Chynelle Ziarah C. Villostas Lab Output - Fourier Transform II
Below is the circular aperture function used in the activity:

```
#create space
N = the_cat.shape[0]  # make the same size as the cat image
space = np.linspace(-10, 10, N)
X, Y = np.meshgrid(space, space)

#Circular aperture
def circ_aperture(radius):
    Z = 1.0 * ((X**2 + Y**2) <= radius**2)
```

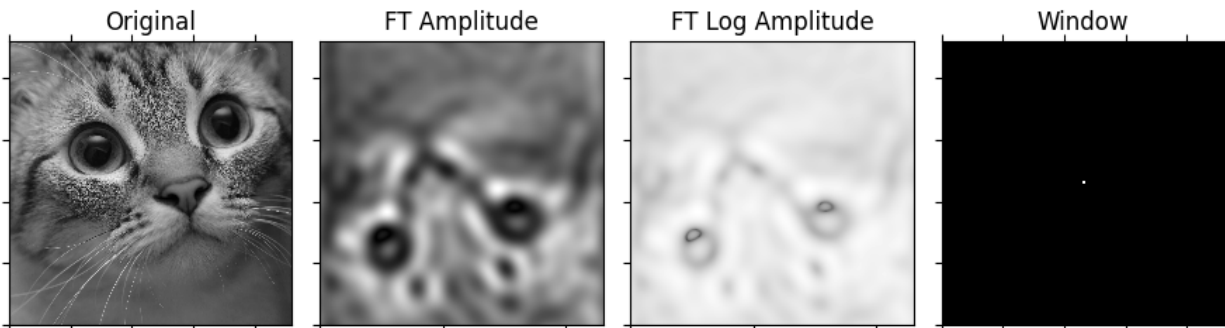Here are the results for varying the radius of the aperture:

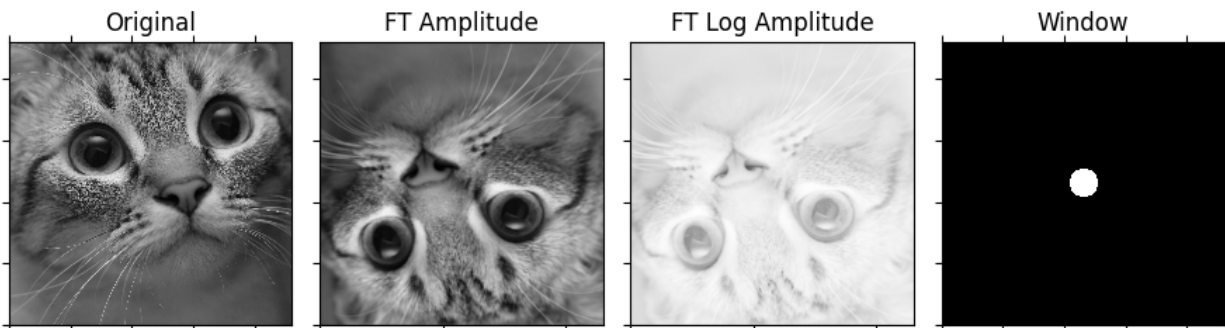Figure 1: Resulting image of a circular aperture of radius 0.1

Figure 2: Resulting image fo a circular aperture of radius 1

The resulting image is one that is upside down, lighter, and less defined than the original. As seen from the figures, increasing the radius of the circular aperture results in a clearer picture. It's not noticeable immediately with just the images above, however when we actually plot the Fourier transform of a circular aperture, we get concentric disks with that decrease intensity as it radiates outward. Looking closely at the images, that effect gets "put on" the original image. Even if this pattern isn't seen immediately, what's important is that a smaller circular aperture makes a wider spread in the Fourier domain so the pattern really affects the original image. On the contrary, a bigger circular aperture makes a narrower spread in the Fourier domain, which makes the image look clearer.

Below is the annular aperture function used in the activity:

```
#the space is already defined previously
#annular aperture
def ann_aperture(o_rad, i_rad):
    Z_ann = X**2 + Y**2
```

```
outer_circ = 1.0 * (o_rad**2 >= Z_ann)
inner_circ = 1.0 * (Z_ann >= i_rad**2)

aperture = outer_circ + inner_circ
```

Here are the results for varying the inner radius of an annular aperture with an outer radius of 10.
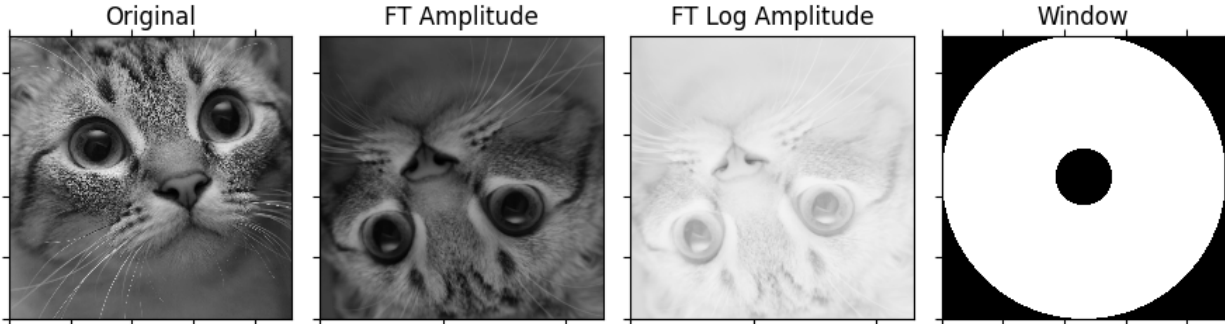

