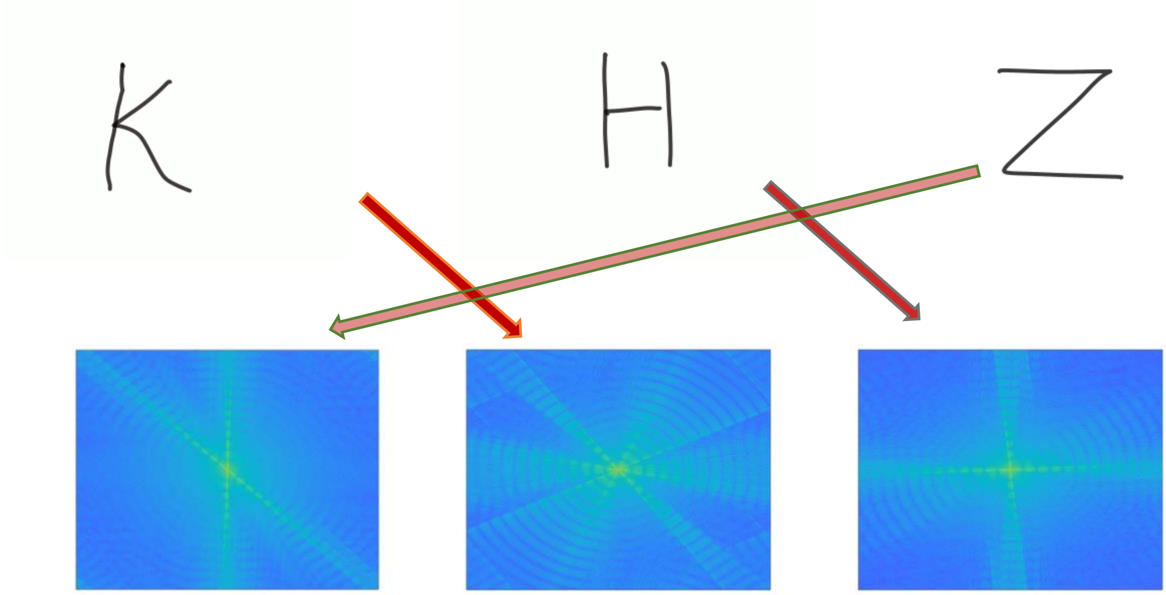
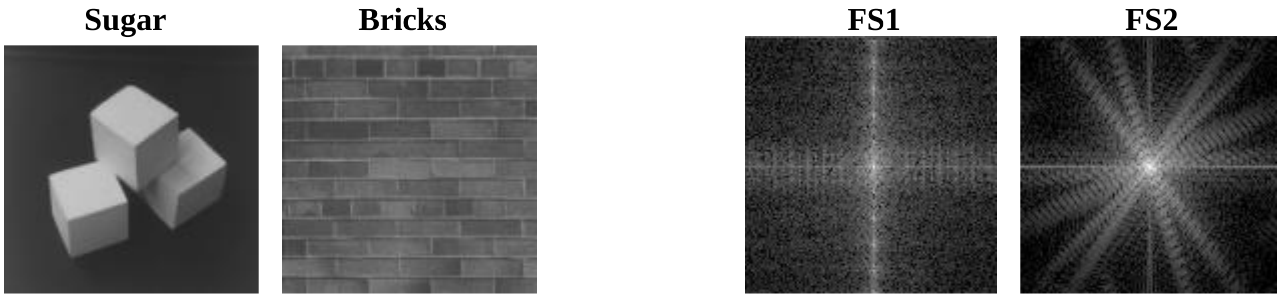
COMS20011 – Data-Driven Computer Science

Problem Sheet MM03

1 – Here are images of three handwritten letters. Their Fourier spaces are randomly shown. Match each image with its own Fourier image.

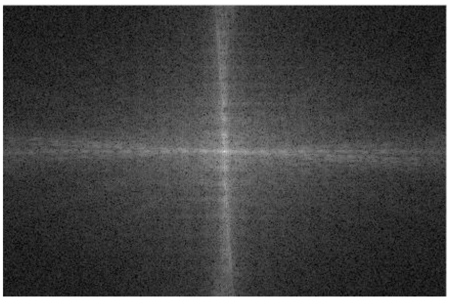


2 – Similar to the previous question, consider the two images (Sugar and Bricks) on the left. Identify which of the Fourier spaces (FS1 and FS2) on the right belongs to which image and explain briefly why.

