x(48) * x(67) - x(49) * x(68) - x(40) * x(69); \%P47$
 $(-2 * (1/\theta + Kd) * x(48)) - x(21) * x(41) - x(25) * x(54) - x(34) * x(38) - x(44) * x(48) - x(45) * x(58) - x(46) * x(63) - x(47) * x(67) - x(48) * x(70) - x(49) * x(71) - x(40) * x(72); \%P48$
 $(-2 * (1/\theta + Kd) * x(49)) - x(21) * x(43) - x(25) * x(29) - x(34) * x(39) - x(44) * x(49) - x(45) * x(59) - x(46) * x(62) - x(47) * x(68) - x(48) * x(71) - x(49) * x(73) - x(40) * x(74); \%P49$
 $2 * (-1/\theta + Kt1) * x(50) - x(22) * x(51) - x(26) * x(61) - x(28) * x(30) - x(45) * x(40) - x(55) * x(50) - x(56) * x(60) - x(57) * x(69) - x(58) * x(72) - x(59) * x(74) - x(50) * x(75); \%P510$
 $((-2/\theta)) * x(51) - x(35) * x(51) - x(52) * x(61) - x(31) * x(30) - x(21) * x(40) - x(22) * x(50) - x(23) * x(60) - x(24) * x(69) - x(41) * x(72) - x(43) * x(74) - x(51) * x(75); \%P110$
 $((-2/\theta)) * x(52) - x(35) * x(52) - x(52) * x(42) - x(31) * x(32) - x(21) * x(25) - x(22) * x(26) - x(23) * x(27) - x(24) * x(53) - x(41) * x(54) - x(43) * x(29) - x(51) * x(61); \%P12$
 $((-2/\theta)) * x(53) - x(52) * x(24) - x(42) * x(53) - x(32) * x(37) - x(25) * x(47) - x(26) * x(57) - x(27) * x(64) - x(53) * x(66) - x(54) * x(67) - x(29) * x(68) - x(61) * x(69); \%P27$
 $((-2/\theta)) * x(54) - x(52) * x(41) - x(42) * x(54) - x(32) * x(38) - x(25) * x(48) - x(26) * x(58) - x(27) * x(63) - x(53) * x(67) - x(54) * x(70) - x(29) * x(71) - x(61) * x(72); \%P28$
 $2 * (-1/\theta + Kt1) * x(55) - x(22)^2 - x(26)^2 - x(28)^2 - x(45)^2 - x(55)^2 - x(56)^2 - x(57)^2 - x(58)^2 - x(59)^2 - x(50)^2; \%P55$
 $2 * (-1/\theta + Kt1) * x(56) - x(22) * x(23) - x(26) * x(27) - x(28) * x(36) - x(45) * x(46) - x(55) * x(56) - x(56) * x(65) - x(57) * x(64) - x(58) * x(63) - x(59) * x(62) - x(50) * x(60); \%P56$
 $2 * (-1/\theta + Kt1) * x(57) - x(22) * x(24) - x(26) * x(53) - x(28) * x(37) - x(45) * x(47) - x(55) * x(57) - x(56) * x(64) - x(57) * x(66) - x(58) * x(67) - x(59) * x(68) - x(50) * x(69); \%P57$
 $2 * (-1/\theta + Kt1) * x(58) - x(22) * x(41) - x(26) * x(54) - x(28) * x(38) - x(45) * x(48) - x(55) * x(58) - x(56) * x(63) - x(57) * x(67) - x(58) * x(70) - x(59) * x(71) - x(50) * x(72); \%P58$

$2^{*}(-1/\theta + Kt_1)^{*}x(59)-x(22)^{*}x(43)-x(26)^{*}x(29)-x(28)^{*}x(39)-x(45)^{*}x(49)-$
 $x(55)^{*}x(59)-x(56)^{*}x(62)-x(57)^{*}x(68)-x(58)^{*}x(71)-x(59)^{*}x(73)-x(50)^{*}x(74); \% P59$

$2^{*}(-1/\theta + Kt_2)^{*}x(60)-x(23)^{*}x(51)-x(27)^{*}x(61)-x(36)^{*}x(30)-x(46)^{*}x(40)-$
 $x(56)^{*}x(50)-x(65)^{*}x(60)-x(64)^{*}x(69)-x(63)^{*}x(72)-x(62)^{*}x(74)-x(60)^{*}x(75); \% P610$

