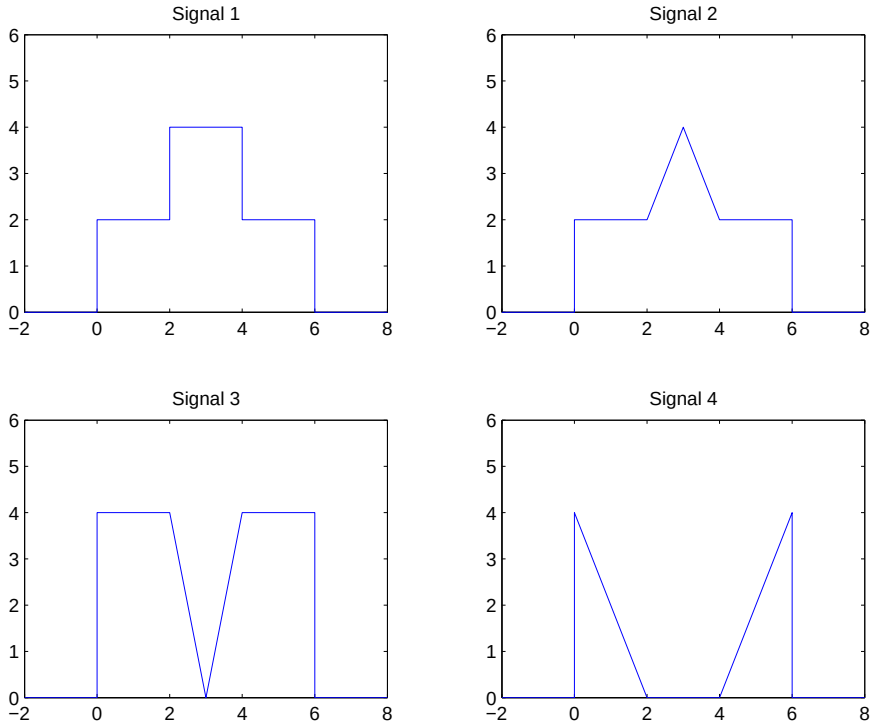
# EE 341 - Homework 1

## Due August 31, 2005

1. Problem 1.1. Instead of the figures in the text, use the followin figures:



2. Problem 1.3 (d) (e) (f) (j).

3. Problem 1.4 (b) (c). Do part (e) for signals (b) and (c).

4. Problem 1.7. Do parts (a) and (b) for signals (b) and (d).

5. Determine if the following signals are periodic. If they are, determine their fundamental period and fundamental frequency.

   (a) $x(t) = \cos(\frac{4}{5}t)$

   (b) $x(t) = \cos(\frac{4}{5}t) - 2\sin(\frac{3}{4}\pi t)$

   (c) $x(t) = \cos\left(t + \frac{\pi}{4}\right) + \sin\left(2\,t + \frac{1}{4}\right)$

   (d) $x(t) = \cos^2\left(\frac{\pi}{8}\,t\right)$

   (e) $x[n] = \cos(\frac{4}{5}n)$

   (f) $x[n] = \cos(\frac{4}{5}\pi n) - 2\sin(\frac{3}{4}\pi n)$

   (g) $x[n] = \cos\left(\frac{\pi}{3}\,n\right) + \cos\left(\frac{\pi}{4}\,n\right)$

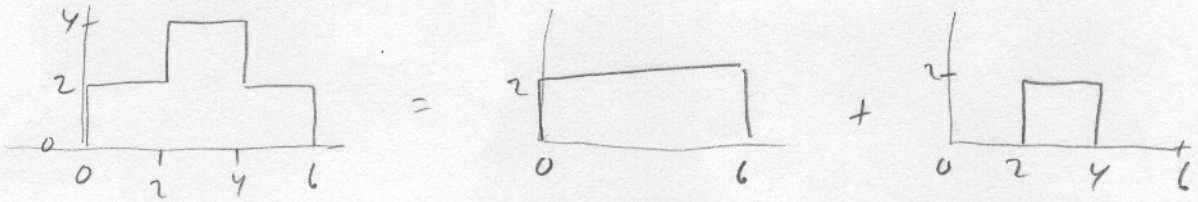
6. Problem 1.10 (c) (e) (g) (i).

7. Problem 1.16.

8. Problem 1.22 (a) (c).

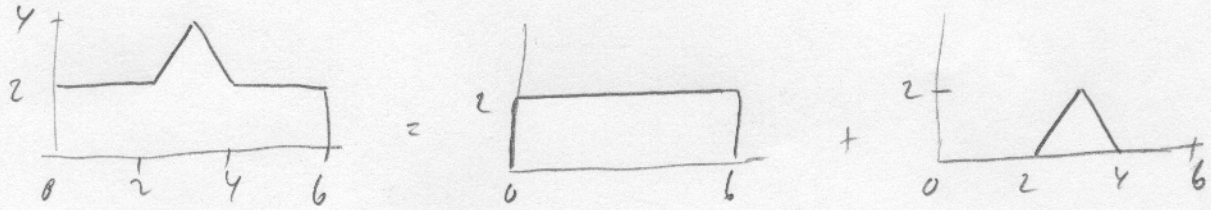
# EE 341 - HW #1

1. (a)



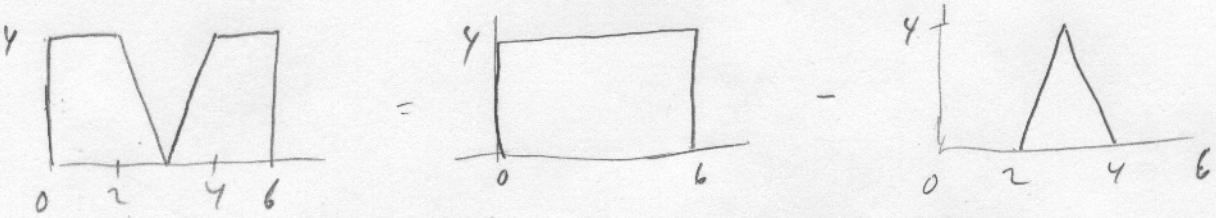

$x(t) = 2P_6(t-3) + 2P_2(t-3)$

(b)



