

HW4 MATLAB code

DFT Program

```
% flag=1:DFT    flag=-1:IDFT
function result = dft(data, N, flag)
WN = exp(-1i*2*pi/N);
if flag == 1
    W = WN.^((0:N-1)'*(0:N-1));
    x = data.';
    result = (W*x).';
end
if flag == -1
    W = WN.^(-(0:N-1)'*(0:N-1));
    X = data.';
    result = (1/N)*(W*X).';
end
```

1.

```
% (a)
h = @(t) cos(2*pi*t);
T = 0.1;
N1 = 16;
n1 = 0:N1-1;
H1 = fft(h(n1*T), N1);
figure(1);
plot(n1, abs(H1), '.-');
title('Amplitude of H[k] N=16');
xlabel('k'); ylabel('|H[k]|');
figure(2);
plot(n1, angle(H1), '.-');
title('Phase of H[k] N=16');
xlabel('k'); ylabel('\angle H[k]');
```

```
% (b)
N2 = 32;
n2 = 0:N2-1;
H2 = fft(h(n2*T), N2);
figure(3);
plot(n2, abs(H2), '.-');
title('Amplitude of H[k] N=32');
xlabel('k'); ylabel('|H[k]|');
figure(4);
plot(n2, angle(H2), '.-');
title('Amplitude of H[k] N=32');
xlabel('k'); ylabel('\angle H[k]');
```

```
% (c)
H1_d = dft(h(n1*T), N1, 1);
figure(5);
subplot(1,2,1);
plot(n1, abs(H1), '.-');
hold on
plot(n1, abs(H1_d), 'o');
title('Amplitude of H[k] N=16');
xlabel('k'); ylabel('|H[k]|');
```

```

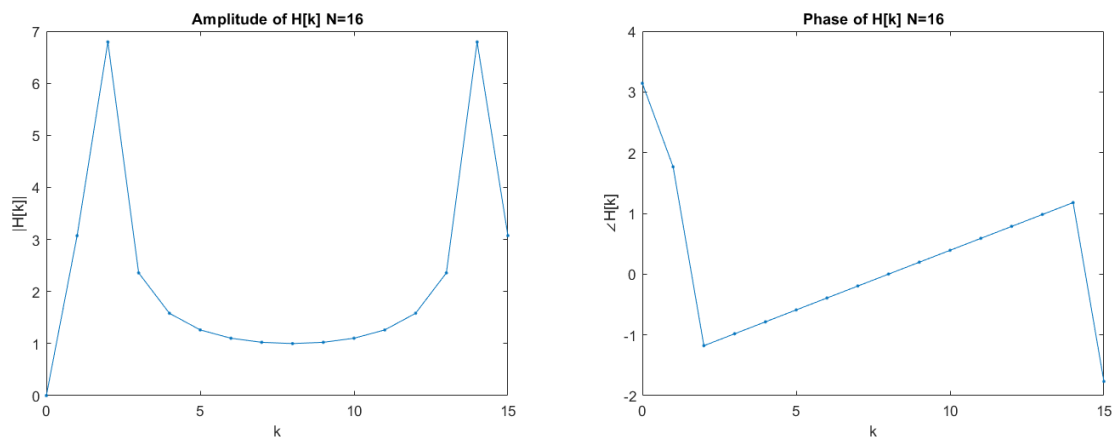
legend('FFT','DFT');
subplot(1,2,2);
plot(n1,angle(H1),'.-');
hold on
plot(n1,angle(H1_d),'o');
title('Phase of H[k] N=16');
xlabel('k'); ylabel('\angle H[k]');
legend('FFT','DFT');

H2_d = dft(h(n2*T),N2,1);
figure(6);
subplot(1,2,1);
plot(n2,abs(H2),'.-');
hold on
plot(n2,abs(H2_d),'o');
title('Amplitude of H[k] N=32');
xlabel('k'); ylabel('|H[k]|');
legend('FFT','DFT');
subplot(1,2,2);
plot(n2,angle(H2),'.-');
hold on
plot(n2,angle(H2_d),'o');
title('Phase of H[k] N=32');
xlabel('k'); ylabel('\angle H[k]');
legend('FFT','DFT');

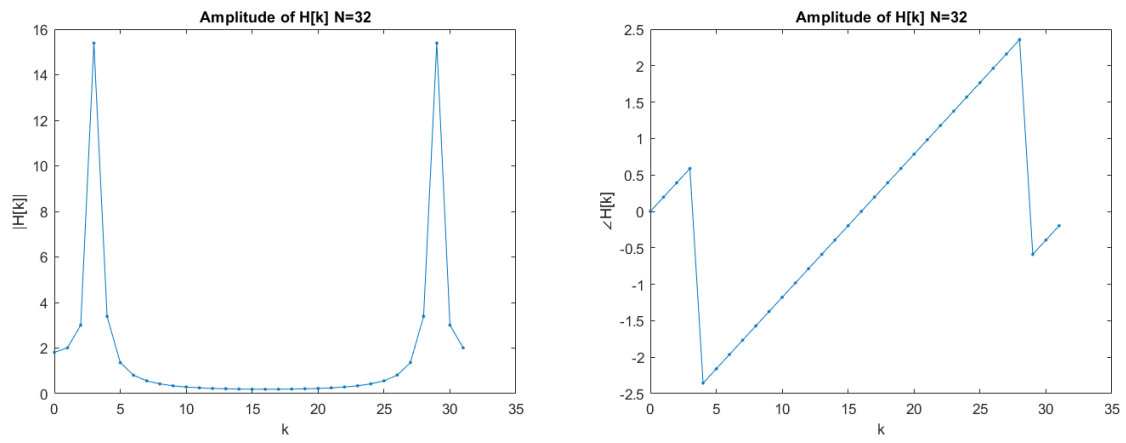
%(d)
h1 = ifft(H1,N1);
h1_d = dft(H1_d,N1,-1);
figure(7);
plot(n1,h1,n1,h1_d,'x');
title('h[n] N=16');
xlabel('n'); ylabel('h[n]');
axis([0 N1-1 -1.5 1.5]);
legend('IFFT','IDFT');
h2 = ifft(H2,N2);
h2_d = dft(H2_d,N2,-1);
figure(8);
plot(n2,h2,n2,h2_d,'x');
title('h[n] N=32');
xlabel('n'); ylabel('h[n]');
axis([0 N2-1 -1.5 1.5]);
legend('IFFT','IDFT');

