**TASK**

**Part I**

1. Use MATLAB to design a bounded-input bounded-output (BIBO) stable lowpass infinite impulse response (IIR) digital filter, which, if used after sampling an analogue signal with sampling rate 10 kHz, attenuates frequency components above 500 Hz. Plot the magnitude response and the phase response of your filter. Explain your design and discuss your plots.

1. Apply your filter to the MATLAB built-in audio signal ‘chirp’. Plot and listen to the original signal and the filtered signal. Compare the two signals.

1. Use the MATLAB function spectrogram to plot the spectrogram of the original ‘chirp’ signal and the spectrogram of the signal after applying your filter. Your plots must show time on the x-axis. Explain how you used the spectrogram function and analyse your plots.

1. The file problem1-4.wav contains an audio signal that has been corrupted with noise. Design in MATLAB a digital filter to remove the noise from the signal. Justify your design and discuss your results.

**Part II**

The signal stored in the file part2.mat was obtained by sampling a continuous-time signal x(t) at 1 kHz and adding random noise. Use the discrete Fourier transform (DFT) to analyse the frequency content of the signal x(t). You must explain your answer.

**Part III**

1. Write a MATLAB function that takes as input arguments a 512x512 grayscale image and an integer n (0<n<65), (1) partitions the image into 8x8 blocks, (2) computes the 2D-discrete cosine transform (DCT) of each block, (3) orders the DCT coefficients in each block according to the zig-zag scan, (4) sets the last n coefficients in each block to zero, (5) computes the inverse 2D-DCT of each block of coefficients, and (6) displays the reconstructed image.

1. Plot the peak signal-to-noise ratio (PSNR) and the structural similarity (SSIM) index as a function of n for n=2, 4, 8, 32, 64 when the input image in part 1) is ‘boat.512’ (Fishing Boat) Show the reconstructed image for each value of n. Analyse the results.