

MASTER OF COMPUTER SC. & ENGG. 2ND SEM. EXAMINATION – 2025

Image Processing and Computer Vision

Time: Three Hours

Full Marks: 100

Answer any FOUR questions

1. a) Briefly discuss different neighbourhood and adjacency relationships between pixels. Define the formulations for 4-, 8- and m -adjacency. Consider the image segment shown below. Let $V=\{0,1\}$ and compute the lengths of the shortest 4-, 8-, and m -paths between p and q . Repeat for $V=\{1,2\}$. If a path does not exist between these two points, explain why.

Let R be the last two digits of your Exam Roll Number. $R\%2$ is the result of the Modulo operator, such that, if $R=23$, $R\%2$ is 1 and, if $R=40$, $R\%2$ is 0.

	3	1	2	1	<i>(q)</i>
	2	2	R%2	2	
	1	2	R%2	1	
<i>(p)</i>	1	0	1	2	

- b) What are morphological Open & Close operations? Design the morphological operations required for boundary extraction and region filling of an object.
- c) How to map 2-d functions to 1-d functions? Design a function $r(\theta)$ for a circle of radius A and a square with edge length D .

10+10+5 = 25

2. a) What is Adaptive Median Filter? Consider the following image segment. Compute 3×3 *Adaptive Median filter* and generate the resultant image. Let R be the last two digits of your Exam Roll Number. What is padding? What padding strategy will you adapt in this case to handle the edge pixels at the boundary?

120	105	110	115	130
140	R	150	R	170
135	155	185	195	190
195	R	200	R	195
165	170	175	170	150

- b) What is HSI color model? Derive the formulation for RGB to HIS conversion and vice-versa. What is intensity slicing in pseudocolor images?
- c) Justify the statement - "It is a common practice to multiply the input image by $(-1)^{x+y}$ prior to computing Fourier transform.", where $f(x, y)$ is the input image function.

10+10+5=25

[Turn over

3. a) Explain the steps involved in JPEG compression of an image.
 b) Write the algorithm for the construction of a Huffman Tree. Use Huffman Coding to encode/decode the following text. Create the frequency table, Huffman tree and show the encoding and decoding steps with examples.

“huffman tree of <your favourite person’s name in lower case>”,

For example, if your favourite person’s name is “Elon Musk”, the text will be: **huffman tree of elon musk**. Please consider space/blank as a character. Ignore any other special characters.

10+15=25

4. a) What is Hough transform? How is it helpful to solve a vision task?
 b) How do convolutional layers in CNNs process visual data? What is the role of activation functions (e.g., ReLU) in CNNs? What is the purpose of pooling layers in CNNs, and how do they affect spatial dimensions? How do CNNs handle variations in object appearance, such as rotation, scaling, and lighting changes?
 c) A convolutional layer has a filter size of 3x3, stride 2, and padding 1. If the input image size is 28x28, what is the output feature map size? If the convolutional layer has 10 filters of size 5x5, with input channels 3. How many parameters (weights) does this layer have? If the max pooling layer has a pool size of 2x2 and stride 2. If the input feature map size is 16x16x32, what will be the output dimension?

5+10 +10 = 25

5. Write short notes on the following:
- Mexican Hat filter
 - Gaussian, Rayleigh, and Gamma* noise models
 - Wiener* filtering
 - CIE Chromaticity Diagram*
 - Histogram Equalization algorithm

5x5 = 25