CECS 463 System On Chip II
FALL 2020

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Assignment #07 – Chapter 5 Problems

12/01/2020

```
% Kuldeep Gohil
% CECS 463 Fall20
% Assignment #07 Due: 12/01/2020

clc; close all;
```

5.1.1

```
% Done using method shown on bottom of page 144

disp('Problem 5.1.1: ')
xn = [4, 1, -1, 1];
N = 4;
Xk = dfs(xn, N)
```

```
Problem 5.1.1:

Xk = 5.0000 + 0.0000i   5.0000 + 0.0000i   1.0000 - 0.0000i   5.0000 + 0.0000i
```

5.1.2

```
clc; close all;
% Done using method shown on bottom of page 144

disp('Problem 5.1.2: ')
xn = [0, 0, 2j, 0, 2j, 0];
N = 6;
Xk = dfs(xn, N)
```

```
Problem 5.1.2:

Xk =

  Columns 1 through 4

   0.0000 + 4.0000i   0.0000 - 2.0000i   0.0000 - 2.0000i  -0.0000 + 4.0000i

  Columns 5 through 6

   0.0000 - 2.0000i   0.0000 - 2.0000i
```

5.2.1

```
clc; close all;
% Done using idfs function found on pg.145 and using knowledge from 5.1

disp('Problem 5.2.1: ')
xn = [j, 2*j, 3*j, 4*j];
N = 4;
Xk = idfs(xn, N)
```

```
Problem 5.2.1:

Xk = 0.0000 + 2.5000i   0.5000 - 0.5000i  -0.0000 - 0.5000i  -0.5000 - 0.5000i
```

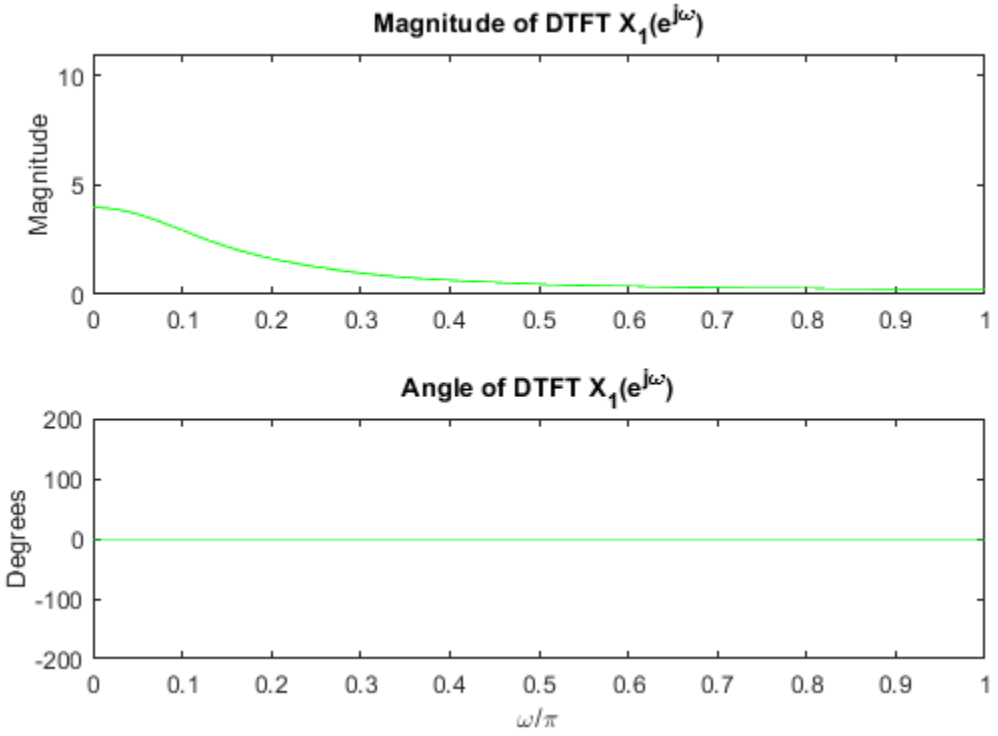
5.2.2

```
clc; close all;
% Done using idfs function found on pg.145 and using knowledge from 5.1

disp('Problem 5.2.2: ')
xn = [0, 0, 2, 0, 0];
N = 5;
Xk = idfs(xn, N)
```

```
Problem 5.2.2:

Xk =

  Columns 1 through 4

   0.4000 + 0.0000i  -0.3236 + 0.2351i   0.1236 - 0.3804i   0.1236 + 0.3804i

  Column 5

  -0.3236 - 0.2351i
```

