Course code: **Ex/ET/PE/B/T/424/G/2025**

B.ETCE 4TH YEAR 2ND SEMESTER EXAMINATION

Digital Image Processing

Session 2024-25

Full Marks: 100. Total Time 3 Hours.

Part I Answer any 10 questions **(CO1) 10x2=20**

1. What does the pixel of a digital image signify?
2. What does the histogram plot?
3. When are geometric transformations needed?
4. Why is interpolation needed in image processing?
5. State the difference between array operation and matrix operation.
6. What is the full form of MRI?
7. What are adaptive filters in digital image processing?
8. Give the expression for the Wiener filter.
9. Name the steps involved to generate the .JPEG files.
10. State the characteristics of the PNG format?
11. State one advantage of lossy compression over lossless compression.
12. State the characteristics of monochromatic light.
13. Name the three fundamental steps performed in edge detection.
14. What kind of image does thresholding produce?
15. Name two edge detectors in image processing.
16. Define a feature descriptor in Image Processing.
17. Which colour image characters are taken together in chromaticity?

Part II Answer any 3 questions **(CO2) 10x3=30**

1. Define the histogram of a digital image with a sketch. Why are histograms considered useful tools for enhancing images? Write the algorithm for histogram equalization and explain how it improves the contrast of the corresponding image. 3+3+4

2. Obtain a 3x3 mask for performing unsharp masking in a single pass through an image.
   Define a Laplacian in image processing.
   Show that subtracting the Laplacian from an image is proportional to unsharp masking.
   4+3+3

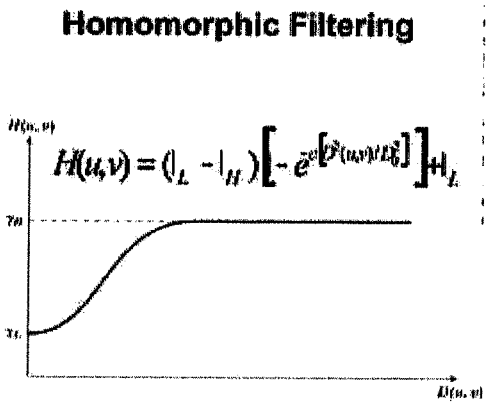
3. A 3x3 spatial mask averages the four closest neighbours of a point (x,), but excludes the point itself from the average. Find the equivalent filter H(u,v) in the frequency domain and show that the result is a lowpass filter. 10

4. Find the best transformation function for histogram equalization if we model the histogram of input images as Gaussian probability density functions of the form shown.

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}$$

10

5. Construct a homomorphic filter using a Buttersworth highpass, that has the same general shape as the filter shown. State the steps in detail. 10



Part III Answer any 3 questions **(CO3) 10x3=30**

1. Define the alpha-trimmed mean filter. Give the condition under which it reduces to the average or mean filter. Explain under which condition the behavior of this filter tends towards the performance of median filter? 2+4+4

2. Consider a linear, position-invariant image degradation system with impulse response $h(x-\alpha,y-\beta)=e^{-[(x-\alpha)2+(y-\beta)2]}$. Let the input to the system be an image consisting of a line of infinitesimal width located at x=a and modeled by $f(x,y)=\delta(x-a)$, δ representing an impulse. Find the output image in absence of noise. 10

3. List the general characteristics of adaptive filters. State the steps of Adaptive Median filter and explain how it works to remove noise. 4+6

4. Illustrate variable-length coding procedures to be used for compression of a histogram equalized image with 2^n intensity levels. Also show how such an image containing spatial or temporal redundancies can be exploited for data compression. 5+5

5. Write a short note on the CMY colour model and its benefits. Derive the CMY transformations to generate the complement of a colour image. 6+4

6. Implement the LZW coding algorithm to encode the 7-bit ASCII string "aaaaaaaaaa". 10

Part IV Answer any 2 questions **(CO4) 10x2=20**

7. Establish the importance of gradient operator for image segmentation. Demonstrate that the Sobel and Prewitt masks give isotropic results only for horizontal and vertical edges oriented at $\pm 45^0$, respectively. 5+5

8. a) Write the Canny edge detector algorithm.
   b) Formulate Step I and the gradient magnitude image computation in Step II of the Canny algorithm using 1-D instead of 2-D convolutions.
   c) Demonstrate the computational advantages of using the 1-D convolution approach. 2+4+4

9. a) Show that if the histogram of an image is uniform over all possible intensity levels, the basic global thresholding algorithm converges to the average intensity of the image (L-1)/2.
   b) Restate the basic global thresholding algorithm so that it uses the histogram of an image instead of the image itself. 5+5

10. Write and explain the region splitting and merging algorithm. Mention one advantage of this segmentation algorithm over other methods. 8+2