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PROBLEM 4

```
clc;
clear;

L=2.*pi;
N=32;                       %varied in each problem: N=8, 16, 32, 64
f_kd=zeros(1,N);
k=-(N/2):1:((N/2)-1);

%Discrete Fourier Transform
for m = 1:N
 for j = 1:N
    x(j)=(L/N).*(j-1);

 f_kd(m)=f_kd(m)+((cos(2.*x(j))+((cos(4.*x(j)))./4)+((cos(12.*x(j)))./36)).*exp(-1i.*2.*pi
L));
 end
 f_kd(m)=(1/N).*f_kd(m);
 f_kd(m)=abs(f_kd(m));
end


%Continuous Fourier Tranform
f_kc=zeros(1,N);
m=-(N/2):1:((N/2)-1);
for j=1:N
    f_kc(j)=(1/(2.*pi)).*(integral(@(x)
 ((cos(2*x)+((cos(4*x))/4)+((cos(12*x))/36)).*(exp(-1i.*2.*pi.*m(j).*x/
L))),0,L));
    f_kc(j)=abs(f_kc(j));
end

%Plotting the coeffcients
subplot(2,1,1)
stem(k,f_kd,'LineWidth',1.5,'Marker','x');
grid on;
hold on;
stem(k,f_kc,'LineWidth',1.5,'Marker','o');
title('N=32')
```

```
xlabel('Wave number, k')
ylabel('Fourier Coefficients')
legend('DFT coeffcients','Exact coefficients')



L=2.*pi;
N=64;                    %varied in each problem: N=8, 16, 32, 64
f_kd=zeros(1,N);
k=-(N/2):1:((N/2)-1);

%Discrete Fourier Transform
for m = 1:N
 for j = 1:N
    x(j)=(L/N).*(j-1);

 f_kd(m)=f_kd(m)+((cos(2.*x(j))+((cos(4.*x(j)))./4)+((cos(12.*x(j)))./36)).*exp(-1i.*2.*pi
L));
 end
 f_kd(m)=(1/N).*f_kd(m);
 f_kd(m)=abs(f_kd(m));
end


%Continuous Fourier Tranform
f_kc=zeros(1,N);
m=-(N/2):1:((N/2)-1);
for j=1:N
    f_kc(j)=(1/(2.*pi)).*(integral(@(x)
 ((cos(2*x)+((cos(4*x))/4)+((cos(12*x))/36)).*(exp(-1i.*2.*pi.*m(j).*x/
L))),0,L));
    f_kc(j)=abs(f_kc(j));
end

%Plotting the coeffcients
subplot(2,1,2)
stem(k,f_kd,'LineWidth',1.5,'Marker','x');
grid on;
hold on;
stem(k,f_kc,'LineWidth',1.5,'Marker','o');
title('N=64')
xlabel('Wave number, k')
ylabel('Fourier Coefficients')
legend('DFT coeffcients','Exact coefficients')
```

PROBLEM 5

```
clc;
clear;

L=20;
N=32;                    %varied in each problem: N=8, 16, 32, 64
f_kd=zeros(1,N);
```

```
k=-(N/2):1:((N/2)-1);

%Discrete Fourier Transform
for m = 1:N
 for j = 1:N
    x(j)=(L/N).*(j-((N/2)+1));
    f_kd(m)=f_kd(m)+((exp(-1.5*(x(j).^2))).*exp(-1i.*2.*pi.*k(m).*x(j)/L));
 end
 f_kd(m)=(1/N).*abs(f_kd(m));
end

%Continuous Fourier Tranform
f_kc=zeros(1,N);
m=-(N/2):1:((N/2)-1);
for j=1:N
    f_kc(j)=(1/L).*(integral(@(x)
 ((exp(-1.5*(x.^2))).*(exp(-1i.*2.*pi.*m(j).*x/L))),-10,10));
end

%Plotting the coeffcients
subplot(2,1,1)
stem(k,f_kd,'LineWidth',1.5,'Marker','x');
grid on;
hold on;
stem(k,f_kc,'LineWidth',1.5,'Marker','o');
title('N=32')
xlabel('Wave number, k')
ylabel('Fourier Coefficients')
legend('DFT coeffcients','Exact coefficients')


L=20;
N=64;                    %varied in each problem: N=8, 16, 32, 64