5.3.1

```
clc; close all;

n = [-10:10];
x = (0.6).^abs(n);
l = length(n);
N = 200; % Length of DFT
x = [x(11:end), zeros(1,N-l), x(1:10)]; % Assemble x
[x1] = fft(x,N);
w = (0:N/2)*2*pi/N;
magnitude = abs(x1(1:N/2+1));
angle = angle(x1(1:N/2+1))*180/pi;
figure = figure('Units','inches','position',[1,1,6,4],...
'color',[1,1,1],'paperunits','inches','paperposition',[0,0,6,4]);
set(figure,'NumberTitle','off','Name','P5.3.1');
subplot(2,1,1);
plot(w/pi,magnitude,'g','linewidth',1);
axis([0,1,0,11]);
title('Magnitude of DTFT X_1(e^{j\omega})');
ylabel('Magnitude');
subplot(2,1,2); plot(w/pi,angle,'g','linewidth',1);
axis([0,1,-200,200]);
title('Angle of DTFT X_1(e^{j\omega})');
ylabel('Degrees');
xlabel('\omega/\pi');
```



5.3.2

```
%{
clc; close all;
n = [-3:3];
x = [1,2,3,4,3,2,1];
l1 = length(n);
N = 100; % Length of DFT
[x2] = fft(x,N);
w = (0:N/2)*2*pi/N;
magnitude = abs(x2(1:N/2+1));
angle1 = angle(x2(1:N/2+1))*180/pi;
figure1 = figure1('Units','inches','position',[1,1,6,4],...
'color',[1,1,1],'paperunits','inches','paperposition',[0,0,6,4]);
set(figure1,'NumberTitle','off','Name','P5.3.2');
subplot(2,1,1);
plot(w/pi,magnitude,'g','linewidth',1);
axis([0,1,0,20]);
title('Magnitude of DTFT X_4(e^{j\omega})');
ylabel('Magnitude');
subplot(2,1,2);
plot(w/pi,angle1,'g','linewidth',1);
axis([0,1,-200,200]);
title('Angle of DTFT X_4(e^{j\omega})');
ylabel('Degrees');
xlabel('\omega/\pi');
%}
```

5.4.1

```
clc; close all;
disp('Problem 5.4.1: ')
N = 10;
x = [10,-2+j*3,3+j*4,2-j*3,4+j*5,12];
x = [x,conj(x(5:-1:2))];
x = real(idft(x,N))
WN = exp(-j*2*pi/N);
k = 0:N-1;
m = 2;
x1 = (WN.^(m*k)).*dft(x,N)

X1 = cirshftt(x,m,N);
X2 = dft(X1,N)
difference = max(abs(X1-X2))
```

```
Problem 5.4.1:

x =

Columns 1 through 7

    3.6000   -2.2397    1.0721   -1.3951    3.7520    1.2000    0.6188

Columns 8 through 10

    1.4132    1.9571    0.0217

x1 =

  Columns 1 through 4

  10.0000 + 0.0000i   2.2351 + 2.8292i  -0.0759 - 4.9994i   0.1453 + 3.6026i

  Columns 5 through 8

  -3.5192 + 5.3493i  12.0000 + 0.0000i  -3.5192 - 5.3493i   0.1453 - 3.6026i

  Columns 9 through 10

  -0.0759 + 4.9994i   2.2351 - 2.8292i



X2 =

  Columns 1 through 4

  10.0000 + 0.0000i   2.2351 + 2.8292i  -0.0759 - 4.9994i   0.1453 + 3.6026i

  Columns 5 through 8
```

```
  -3.5192 + 5.3493i  12.0000 + 0.0000i  -3.5192 - 5.3493i   0.1453 - 3.6026i

  Columns 9 through 10

  -0.0759 + 4.9994i   2.2351 - 2.8292i


difference =

   13.3951
```

