# EE6310 Image and Video Processing, Spring 2023

Indian Institute of Technology Hyderabad
Homework 3, Assigned 26.02.2023, Due **11:59 pm on 05.03.2023**

*Train yourself to let go of everything you fear to lose.* – Jedi Master Yoda

**Instructions:**

- You can work with grayscale images used in HW1.
- Please turn in Python Notebooks with the following file name convention: `your-roll-number`-hw3.ipynb.
- Do not turn in images. Please use the same names for images in your code as in the database.

## 1 Periodic Convolution

Write a program to do the following:

1. Circulary convolve two images. Test your program by using an image and an averaging filter of size $5 \times 5$. (5)
2. Linearly convolve the same image and filter using the circular convolution function above after appropriate zero padding. (2)
3. Now, verify that you can perform linear covolution using the DFT of zero padded images. Use your DFT implementation for HW2 for this verification. (3)

## 2 Image Denoising using Linear Filters

In this problem you will denoise images using the linear filtering techniques discussed in class. Use additive white Gaussian noise (AWGN) with zero mean and variance $\sigma^2 = 25$. Write a program to denoise the image using the following techniques:

1. Average filter of size $M \times M$. Vary $M$ from 3 to 15 in increments of 2 and observe the tradeoff between denoising and smoothing. What could be an appropriate window size for this noise level? (5)
2. Gaussian filter of size $5 \times 5$. Experiment with the standard deviation $\sigma_h$ of the filter from 0.5 to 5 in steps of 0.5 and observe its effect on denoising. (5)

## 3 Image Quality Assessment

In this problem you will compare the two full reference image quality assessment techniques discussed in class – PSNR (MSE) and the SSIM index. This problem is aimed at understanding the shortcomings of PSNR (MSE) in measuring image quality.

1. Write a Python function that accepts a pair of images of identical dimensions and computes the MSE and PSNR between them. (2)
2. Write a Python function that accepts a pair of images of identical dimensions and computes the SSIM index between them. The function should return the mean SSIM (MSSIM) index as well as the SSIM map. Use the definition of the SSIM index from the slides and use a Gaussian window for the weighted mean, variance and covariance computations. (8)

Write a program to generate the following distortions:

1. Mean shift by 16. (1)

2. Additive white gaussian noise (AWGN) with standard deviation $\sigma = 16$. (1)

3. JPEG compression at quality level 10. Use any open source Python library for this. (1)

4. Gaussian blur using a $5 \times 5$ window with $\sigma = 2$. (1)

Work with 3 images of your choice from the set mentioned in 'Instructions' above. Subject the images to the distortions mentioned above. Compute the MSE, PSNR and SSIM index for each distortion. Also, rate the images yourself (subjectively) using a continuous scale between 0 and 1. Compute the correlation between your scores and PSNR, your scores and SSIM. What can you conclude about the two metrics? (1)