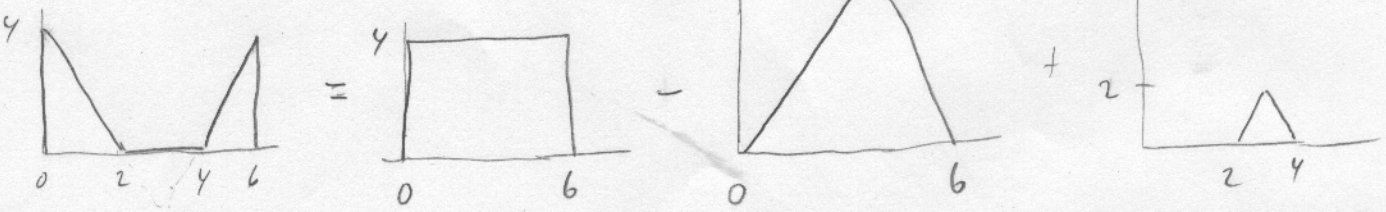

$x(t) = 2P_6(t-3) + 2(1-2|t-3|/2)P_2(t-3)$

(c)




$x(t) = 4P_6(t-3) - 4(1-2|t-3|/2)P_2(t-3)$

(d)




$x(t) = 4P_6(t-3) - 6(1-2|t-3|/6)P_6(t-3) + 2(1-2|t-3|/2)P_2(t-3)$

(b) See MATLAB

2. Problem 1.3 (d), (e), (f), (i)

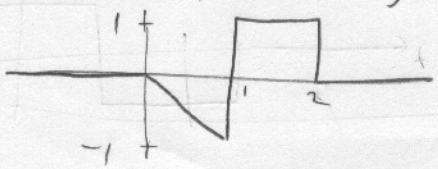
(d) See MATLAB

3. Problem 1.4

(b) $x(t) = (t+1)u(t-1) - tu(t) - u(t-2)$

$= tu(t-1) + u(t-1) - tu(t) - u(t-2)$

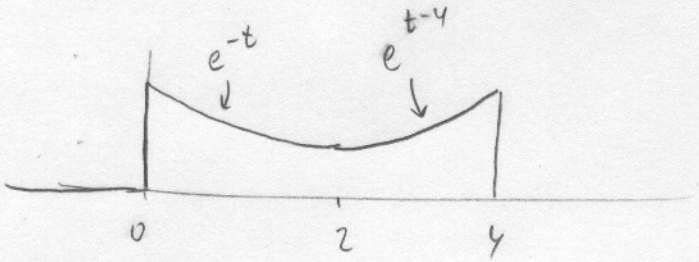
$= -t[u(t) - u(t-1)) + [u(t-1) - u(t-2)]$



(c) $x(t) = e^{-t}u(t) + e^{-t}\left[e^{2t-4} - 1\right]u(t-2) + e^{t-4}u(t-4)$

$= e^{-t}u(t) - e^{-t}u(t-2) + e^{t-4}u(t-2) - e^{t-4}u(t-4)$

$= e^{-t}[u(t) - u(t-2)] + e^{t-4}[u(t-2) - u(t-4)]$




(e) See MATLAB

4 Problem 1.7 (a) (b) for signals (b) (d)

Signal (b)

(a) 1 from 0 to 1: $u(t) - u(t-1)$

$2-t$ from 1 to 3: $(2-t)[u(t-1) - u(t-3)]$

$-1$ from 3 to 5: $-[u(t-3) - u(t-5)]$

$x(t) = u(t) - u(t-1) + (2-t)[u(t-1) - u(t-3)] - [u(t-3) - u(t-5)]$

(b) See MATLAB

Signal (d)

(a) From $-1$ to 0: $e^{t}[u(t+1) - u(t)]$

From 0 to 2: $e^{-t}[u(t) - u(t-2)]$

$x(t) = e^{t}[u(t+1) - u(t)] - e^{-t}[u(t) - u(t-2)]$

(b) See MATLAB

5. (a) $x(t) = \cos\left(\frac{4}{5}t\right)$ $\omega = \frac{4}{5}$ $T = \frac{2\pi}{\omega} = \frac{2\pi}{4/5} = \frac{5}{2}\pi$ sec

$T = \frac{5}{2}\pi$ sec $f = \frac{1}{T} = \frac{2}{5\pi}$ Hz

(b) $x(t) = \cos\left(\frac{4}{5}t\right) - 2\sin\left(\frac{3}{4}\pi t\right)$ $\omega_1 = \frac{4}{5}$ $T_1 = \frac{5}{2}\pi$

$\omega_2 = \frac{3}{4}\pi$ $T_2 = \frac{2\pi}{\frac{3}{4}\pi} = \frac{8}{3}$ $\frac{T_1}{T_2} = \frac{5/2\,\pi}{8/3} = \frac{15\pi}{16}$

$\frac{T_1}{T_2}$ not rational ; $x(t)$ not periodic

(c) $x(t) = \cos\left(t + \frac{\pi}{4}\right) + \sin\left(2t + \frac{1}{4}\right)$

$\omega_1 = 1$ $T_1 = 2\pi$ $\omega_2 = 2$ $T_2 = \frac{2\pi}{2} = \pi$

$\frac{T_1}{T_2} = \frac{1}{2} = \frac{r}{q}$ $T = qT_1 = rT_2 = 2$ sec $f = \frac{1}{T} = \frac{1}{2}$ Hz