5.4.2

```
clc; close all;
disp('Problem 5.4.2: ')

N = 10;
x = [10,-2+j*3,3+j*4,2-j*3,4+j*5,12];
x = [x,conj(x(5:-1:2))];
X = real(idft(x,N))
WN = exp(-j*2*pi/N);
k = 0:N-1;
m = -5;
X2 = (WN.^(m*k)).*dft(X,N)

x2 = cirshftt(X,m,N); X22 = dft(x2,N)
difference = max(abs(X2-X22))
```

```
Problem 5.4.2:

X =

  Columns 1 through 7

    3.6000   -2.2397    1.0721   -1.3951    3.7520    1.2000    0.6188

  Columns 8 through 10

    1.4132    1.9571    0.0217



X2 =

  Columns 1 through 4

  10.0000 + 0.0000i   2.0000 - 3.0000i   3.0000 + 4.0000i  -2.0000 + 3.0000i

  Columns 5 through 8

   4.0000 + 5.0000i -12.0000 + 0.0000i   4.0000 - 5.0000i  -2.0000 - 3.0000i

  Columns 9 through 10

   3.0000 - 4.0000i   2.0000 + 3.0000i



X22 =

  Columns 1 through 4

  10.0000 + 0.0000i   2.0000 - 3.0000i   3.0000 + 4.0000i  -2.0000 + 3.0000i
```

```
  Columns 5 through 8

   4.0000 + 5.0000i -12.0000 - 0.0000i   4.0000 - 5.0000i  -2.0000 - 3.0000i

  Columns 9 through 10

   3.0000 - 4.0000i   2.0000 + 3.0000i


difference =

   3.2150e-14
```

5.5.a

```
clc; close all;
disp('Problem 5.5.a: ')
x = [5,4,3,2,1,0,0,1,2,3,4,5];
m = -5;
N = 12;
y = cirshftf(x,m,N);
y = real(y);
```

```
Problem 5.5.a:

y =

  Columns 1 through 7

   -0.0000   -0.0000    1.0000    2.0000    3.0000    4.0000    5.0000

  Columns 8 through 12

    5.0000    4.0000    3.0000    2.0000    1.0000
```

5.5.b

```
clc; close all;
disp('Problem 5.5.b: ')
x = [5,4,3,2,1,0,0,1,2,3,4,5];
m = 8; N = 15;
y = cirshftf(x,m,N);
y = real(y);
```

```
Problem 5.5.b:

y =

  Columns 1 through 7

    1.0000    2.0000    3.0000    4.0000    5.0000    0.0000    0.0000

  Columns 8 through 14

    0.0000    5.0000    4.0000    3.0000    2.0000    1.0000    0.0000

  Column 15

    0.0000
```