$((-2/\theta)^{*}x(61)-x(52)^{*}x(51)-x(42)^{*}x(61)-x(32)^{*}x(30)-x(25)^{*}x(40)-x(26)^{*}x(50)-$
 $x(27)^{*}x(60)-x(53)^{*}x(69)-x(54)^{*}x(72)-x(29)^{*}x(74)-x(61)^{*}x(75); \% P210$

$2^{*}(-1/\theta + Kt_2)^{*}x(62)-x(23)^{*}x(43)-x(27)^{*}x(29)-x(36)^{*}x(39)-x(46)^{*}x(49)-$
 $x(56)^{*}x(59)-x(65)^{*}x(62)-x(64)^{*}x(68)-x(63)^{*}x(71)-x(62)^{*}x(73)-x(60)^{*}x(74); \% P69$

$2^{*}(-1/\theta + Kt_2)^{*}x(63)-x(23)^{*}x(41)-x(27)^{*}x(54)-x(36)^{*}x(38)-x(46)^{*}x(48)-$
 $x(56)^{*}x(58)-x(65)^{*}x(63)-x(64)^{*}x(67)-x(63)^{*}x(70)-x(62)^{*}x(71)-x(60)^{*}x(72); \% P68$

$2^{*}(-1/\theta + Kt_2)^{*}x(64)-x(23)^{*}x(24)-x(27)^{*}x(53)-x(36)^{*}x(37)-x(46)^{*}x(47)-$
 $x(56)^{*}x(57)-x(65)^{*}x(64)-x(64)^{*}x(66)-x(63)^{*}x(67)-x(62)^{*}x(68)-x(60)^{*}x(69); \% P67$

$2^{*}(-1/\theta + Kt_2)^{*}x(65)-x(23)^2-x(27)^2-x(36)^2-x(46)^2-x(56)^2-x(65)^2-x(64)^2-$
 $x(63)^2-x(62)^2-x(60)^2; \% P66$

$2^{*}(-1/\theta + Kt_3)^{*}x(66)-x(24)^2-x(53)^2-x(37)^2-x(47)^2-x(57)^2-x(64)^2-x(66)^2-$
 $x(67)^2-x(68)^2-x(69)^2; \% P77$

$2^{*}(-1/\theta + Kt_3)^{*}x(67)-x(24)^{*}x(41)-x(53)^{*}x(54)-x(37)^{*}x(38)-x(47)^{*}x(48)-$
 $x(57)^{*}x(58)-x(64)^{*}x(63)-x(66)^{*}x(67)-x(67)^{*}x(70)-x(68)^{*}x(71)-x(69)^{*}x(72); \% P78$

$2^{*}(-1/\theta + Kt_3)^{*}x(68)-x(24)^{*}x(43)-x(53)^{*}x(29)-x(37)^{*}x(39)-x(47)^{*}x(49)-$
 $x(57)^{*}x(59)-x(64)^{*}x(62)-x(66)^{*}x(68)-x(67)^{*}x(71)-x(68)^{*}x(73)-x(69)^{*}x(74); \% P79$

$2^{*}(-1/\theta + Kt_3)^{*}x(69)-x(24)^{*}x(51)-x(53)^{*}x(61)-x(37)^{*}x(30)-x(47)^{*}x(40)-$
 $x(57)^{*}x(50)-x(64)^{*}x(60)-x(66)^{*}x(69)-x(67)^{*}x(72)-x(68)^{*}x(74)-x(69)^{*}x(75); \% P710$

$2^{*}(-1/\theta)^{*}x(70)-x(41)^2-x(54)^2-x(38)^2-x(48)^2-x(58)^2-x(63)^2-x(67)^2-x(70)^2-$
 $x(71)^2-x(72)^2; \% P88$

