

---

## Table of Contents

MAE5903 - HW#4 Part 1 Sliding Controller .....	1
Plots .....	2
Equation of Motion .....	6

## MAE5903 - HW#4 Part 1 Sliding Controller

Time-vary mass, Integrate phi

```
function HW4P1_ef()  
  
% Given  
n = 2;  
m_lims = [1 2];  
alpha1_lims = [4 6];  
alpha2_lims = [1 2];  
dlims = [-1 1];  
omega_avoid = 4.2;      % (rad/s)  
  
% Choose parameters  
m_hat = mean(m_lims);  
alpha1_hat = mean(alpha1_lims);  
alpha2_hat = mean(alpha2_lims);  
d_hat = mean(dlims);  
lambda = [2*pi*omega_avoid/3 2*pi*omega_avoid/5];  
eta = [1 10];  
  
tspan = [0 6];  
X0 = [0; 0; 0];  
for i1 = 1:length(lambda)  
    for i2 = 1:length(eta)  
  
        casenum = 2*(i1-1) + i2;  
        [t,X] = ode45(@slidingEOM_VaryMass,tspan,X0,  
[ ],m_hat,alpha1_hat,alpha2_hat,d_hat,eta(i2),lambda(i1));  
        x1 = X(:,1);  
        x2 = X(:,2);  
        xd = 2*sin(t);  
        xd_dot = 2*cos(t);  
        x1_tilde = x1 - xd;  
        % Calc s and phi again (I haven't found a better way to do  
this yet)  
        clear s phi u kd  
        for i3 = 1:length(t)  
            [~,s(i3),phi(i3),u(i3),kd(i3)] =  
slidingEOM_VaryMass(t(i3),X(i3,:),m_hat,alpha1_hat,alpha2_hat,d_hat,eta(i2),lambda(i1));  
        end  
        x_tilde_bound = kd/lambda(i1);
```

