

Matlab Code

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% Hunter Phillips
% Homework 6
% MAE 488
% 03/10/19

clc
clear
format compact

%% Header
d_bullets = repmat('*', 50, 1); % concise way to make a lot of chars
fprintf('%c',d_bullets)
fprintf('\nMAE 488, Homework #6, Spring 2019, Hunter Phillips\n')
fprintf('%c',d_bullets)
fprintf('\n\n')

clear

%% Problem 8M

su_bullets = repmat('*', 25, 1); % setting up cmd line output
fprintf('\n\n')
fprintf('%c',su_bullets)
fprintf('\nProblem 8M\n')
fprintf('%c',su_bullets)
fprintf('\n\n')

% X(s)/F(s)
sys1=tf(4,[1,0]);
sys2=feedback(tf(1,[1,0]),8);
sys3=series(sys1,sys2);
sys4=feedback(sys3,6);
X_s_F_s = sys4

% X(s)/G(s)
sys4=sys2;
sys5=series(24,tf(1,[1,0]));
sys6=-feedback(sys4,sys5);
X_s_G_s = sys6

%% Problem 9M

su_bullets = repmat('*', 25, 1);
fprintf('\n\n')
fprintf('%c',su_bullets)
fprintf('\nProblem 9M\n')
fprintf('%c',su_bullets)
fprintf('\n\n')

% C(s)/R(s)
sys1=tf([4,10],[3,1]);
sys2=tf(1,[7,1]);
sys3=series(sys1,sys2);
sys4=feedback(sys3,1);
C_s_R_s = sys4

% C(s)/D(s)
sys5=-feedback(sys2,sys1);
X_s_G_s = sys5

%% Problem 23M (b)

su_bullets = repmat('*', 25, 1);
fprintf('\n\n')
fprintf('%c',su_bullets)
fprintf('\nProblem 23M (b)\n')
fprintf('%c',su_bullets)
fprintf('\n\n')

A = [-5, 3; 1, -4];
B = [4, 0; 0, 5];
C = [1, 0];
D = [0, 0];
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sys = ss(A,B,C,D);

fprintf('X_1(s)/U_1(s) is from input 1 to output\n')
fprintf('X_1(s)/U_2(s) is from input 2 to output\n')

transfer_fun = tf(sys)

%% Problem 25M (b)

su_bullets = repmat('*', 25, 1);
fprintf('\n\n')
fprintf('%c',su_bullets)
fprintf('\nProblem 25M (b)\n')
fprintf('%c',su_bullets)
fprintf('\n\n')

sys1 = tf([1, 2], [1, 4, 3]);
sys2 = ss(sys1)

fprintf('The model is:\n')
fprintf('z_1'' = %.0f*z_1 %.1f*z_2 + %.0f*f\n',sys2.A(1), sys2.A(3), sys2.B(1))
fprintf('z_2'' = %.0f*z_1\n', sys2.A(2))
fprintf('y = %.1f*z_1 + %.1f*z_2\n', sys2.C(1), sys2.C(2))

%% Problem 35M

f1 = figure(1);
su_bullets = repmat('*', 25, 1);
fprintf('\n\n')
fprintf('%c',su_bullets)
fprintf('\nProblem 35M\n')
fprintf('%c',su_bullets)
fprintf('\n\n')

[t,v] = ode45('problem35',[0, 7], 0);
plot(t,v)
xlabel('t (sec)')
ylabel('v (ft/sec)')
title({'MAE 488, Homework 6, Problem 6.35M'},'interpreter','latex')
ylim([0 275])

fprintf('Results Plotted in Figure 1\n')
print(f1,'..\results\problem_5_35M.png','-dpng','-r1200');

%% Problem 41S

f2 = figure(2);

su_bullets = repmat('*', 25, 1);
fprintf('\n\n')
fprintf('%c',su_bullets)
fprintf('\nProblem 41S\n')
fprintf('%c',su_bullets)
fprintf('\n\n')

sim('problem_41s')

plot(simout.time, simout.data,'r')
title({'MAE 488, Homework 6, Problem 6.41S'},'interpreter','latex')
xlabel('t')
ylabel('y(t)')

fprintf('Results Plotted in Figure 2\n')
print(f2,'..\results\problem_5_41S.png','-dpng','-r1200');

