Appendix B: Example Matlab / Simulink S- function files

B.1: Simulink program for PD controller

```
function[sys,x0]=Mitsu_3(t,x,u,flag,m,l,xx0)

if flag==0
    x0=xx0;
    sys=[6,0,6,3,0,1];
elseif flag==1
    M1=m(1);
    M2=m(2);
    M3=m(3);
    L1=l(1);
    L2=l(2);
    L3=l(3);
    I1=M1*L1^2/12;
    I2=M2*L2^2/12;
    I3=M3*L3^2/12;

    p1=I1+M3*(L2*cos(x(2))+0.5*L3*cos(x(2)+x(3)))^2;
    p2=2*M3*(L2^2*cos(x(2))*sin(x(2))+0.5*L3*L2*cos(x(2)+x(3))*cos(x(2)))-
    0.5*M2*L2^2*cos(x(2))*sin(x(2));
    p3=0.25*M2*L2^2*cos(x(2))^2;
    p4=2*M3*(0.5*L2*L3*cos(x(2))+0.25*L3^2*cos(x(2)+x(3))*sin(x(2)+x(3)));

    p5=I2+0.25*M2*L2^2+M3*(2*L2^2+0.5*L3^2+2*L2*L3*cos(x(2)+x(3)));
    p6=0.5*M3*(L3^2+L2*L3*cos(x(2)));
    p7=0.5*M3*L2*L3;
    p8=cos(x(2))*(0.5*L2*L2*9.81+M3*9.81*L2);
    p9=M3*9.81*L3*cos(x(2)+x(3))/2;

    p10=I3+M3*L3^2/4;
    p11=0.5*L2*L3*cos(x(3))+M3*L3^2/4;
    p12=M3*L2*L3*sin(x(3))/2;
    p13=M3*9.81*L3*cos(x(2)+x(3))/2;

    M=[p1 p3 0;0 p5+p11 p6+p10;0 p11 p10];
    C1=(p2+p4)*x(4)*x(5)+p4*x(4)*x(6);
    C2=(2*p7+p12)*x(5)*x(6)-p7*sin(x(3))*x(6)^2+p8+p9+p13;
    C3=p12*x(5)*x(6)+p13;
    C=[C1;C2;C3];
    T=[u(1);u(2);u(3)];
    dx=inv(M)*(T-C);
    dx1=x(4);
    dx2=x(5);
    dx3=x(6);
    dx4=dx(1);
    dx5=dx(2);
    dx6=dx(3);
        sys=[dx1;dx2;dx3;dx4;dx5;dx6];
elseif flag==3
    sys=[x(1);x(2);x(3);x(4);x(5);x(6)];
else
    sys=[];
end
```

B.2 Simulink program for DC motor:

```
function [sys,x0]=dc_motor(t,x,u,flag,Ra,La,J,B,Kt,Kb,xx0)
if flag==0
   x0=xx0;
   sys=[2,0,3,2,0,1];
elseif flag==1
   dx1=-Ra*x(1)/La-Kb*x(2)/La+u(1)/La ;
   dx2=Kt*x(1)/J-B*x(2)/J-u(2)/J;
   sys=[dx1;dx2];
elseif flag==3
   Te=Kt*x(1);
   sys=[x(1);x(2);Te];
else
   sys=[];
end
```