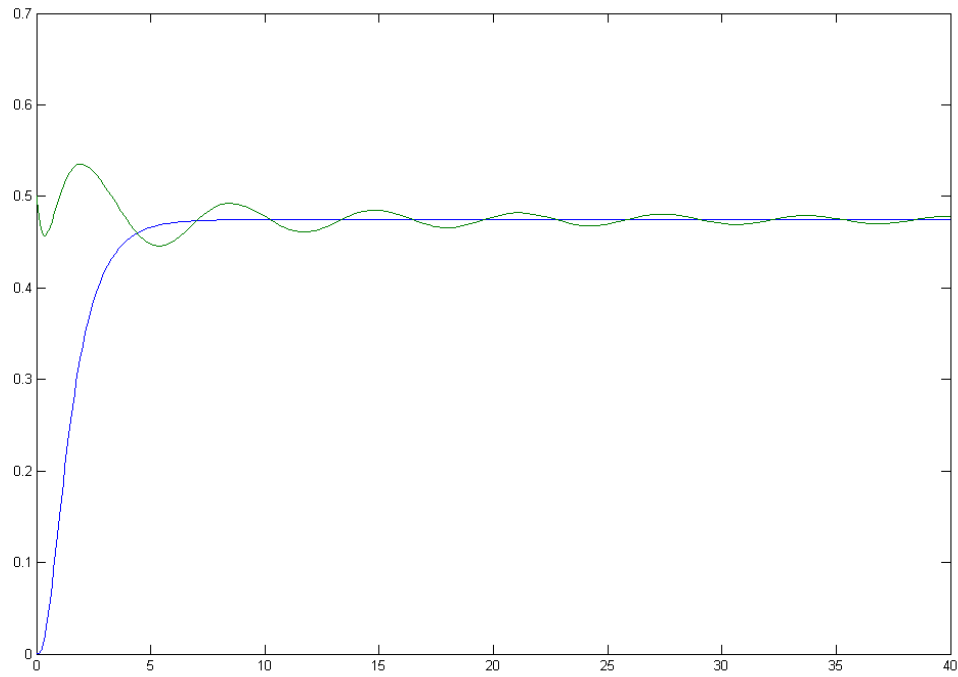
$2^{*}(-1/\theta)^{*}x(71)-x(41)^{*}x(43)-x(54)^{*}x(29)-x(38)^{*}x(39)-x(48)^{*}x(49)-x(58)^{*}x(59)-$
 $x(63)^{*}x(62)-x(67)^{*}x(68)-x(70)^{*}x(71)-x(71)^{*}x(73)-x(72)^{*}x(74); \% P89$

$2^{*}(-1/\theta)^{*}x(72)-x(41)^{*}x(51)-x(54)^{*}x(61)-x(38)^{*}x(30)-x(48)^{*}x(40)-x(58)^{*}x(50)-$
 $x(63)^{*}x(60)-x(67)^{*}x(69)-x(70)^{*}x(72)-x(71)^{*}x(74)-x(72)^{*}x(75); \% P810$

$2^{*}(-1/\theta)^{*}x(73)-x(43)^2-x(29)^2-x(39)^2-x(49)^2-x(59)^2-x(62)^2-x(68)^2-x(71)^2-$
 $x(73)^2-x(74)^2; \% P99$

$2^{*}(-1/\theta)^{*}x(74)-x(43)^{*}x(51)-x(29)^{*}x(61)-x(39)^{*}x(30)-x(49)^{*}x(40)-x(59)^{*}x(50)-$
 $x(62)^{*}x(60)-x(68)^{*}x(69)-x(71)^{*}x(72)-x(73)^{*}x(74)-x(74)^{*}x(75); \% P910$

$2^{*}(-1/\theta)^{*}x(75)-x(51)^2-x(61)^2-x(30)^2-x(40)^2-x(50)^2-x(60)^2-x(69)^2-x(72)^2-$
 $x(74)^2-x(75)^2; \% P1010$



Numerical Table

$x_{10}(0)=0$ $x_{10}(1)=0.15$ $x_{10}(2)=0.334$ $x_{10}(3)=0.419$ $x_{10}(4)=0.453$ $x_{10}(5)=0.466$
 $x_{10}(10)=0.475$ $x_{10}(20)=0.475$

$x_{20}(0)=0.5$ $x_{20}(1)=0.499$ $x_{20}(2)=0.536$ $x_{20}(3)=0.511$ $x_{20}(4)=0.473$ $x_{20}(5)=0.447$
 $x_{20}(10)=0.478$ $x_{20}(20)=0.477$