%% Problem 45S

f3 = figure(3);

su_bullets = repmat('*', 25, 1);
fprintf('\n\n')
fprintf('%c',su_bullets)
fprintf('\nProblem 45S\n')
fprintf('%c',su_bullets)
fprintf('\n\n')

A_45s = [-5, 3; 0 -4]
B_45s = [2;0]

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C_45s = [1, 3; 0, 1]
D_45s = [2;0]

sim('problem_45s')

plot(simout.time, simout.data)
title({'MAE 488, Homework 6, Problem 6.45S'}, 'interpreter', 'latex')
xlabel('t')
legend('y_1(t)', 'y_2(t)', 'location', 'southeast', 'fontsize', 16)
ylim([-2 3])

fprintf('\nResults Plotted in Figure 3\n')
print(f3, '..\results\problem_5_45S.png', '-dpng', '-r1200');

%% Problem 46S

f4 = figure(4);

su_bullets = repmat('*', 25, 1);
fprintf('\n\n')
fprintf('%c', su_bullets)
fprintf('\nProblem 46S\n')
fprintf('%c', su_bullets)
fprintf('\n\n')

A_45s = [-5, 3; 0 -4]
B_45s = [0;0]
C_45s = [1, 3; 0, 1]
D_45s = [0;0]

sim('problem_46s')

plot(simout.time, simout.data)
title({'MAE 488, Homework 6, Problem 6.46S'}, 'interpreter', 'latex')
xlabel('t')
legend('y_1(t)', 'y_2(t)', 'location', 'northeast', 'fontsize', 16)
ylim([-1 15])
grid

fprintf('\nResults Plotted in Figure 4\n')
print(f4, '..\results\problem_5_46S.png', '-dpng', '-r1200');

%% Problem 28M

format long
f5 = figure(5);

su_bullets = repmat('*', 25, 1);
fprintf('\n\n')
fprintf('%c', su_bullets)
fprintf('\nProblem 28M\n')
fprintf('%c', su_bullets)
fprintf('\n\n')

% part a
m1 = 36;
m2 = 240;
k1 = 1.6e+5;
k2 = 1.6e+4;
c1 = 98;

A = [0, 1, 0, 0; -k1/m1, -c1/m1, k1/m1, c1/m1; ...
     0, 0, 0, 1; k1/m2, c1/m2, -(k1+k2)/m2, -c1/m2];
B = [0; 0; 0; k2/m2];
C = [1, 0, 0, 0; 0, 0, 1, 0];
D = [0; 0];

fprintf('Part A\n-----\n')
sys = ss(A,B,C,D)

% part b
fprintf('\nPart B\n-----\n\n')
fprintf('Results Plotted in Figure 5\n\n')
impulse(sys)
title({'MAE 488, Homework 6, Problem 5.28M'}, 'interpreter', 'latex')

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% part c
fprintf('\nPart C\n-----\n\n')
print(f5, '..\results\problem_5_28M.png', '-dpng', '-r1200');

% characteristic polynomial
po = poly(A);
fprintf('Characteristic Polynomial:\n')
fprintf('%.2fs^4 + %.2fs^3 + %.2fs^2 + %.2fs^1 + %.2f = 0\n\n'...
    ,po(1), po(2), po(3), po(4), po(5))

% roots
roots = eig(A)