```

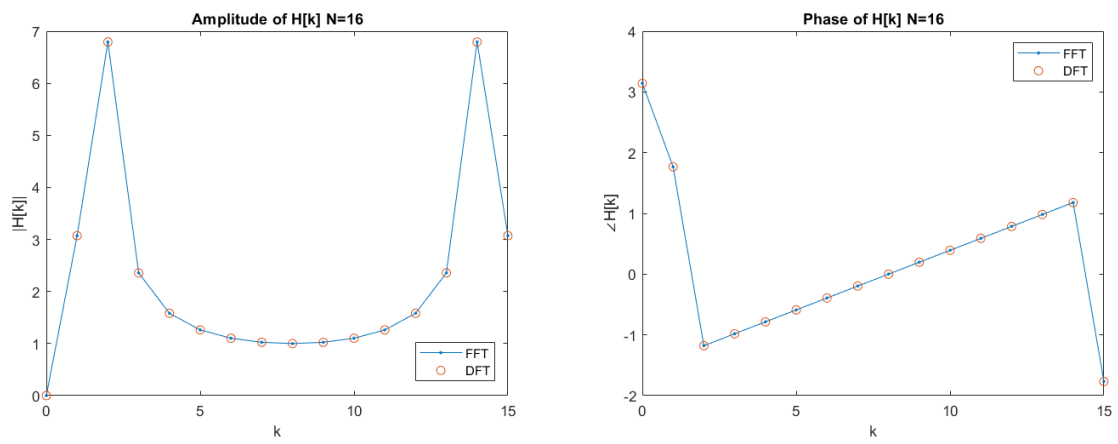
(a)