f_kd=zeros(1,N);
k=-(N/2):1:((N/2)-1);

%Discrete Fourier Transform
for m = 1:N
 for j = 1:N
    x(j)=(L/N).*(j-((N/2)+1));
    f_kd(m)=f_kd(m)+((exp(-1.5*(x(j).^2))).*exp(-1i.*2.*pi.*k(m).*x(j)/L));
 end
 f_kd(m)=(1/N).*abs(f_kd(m));
end

%Continuous Fourier Tranform
f_kc=zeros(1,N);
m=-(N/2):1:((N/2)-1);
for j=1:N
    f_kc(j)=(1/L).*(integral(@(x)
 ((exp(-1.5*(x.^2))).*(exp(-1i.*2.*pi.*m(j).*x/L))),-10,10));
end

%Plotting the coeffcients
```

```
subplot(2,1,2)
stem(k,f_kd,'LineWidth',1.5,'Marker','x');
grid on;
hold on;
stem(k,f_kc,'LineWidth',1.5,'Marker','o');
title('N=64')
xlabel('Wave number, k')
ylabel('Fourier Coefficients')
legend('DFT coeffcients','Exact coefficients')
```

PROBLEM 6A I

```
clc;
clear;

L=2.*pi;
N=16;
f_kd=zeros(1,N);
k=-(N/2):1:((N/2)-1);

%Discrete Fourier Transform
for m = 1:N
 for j = 1:N
    x(j)=(L/N).*(j-1);
    f_kd(m)=f_kd(m)+(cos(5.*x(j)).*exp(-1i.*2.*pi.*k(m).*x(j)/L));
 end
 f_kd(m)=(1/N).*f_kd(m);
end


%Continuous Fourier Tranform
f_kc=zeros(1,N);
m=-(N/2):1:((N/2)-1);
for j=1:N
    f_kc(j)=(1/(2.*pi)).*(integral(@(x) ((cos(5*x)).*(exp(-1i.*2.*pi.*m(j).*x/
L))),0,L));
end

%Plotting the coeffcients
subplot(2,1,1)
stem(k,f_kd,'LineWidth',1.5,'Marker','x');
grid on;
hold on;
stem(k,f_kc,'LineWidth',1.5,'Marker','o');
title('N=16')
xlabel('Wave number, k')
ylabel('Fourier Coefficients')
legend('DFT coeffcients','Exact coefficients')

L=2.*pi;
N=32;                    %varied in each problem: N=8, 16, 32, 64
f_kd=zeros(1,N);
k=-(N/2):1:((N/2)-1);
```

```
%Discrete Fourier Transform
for m = 1:N
 for j = 1:N
    x(j)=(L/N).*(j-1);
    f_kd(m)=f_kd(m)+((cos(5.*x(j))).*exp(-1i.*2.*pi.*k(m).*x(j)/L));
 end
 f_kd(m)=(1/N).*f_kd(m);
end


%Continuous Fourier Tranform
f_kc=zeros(1,N);
m=-(N/2):1:((N/2)-1);
for j=1:N
    f_kc(j)=(1/(2.*pi)).*(integral(@(x) ((cos(5*x)).*(exp(-1i.*2.*pi.*m(j).*x/
L))),0,L));
end

%Plotting the coeffcients
subplot(2,1,2)
stem(k,f_kd,'LineWidth',1.5,'Marker','x');
grid on;
hold on;
stem(k,f_kc,'LineWidth',1.5,'Marker','o');
title('N=32')
xlabel('Wave number, k')
ylabel('Fourier Coefficients')
legend('DFT coeffcients','Exact coefficients')
```

PROBLEM 6A II

```
clc;
clear;

L=2.*pi;
N=16;
f_kd=zeros(1,N);
k=-(N/2):1:((N/2)-1);

%Discrete Fourier Transform
for m = 1:N
 for j = 1:N
    x(j)=(L/N).*(j-1);
    f_kd(m)=f_kd(m)+(cos(4.*x(j)).*exp(-1i.*2.*pi.*k(m).*x(j)/L));
 end
 f_kd(m)=(1/N).*f_kd(m);
end


%Continuous Fourier Tranform
f_kc=zeros(1,N);
m=-(N/2):1:((N/2)-1);
```

```
for j=1:N
    f_kc(j)=(1/(2.*pi)).*(integral(@(x) ((cos(4*x)).*(exp(-1i.*2.*pi.*m(j).*x/
L))),0,L));
end

%Plotting the coeffcients