% part d
fprintf('\n\nPart D\n-----\n\n')
tfsys = tf(sys);
X1_s_Y_s = tfsys(1)
X2_s_Y_s = tfsys(2)

```

Matlab Output

MAE 488, Homework #6, Spring 2019, Hunter Phillips

Problem 8M

$X_s F_s =$

4

$s^2 + 8s + 24$

Continuous-time transfer function.

$X_s G_s =$

-s

$s^2 + 8s + 24$

Continuous-time transfer function.

Problem 9M

$C_s R_s =$

$$4s + 10$$

$$21s^2 + 14s + 11$$

Continuous-time transfer function.

$X_s G_s =$

$$-3s - 1$$

$$21s^2 + 14s + 11$$

Continuous-time transfer function.

Problem 23M (b)

$X_1(s)/U_1(s)$ is from input 1 to output

$X_1(s)/U_2(s)$ is from input 2 to output

transfer_fun =

From input 1 to output:

$$4s + 16$$

$$s^2 + 9s + 17$$

From input 2 to output:

$$15$$

$$s^2 + 9s + 17$$

Continuous-time transfer function.

Problem 25M (b)

sys2 =

A =

$$\begin{array}{cc} & x_1 & x_2 \\ x_1 & -4 & -1.5 \\ x_2 & 2 & 0 \end{array}$$

B =

$$\begin{array}{c} u_1 \\ x_1 & 2 \\ x_2 & 0 \end{array}$$

C =

$$\begin{array}{cc} & x_1 & x_2 \\ y_1 & 0.5 & 0.5 \end{array}$$

D =

$$\begin{array}{c} u_1 \\ y_1 & 0 \end{array}$$

Continuous-time state-space model.

The model is:

$$z_1' = -4z_1 - 1.5z_2 + 2f$$

