

```

B.1
clear
clc

%%N=16
x=0:pi/8:2*pi
cenddiff=zeros(1,17)
for i=2:15
    cenddiff(i)=(sin(3*x(i+1))+3*cos(6*x(i+1))-
sin(3*x(i-1))-3*cos(6*x(i-1)))/(pi/4);
end
plot(x,cenddiff,"o")
hold on

t=linspace(0,2*pi)
actdiff=3*cos(3*t)-18*sin(6*t)
plot(t,actdiff)
hold on

cutx=0:pi/8:15*pi/8
actf=sin(3*cutx)+3*cos(6*cutx)
fhat=fft(actf)
ikfhat=zeros(1,16)

k=-8:7
for s=1:8
    ikfhat(s)=fhat(s).*1i.*k(s+8)
end
for s=1:8
    ikfhat(s+8)=fhat(s+8).*1i.*k(s)
end

differfhat=ifft(ikfhat)
plot(cutx,differfhat,"+","markersize",10)
legend("Central difference","Exact","FFT")
hold on

xlabel("x")
ylabel("f'")
print -dpng output.png

```

```

clear
clc

%%N=32
x=0:pi/16:2*pi
cenddiff=zeros(1,33)
for i=2:31
    cenddiff(i)=(sin(3*x(i+1))+3*cos(6*x(i+1))-
sin(3*x(i-1))-3*cos(6*x(i-1)))/(pi/8);
end
plot(x,cenddiff,"o")
hold on

t=linspace(0,2*pi)
actdiff=3*cos(3*t)-18*sin(6*t)
plot(t,actdiff)
hold on

cutx=0:pi/16:31*pi/16
actf=sin(3*cutx)+3*cos(6*cutx)
fhat=fft(actf)
ikfhat=zeros(1,32)

k=-16:15
for s=1:16
    ikfhat(s)=fhat(s).*1i.*k(s+16)
end
for s=1:16
    ikfhat(s+16)=fhat(s+16).*1i.*k(s)
end

differfhat=ifft(ikfhat)
plot(cutx,differfhat,"+","markersize",10)
legend("Central difference","Exact","FFT")
hold on

xlabel("x")
ylabel("f'")
print -dpng output.png

```

```

B.2
clear
clc

%%N=16
x=0:pi/8:2*pi
cenddiff=zeros(1,17)
for i=2:15
    cenddiff(i)=(6*x(i+1)-x(i+1).*x(i+1)-6*x(i-1)+x(i-1).
    *x(i-1))/(pi/4);
end
plot(x,cenddiff,"o")
hold on

t=linspace(0,2*pi)
actdiff=6-2*t
plot(t,actdiff)
hold on

cutx=0:pi/8:15*pi/8
actf=6*cutx-cutx.*cutx
fhat=fft(actf)
ikfhat=zeros(1,16)

k=-8:7
for s=1:8
    ikfhat(s)=fhat(s).*1i.*k(s+8)
end
for s=1:8
    ikfhat(s+8)=fhat(s+8).*1i.*k(s)
end

differfhat=ifft(ikfhat)
plot(cutx,differfhat,"+", "markersize",10)
legend("Central difference", "Exact", "FFT")
hold on

xlabel("x")
ylabel("f")
print -dpng output.png

```

```

clear
clc

%%N=32
x=0:pi/16:2*pi
cenddiff=zeros(1,33)
for i=2:31
    cenddiff(i)=(6*x(i+1)-x(i+1).*x(i+1)-6*x(i-1)+x(i-1).
    *x(i-1))/(pi/8);
end
plot(x,cenddiff,"o")
hold on

t=linspace(0,2*pi)
actdiff=6-2*t
plot(t,actdiff)
hold on

cutx=0:pi/16:31*pi/16
actf=6*cutx-cutx.*cutx
fhat=fft(actf)
ikfhat=zeros(1,32)

k=-16:15
for s=1:16
    ikfhat(s)=fhat(s).*1i.*k(s+16)
end
for s=1:16
    ikfhat(s+16)=fhat(s+16).*1i.*k(s)
end

differfhat=ifft(ikfhat)
plot(cutx,differfhat,"+", "markersize",10)
legend("Central difference", "Exact", "FFT")
hold on

xlabel("x")
ylabel("f")
print -dpng output.png

```

```

C.1
clear
clc

x=0:pi/16:2*pi/32*31;
f=sin(2*x)+0.1*sin(15*x);
g=sin(2*x)+0.1*cos(15*x);
H=f.*g;
Hhat=fft(H);

```

```

C.2
clear
clc
N=32;
x=0:2*pi/N:2*pi/N*(N-1);

f=sin(2*x)+0.1*sin(15*x);
g=sin(2*x)+0.1*cos(15*x);

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fhat=fft(f);
ghat=fft(g);

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%%change position
fhat2=[];
ghat2=[];
for i=1:(N/2)
    fhat2(i)=fhat(i+N/2);
    ghat2(i)=ghat(i+N/2);
    fhat2(i+N/2)=fhat(i);
    ghat2(i+N/2)=ghat(i);
end

```

```

%%put 0 in gkm
gkm=[];
for i=1:(N/2-1)
    gkm(i)=0;
end
for i=(3/2*N):(2*N-1)
    gkm(i)=0;
end
for i=(N/2):(3/2*N-1)

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    gkm(i)=ghat2(i-N/2+1);
end

%%multiply
hhat=zeros(1,N);
for k=1:N
    h=0;
    for m=1:N
        h+=fhat2(m).*gkm(k-m+N);
        hhat(k)=h/32;
    endfor
endfor

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```

C.3
clear
clc
N=32;
x=0:2*pi/N:2*pi/N*(N-1);

E=sin(2*x).*sin(2*x)+0.05*(cos(13*x)-
cos(17*x)+sin(17*x)-sin(13*x))+0.005*(sin(30*x));
Ehat=fft(E)

```

```

D.1 D.2
clear
clc
N=7;
for i=1:8
    x(i)=cos(pi*(i-1)/7);
end
x=x'
u=4.*(x.^2-x.^4).*exp(-x./2)

That=zeros(8,8);
T=[];
for i=1:8
    for j=1:8
        T(i,j)=cos((i-1)*(j-1)/N*pi);
        That(i,j)=T(i,j)*2/N;
        if (i==1) || (i==8)

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        That(i,j)=That(i,j)/2;
    end
    if (j==8) || (j==1)
        That(i,j)=That(i,j)/2;
    end
end
end

G=zeros(8,8);
for p=1:8
    for n=1:8
        if (p==1) || (p==8)
            cp=2;
        else
            cp=1;
        end
        if (p>=n) || (rem((p+n),2)==0)
            G(p,n)=0;
        else
            G(p,n)=2*(n-1)/cp;
        end
    end
end
D=T*G*That
uderv=D*u

s=linspace(-1,1);
uactderv=(2*s.^4-16*s.^3-2*s.^2+8*s).*exp(-s/2);
figure(1);
plot(s,uactderv);
hold on;
plot(x,uderv,"o");
legend("Chebyshev derivative","Exact derivative");
xlabel("grid point");
ylabel("derivative");
hold off;

figure(2);
uactderv2=(-1*s.^4+16*s.^3-47*s.^2-8*s+8).*exp(-s/2);
plot(s,uactderv2);
hold on;

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