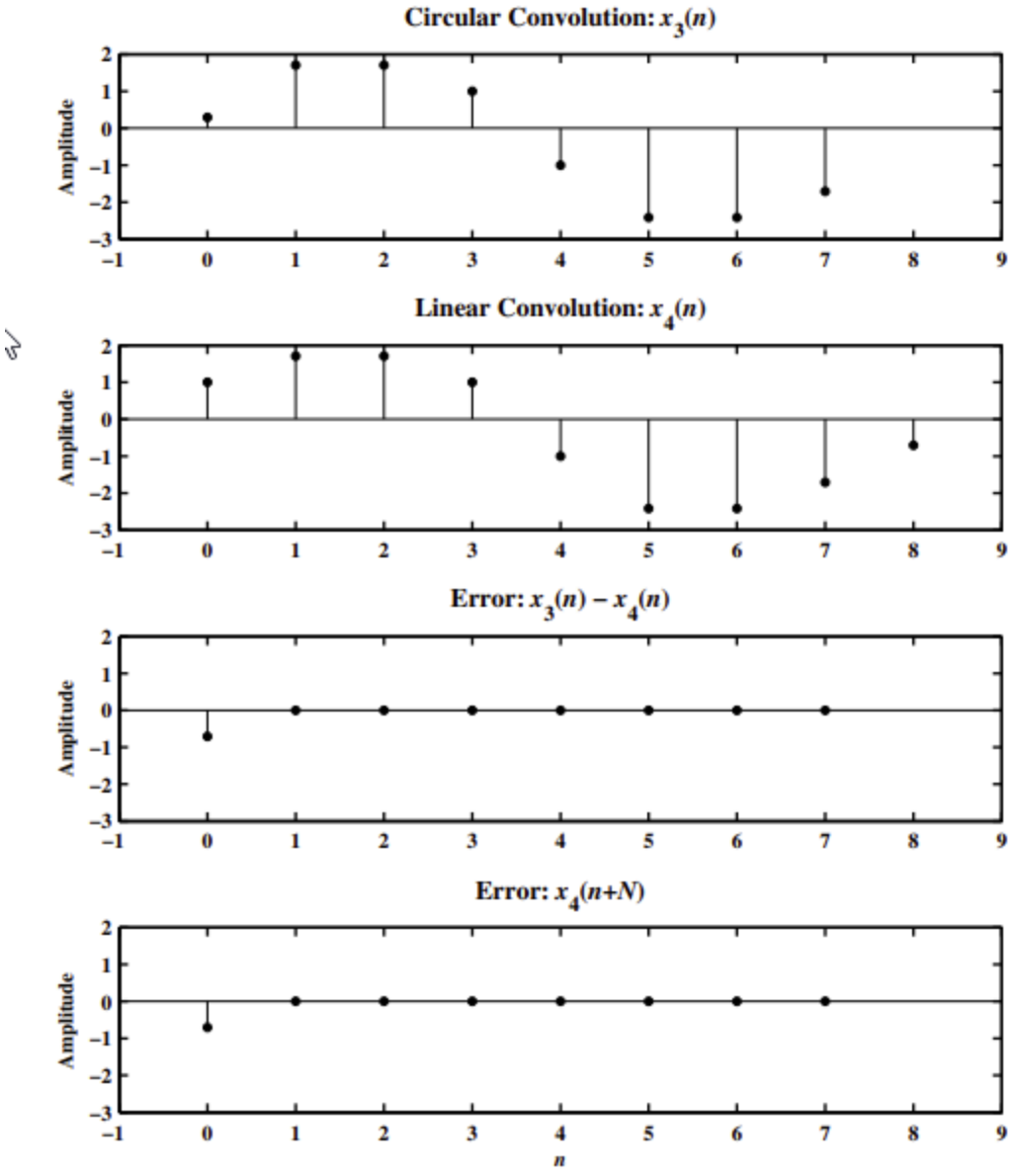
5.6

```
clc; close all;
disp('Problem 5.6: ')
x1 = [4,3,2,1]; x2 = [1,2,3,4];
x3 = circonvf(x1,x2,4)
```

```
Problem 5.6:

x3 =

    24    22    24    30
```

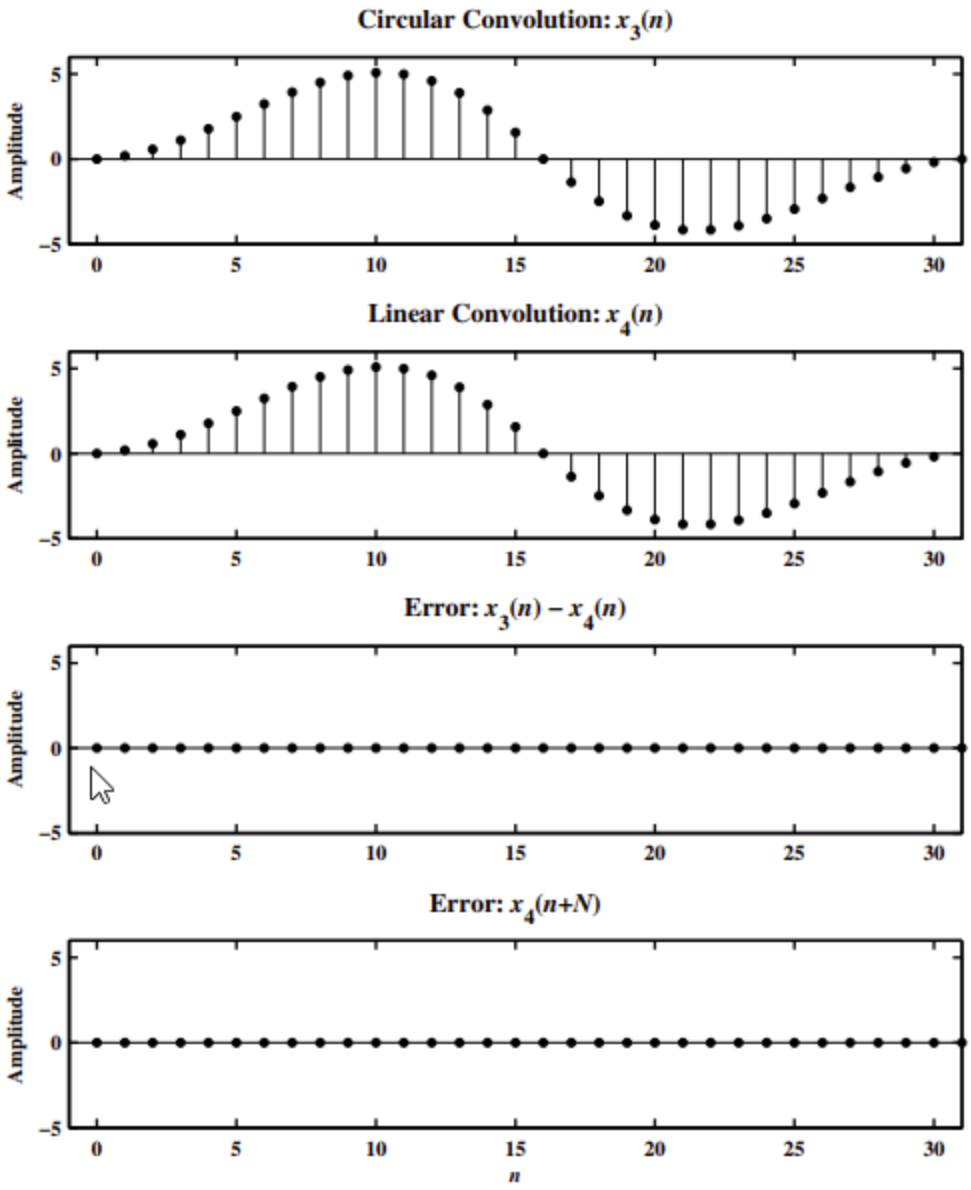
5.7.1

```
clc; close all;
x1 = [1,1,1,1];
x2 = cos(pi*[0:5]/4);
N = 8;
n = 0:N-1;
x3 = circonvt(x1,x2,N);
x4 = conv(x1,x2);
n4 = 0:length(x4)-1;
e1 = x3 - x4(1:N);
e2 = x4(N+1:end);
```