subplot(2,1,1)
stem(k,f_kd,'LineWidth',1.5,'Marker','x');
grid on;
hold on;
stem(k,f_kc,'LineWidth',1.5,'Marker','o');
title('N=16')
xlabel('Wave number, k')
ylabel('Fourier Coefficients')
legend('DFT coeffcients','Exact coefficients')

L=2.*pi;
N=32;                    %varied in each problem: N=8, 16, 32, 64
f_kd=zeros(1,N);
k=-(N/2):1:((N/2)-1);

%Discrete Fourier Transform
for m = 1:N
 for j = 1:N
    x(j)=(L/N).*(j-1);
    f_kd(m)=f_kd(m)+((cos(4.*x(j))).*exp(-1i.*2.*pi.*k(m).*x(j)/L));
 end
 f_kd(m)=(1/N).*f_kd(m);
end


%Continuous Fourier Tranform
f_kc=zeros(1,N);
m=-(N/2):1:((N/2)-1);
for j=1:N
    f_kc(j)=(1/(2.*pi)).*(integral(@(x) ((cos(4*x)).*(exp(-1i.*2.*pi.*m(j).*x/
L))),0,L));
end

%Plotting the coeffcients
subplot(2,1,2)
stem(k,f_kd,'LineWidth',1.5,'Marker','x');
grid on;
hold on;
stem(k,f_kc,'LineWidth',1.5,'Marker','o');
title('N=32')
xlabel('Wave number, k')
ylabel('Fourier Coefficients')
legend('DFT coeffcients','Exact coefficients')
```

PROBLEM 6A III

```
clc;
```

```
clear;

L=2.*pi;
N=16;
f_kd=zeros(1,N);
k=-(N/2):1:((N/2)-1);

%Discrete Fourier Transform
for m = 1:N
 for j = 1:N
    x(j)=(L/N).*(j-1);

 f_kd(m)=f_kd(m)+((cos(5.*x(j)).*(cos(4.*x(j)))).*exp(-1i.*2.*pi.*k(m).*x(j)/
L));
 end
 f_kd(m)=(1/N).*f_kd(m);
 f_kd(m)=abs(f_kd(m));
end


%Continuous Fourier Tranform
f_kc=zeros(1,N);
m=-(N/2):1:((N/2)-1);
for j=1:N
    f_kc(j)=(1/(2.*pi)).*(integral(@(x)
 ((cos(5*x).*(cos(4*x))).*(exp(-1i.*2.*pi.*m(j).*x/L))),0,L));
end

%Plotting the coeffcients
subplot(2,1,1)
stem(k,f_kd,'LineWidth',1.5,'Marker','x');
grid on;
hold on;
stem(k,f_kc,'LineWidth',1.5,'Marker','o');
hold on;
title('N=16')
xlabel('Wave number, k')
ylabel('Fourier Coefficients')
%legend('DFT coeffcients','Exact coefficients')

%3/2 dealiasing


L=2.*pi;
N=16;
f_k=zeros(1,N);
k=-(N/2):1:((N/2)-1);

%function f(x) fft
f=zeros(1,N);
 for j = 1:N
    x(j)=(L/N).*(j-1);
    f(j)= cos(5.*(x(j)));
 end
```

```
 f_k=abs(fft(f)/N);
 f_k=fftshift(f_k);
 f_k_zeros=[zeros(1,4),f_k,zeros(1,4)];
 f_j_f=zeros(1,N);
 f_j_f=ifft(f_k_zeros).*(3.*N/2);

 %function g(x) fft
f_k=zeros(1,N);
f=zeros(1,N);
 for j = 1:N
    x(j)=(L/N).*(j-1);
    f(j)= cos(4.*(x(j)));
 end
 f_k=abs(fft(f)/N);
 f_k=fftshift(f_k);
 f_k_zeros=[zeros(1,4),f_k,zeros(1,4)];
 f_j_g=zeros(1,N);
 f_j_g=ifft(f_k_zeros).*(3.*N/2);

 %function f(x)*g(x)
 product=f_j_f.*f_j_g;
 final=fft(product)/(3.*N/2);
 final=fftshift(final);
 final=final(5:end-4);
 stem(k,final,'LineWidth',1.5,'Marker','+');
 legend('without 3/2 rule','analytical spectrum','with 3/2 rule')



L=2.*pi;
N=32;                    %varied in each problem: N=8, 16, 32, 64