(d) $x(t) = \cos^2\left(\frac{\pi}{8}t\right) = \frac{1}{2}\left[1 + \cos\left(\frac{\pi}{4}t\right)\right]$

$\omega = \frac{\pi}{4}$ $T = \frac{2\pi}{\omega} = \frac{2\pi}{\pi/4} = 8$ sec $f = \frac{1}{T} = \frac{1}{8}$ Hz

(e) $x[n] = \cos\left(\frac{4}{5}n\right)$ $\Omega = \frac{4}{5}$ $N = \frac{2\pi k}{\Omega} = \frac{2\pi k}{4/5} = \frac{5\pi k}{2}$

$N$ cannot be an integer $x(n)$ not periodic

(f) $x(n) = \cos\left(\frac{4}{5}\pi n\right) - 2\sin\left(\frac{3}{4}\pi n\right)$

$\Omega_1 = \frac{4}{5}\pi$ $N_1 = \frac{2\pi k}{\Omega_1} = \frac{5k}{2} = 5$

$\Omega_2 = \frac{3}{4}\pi$ $N_2 = \frac{2\pi k}{\Omega_2} = \frac{8k}{3} = 8$

$\frac{N_1}{N_2} = \frac{5}{8} = \frac{r}{q}$ $N = qN_1 = rN_2 = 5 \cdot 8 = 40$ $F = \frac{1}{N} = \frac{1}{40}$ cycles/sample

(g) $x(n) = \cos\left(\frac{\pi}{3}n\right) + \cos\left(\frac{\pi}{4}n\right)$

$\Omega_1 = \frac{\pi}{3}$ $N_1 = \frac{2\pi k}{\Omega_1} = 6k = 6$

$\Omega_2 = \frac{\pi}{4}$ $N_2 = \frac{2\pi k}{\Omega_2} = 8\pi k = 8$

$\frac{N_1}{N_2} = \frac{6}{8} = \frac{3}{4} = \frac{r}{q}$

$N = qN_1 = rN_2 = 4 \cdot 6 = 24$

$F = \frac{1}{N} = \frac{1}{24}$ cycles/sample

6. Problem 1.10 (c) (e) (g) (i)

See MATLAB

7. Problem 1.16

$$y(t) = e^{-(1/RC)(t-t_0)} y(t_0^-) + \int_{t_0^-}^{t} \frac{1}{C} e^{-(1/RC)(t-\lambda)} x(\lambda)\, d\lambda$$

(a) $x(t) = u(t)$ $\quad t_0 = 0$ $\quad y(t_0^-) = y(0^-) = 0$

$$y(t) = \int_{0^-}^{t} \frac{1}{C} e^{-(1/RC)(t-\lambda)} u(\lambda)\, d\lambda \quad \text{for } t \geq 0$$

$$= \frac{1}{C} e^{-(\frac{1}{RC})t} \int_{0^-}^{t} e^{(\frac{1}{RC})\lambda}\, d\lambda$$

$$= \frac{1}{C} e^{-(\frac{1}{RC})t} \left[ RC\, e^{(\frac{1}{RC})\lambda} \Big|_{0^-}^{t} \right]$$

$$= R e^{-(\frac{1}{RC})t} \left[ e^{(\frac{1}{RC})t} - 1 \right]$$

$$= R \left[ 1 - e^{-(\frac{1}{RC})t} \right]$$

$$y(t) = R \left[ 1 - e^{-(\frac{1}{RC})t} \right] \qquad R = 10^3 \left[ 1 - e^{-\left(\frac{1}{10^3 \cdot 10^{-4}}\right)t} \right]$$

$$= 1000 \left( 1 - e^{-10t} \right) \qquad t \geq 0$$

(b) $x(t) = \delta(t)$ $\quad t_0 = 0$ $\quad y(t_0^-) = 0$

$$y(t) = \int_{0^-}^{t} \frac{1}{C} e^{-\frac{1}{RC}(t-\lambda)} \delta(\lambda)\, d\lambda \qquad t \geq 0$$

$$= \frac{1}{C} e^{-(\frac{1}{RC})t} \int_{0^-}^{t} e^{(\frac{1}{RC})\lambda} \delta(\lambda)\, d\lambda$$

$$= \frac{1}{C} e^{-(\frac{1}{RC})t}$$

$$= 10^4 e^{-10t} \qquad t \geq 0$$

(c) $x(t) = u(t)$ $\quad y(0^-) = -1$

$$y(t) = e^{-(1/RC)t}\, y(0^-) + \underbrace{\int_{0^-}^{t} \frac{1}{C} e^{-(\frac{1}{RC})(t-\lambda)}\, u(\lambda)\, d\lambda}_{R\left[1 - e^{-(\frac{1}{RC})t}\right] \text{ from (a)}}$$

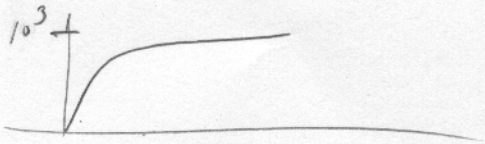
$y(0^-) = -1$

$$= -e^{-(\frac{1}{RC})t} + R\left[1 - e^{-(\frac{1}{RC})t}\right]$$

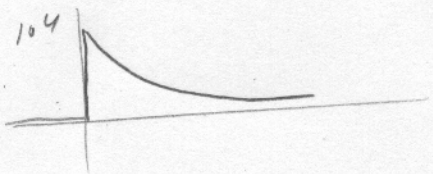
$$= -e^{-10t} + 1000\left[1 - e^{-10t}\right]$$

$$= 1000 - 1001\, e^{-10t} \qquad t \geq 0$$

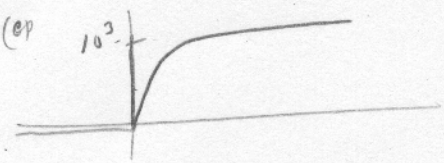
(a)




