Tutorial: Discrete Cosine Transform

Q1

(a) Describe the technical reasons how the Discrete Cosine Transform of a signal x[n] produces only real numbers.

(b) Use the DCT/IDCT transform equations to compute the DCT of x[n] and the IDCT of X[k] where x[n]=[2 4 6 4] and X[k] = [12 2 4 1]. Verify your answers using the DCT and IDCT matlab command.

(c) Write notes on the use of the DCT for compression and use illustrations in your answer.

Q2.

(a) The 2D Discrete Cosine Transform (DCT) of a 2D NxN signal $\boldsymbol{X}=X(i,j)$, $i= 0,1,2\ldots N-1$ and $j=0,1,2\ldots N-1$ can be formed by firstly computing the DCT of all rows of $\boldsymbol{X}$ and storing this in a new matrix $\boldsymbol{Y}$ and then taking the 1D DCT of all columns of Y. Using the DCT compute the 2D DCT ($\boldsymbol{X_{DCT}}$) of the following 2x2 2D signal ($\boldsymbol{X}$):

$$X = \begin{bmatrix} 10 & 4 \\ 3 & 10 \end{bmatrix}$$

(b) As part of a process to compress $\boldsymbol{X}$, any absolute value of $\boldsymbol{X_{DCT}}$ from part (a) above that is less than 0.7 is assigned to zero to form $\boldsymbol{X_{DCT\text{-}thr}}$. Using the Inverse DCT formulation compute the Inverse 2D DCT of $\boldsymbol{X_{DCT=thr}}$ to form **X-recon**

(c) Compute the mean square error in dBs for the compression process described in part (c) above.