Shaan Ul Haque(180070053)
Samarth Singh (180050090)
Niraj Mahajan (180050069)

Question 6

Formula:

$$F(u,v) = \sum_{x=0}^{W_1-1}\sum_{y=0}^{W_2-1} f(x,y)exp(-j2\pi(\frac{ux}{W_1}+\frac{vy}{W_2}))$$

$$F_{k1}(u,v) = -6exp(-j2\pi\frac{\lfloor N/2\rfloor u+\lfloor N/2\rfloor v}{N})$$
$$+\sum_{x=\lfloor N/2\rfloor-1}^{\lfloor N/2\rfloor+1} exp(-j2\pi(\frac{ux+v(\lfloor N/2\rfloor)}{N})) + \sum_{y=\lfloor N/2\rfloor-1}^{\lfloor N/2\rfloor+1} exp(-j2\pi(\frac{u(\lfloor N/2\rfloor)+vy}{N}))$$

$$F_{k2}(u,v) = 9exp(-j2\pi\frac{\lfloor N/2\rfloor u+\lfloor N/2\rfloor v}{N}) - \sum_{x=\lfloor N/2\rfloor-1}^{\lfloor N/2\rfloor+1}\sum_{y=\lfloor N/2\rfloor-1}^{\lfloor N/2\rfloor+1} exp(-j2\pi(\frac{ux+vy}{N}))$$

Code Snippet:

```
N = 201;
F1 = zeros(N,N);
F2 = zeros(N,N);
for u = 1:201
    for v = 1:201
        for x = 99:101
            for y = 99:101
                if x==y && x==100
                    F1(u,v) = F1(u,v)-4*exp(-1i*2*pi*((u-1-100)*x/N+(v-1-100)*y/N));
                    F2(u,v) = F2(u,v)+8*exp(-1i*2*pi*((u-1-100)*x/N+(v-1-100)*y/N));
                else
                    if x~=y && (x+y)~=(N-1)
                        F1(u,v)= F1(u,v)+exp(-1i*2*pi*((u-1-100)*x/N+(v-1-100)*y/N));
                    end
                    F2(u,v) = F2(u,v)-exp(-1i*2*pi*((u-1-100)*x/N+(v-1-100)*y/N));
                end
            end
        end
    end
end
[U,V]=meshgrid(-100:100,-100:100);
lF1 = log(abs(F1)+1);
figure('Name','k1-2d');imshow(lF1,[min(lF1(:)) max(lF1(:))]);colormap('jet');colorbar
figure('Name','k1-3d'); surf(U,V,lF1); colormap('jet'); colorbar;
lF2 = log(abs(F2)+1);
figure('Name','k2-2d');imshow(lF2,[min(lF2(:)) max(lF2(:))]);colormap('jet');colorbar
figure('Name','k2-3d'); surf(U,V,lF2); colormap('jet'); colorbar;
```

Shaan Ul Haque(180070053)
Samarth Singh (180050090)
Niraj Mahajan (180050069)

Results:

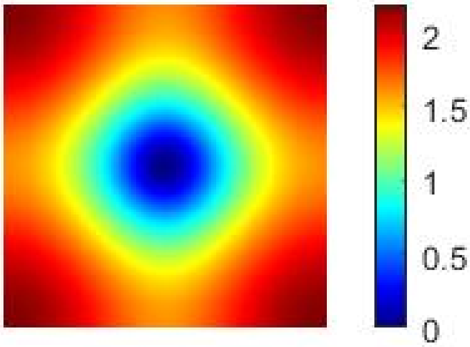

Figure 6.1: N,N-point DFT on **k1** (imshow)