f_kd=zeros(1,N);
k=-(N/2):1:((N/2)-1);

%Discrete Fourier Transform
for m = 1:N
 for j = 1:N
    x(j)=(L/N).*(j-1);

 f_kd(m)=f_kd(m)+((cos(5.*x(j)).*(cos(4.*x(j)))).*exp(-1i.*2.*pi.*k(m).*x(j)/
L));
 end
 f_kd(m)=(1/N).*f_kd(m);
end


%Continuous Fourier Tranform
f_kc=zeros(1,N);
m=-(N/2):1:((N/2)-1);
for j=1:N
    f_kc(j)=(1/(2.*pi)).*(integral(@(x)
 ((cos(5*x).*(cos(4*x))).*(exp(-1i.*2.*pi.*m(j).*x/L))),0,L));
end
```

```
%Plotting the coeffcients
subplot(2,1,2)
stem(k,f_kd,'LineWidth',1.5,'Marker','x');
grid on;
hold on;
stem(k,f_kc,'LineWidth',1.5,'Marker','o');
title('N=32')
xlabel('Wave number, k')
ylabel('Fourier Coefficients')
```

```
%3/2 dealiasing
L=2.*pi;
N=32;
f_k=zeros(1,N);
k=-(N/2):1:((N/2)-1);

%function f(x) fft
f=zeros(1,N);
 for j = 1:N
    x(j)=(L/N).*(j-1);
    f(j)= cos(5.*(x(j)));
 end
 f_k=abs(fft(f)/N);
 f_k=fftshift(f_k);
 f_k_zeros=[zeros(1,8),f_k,zeros(1,8)];
 f_j_f=zeros(1,N);
 f_j_f=ifft(f_k_zeros).*(3.*N/2);

%function g(x) fft
f_k=zeros(1,N);
f=zeros(1,N);
 for j = 1:N
    x(j)=(L/N).*(j-1);
    f(j)= cos(4.*(x(j)));
 end
 f_k=abs(fft(f)/N);
 f_k=fftshift(f_k);
 f_k_zeros=[zeros(1,8),f_k,zeros(1,8)];
 f_j_g=zeros(1,N);
 f_j_g=ifft(f_k_zeros).*(3.*N/2);

 %function f(x)*g(x)
 product=f_j_f.*f_j_g;
 final=fft(product)/(3.*N/2);
 final=fftshift(final);
 final=final(9:end-8);
 stem(k,final,'LineWidth',1.5,'Marker','+');
 legend('without 3/2 rule','analytical spectrum','with 3/2 rule')
```

PROBLEM 6B I

```
clc;
clear;

L=2.*pi;
N=16;
f_kd=zeros(1,N);
k=-(N/2):1:((N/2)-1);

%Discrete Fourier Transform
for m = 1:N
 for j = 1:N
    x(j)=(L/N).*(j-1);
    f_kd(m)=f_kd(m)+(exp(sin(2.*x(j))).*exp(-1i.*2.*pi.*k(m).*x(j)/L));
 end
 f_kd(m)=(1/N).*f_kd(m);
 f_kd(m)=abs(f_kd(m));
end


%Continuous Fourier Tranform
f_kc=zeros(1,N);
m=-(N/2):1:((N/2)-1);
for j=1:N
    f_kc(j)=(1/(2.*pi)).*(integral(@(x)
 (exp((sin(2*x))).*(exp(-1i.*2.*pi.*m(j).*x/L))),0,L));
    f_kc(j)=abs(f_kc(j));
end

%Plotting the coeffcients
subplot(2,1,1)
stem(k,f_kd,'LineWidth',1.5,'Marker','x');
grid on;
hold on;
stem(k,f_kc,'LineWidth',1.5,'Marker','o');
title('N=16')
xlabel('Wave number, k')
ylabel('|Fourier Coefficients|')
legend('DFT coeffcients','Exact coefficients')

L=2.*pi;
N=32;                    %varied in each problem: N=8, 16, 32, 64
f_kd=zeros(1,N);
k=-(N/2):1:((N/2)-1);

%Discrete Fourier Transform
for m = 1:N
 for j = 1:N
    x(j)=(L/N).*(j-1);
    f_kd(m)=f_kd(m)+((exp(sin(2.*x(j)))).*exp(-1i.*2.*pi.*k(m).*x(j)/L));
 end
 f_kd(m)=(1/N).*f_kd(m);
```

```
 f_kd(m)=abs(f_kd(m));
end


%Continuous Fourier Tranform
f_kc=zeros(1,N);
m=-(N/2):1:((N/2)-1);
for j=1:N