$$z_2' = 2z_1$$

$$y = 0.5z_1 + 0.5z_2$$

Problem 35M

Results Plotted in Figure 1

Problem 41S

Results Plotted in Figure 2

Problem 45S

A_45s =

-5 3

0 -4

B_45s =

2

0

C_45s =

1 3

0 1

D_45s =

2

0

Results Plotted in Figure 3

Problem 46S

A_45s =

-5 3

0 -4

B_45s =

0

0

C_45s =

1 3

0 1

D_45s =

0

0

Results Plotted in Figure 4

Problem 28M

Part A

sys =

A =

	x1	x2	x3	x4
x1	0	1	0	0
x2	-4444	-2.722	4444	2.722
x3	0	0	0	1
x4	666.7	0.4083	-733.3	-0.4083

B =

	u1
x1	0
x2	0
x3	0
x4	66.67

C =

	x1	x2	x3	x4
y1	1	0	0	0
y2	0	0	1	0

D =

u1

y1 0

y2 0

Continuous-time state-space model.

Part B

Results Plotted in Figure 5

Part C

Characteristic Polynomial:

$$1.00s^4 + 3.13s^3 + 5177.78s^2 + 181.48s^1 + 296296.30 = 0$$

roots =

-1.565246984696029 +71.536397419391108i

-1.565246984696029 -71.536397419391108i

-0.000030793081745 + 7.607327461964152i

-0.000030793081745 - 7.607327461964152i

Part D

X1_s_Y_s =

$$181.5 s + 2.963e05$$

$$s^4 + 3.131 s^3 + 5178 s^2 + 181.5 s + 2.963e05$$

Continuous-time transfer function.

X2_s_Y_s =

$$66.67 s^2 + 181.5 s + 2.963e05$$

$$s^4 + 3.131 s^3 + 5178 s^2 + 181.5 s + 2.963e05$$

