Course code: **Ex/PG /ETC/PE/T/123B/2025**

M.E. Electronics and Tele-communication Engineering

1st Year 2nd Semester Examination

Digital Image Processing

Session 2024-25

Full Marks: 100. Answer any 10 questions Total Time 3 Hours

Part A-CO1: Answer any 2 questions 10x2

1. State the power law transform. Why are offsets implemented and required in the expression? How do the relation between input intensity level r change with output intensity level s for gamma less than 1 and gamma greater than 1 and explain the effect on the output images. 2+2+6

2. (i)Prove that both the 1-D continuous and discrete Fourier transforms are linear operations.
   (ii) Show that the Fourier transform of the 2-D continuous sine function

   $f(x,y) = Asin(u_0x + v_0y)$ 5+5

3. Explain the difference in operation of a mean filter and a median filter. Also explain how the resulting images are different from one another. 5+5

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

Part B-CO2: Answer any 3 questions 10x3

5. How is Image Sharpening done in frequency domain? Compare image sharpening performance with Ideal, Butterworth and Gaussian highpass filter. 5+5

6. Explain the concept of tristimulus values and chromaticity in the context of color images. How does device dependency impact the display of RGB color images across different devices? 6+4

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

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8. 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

Part C-CO3: Answer any 3 questions 10x3

9. Consider the simple 4x8, 8-bit image as given:

21	21	21	95	169	243	243	243
21	21	21	95	169	243	243	243
21	21	21	95	169	243	243	243
21	21	21	95	169	243	243	243

   a) Compute the entropy of the image.
   b) Compress the image using Huffman coding.
   c) Compute the compression achieved and the effectiveness of the Huffman coding.

   3+3+4

10. Develop an algorithm for a nxn filter that is applied to an image by systematically scanning the image and computing the sum of the products of the mask or filter coefficients with corresponding pixel values. 10

11. If we model the histogram of input images as Gaussian probability density functions of the form shown, explain what would be the best transformation function for histogram equalization then? 10

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

12. 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

13. Examine the differences between an Inverse Filter and Wiener Filter in the frequency domain. Show how the parameter Mean Square Error or MSE is derived from it. 8+2

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CO4 : Answer any 2 questions 10x2

14. 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

15. Remodel the basic global thresholding algorithm so that it uses the histogram of an image instead of the image itself. 10

16. Develop an expression for the blurring function *H(u,v)* for the following case: During acquisition an image undergoes uniform linear motion in the vertical direction for a time T_1. The direction of motion then switches to the horizontal direction for a time interval T_2. Assuming the time taken for the image to change directions is negligible, and that the shutter opening and closing times are negligible too. 10