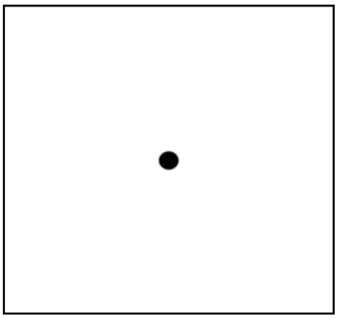


FS2 belongs to the sugar blocks image and FS1 belongs to the brick image. The high magnitude frequencies in FS1 are for the Brick image as they clearly signify the presence of very strong horizontal and vertical lines in that image. The angled lines in the sugar blocks image result in the strong non-horizontal and non-vertical directional lines in FS2.

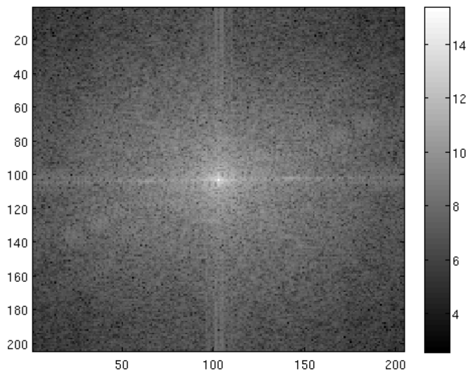
3 – The figure below on the left shows an image of a building wall, with its Fourier Space magnitudes shown in the middle. A reconstructed image (inverse FFT image), after some manipulation of the Fourier magnitudes, is shown on the right. How should the Fourier space be manipulated (e.g., what kind of a mask could have been applied to it) to achieve this reconstructed result? Include a sketch to illustrate your answer.

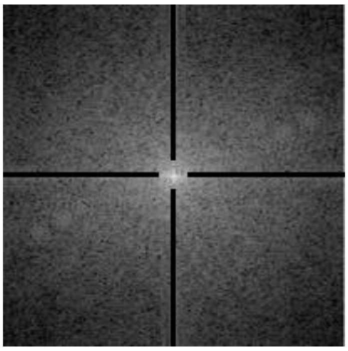

Much of the contrast has been removed and an almost edge-map of the image has resulted. Edges signify high frequency changes in the image pixels. Hence, all this evidence points to a loss of low frequency magnitudes. The mask applied to the Fourier space magnitudes is therefore something similar to this:



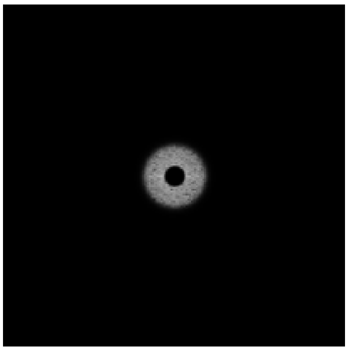
4 – Below is an original image of a clown and its Fourier space after an FFT operation.

Next, there are three images, labelled (A;B;C), in each case after applying a specific mask to the Clown's Fourier space.



A

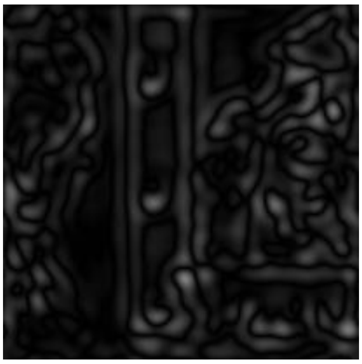


B

C

Below, there are three results, labelled (X;Y;Z) that represent in an arbitrary order, the inverse FFT of the Fourier spaces in (A;B;C) above. Explain which inverse FFT space corresponds to which filtered image.

X



Y

Z

A results in Z because it is clear that many horizontal and vertical frequencies are eroded except those around the centre. All other frequencies remain too. B results in Y because this band pass filter loses key low frequencies and much of the mid-range to high frequencies. The outcome shows little contrast and no sharp changes. Finally, C produces X. Contrast is somewhat preserved and sharpness is lost, but what exists is very directional as many frequencies are missing along other directions.