Continuous-time transfer function.

Matlab Figures

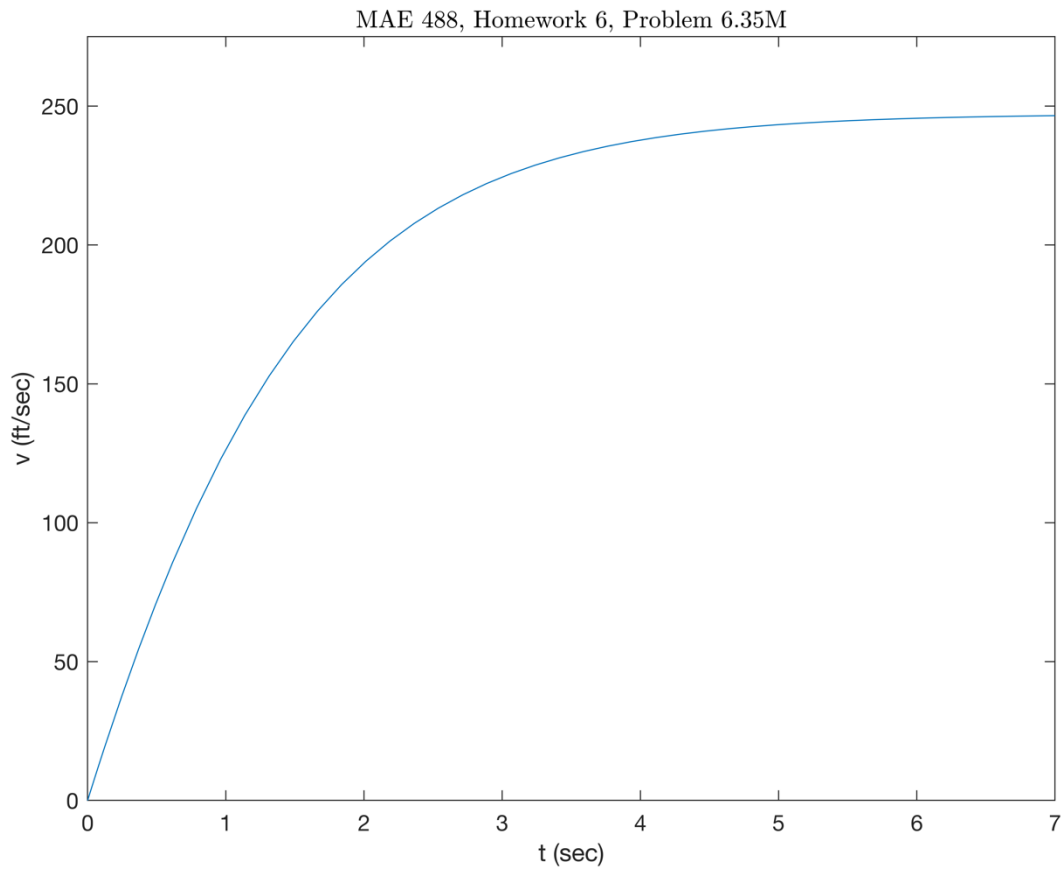


Figure 1: Problem 5.35M

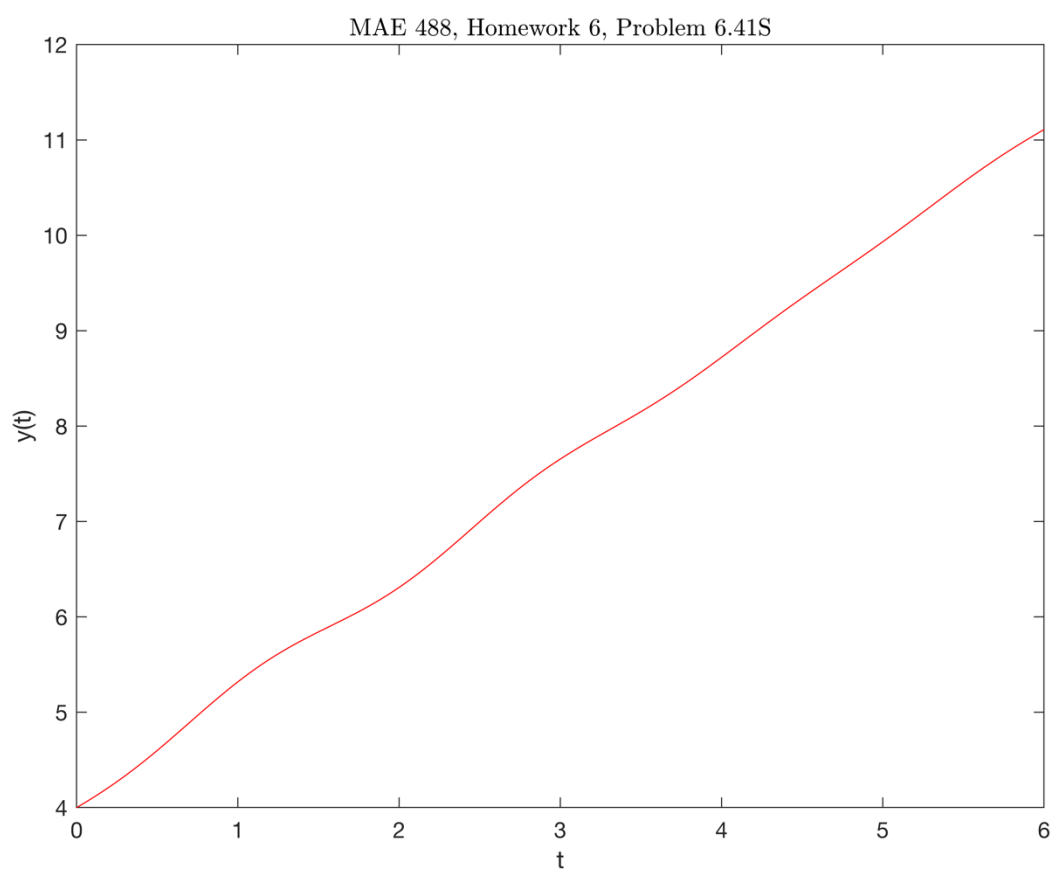


Figure 2: Problem 5.41S

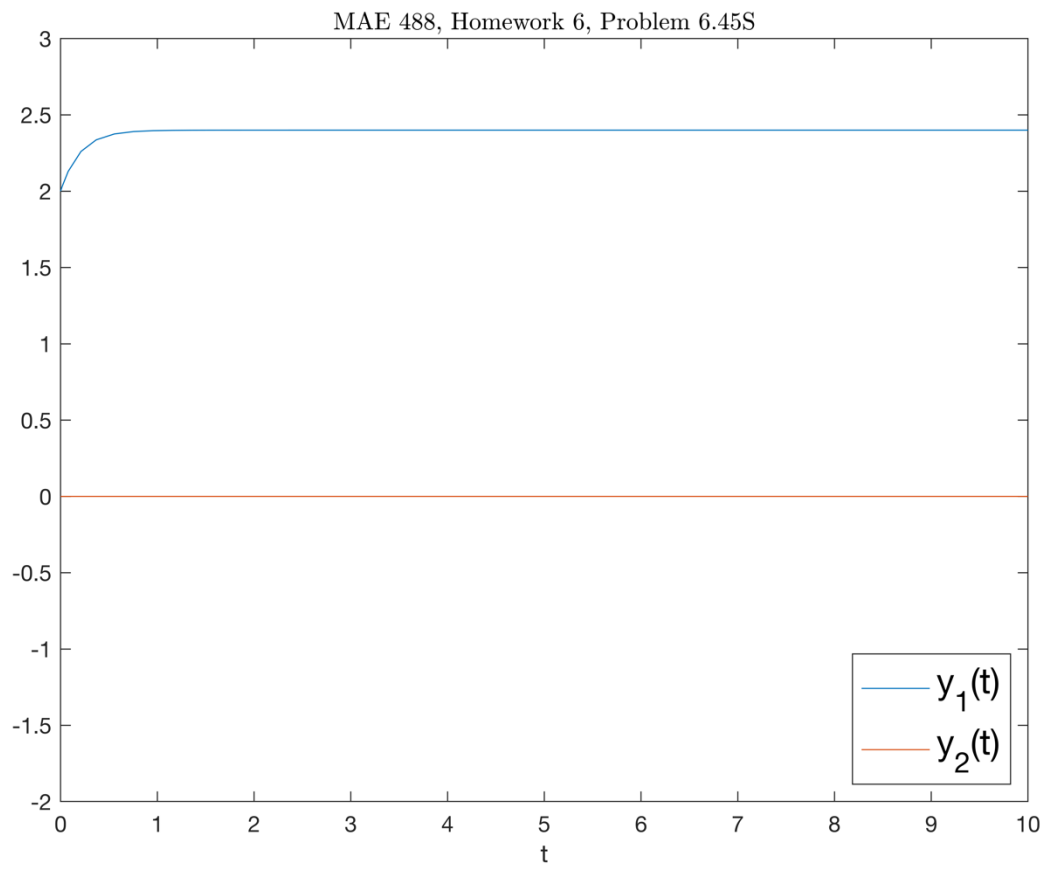


Figure 3: Problem 5.45S

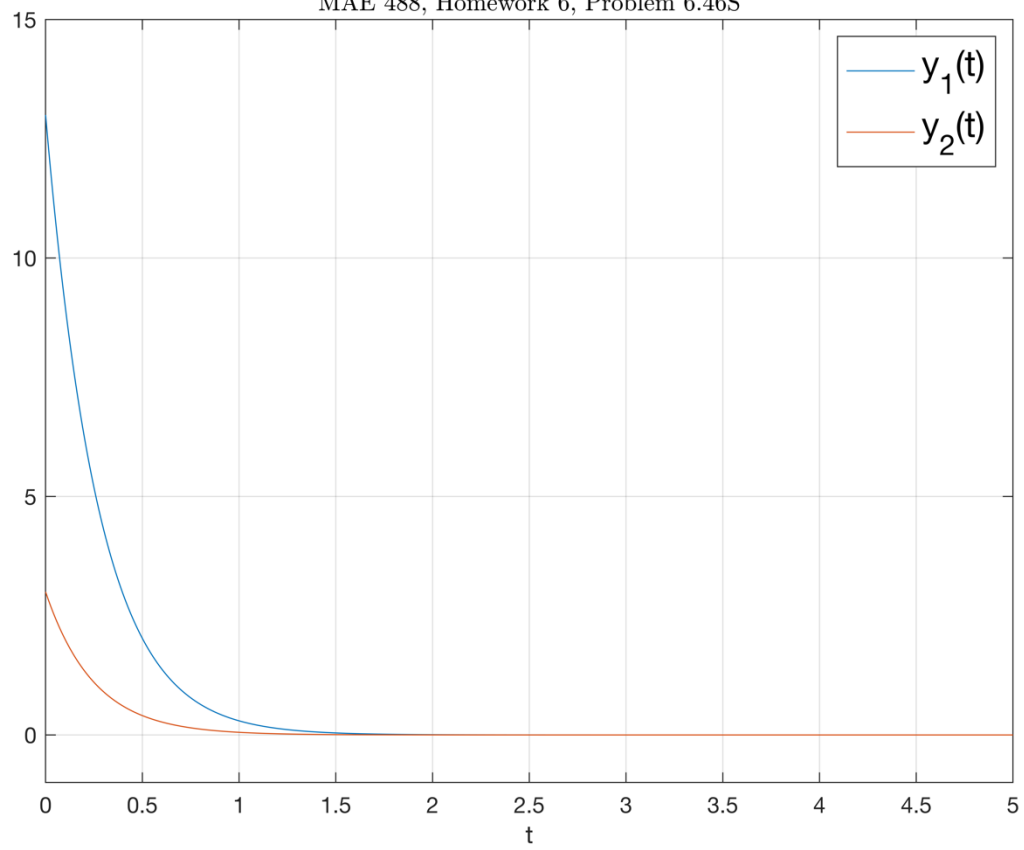


Figure 4: Problem 5.46S

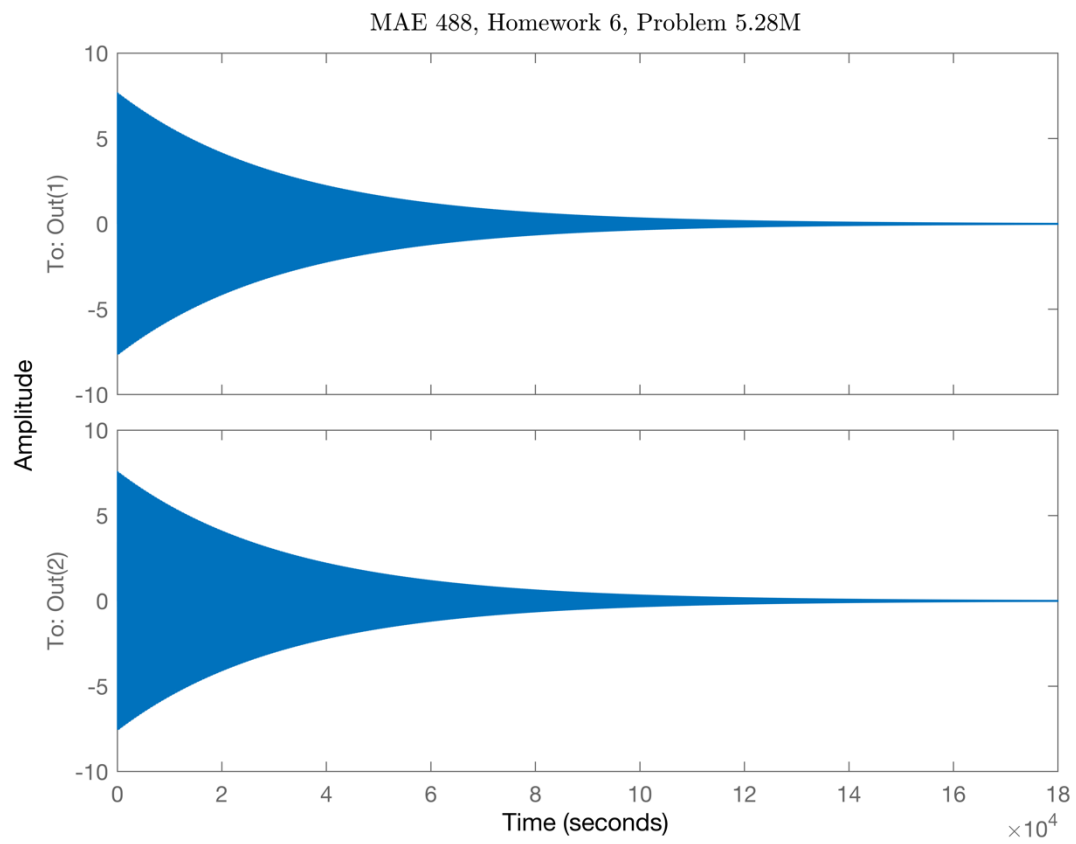
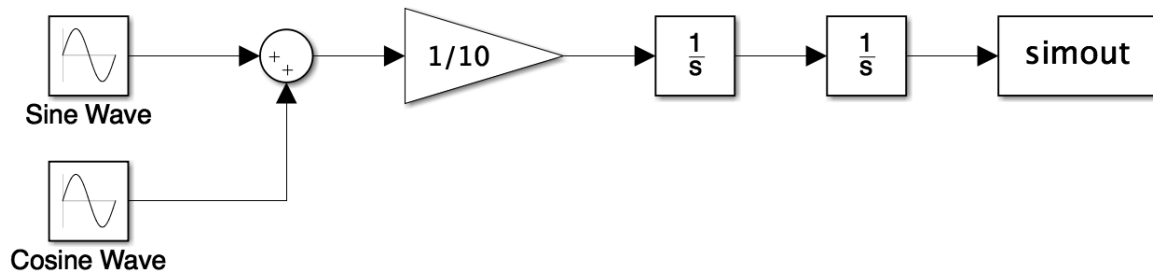
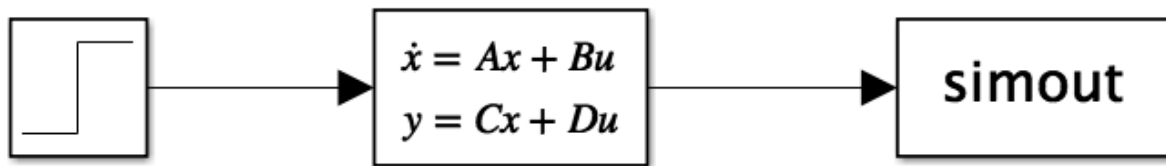


Figure 5: Problem 5.28M

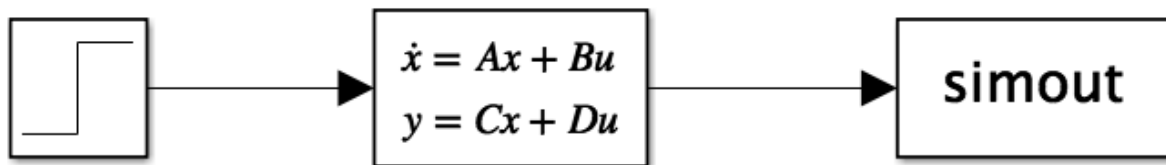
Simulink Models



Problem 41.S



Problem 45.S



Problem 46.S