(b)




(c)




8. Problem 1.22 (a) (c)

See MATLAB

```
% EE 341 Fall 2005
% Homework #1

% Problem 1
%
% Two different ways
% (1) Give a list of points and values, and plot
% (2) Define functions pulse(tau,t) and tri(tau,t) and

% To do (2), have a file called pulse.m with the following:
%
% function x = pulse(tau,t)
% x = ((t + tau/2) > 0) - ((t - tau/2) > 0);
% return
%
% and have a file called tri.m with the following:
%
% function x = tri(tau,t)
% x = (1-2*abs(t)/tau).*pulse(tau,t);
%

%     plot functions from equations from part (a)
figure(1)
clf

% Signal 1
subplot(221)
t  = [-2 0 0 2 2 4 4 6 6 8];
x1 = [ 0 0 1 1 2 2 1 1 0 0];
plot(t,x1);

% or

t = -2:0.01:8;
x1 = 2*pulse(6,t-3) + 2*pulse(2,t-3);
plot(t,x1)

axis([-2 8 0 6]);
title('Signal 1');

% Signal 2
subplot(222)
t  = [-2 0 0 2 3 4 6 6 8];
x2 = [ 0 0 2 2 3 2 2 0 0];
plot(t,x2);

% or

t = -2:0.01:8;
x2 = 2*pulse(6,t-3) + 2*tri(2,t-3);
plot(t,x2)

axis([-2 8 0 6]);
title('Signal 2');

% Signal 3
subplot(223)
t  = [-2 0 0 2 3 4 6 6 8];
x3 = [ 0 0 4 4 0 4 4 0 0];
plot(t,x3);

% or

t = -2:0.01:8;
x3 = 4*pulse(6,t-3) - 4*tri(2,t-3);
plot(t,x3)

axis([-2 8 0 6]);
title('Signal 3');
```



```
% Signal 4
subplot(224)
t  = [-2 0 0 2 4 6 6 0];
x3 = [ 0 0 4 0 0 4 0 0];
plot(t,x3);

% or

t = -2:0.01:8;
x3 = 4*pulse(6,t-3) - 6*tri(6,t-3) + 2*tri(2,t-3);
plot(t,x3)

axis([-2 8 0 6]);
title('Signal 4');

print -dpsc2 hw01_p1.ps

% Problem 2  --- 1.3 (d) (e) (f) (j)
figure(2)
clf
t = -1:0.01:5;

% (d)
%x(t) = exp(-t)*(u(t) - u(t-2))
subplot(221)
xd = exp(-t).*((t >= 0) - (t >= 2));
plot(t,xd)
axis([-1 5 0 1.5])
xlabel('t (seconds)');
ylabel('x_d(t)')

% (e)
subplot(222)
xe = sin(2*t) + 2*cos(3*t-0.2);
plot(t,xe)
axis([-1 5 -2 4])
xlabel('t (seconds)');
ylabel('x_e(t)')

% (f)
subplot(223)
% Write an m-file called pulse.m as described above
xf = pulse(2,t);
plot(t,xf)
axis([-1 5 0 1.5])
xlabel('t (seconds)');
ylabel('x_f(t)')

% (j)
subplot(224)
xj = exp(-2*t).*sin(3*t).*(t >= 0);
plot(t,xj)
axis([-1 5 -1 1])
xlabel('t (seconds)');
ylabel('x_j(t)')

print -dpsc2 hw01_p2.ps

% Problem 3 --- 1.4 (b) (c)
figure(3)
clf

% (b)
subplot(211)
t = -2:0.001:4;
xb = (t+1).*(t >= 1) - t.*(t >= 0) - (t >= 2);
plot(t,xb)
axis([-2 4 -2 2])
```

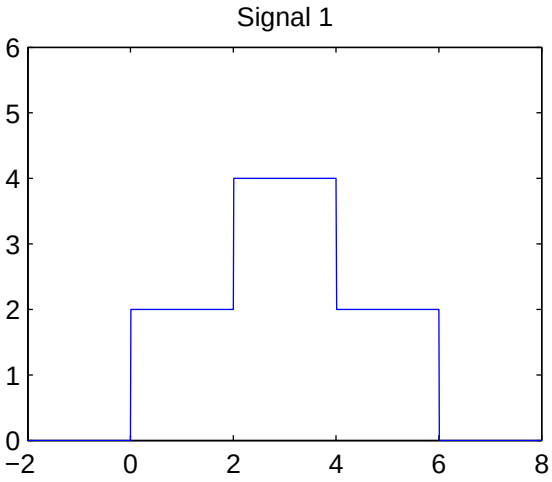
```
xlabel('t (seconds)');
ylabel('x_b(t)')
title('Problem 1.4 (b) (c)')

% (c)
subplot(212)
t = -2:0.001:6;
xc = exp(-t).*(t >= 0) + exp(-t).*(exp(2*t-4)-1).*(t >= 2) - exp(t-4).*(t >= 4);
plot(t,xc)
axis([-2 6 -2 2])
xlabel('t (seconds)');
ylabel('x_c(t)')
title('Problem 1.4 (b) (c)')

print -dpsc2 hw01_p3.ps

% Problem 6: 1.10 (c) (e) (g) (i)
figure(4)
clf
n = -5:15;

% (c)
subplot(221)
xc = ((0.8).^n) .* (n >= 0);
stem(n,xc)
xlabel('n')
ylabel('x_c(n)')

% (e)
subplot(222)
xe = sin(pi*n/4);
stem(n,xe)
xlabel('n')
ylabel('x_e(n)')

% (g)
subplot(223)
xg = ((0.9).^n) .* (sin(pi*n/4) + cos(pi*n/4));
stem(n,xg)
xlabel('n')
ylabel('x_g(n)')

% (i)
subplot(224)
xi = 1*((n >= -4) - (n >= 5));
stem(n,xi)
xlabel('n')
ylabel('x_i(n)')

print -dpsc2 hw01_p6.ps

% Problem 8 -- 1.22 (a) (c)
figure(5)

% (a)
subplot(211)
ynm1 = 0;
ya = [];
ya(1) = 0.5*ynm1 + 0;   % This is actuall ya(0), but MATLAB does
                        % not allow subscripts of 0
N = 10;
for n=1:N
  ya(n+1) = 0.5*ya(n) + 1;
end
n = 0:N;
stem(n,ya)
xlabel('n')
ylabel('y_a[n]')
axis([0 10 0 3])
```