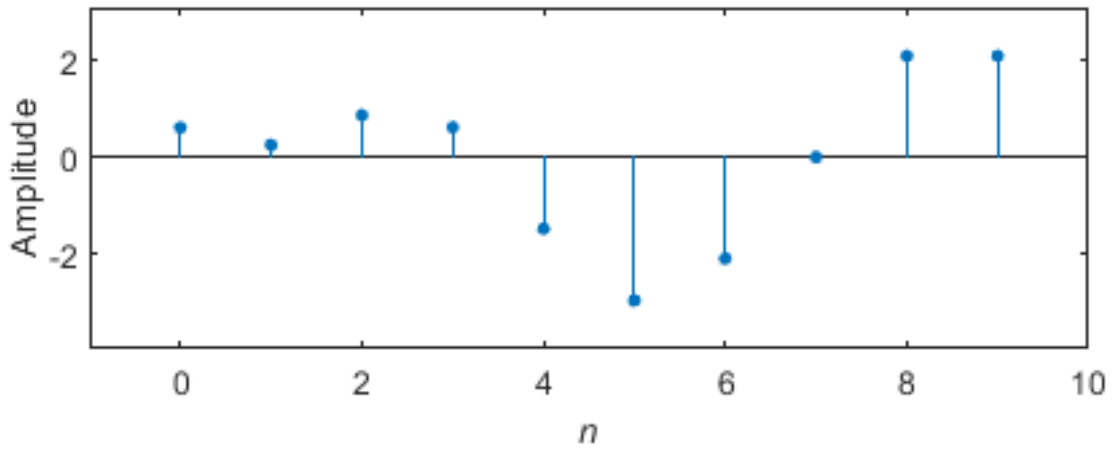
5.7.2

```
clc; close all;
N = 32;
x1 = cos(2*pi*[0:15]/N);
x2 = sin(2*pi*[0:15]/N);
x3 = circonvt(x1,x2,N);
n3 = 0:N-1;
x4 = conv(x1,x2);
n4 = 0:length(x4)-1;
e1 = x3 - [x4,0];
e2 = x4(N+1:end);
```