    f_kc(j)=(1/(2.*pi)).*(integral(@(x)
 ((exp(sin(2*x))).*(exp(-1i.*2.*pi.*m(j).*x/L))),0,L));
    f_kc(j)=abs(f_kc(j));
end

%Plotting the coeffcients
subplot(2,1,2)
stem(k,f_kd,'LineWidth',1.5,'Marker','x');
grid on;
hold on;
stem(k,f_kc,'LineWidth',1.5,'Marker','o');
title('N=32')
xlabel('Wave number, k')
ylabel('|Fourier Coefficients|')
legend('DFT coeffcients','Exact coefficients')
```

PROBLEM 6B II

```
clc;
clear;

L=2.*pi;
N=16;
f_kd=zeros(1,N);
k=-(N/2):1:((N/2)-1);

%Discrete Fourier Transform
for m = 1:N
 for j = 1:N
    x(j)=(L/N).*(j-1);
    f_kd(m)=f_kd(m)+(cos((x(j).^2)/(2.*pi)).*exp(-1i.*2.*pi.*k(m).*x(j)/L));
 end
 f_kd(m)=(1/N).*f_kd(m);
 f_kd(m)=abs(f_kd(m));
end


%Continuous Fourier Tranform
f_kc=zeros(1,N);
m=-(N/2):1:((N/2)-1);
for j=1:N
    f_kc(j)=(1/(2.*pi)).*(integral(@(x) ((cos((x.^2)/
(2.*pi))).*(exp(-1i.*2.*pi.*m(j).*x/L))),0,L));
    f_kc(j)=abs(f_kc(j));
end
```

```
%Plotting the coeffcients
subplot(2,1,1)
stem(k,f_kd,'LineWidth',1.5,'Marker','x');
grid on;
hold on;
stem(k,f_kc,'LineWidth',1.5,'Marker','o');
title('N=16')
xlabel('Wave number, k')
ylabel('|Fourier Coefficients|')
legend('DFT coeffcients','Exact coefficients')

L=2.*pi;
N=32;                    %varied in each problem: N=8, 16, 32, 64
f_kd=zeros(1,N);
k=-(N/2):1:((N/2)-1);

%Discrete Fourier Transform
for m = 1:N
 for j = 1:N
    x(j)=(L/N).*(j-1);
    f_kd(m)=f_kd(m)+(cos((x(j).^2)/(2.*pi)).*exp(-1i.*2.*pi.*k(m).*x(j)/L));
 end
 f_kd(m)=(1/N).*f_kd(m);
 f_kd(m)=abs(f_kd(m));
end


%Continuous Fourier Tranform
f_kc=zeros(1,N);
m=-(N/2):1:((N/2)-1);
for j=1:N
    f_kc(j)=(1/(2.*pi)).*(integral(@(x) ((cos((x.^2)/
(2.*pi))).*(exp(-1i.*2.*pi.*m(j).*x/L))),0,L));
    f_kc(j)=abs(f_kc(j));
end

%Plotting the coeffcients
subplot(2,1,2)
stem(k,f_kd,'LineWidth',1.5,'Marker','x');
grid on;
hold on;
stem(k,f_kc,'LineWidth',1.5,'Marker','o');
title('N=32')
xlabel('Wave number, k')
ylabel('|Fourier Coefficients|')
legend('DFT coeffcients','Exact coefficients')
```

PROBLEM 6B III

```
clc;
clear;
```

```
L=2.*pi;
N=16;
f_kd=zeros(1,N);
k=-(N/2):1:((N/2)-1);

%Discrete Fourier Transform
for m = 1:N
 for j = 1:N
    x(j)=(L/N).*(j-1);
    f_kd(m)=f_kd(m)+(exp(sin(2.*x(j))).*cos((x(j).^2)/
(2.*pi)).*exp(-1i.*2.*pi.*k(m).*x(j)/L));
 end
 f_kd(m)=(1/N).*f_kd(m);
 f_kd(m)=abs(f_kd(m));
end


%Continuous Fourier Tranform
f_kc=zeros(1,N);
m=-(N/2):1:((N/2)-1);
for j=1:N
    f_kc(j)=(1/(2.*pi)).*(integral(@(x) ((exp(sin(2.*x)).*cos((x.^2)/
(2.*pi))).*(exp(-1i.*2.*pi.*m(j).*x/L))),0,L));
    f_kc(j)=abs(f_kc(j));
end

%Plotting the coeffcients
subplot(2,1,1)
stem(k,f_kd,'LineWidth',1.5,'Marker','x');
grid on;
hold on;