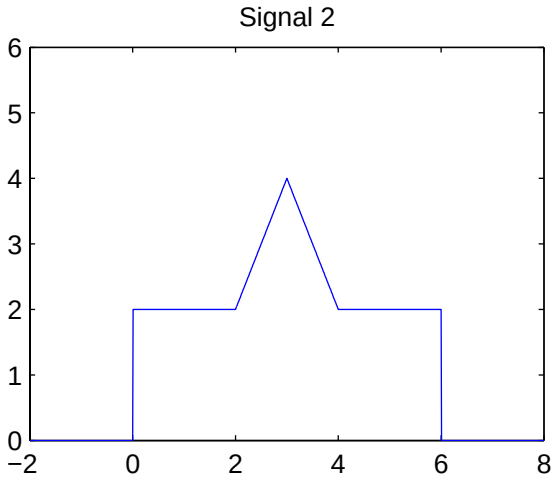


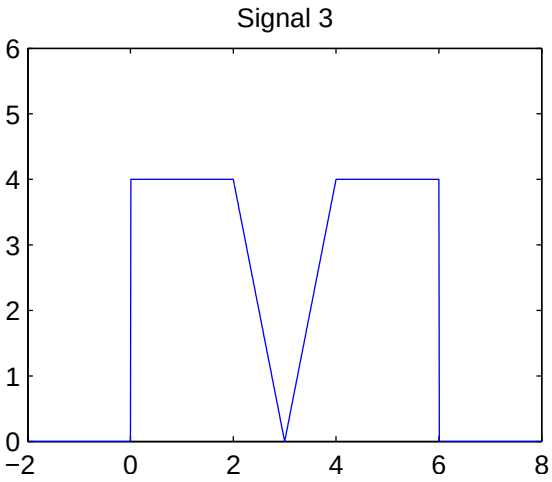
```
title('Problem 1.22 (a) (c)')

% (c)
subplot(212)
ynm1 = 0;
ynm2 = 1;
yc = [];
yc(1) = 0.5*ynm1 + 0.1*ynm2 + 0;   % This is actuall ya(0), but MATLAB does
                                   % not allow subscripts of 0
yc(2) = 0.5*yc(1) + 0.1*ynm1 + 1;  % This is actuall ya(1)
for n=2:N
  yc(n+1) = 0.5*yc(n)+0.1*yc(n-1)+1;
end
n = 0:N;
stem(n,yc)
xlabel('n')
ylabel('y_c[n]')
axis([0 10 0 3])

print -dpsc2 hw01_p8.ps
```

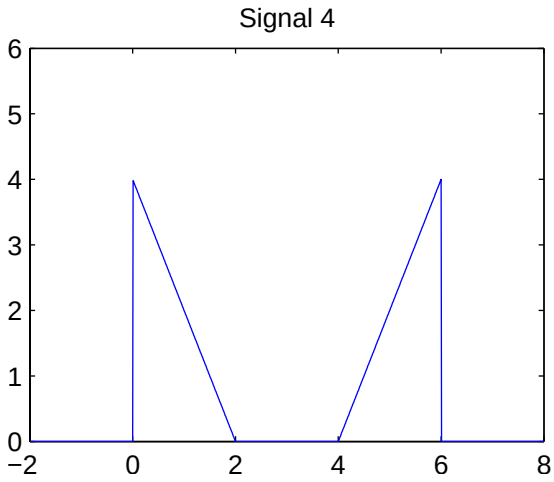
```
function x = pulse(tau,t)

x = ((t + tau/2) > 0) - ((t - tau/2) > 0);
return
```

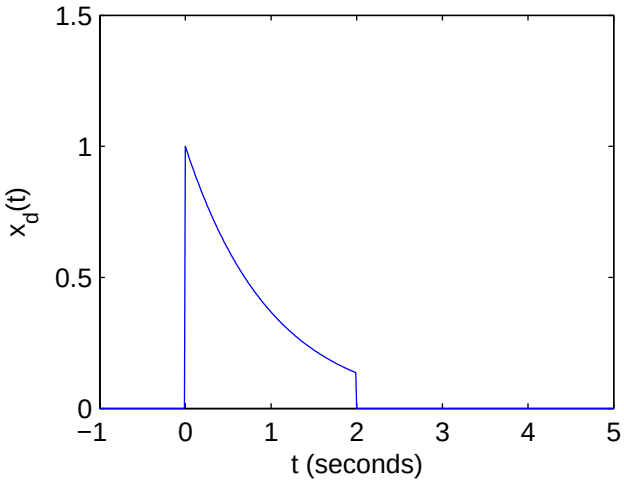
```
function x = tri(tau,t)
x = (1-2*abs(t)/tau).*pulse(tau,t);
return
```