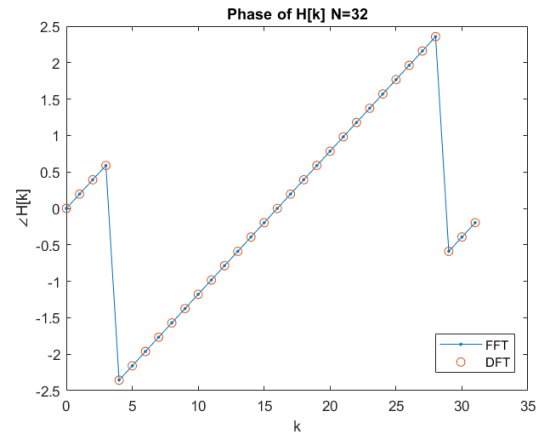
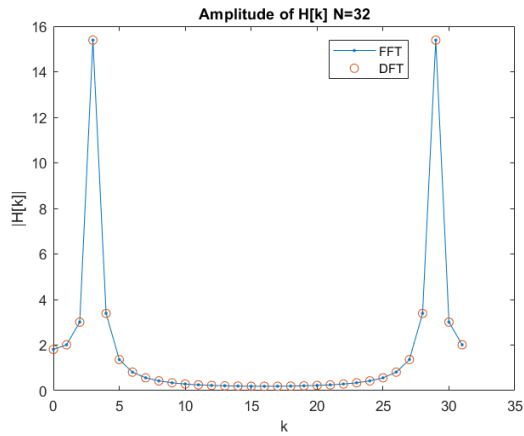


(b)



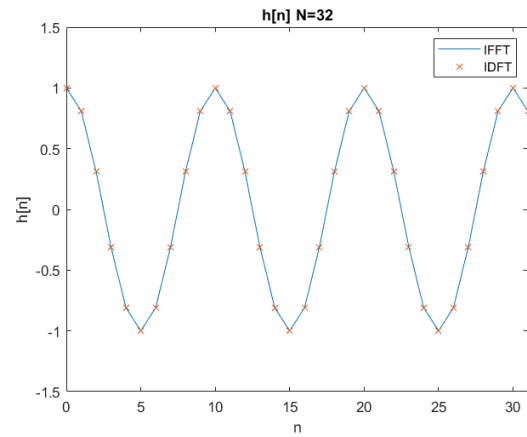
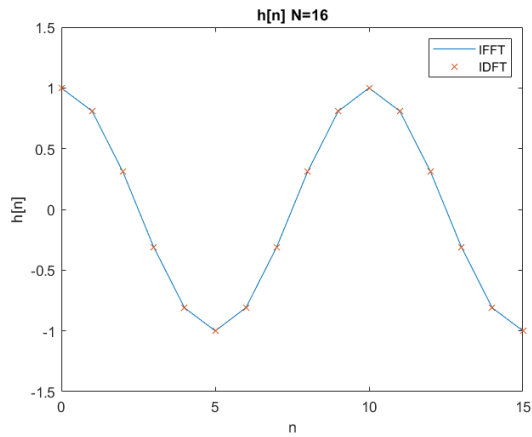
(c)





The results from DFT and FFT algorithms are the same.

(d)



2.

```
h = @(t) cos(2*pi*t);
T = 0.1;
for i = 8:12
    N = 2^i;
    n = 0:N-1;
    hn = h(n*T);
    tic;
    H_d = dft(hn,N,1);
    t1 = toc;
    tic;
    H = fft(hn,N);
    t2 = toc;
    plot(i,t1/t2,'o');
    hold on
    title('Time comparison between DFT and FFT for N=2^i');
    xlabel('i'); ylabel('t_1/t_2');
end
```