---

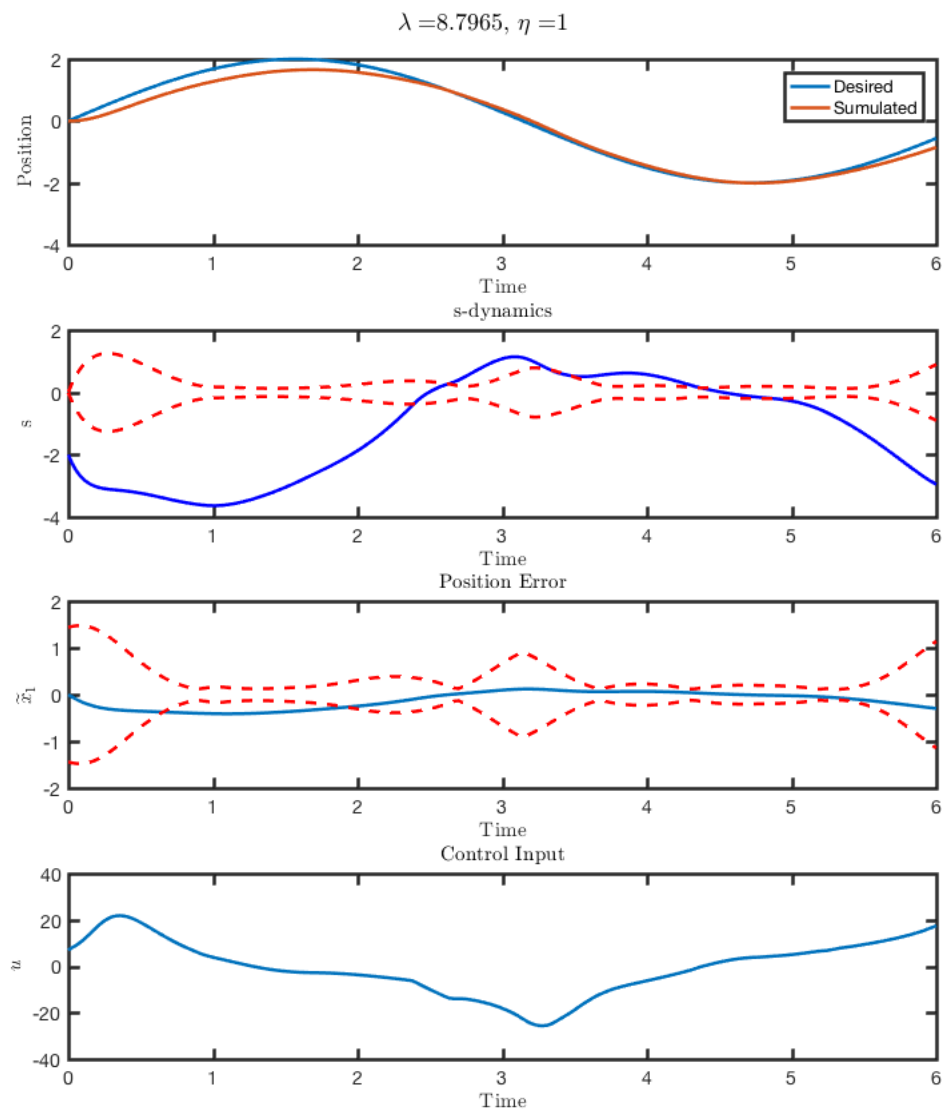
# Plots

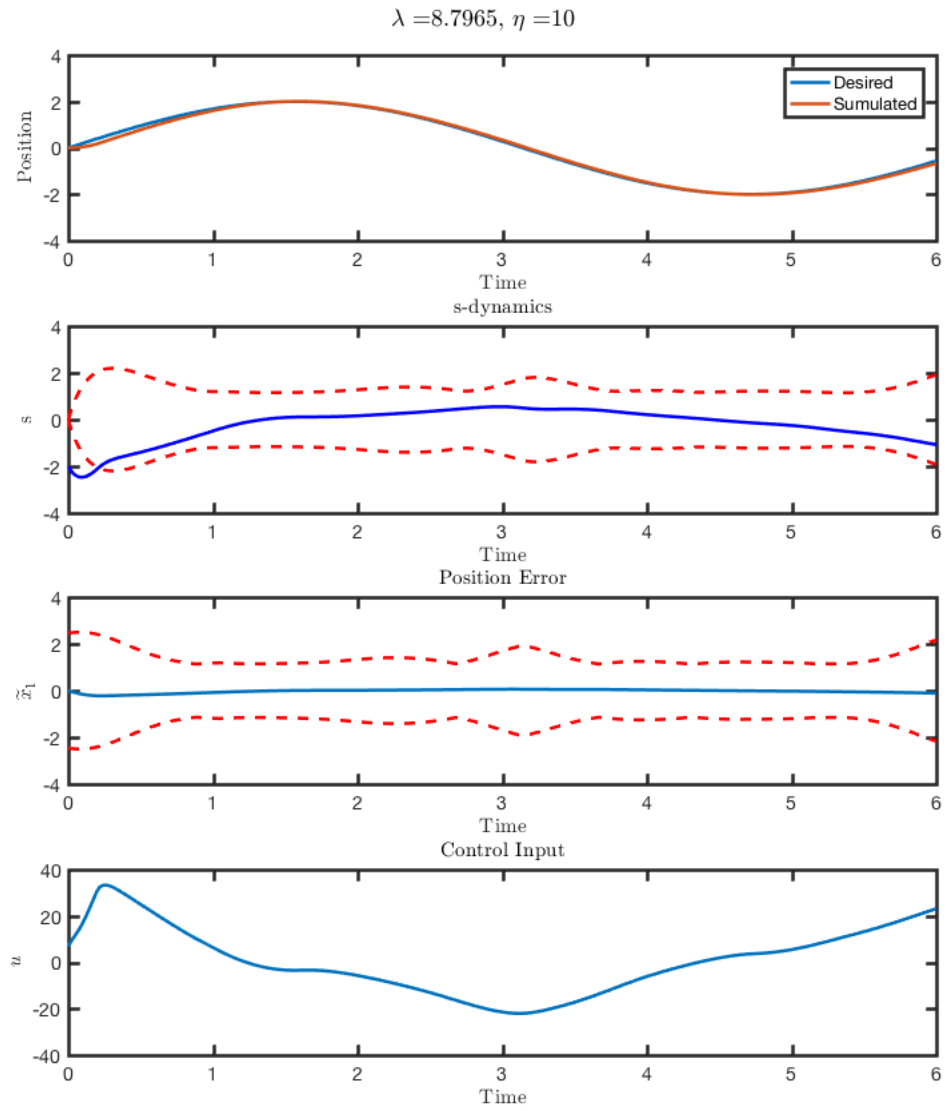
```
figure(casenum)
suptitle(['$\lambda = $' num2str(lambda(i1)) ', $\eta = $'
num2str(eta(i2))]);
% Dynamics
subplot(411)
plot(t,xd,t,x1)
legend('Desired','Sumulated','location','northeast')
xlabel('Time'); ylabel('Position');

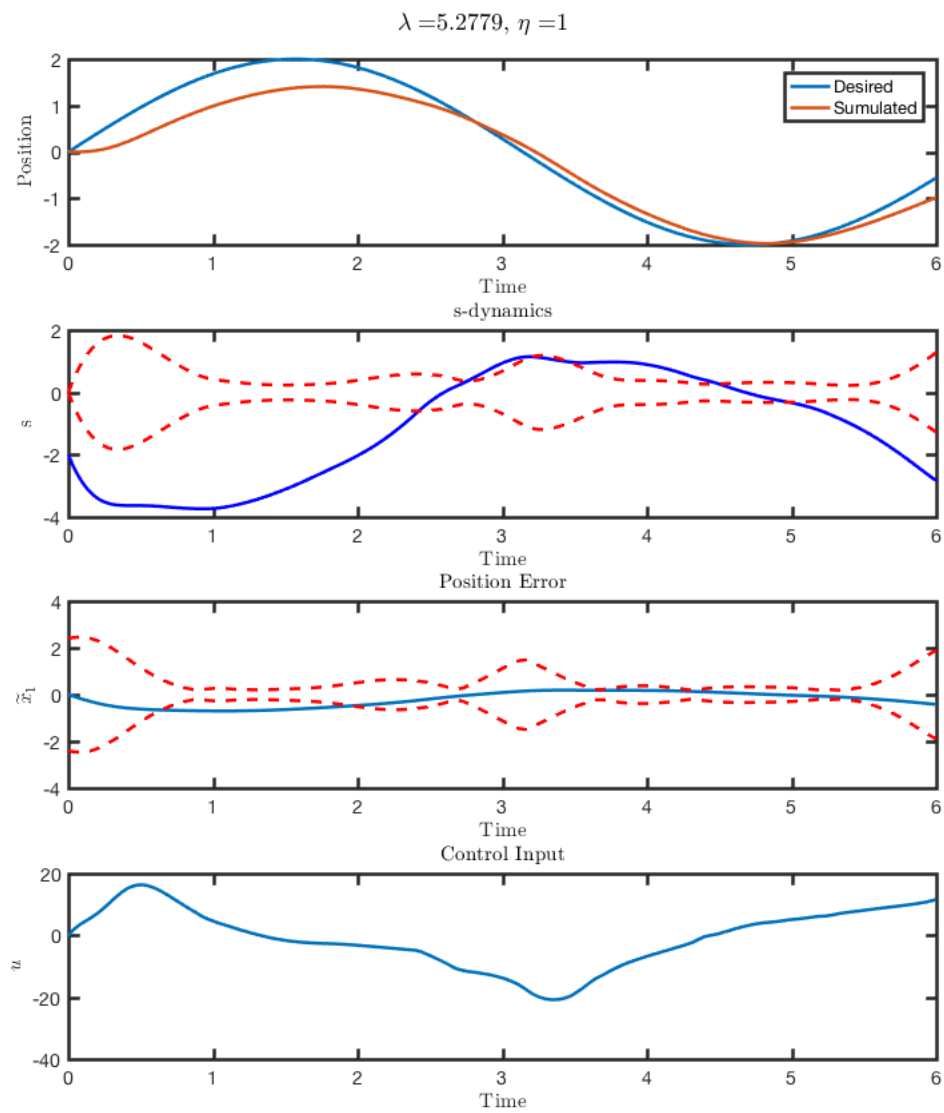
% s-Dynamics
subplot(412)
