```
clc
clear all
close all

%Ball & Beam: PID Controller Design

%Proportional control
m = 0.111;
R = 0.015;
g = -9.8;
L = 1.0;
d = 0.03;
J = 9.99e-6;
s = tf('s');
P_ball = -m*g*d/L/(J/R^2+m)/s^2

Kp = 1;
C = pid(Kp)
sys_cl=feedback(C*P_ball,1)
figure(1)
step(0.25*sys_cl)
axis([0 70 0 0.5])

%Proportional-derivative control
m = 0.111;
R = 0.015;
g = -9.8;
L = 1.0;
d = 0.03;
J = 9.99e-6;
s = tf('s');
P_ball = -m*g*d/L/(J/R^2+m)/s^2

Kp = 10;
Kd = 10;
C = pid(Kp,0,Kd)
sys_cl=feedback(C*P_ball,1)
figure(2)
t=0:0.01:5;
step(0.25*sys_cl)
Kp = 10;
Kd = 20;
C = pid(Kp,0,Kd)
figure(3)
sys_cl=feedback(C*P_ball,1)
step(0.25*sys_cl)
Kp = 15;
Kd = 40;
C = pid(Kp,0,Kd)
figure(4)
sys_cl=feedback(C*P_ball,1)
step(0.25*sys_cl)
```