

Q.1. Write and proof the various properties related to 2D Discrete Fourier Transform.

Q.2. (a) Write python from scratch for computing 2D DFT $\{X(k,l)\}$ of the following 2D array

(i) $x(m,n) = \text{np.array}([[1, 0], [2, 1]])$

(ii) $x(m,n) = \text{np.array}([[1,2, 3,4], [5, 6, 7, 8], [9,10,11,12], [13,14,15,16]])$

(b) Verify the results of part (a) by analytical solution method (i.e. pen and paper based solution)

Q.3. Write python from scratch for 2D Circular convolution using Doubly Block Circulant matrices method between $\text{input}=\text{np.array}([[1,2,3],[4,5,6],[7,8,9]])$ and $\text{filter}=\text{np.array}([[1,2,1],[0,0,0],[-1,-2,-1]])$