Appendixes

Appendix (A)

```
function [Gc,Kp,Ti,Td,H]=ziegler(key,vars)
 Ti=[]; Td=[]; H=1;
 if length(vars)==4,
 K=vars(1); L=vars(2); T=vars(3); N=vars(4); a=K*L/T;
 if key==1, Kp=1/a;
 elseif key==2, Kp=0.9/a; Ti=3.33*L;
 elseif key==3 | key==4, Kp=1.2/a; Ti=2*L; Td=L/2; end
 elseif length(vars)==3,
 K=vars(1); Tc=vars(2); N=vars(3);
 if key==1, Kp=0.5*K;
 elseif key==2, Kp=0.4*K; Ti=0.8*Tc;
 elseif key==3 | key==4, Kp=0.6*K; Ti=0.5*Tc; Td=0.12*Tc; end
 elseif length(vars)==5,
 K=vars(1); Tc=vars(2); rb=vars(3); N=vars(5);
 pb=pi*vars(4)/180; Kp=K*rb*cos(pb);
 if key==2, Ti=-Tc/(2*pi*tan(pb));
 elseif key==3|key==4, Ti=Tc*(1+sin(pb))/(pi*cos(pb)); Td=Ti/4; end
 end
 [Gc,H]=writepid(Kp,Ti,Td,N,key);
```

Appendix (B)

```
function [Gc,H]=writepid(Kp,Ti,Td,N,key)
switch key
case 1, Gc=Kp;
 case 2, Gc=tf(Kp*[Ti,1],[Ti,0]); H=1;
 case 3, nn=[Kp*Ti*Td*(N+1)/N,Kp*(Ti+Td/N),Kp];
 dd=Ti*[Td/N,1,0]; Gc=tf(nn,dd); H=1;
 case 4, d0=sqrt(Ti*(Ti-4*Td)); Ti0=Ti; Kp=0.5*(Ti+d0)*Kp/Ti;
 Ti=0.5*(Ti+d0); Td=Ti0-Ti; Gc=tf(Kp*[Ti,1],[Ti,0]);
 nH=[(1+Kp/N)*Ti*Td, Kp*(Ti+Td/N), Kp];
 H=tf(nH,Kp*conv([Ti,1],[Td/N,1]));
 case 5, Gc=tf(Kp*[Td*(N+1)/N,1],[Td/N,1]); H=1;
 end
```

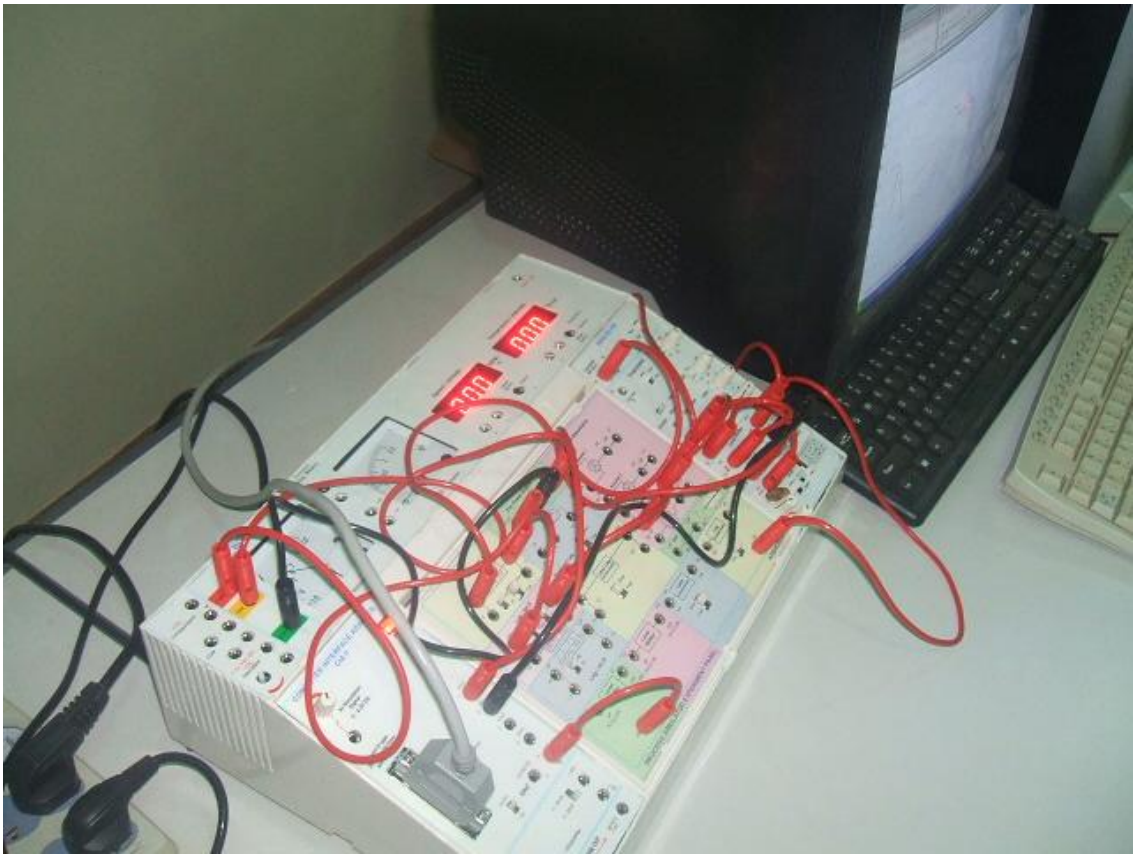
Appendix (C)

```
function [Gc,Kp,Ti,Td,H]=chrpid(key,tt,vars)
 K=vars(1); L=vars(2); T=vars(3); N=vars(4); a=K*L/T; Ti=[]; Td=[];
 ovshoot=vars(5); if tt==1, TT=T; else TT=L; tt=2; end
 if ovshoot==0,
 KK=[0.3,0.35,1.2,0.6,1,0.5; 0.3,0.6,4,0.95,2.4,0.42];
 else,
 KK=[0.7,0.6,1,0.95,1.4,0.47; 0.7,0.7,2.3,1.2,2,0.42];
 end
 switch key
 case 1, Kp=KK(tt,1)/a;
 case 2, Kp=KK(tt,2)/a; Ti=KK(tt,3)*TT;
 case {3,4}, Kp=KK(tt,4)/a; Ti=KK(tt,5)*TT; Td=KK(tt,6)*L;
 end
 [Gc,H]=writepid(Kp,Ti,Td,N,key);
```