stem(k,f_kc,'LineWidth',1.5,'Marker','o');
title('N=16')
xlabel('Wave number, k')
ylabel('|Fourier Coefficients|')

%3/2 dealiasing


L=2.*pi;
N=16;
f_k=zeros(1,N);
k=-(N/2):1:((N/2)-1);

%function f(x) fft
f=zeros(1,N);
 for j = 1:N
    x(j)=(L/N).*(j-1);
    f(j)= exp(sin(2.*x(j)));
 end
 f_k=(fft(f)/N);
 f_k=fftshift(f_k);
 f_k_zeros=[zeros(1,4),f_k,zeros(1,4)];
 f_j_f=zeros(1,N);
```

```
 f_j_f=ifft(f_k_zeros).*(3.*N/2);

 %function g(x) fft
f_k=zeros(1,N);
f=zeros(1,N);
 for j = 1:N
    x(j)=(L/N).*(j-1);
    f(j)= cos((x(j).^2)/(2.*pi));
 end
 f_k=(fft(f))/N;
 f_k=fftshift(f_k);
 f_k_zeros=[zeros(1,4),f_k,zeros(1,4)];
 f_j_g=zeros(1,N);
 f_j_g=ifft(f_k_zeros).*(3.*N/2);

 %function f(x)*g(x)
 product=f_j_f.*f_j_g;
 final=(fft(product)/(3.*N/2));
 final=abs(fftshift(final));
 final=final(5:end-4);
 stem(k,final,'LineWidth',1.5,'Marker','+');
 legend('without 3/2 rule','analytical spectrum','with 3/2 rule')

L=2.*pi;
N=32;                    %varied in each problem: N=8, 16, 32, 64
f_kd=zeros(1,N);
k=-(N/2):1:((N/2)-1);

%Discrete Fourier Transform
for m = 1:N
 for j = 1:N
    x(j)=(L/N).*(j-1);
    f_kd(m)=f_kd(m)+(exp(sin(2.*x(j))).*cos((x(j).^2)/
(2.*pi)).*exp(-1i.*2.*pi.*k(m).*x(j)/L));
 end
 f_kd(m)=(1/N).*f_kd(m);
 f_kd(m)=abs(f_kd(m));
end


%Continuous Fourier Tranform
f_kc=zeros(1,N);
m=-(N/2):1:((N/2)-1);
for j=1:N
    f_kc(j)=(1/(2.*pi)).*(integral(@(x) ((exp(sin(2.*x)).*cos((x.^2)/
(2.*pi))).*(exp(-1i.*2.*pi.*m(j).*x/L))),0,L));
    f_kc(j)=abs(f_kc(j));
end

%Plotting the coeffcients
subplot(2,1,2)
stem(k,f_kd,'LineWidth',1.5,'Marker','x');
grid on;
hold on;
```

```
stem(k,f_kc,'LineWidth',1.5,'Marker','o');
title('N=32')
xlabel('Wave number, k')
ylabel('|Fourier Coefficients|')
legend('DFT coeffcients','Exact coefficients')

%3/2 dealiasing
L=2.*pi;
N=32;
f_k=zeros(1,N);
k=-(N/2):1:((N/2)-1);

%function f(x) fft
f=zeros(1,N);
 for j = 1:N
    x(j)=(L/N).*(j-1);
    f(j)= exp(sin(2.*x(j)));
 end
 f_k=(fft(f)/N);
 f_k=(fftshift(f_k));
 f_k_zeros=[zeros(1,8),f_k,zeros(1,8)];
 f_j_f=zeros(1,N);
 f_j_f=ifft(f_k_zeros).*(3.*N/2);

%function g(x) fft
f_k=zeros(1,N);
f=zeros(1,N);
 for j = 1:N
    x(j)=(L/N).*(j-1);
    f(j)= cos((x(j).^2)/(2.*pi));
 end
 f_k=(fft(f)/N);
 f_k=(fftshift(f_k));
 f_k_zeros=[zeros(1,8),f_k,zeros(1,8)];
 f_j_g=zeros(1,N);
 f_j_g=ifft(f_k_zeros).*(3.*N/2);

 %function f(x)*g(x)
 product=f_j_f.*f_j_g;
 final=(fft(product)/(3.*N/2));
 final=abs(fftshift(final));
 final=final(9:end-8);
 stem(k,final,'LineWidth',1.5,'Marker','+');
 legend('without 3/2 rule','analytical spectrum','with 3/2 rule')
```

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