**ASSIGNMENT 1**

**Due date - 05-02-2024**

**CT IMAGING**

Q1) A sinogram is a 2D plot showing all the projections for a CT scan. On the horizontal axis, each projection is displayed. Each vertical line has the data from a different projections. The vertical lines are organized so that the projection angle increases from 0 to 180 degrees. A point in the image will move as a sine wave in a sinogram – hence the name. Generate the sinogram of a Shepp Logan phantom

**Clues**

Decide number of projections and use Radon transfrms (say eg. projections with an angular spacing of 0.5° over 180°.

Hint: you can use the MATLAB function radon. Provide an image of the sinogram.

Q2) What do you mean by filtered back projection? Use a good filter (e.g. Mexican hat wavelet, Shepp-Logan Filter, Rectangular filter etc.) or any other along with backprojection and redo the exercise and show the results of filtered backprojection. Compare the two results and comment how you can make it better.

Q3) Perform projection tomography on shep logan using blind backprojection and show the reconstruction.

Q4) Implement projection and back-projection using Radon transform on Shepp Logan phantom.  
Generate a sinogram using 360-degree projection.  
**Clues**  
Decide number of projections and use Radon transforms (say eg. projections with an angular spacing of 0.5° over 180°. Hint: you can use the MATLAB function radon. Provide an image of the sinogram.

Q5). Show a reconstruction of shep logan phantom applying Central slice theorem on shepp logan  
phantom.

Q6). Implement filtered backprojection with different filters and find mean squared error between original image and reconstructed image for all filters. 1. Ram-Lak 2. Shepp-Logan 3. cosine, 4. Hamming.

Q7) What are the limitations of projection radiography?

**XRAY IMAGING**

1. What factors affect the SNR in x-ray imaging? What is the dose increase if 𝑆𝑁𝑅 doubles?  
2. What is beam hardening?  
3. Define aliasing, bandwidth limiting and the Nyquist condition  
  
4. If the thickness of the chest is 20 cm, what percentage of X-rays are transmitted through the chest at an incident X-ray energy of 70 keV assuming HVL values of 3.5 and 1.8 cm21 for muscle and bone, respectively, and the bone thickness to be 4 cm and the tissue thickness 16 cm?  
5. Two X-ray images of the hand are shown in Figure. One corresponds to an X-ray beam with an effective energy of 140 keV and the other to an effective energy of 50 keV. Explain which is which, and the reasons for the differences in image contrast and signal intensity.

A close-up of a hand

Description automatically generated

6. Assume that friend came to you for getting your opinion on getting Xray imaging for heart related diseases. How would you advise them and what are the pros and cons?  
7. Below is the basic diagram for an Xray machine, but something is wrong with it. Can you find that and explain the system briefly?

A diagram of a circuit

Description automatically generated  
8. Using your knowledge of Fourier convolution, calculate the Fourier transforms of the following functions and draw both the real and imaginary spectra. k0 is a real number.  
a. cos2(k0 z) b. sin3(k0 z)