plot(t,s,'b',t,phi,'r--',t,-phi,'r--')
title('s-dynamics')
xlabel('Time'); ylabel('s');

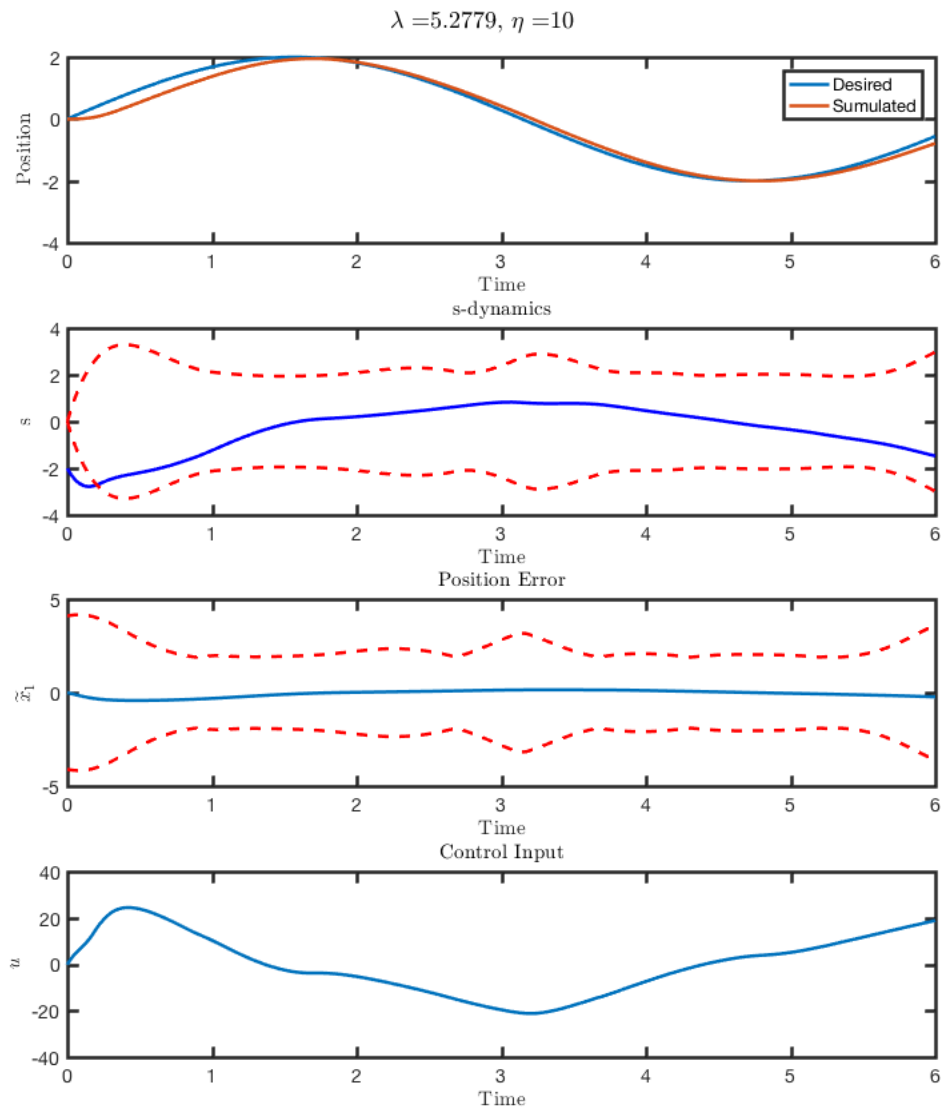
% Error Plot
subplot(413)
plot(t,x1_tilde,t,x_tilde_bound,'r--',t,-x_tilde_bound,'r--');
title('Position Error')
xlabel('Time'); ylabel('$\widetilde{x}_1$');

% Control Input
subplot(414)
plot(t,u);
title('Control Input')
xlabel('Time'); ylabel('$u$');
```









```

end
end
end