Figure 3: Resulting image for an annular aperture of radius 2
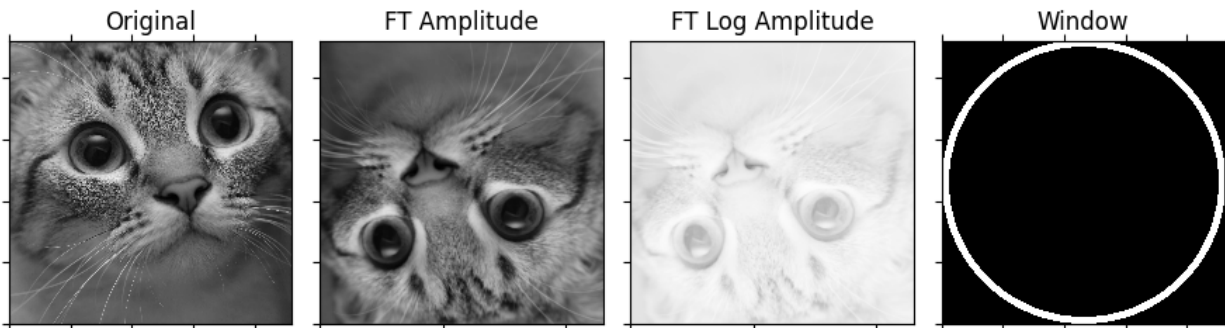

Figure 4: Resulting image for an annular aperture of radius 9.5

Just like the circular aperture, the resulting image here is also upside down, and less clear than the original. As we increase the size of the inner radius, we get a brighter and less defined picture. Just like what was previously mentioned, a bigger aperture or opening makes a narrower spread in the frequency domain, vice versa. So a big outer radius, with a small inner radius (thick) makes a better or clearer picture than the one with a big outer radius (thin).

Finally, below are the results for varying the inner radius of an annular aperture with an outer radius of 1.
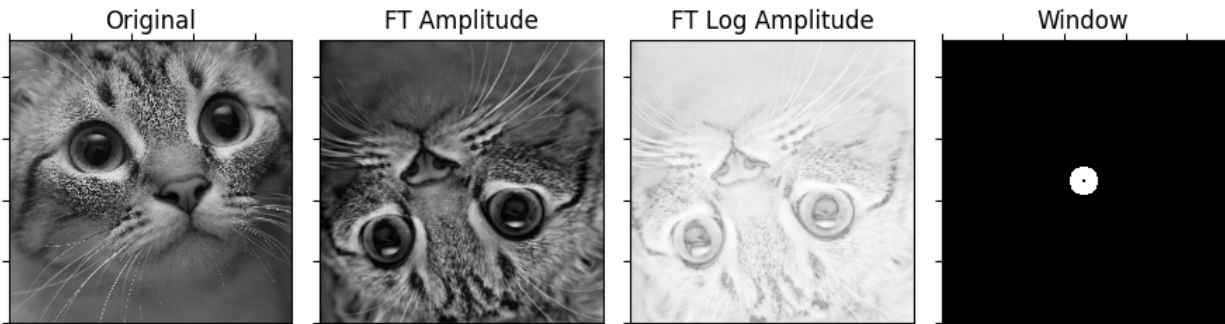

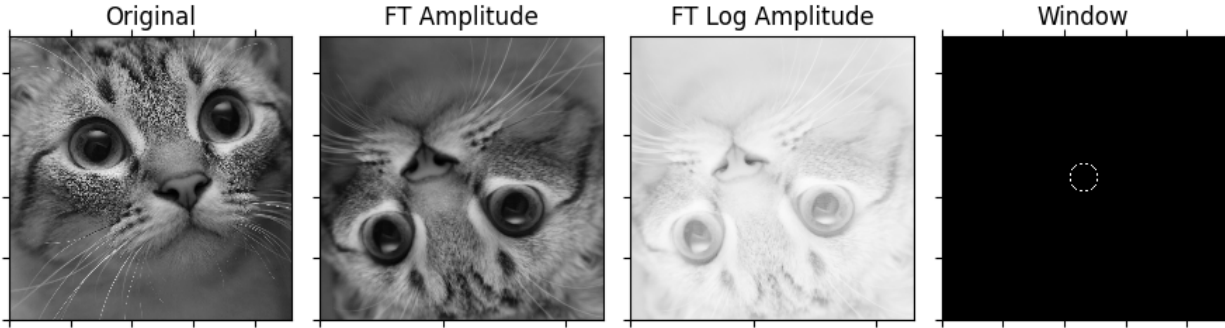Figure 5: Resulting image for an annular aperture of inner radius 0.1

Figure 6: Resulting image for an annular aperture of inner radius 0.95

Again, we have an upside down image that is less clear than the original. Just like what was mentioned, the thinner ring results in a clearer output, while a thicker ring blurs the image more. Finally, let's answer what "putting a mask in the middle of the 4f setup" effectively do. So the setup is essentially 2 lenses, separated by twice their focal length, hence the name "4f". The input is put behind one of the lenses, and so the image or output should be in front of the other lens. In between the 2 lenses is the "Fourier Plane", so a mask in the middle of the setup is essentially like a filter in the spatial frequency space.