COMS20011 – Data-Driven Computer Science

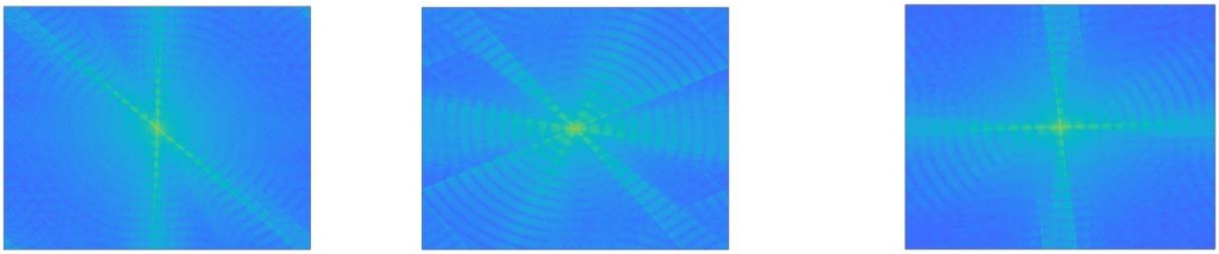
Problem Sheet MM04

1 – How would low pass filtering be achieved using the Fourier domain? In your answer describe what is meant by Cut-off Frequency.

2 – Consider you are given the Fourier Transform space of an image. Using simple descriptions or sketches to illustrate your answer, how would you select relevant regions to extract spectral features from

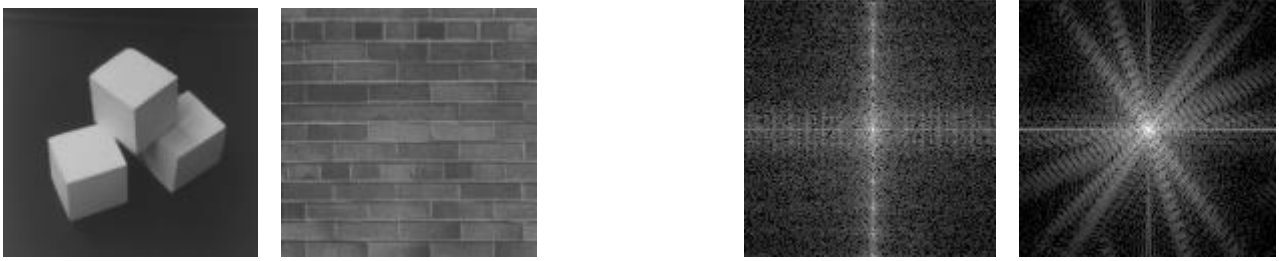
(a) only low frequency regions,
(b) only the very high frequency regions corresponding to prominent variations in intensity in the image that are at around 45 degrees to the horizontal,
(c) all approximately mid-range frequencies.

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



4 – 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.

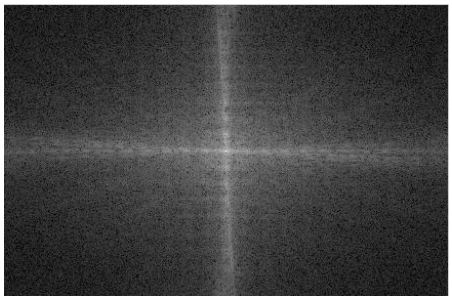
Sugar **Bricks** **FS1** **FS2**



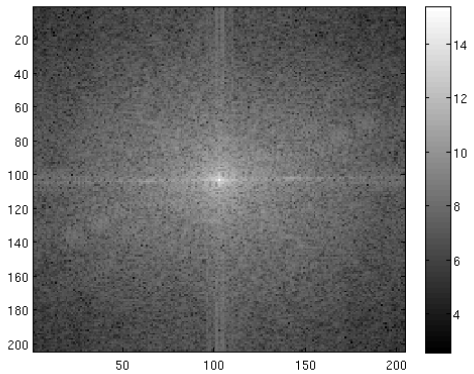
5 – Rotate an object, Fourier space rotates too. Translate an object, Fourier space translates too.

(a) Both statements are **True**.
(b) First statement is **True** and second one is **False**.
(c) First statement is **False** and the second one is **True**.
(d) Both statements are **False**.

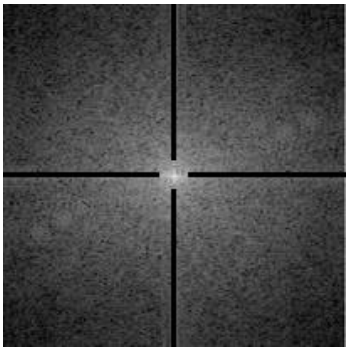
6 – The figure below on the left shows an image of a building wall, with its Fourier Space magnitudes shown in the middle. A reconstructed image (inverse FFT image), after some manipulation of the Fourier magnitudes, is shown on the right. How should the Fourier space be manipulated (e.g., what kind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

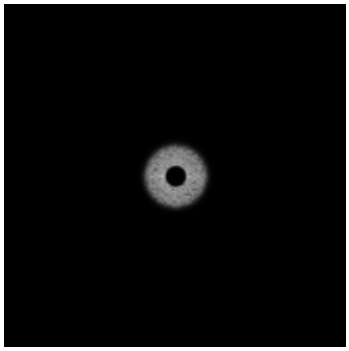

7 – Below is an original image of a clown and its Fourier space after an FFT operation.

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



A

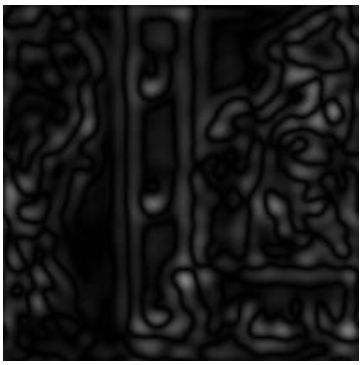


B

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

8 – What are the two 1D filters that can replace the 2D filter (in each example for W and X) if they were applied consecutively?

$$W = \frac{1}{9}\begin{pmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{pmatrix} \qquad X = \begin{pmatrix} 1 & 1 & -1 \\ 2 & 2 & -2 \\ 1 & 1 & -1 \end{pmatrix}$$