```

## Equation of Motion

```

function [dx, s, phi, u, kd] =
    slidingEOM_VaryMass(t,x,m_hat,a1_hat,a2_hat,d_hat,eta,lambda)
dx = zeros(size(x));
x1 = x(1);
x2 = x(2);
phi = x(3);
xd = 2*sin(t);

```

---

```

xd_dot = 2*cos(t);
xd_dd = -2*sin(t);

m = 2 - abs(cos(1.5*t));
a1 = 5 + cos(t);
a2 = 1 + abs(sin(2*t));
d = cos(1.3*t);
f = (-1/m)*((a1 + a2*cos(x1)^2)*abs(x2)*x2 + d);
fd = (-1/m)*((a1 + a2*cos(xd)^2)*abs(xd_dot)*xd_dot + d);
b = 1/m;
f_hat = (-1/m_hat)*((a1_hat + a2_hat*cos(x1)^2)*abs(x2)*x2 + d_hat);
fd_hat = (-1/m_hat)*((a1_hat + a2_hat*cos(xd)^2)*abs(xd_dot)*xd_dot +
    d_hat);
F = abs(f-f_hat);
Fd = abs(fd-fd_hat);
k = F + eta;
kd = Fd + eta;
% phi = 0.1;
% phi = kd/lambda;
% phi_dot = 0;
phi_dot = kd - lambda*phi;
s = x2 - xd_dot + lambda*(x1-xd);
u_hat = -f_hat + xd_dd - lambda*(x2-xd_dot);

if abs(s) >= phi
    u = u_hat - (k-phi_dot)*sign(s);
else
    u = u_hat - (k-phi_dot)*(s/phi);
end

dx(1) = x2;
dx(2) = f + b*u;
dx(3) = phi_dot;

end

```

*Published with MATLAB® R2016a*