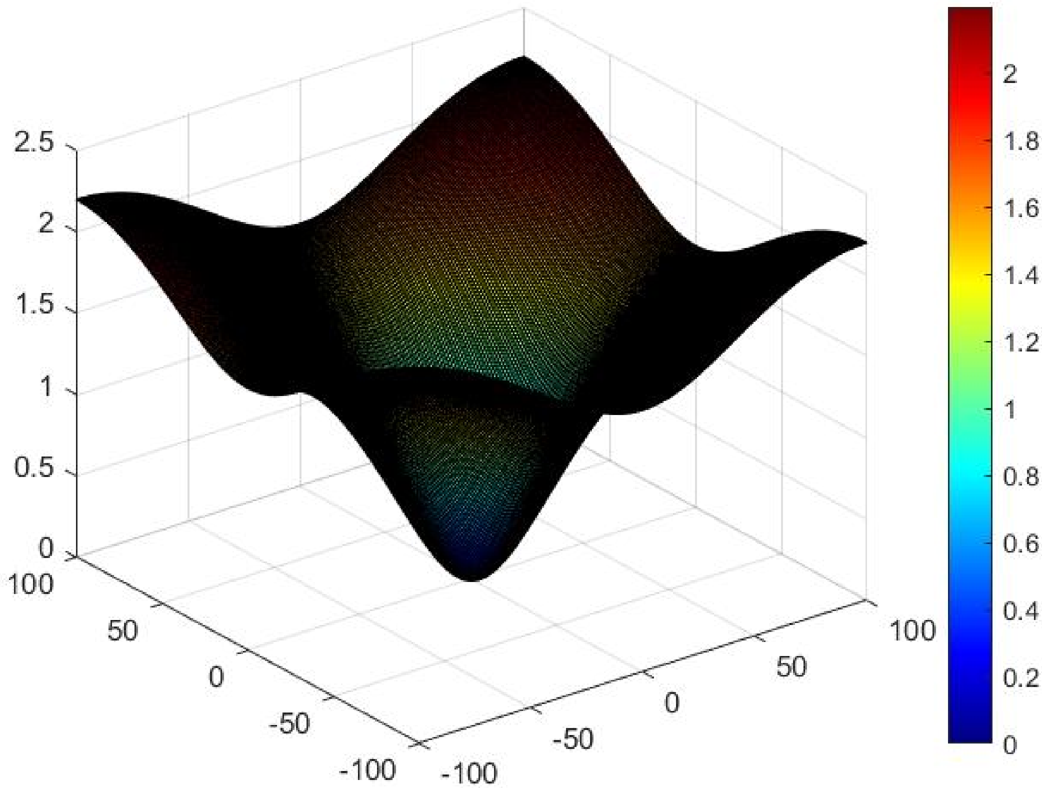

Figure 6.2: N,N-point DFT on **k1** (surf)

Shaan Ul Haque(180070053)
Samarth Singh (180050090)
Niraj Mahajan (180050069)

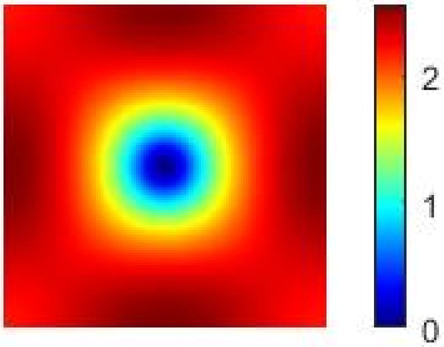

Figure 6.3: N,N-point DFT on **k2** (imshow)

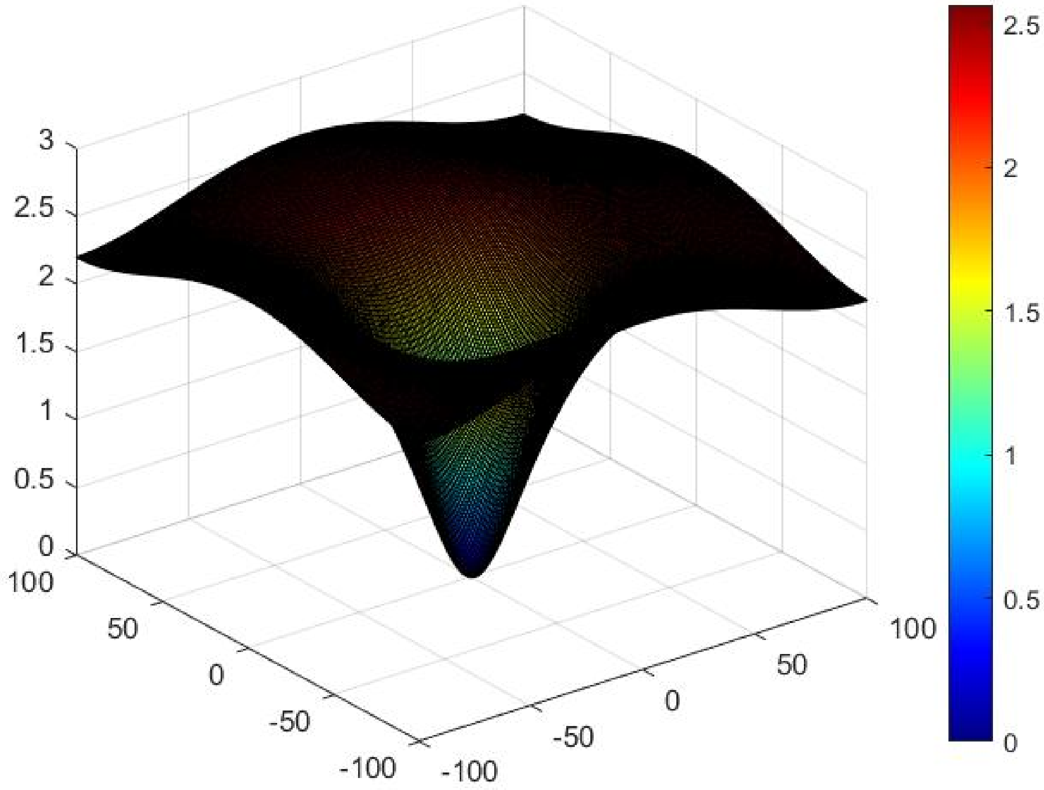

Figure 6.4: N,N-point DFT on **k2** (imshow)

Difference in Fourier Transforms of k1 and k2

Contours for k2 are roughly square (parallel to u and v axes) whereas for k1 they are roughly rotated squares. This can be inferred from the structure of kernels k1 and k2. In k2 we can visualise a square formed by connecting coordinates with value -1. We know that horizontal lines in x-y space result in vertical lines in u-v space on Fourier transformation and similarly vertical lines are translated to horizontal lines. Thus the Fourier transform will result in some square shaped contours parallel to u and v axes. In k1 we can visualise a rotated square formed by connecting coordinates with value 1. Using rotation transformation in DFT we know that the Fourier transform will result in some rotated square shaped contours.