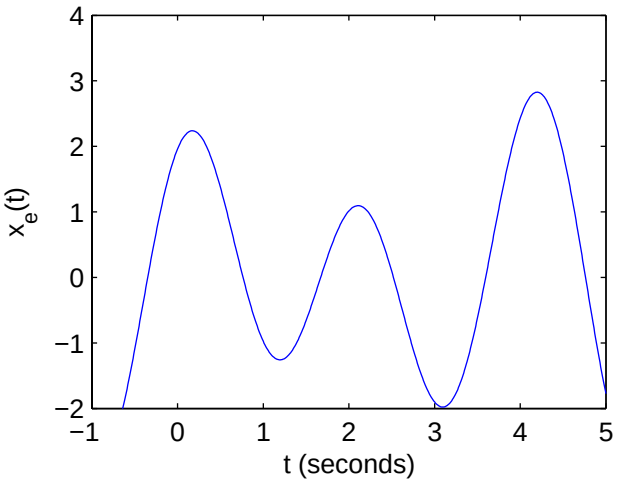

Signal 1
6
5
4
3
2
1
0
−2
0
2
4
6
8

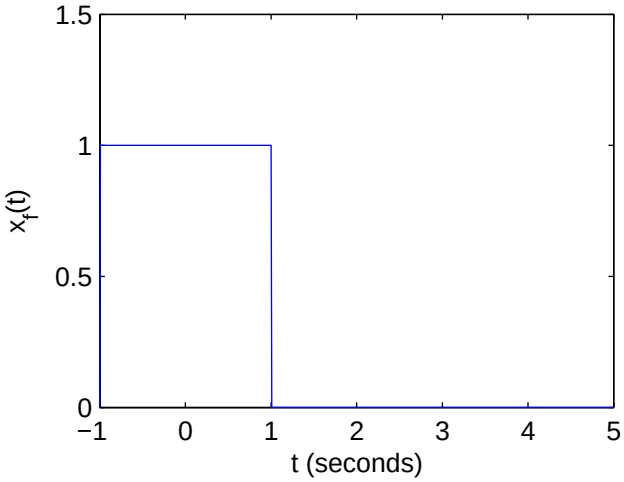

Signal 2
6
5
4
3
2
1
0
−2
0
2
4
6
8

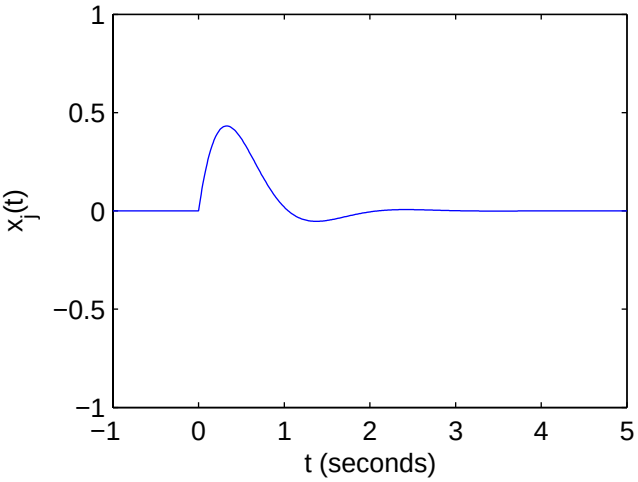

Signal 3
6
5
4
3
2
1
0
−2
0
2
4
6
8

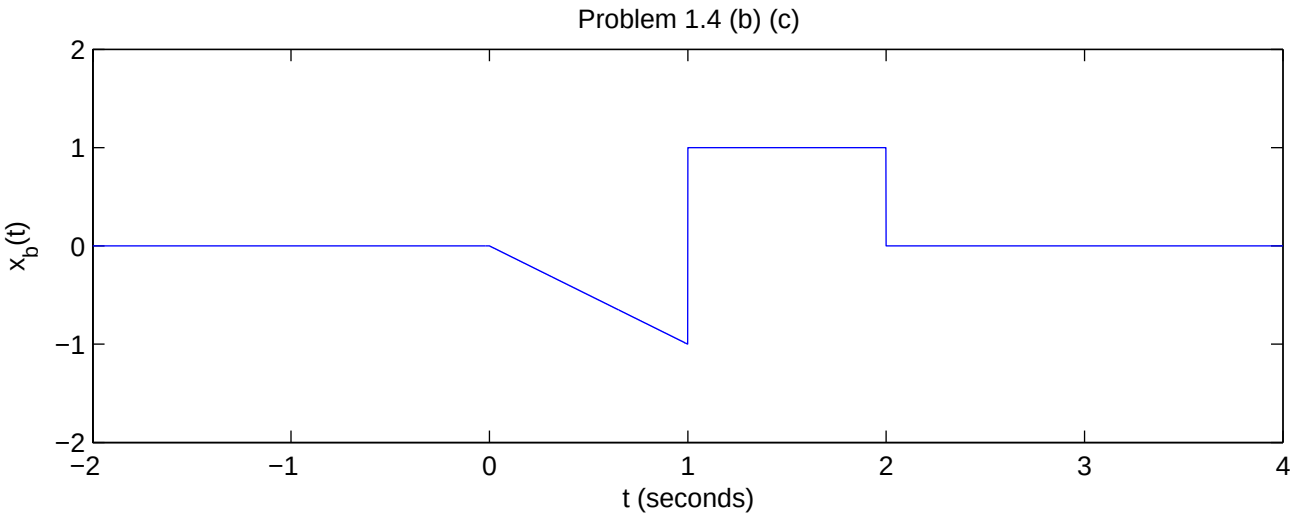

Signal 4
6
5
4
3
2
1
0
−2
0
2
4
6
8

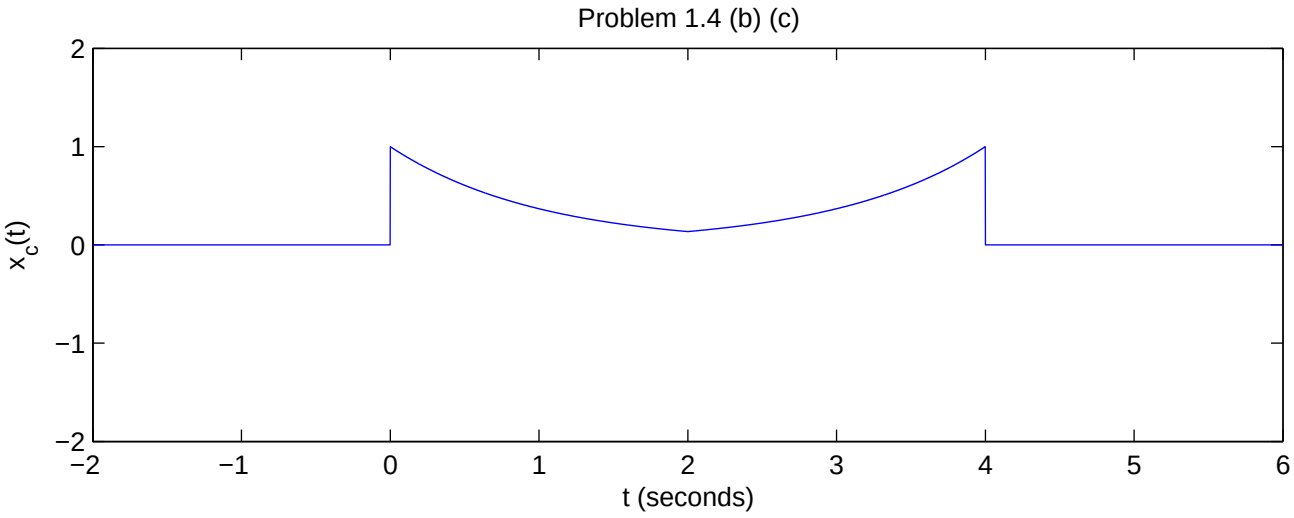

1.5
1
0.5
0
−1
0
1
2
3
4
5
t (seconds)
