Appendix A

MATLAB m-file defining variables, state-space model, and open response of the system

```
M=0.5;
m=0.5;
b=0.1;
L=0.3;
I=0.006;
g=9.81;
d=I*(M+m)+M*m*L^2;
disp('state space model of the system is: ')
A= [0 1 0 0 ;m*g*L(M+m)/d 0 0 m*L*b/d;0 0 0 1;-g*m^2*L^2/d 0 0 -
b*(I+m*L^2)/d];
B= [0;-m*L/d;0;(I+m*L^2)/d];
C= [0 0 1 0;1 0 0 0 ];
D= [0;0];
System=ss(A,B,C,D);
disp('the transfer function of the system is: ')
inputs ={'u'};
outputs ={'theta';'x'};
G=tf(system);
inputs={'u'};
Outputs={'x';'theta'};
set (G,'INPUTNAME',inputs);
set (G,'OUTPUTNAME',outputs);
t=0:0.05:10;
u=ones(size(t));
[y,t] = lsim(G,u,t);
plot(t,y)
title ('open loop step response of the system')
axis ([0 2 -50 50])
legend ('x','theta')
grid
xlabel('Time(sec)')
ylabel('pendulum,s angle and cart,s position')
```

Appendix B

MATLAB m-file poles of the system, pole-zero mapping and checking controllability

```
M=0.5;
m=0.5;
b=0.1;
L=0.3;
I=0.006;
g=9.81;
d=I*(M+m) +M*m*L^2;
A= [0 1 0 0; m*g*L(M+m)/d 0 0 m*L*b/d;0 0 0 1;-g*m^2*L^2/d 0 0 -
b*(I+m*L^2)/d];
B= [0;-m*L/d; 0 ;( I+m*L^2)/d];
C= [0 0 1 0; 1 0 0 0];
D= [0; 0];
disp('poles of system are:')
Poles=eig(A);
pzmap(system);
title ('pole zero mapping of the system')
disp('checking controllability');
Co=ctrb (system);
rank_co=rank (co);
```

Appendix C

MATLAB m-file state feedback controller-pole placement method-1st test

```
M=0.5;
m=0.5;
b=0.1;
L=0.3;
I=0.006;
g=9.81;
d=I*(M+m)+M*m*L^2;
A= [0 1 0 0; m*g*L (M+m)/d 0 0 m*L*b/d; 0 0 0 1;-g*m^2*L^2/d 0 0 -
b*(I+m*L^2)/d];
B= [0;-m*L/d; 0 ;(I+m*L^2)/d];
C= [0 0 1 0; 1 0 0 0];
D= [0; 0];
p1= [-2.433 -1.622 -0.811+ j*1.584 -0.811-j*1.584];
k1=place (A, B, p1);
AC1=A-B*k1;
system1=ss(AC1,B,C,D);
t=0:0.1:10;
r=0.2*ones (size (t));
[y,t,x]=lsim(system1,r,t);
[AX, H1,H2]=plotyy(t,y(:,1),t,y(:,2),'plot');
set (get(AX(1),'ylabel'),'string','cart positio(m)')
set (get(AX(2),'ylabel'),'string','pen-angle(rad)')
title('Step Response using pole placement-1st test')
grid
```

Appendix D

MATLAB m-file state feedback controller-pole placement method-2st test

```
M=0.5;
m=0.5;
b=0.1;
L=0.3;
I=0.006;
g=9.81;
d=I*(M+m)+M*m*L^2;
A= [0 1 0 0; m*g*L (M+m)/d 0 0 m*L*b/d; 0 0 0 1;-g*m^2*L^2/d 0 0 -
b*(I+m*L^2)/d];
B= [0;-m*L/d; 0 ;(I+m*L^2)/d];
C= [0 0 1 0; 1 0 0 0];
D= [0; 0];
p2=[-11.354  -9.732  -0.811+ j*1.584 -0.811-j*1.584 ];
k2=place (A, B, p2);
AC2=A-B*k2;
system2=ss (AC2, B, C, D);
t=0:0.1:10;
r=0.2*ones (size (t));
[y,t,x]=lsim (system2, r, t);
[AX, H1, H2]=plotyy(t,y(:,1),t,y(:,2),'plot');
set(get(AX(1),'ylabel'),'string','cart positio(m)')
set(get(AX(2),'ylabel'),'string','pen-angle(rad)')
title('Step Response using pole placement-2st test')
grid
```