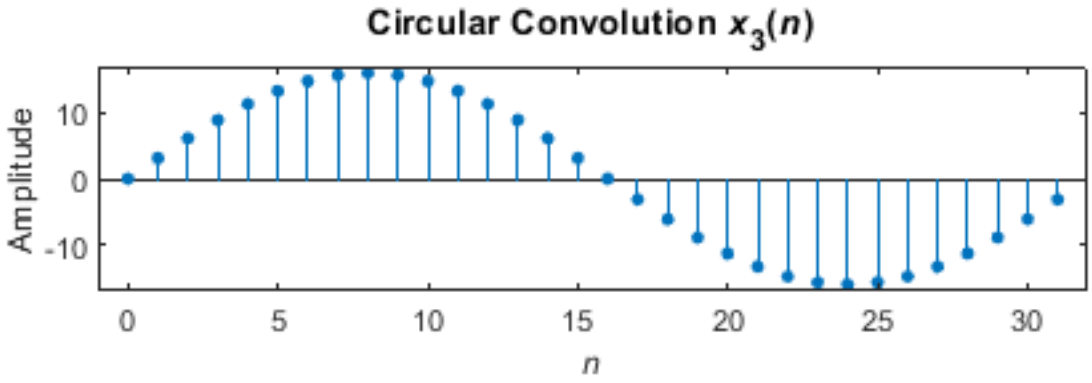
5.8.1

```
clc; close all;
N = 10;
n = 0:N-1;
n1 = 0:5;
x1 = sin(pi*n1/3);
n2 = 0:7;
x2 = cos(pi*n2/4);
x3 = circonvt(x1,x2,N);
figure = figure('Units','inches','position',[1,1,5,2],'color',[1,1,1],...
'paperunits','inches','paperposition',[0,0,5,2]);
set(figure,'NumberTitle','off','Name','P5.8.1');
H = stem(n,x3,'filled');
set(H,'markersize',3);
title('Circular Convolution {\itx}_3({\itn})','fontsize',10);
ylabel('Amplitude');
xlabel('{\itn}');
axis([-1,N,min(x3)-1,max(x3)+1]);
```



5.8.2

```
clc; close all;
N = 32;
n = 0:N-1;
x1 = cos(2*pi*n/N);
x2 = sin(2*pi*n/N);
x3 = circonvt(x1,x2,N);
figure = figure('Units','inches','position',[1,1,5,1.5],'color',[1,1,1],...
'paperunits','inches','paperposition',[0,0,5,1.5]);
set(figure,'NumberTitle','off','Name','P5.8.2');
H = stem(n,x3,'filled');
set(H,'markersize',3);
title('Circular Convolution {\itx}_3({\itn})','fontsize',10);
ylabel('Amplitude');
xlabel('{\itn}');
axis([-1,N,min(x3)-1,max(x3)+1]);
```



5.9

```
% 1. Compute the circular convolution
    % N = 4 : x1(n) (4) x2(n) = {0, 0, 0, 0}
    % N = 7 : x1(n) (7) x2(n) = {2, -1, 2, 0, -2, 1, -2}
    % N = 8 : x1(n) (8) x2(n) = {2, -1, 2, 0, -2, 1, -2, 0}

% 2. Linear Convolution
    % x1(n) * x2(n) = {2, -1, 2, 0, -2, 1, -2}

% 3. Minimum value of N is 7
```

5.10

```
disp('Problem 5.10.1')
N = 1000001;
x = 2*rand(1,N)-1;
h = cos(0.4*pi*(0:15));

t = cputime;
y1 = conv(x,h);
t_conv = cputime - t
y1 = y1(1:1000001);

% 5.10.2
disp('Problem 5.10.2')

disp('t_1024:')
t = cputime;
y2a = hsolpsav(x,h,1024);
t_1024 = cputime - t
y2a = y2a(1:1000001);
diffa = max(abs(y1-y2a))

disp('t_2048:')
t = cputime;
y2b = hsolpsav(x,h,2048);
t_2048 = cputime - t
y2b = y2b(1:1000001);
diffb = max(abs(y1-y2b))


disp('t_4096:')
t = cputime;
y2c = hsolpsav(x,h,4096);
t_4096 = cputime - t
y2c = y2c(1:1000001);
diffc = max(abs(y1-y2c))
```

```
Problem 5.10.1

t_conv = 0.0313



Problem 5.10.2

t_1024 = 0.2969

diffa = 3.5527e-15

t_2048 = 0.3438

diffb = 3.1086e-15

t_4096 = 0.3281

diffc = 3.5527e-15
```