$x_d(t)$

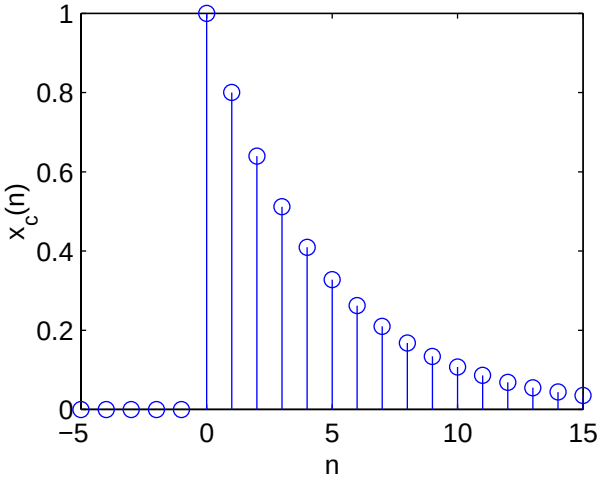

4
3
2
1
0
−1
−2
−1
0
1
2
3
4
5
t (seconds)
$x_e(t)$

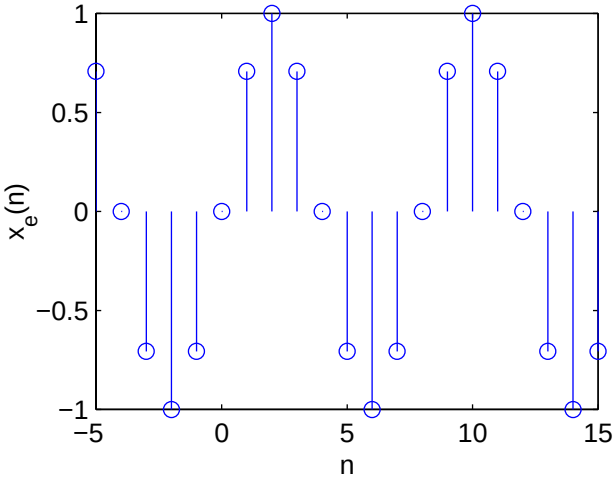

1.5
1
0.5
0
−1
0
1
2
3
4
5
t (seconds)
$x_f(t)$

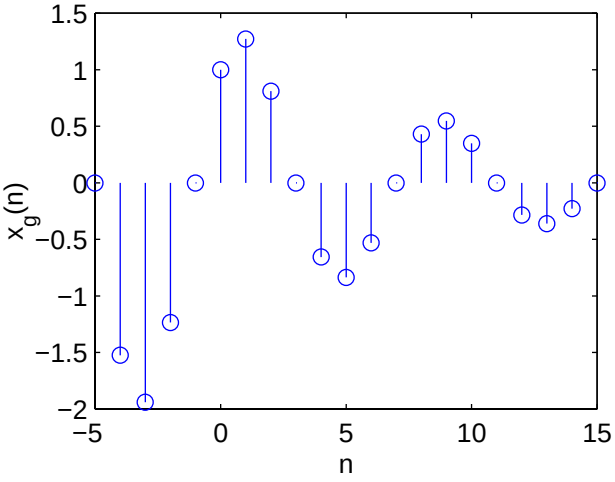

1
0.5
0
−0.5
−1
−1
0
1
2
3
4
5
t (seconds)
$x_j(t)$

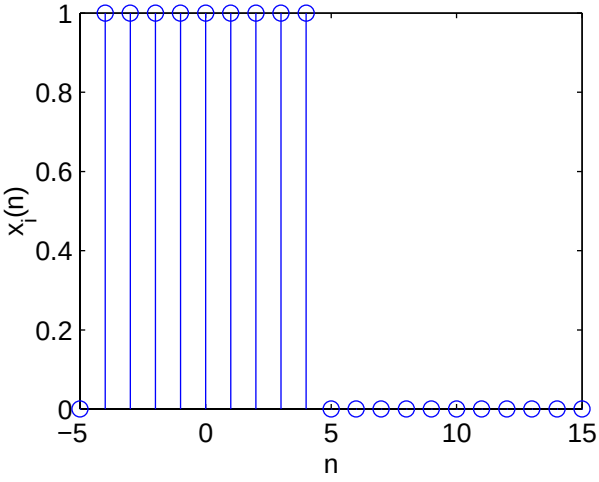

Problem 1.4 (b) (c)
2
1
0
−1
−2
$x_b(t)$
−2
−1
0
1
2
3
4
