Assign 3, ECE350/CSE340
Monsoon, 2021

Instructions: For theory, show all steps involved.

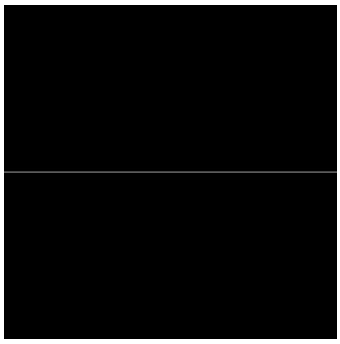
All questions carry equal marks.

Q1. Write a code for 2nd order Butterworth filtering in Fourier domain. You can use the cameraman image and resize it to 256x256. You should perform

- Centered 2D DFT of input image. You can do this by multiplying image by $(-1)^{n+m}$. Note you must apply zero-padding of sufficient size.
- Define the centered filter in Fourier domain using a cut-off D0 = {10, 30, 60}.
- Multiply both DFT' elementwise.
- Take IDFT and take real component
- Perform inverse centering by multiplying $(-1)^{n+m}$
- Crop the size of input image from top left
- Show the above for all three cut-offs.

You can use inbuilt FFT commands and resizing commands. Your code must clearly show the code for filter. You are not allowed to use any inbuilt function which can just take D0 as input and give the filter.
Show the input image, zero-padded input image, magnitude spectrum of zero-padded input image, centered magnitude spectrum of zero-padded input image, the filter, centered magnitude spectrum of filter, and output image for all cut-off frequencies. You should observe that with increasing D0, the blurring decreases.

Q2. Theory. Compute 2d DFT of a line image given below. The image is of dimension 512x512 and the line is at n = 256. The intensity of line is 1. The origin is at top-left.



Q3. Given a cameraman image and a Box filter of size 9x9-
Obtain the convolution of image with the filter using DFT.

- You need to zero pad both image and filter
- Compute 2D DFT of both
- Multiply elementwise

- Take IDFT
- Take real part and display
- Verify the output using a spatial convolution. You can use inbuilt functions for convolution.

You can resize the image to 256x256.

Q4. Denoise the Barbara' corrupted image (left { noiseIm.jpg }) given below


The output should be atleast as given in the right image (denoiseIm.jpg) or better.

- You first need to investigate the noise that is added to obtain the left image (noiseIm.jpg). It is some sort of sinusoidal noise.
- Then identify which part of the frequency components are corrupted and block only those components.
- You need to design a filter which can block the frequencies that correspond to the noise. For this, you need to inspect the magnitude spectrum of the image and determine the coordinates of component that are corrupted.
- Once you determine the coordinates you can design the filter using an appropriate cut-off. The cut-off can be small, may be of the order of 1-10% of one of the dimensions.