Appendix (D)

```
function [Gc,Kp,Ti,Td,H]=optPID(key,typ,vars)
 k=vars(1); L=vars(2); T=vars(3); N=vars(4); Td=[];
 if length(vars)==5, iC=vars(5);
 switch key
 case 2
A=[0.980,0.712,0.569,1.072,0.786,0.628;0.892,0.921,0.951,0.560,0.559,0.5
83;70.690,0.968,1.023,0.648,0.883,1.007;0.155,0.247,0.179,0.114,0.158,0.1
67];
 case 3
A=[1.048,1.042,0.968,1.154,1.142,1.061;0.897,0.897,0.904,0.567,0.579,0.5
83;101.195,0.987,0.977,1.047,0.919,0.892;0.368,0.238,0.253,0.220,0.172,0.
165;110.489,0.385,0.316,0.490,0.384,0.315;0.888,0.906,0.892,0.708,0.839,0
.832];
case 4
A=[1.260,1.053,0.942,1.295,1.120,1.001;0.887,0.930,0.933,0.619,0.625,0.6
24;140.701,0.736,0.770,0.661,0.720,0.754;0.147,0.126,0.130,0.110,0.114,0.
116;150.375,0.349,0.308,0.378,0.350,0.308;0.886,0.907,0.897,0.756,0.811,0
.813];
 end
ii=0; if (L/T>1) ii=3; end; tt=L/T; a1=A(1,ii+iC); b1=-A(2,ii+iC);
 a2=A(3,ii+iC); b2=-A(4,ii+iC); Kp=a1/k*ttˆb1; Ti=T/(a2+b2*tt);
 if key==3| key==4
 a3=A(5,ii+iC); b3=A(6,ii+iC); Td=a3*T*ttˆb3;
 end
 else,
Kc=vars(5); Tc=vars(6); k=vars(7);
switch key
```

Appendix (E)



Master Unit device (MU)

Model: XPO-PID

Process SIM./CE1

Panel: Process Simulator experiment panel

Computer interface (located at left hand side slot of MU)

Interfacing through 25 pin parallel port (LPT port):

4 ADC channels : 0 to 2.5v full scale

1 ADC channel : O/P 2.5v full scale

V to I function block : Input : 0-2.5 V dc

Output : 0-20 mA, into max 100 Ω load, upto max. 8 Vdc, gnd compliance @ 12V dc supply.

Analogue PID controller (located at right hand side slot of MU)

Process Selection like P, PI, PD, PID

Parameter setting like : Integral Time Ti (0.5 - 25 Sec)

: Derivative Time Ti (0 - 2 Sec)

: Proportional Band Pb (5 – 200%)