t (seconds)

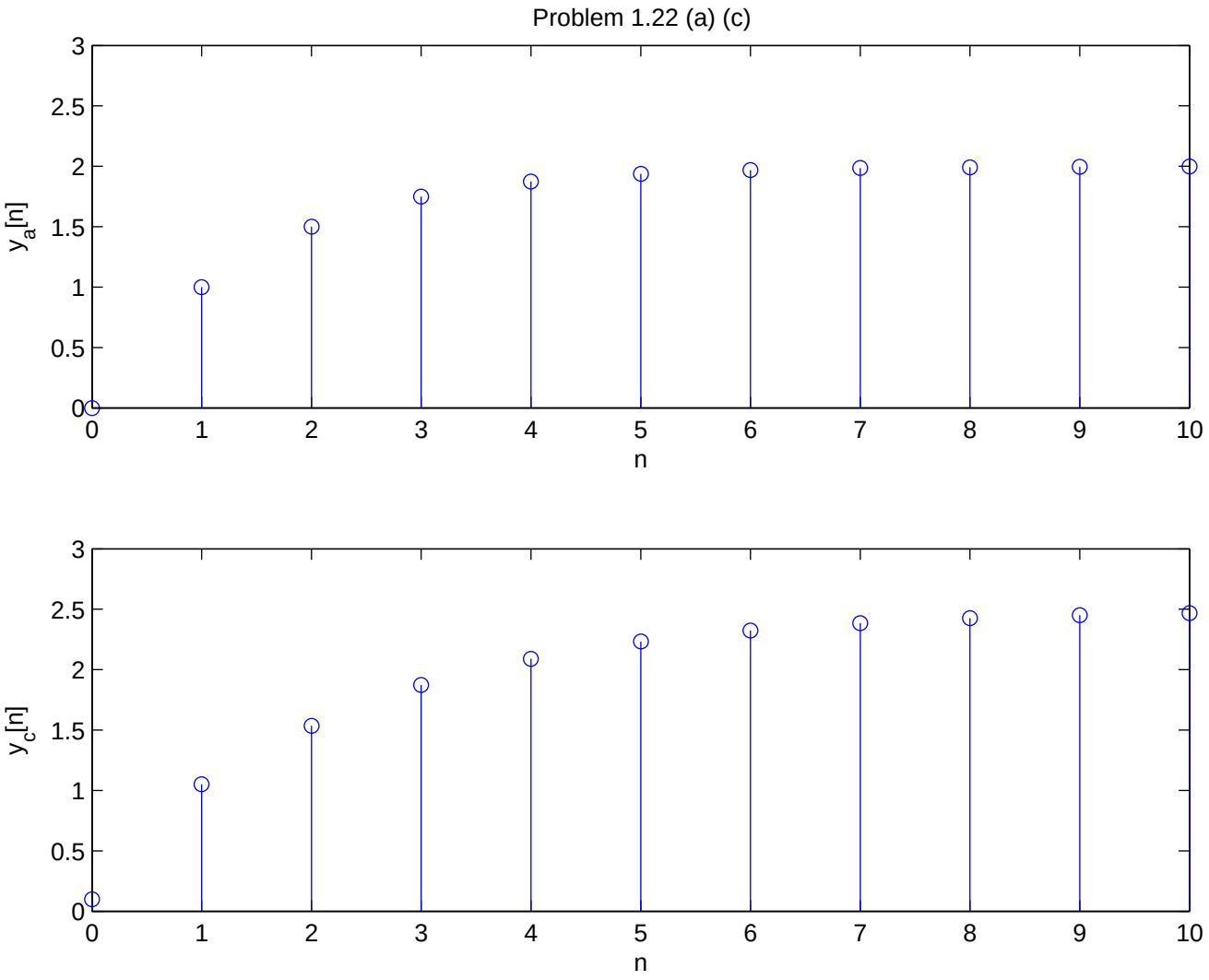

Problem 1.4 (b) (c)
2
1
0
−1
−2
$x_c(t)$
−2
−1
0
1
2
3
4
5
6
t (seconds)


1
0.8
0.6
0.4
0.2
0
−5
0
5
10
15
n
$x_c(n)$


1
0.5
0
−0.5
−1
−5
0
5
10
15
n
$x_e(n)$


1.5
1
0.5
0
−0.5
−1
−1.5
−2
−5
0
5
10
15
n
$x_g(n)$


1
0.8
0.6
0.4
0.2
0
−5
0
5
10
15
n
$x_l(n)$


Problem 1.22 (a) (c)
$y_a[n]$
$y_c[n]$
n
n
0
0.5
1
1.5
2
2.5
3
0
1
2
3
4
5
6
7
8
9
10