



PES University, Bengaluru

(Established under Karnataka Act 16 of 2013)

END SEMESTER ASSESSMENT (ESA) - May 2023

UE20CS333 - Image Processing and Computer Vision

Total Marks : 100.0

1.a. **[3x2 marks]** Given that wavelengths other than visible light are used for imaging, state the type of signal used for imaging and any one application of each imaging modality listed below:

1. MRI scan
2. CT Scan
3. PET scan with a radioactive dye

(6.0 Marks)

1.b. **[4 marks]** For a 3 bits/pixel image of dimensions 6x6, the number pixels for each gray level are recorded below. After histogram equalization, what does the value of 3 in the input image get mapped to in the output? (Note: The output image is also encoded using 3 bits/ pixel.)

Gray level	0	1	2	3	4	5	6	7
No of pixels	5	3	6	4	4	4	4	6

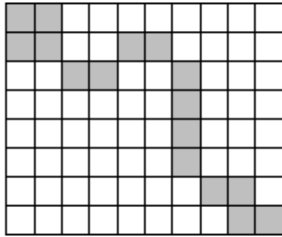
(4.0 Marks)

1.c. **[2 x 3 marks]** For each imaging condition described below,
 (i) draw a schematic diagram of the histogram of the image
 (ii) suggest a transform that can enhance the image and
 (iii) write the equation and graph the transform (input gray to output gray values).

Condition 1: An image is taken outdoors on a bright and sunny day with the flash switched on.

Condition 2: Due to nonuniform illumination in a basement and shadows cast, intensity values lie between 100 and 170. (6.0 Marks)

1.d. **[2x2 marks]** What are the number of connected components in the following binary image if we assume
(i) 4-adjacency and
(ii) 8-adjacency for the pixels shaded gray?
(Note: In the picture below, pixels shaded gray are assumed to have the value 1 (white) for foreground and pixels that are white are assumed to have the value 0 (black) for background.)



(4.0 Marks)

2.a. **[2 x 2 marks]** Give an example of a 3x3 filter that can be used with the convolution operator for

- (i) smoothing an image
- (ii) to find changes in the intensity of an image (or to find edges in an image)

(4.0 Marks)

2.b. **[2 + 2 marks]** Draw a schematic sketch of an ideal (2D) low pass filter and answer the following questions:

1. Why is this filter not preferred in practice?
2. Suggest a 'practical' alternative that tends to achieve the same effect without the undesirable artefacts.

(4.0 Marks)

2.c. Name a transform that matches the description below:

(i) symmetric

(ii) real

(iii) bases images are derived from the input image

(iv) generally implemented using a filter bank

(4.0 Marks)

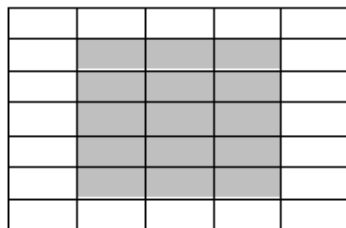
2.d. **[4 + 4 marks]** List the steps in sequence for each of the following processes –

(i) Homomorphic filtering

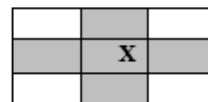
(ii) Unsharp masking

(8.0 Marks)

3.a. Given the binary image A and structuring element B, what is the result of the following operations? **(2+2+1)**



Binary Image A



Structuring element B

Please note: Pixels are the same size (and square). In these images, the pixels shaded gray have the value 1 (and represent white or the foreground), pixel values with white have the value 0 (and represent the background), the X mark indicates the origin or center of the structuring element.

1. A eroded by B

2. A dilated by B

3. In general, if erosion is followed by dilation, can we expect to recover the original image? Substantiate your answer with a reason.

(5.0 Marks)

3.b. [3 + 2 marks]

a) What is the hit or miss transform? How does it help identify any 'template' shape or binary object in an image?

b) What is the skeleton of an image? How can we compute this using morphological operations? (A brief explanation with an example will suffice; equations are not necessary.) (5.0 Marks)

3.c. List the steps in Canny edge detection and explain in a line how this leads to more accurate edges compared to other first order operators such as Canny or Sobel. (5.0 Marks)

3.d. [3+2 marks] List the steps used in segmentation using

a) thresholding (any one approach)

b) region splitting and merging (5.0 Marks)

4.a. 3x 3 marks Answer the following questions:

(i) Draw a schematic sketch of the CIE chromaticity diagram and mark the subregions that represent the color gamut for display systems and for printers.

(ii) What are the primary colors? List the combinations of primary colors that lead to the three secondary colors.

(iii) What is the HSI space? If an image appears very dark in the RGB space, what is the type of transformation we must apply to the corresponding HSI version of this image to see an improvement in the intensity values? (9.0 Marks)

4.b. Answer the following questions:

(i) (3 marks) For the table below , what is the average length of the code?

Symbol (s)	A	B	C	D	E	F
Probability P(s)	0.4	0.3	0.1	0.1	0.06	0.04
Huffman Code	1	00	011	0100	01010	01011

(ii) (2 marks) What is meant by lossy compression?

Give any example for this type of compression and where it can be used.

(5.0 Marks)

4.c. List the 3 types of redundancies that can be found in images and a method or compression technique that can be used to overcome each type of redundancy.

(6.0 Marks)

5.a. What is an 'Eigen face'? How it is obtained and used for face recognition?

(5.0 Marks)

5.b. (i) (3 marks) What is Freeman Chain Code (FCC) in the context of describing the boundary of a binary object? Does it change if the object is rotated?

(ii) (2 marks) what is the vignetting in computational photography? (5.0 Marks)

5.c. **[2 marks]** (i) List any two region-based feature descriptors.
[2 marks] (ii) How are boundary based or region based features used with the Naive Bayes classifier or SVM for image clarification? (Describe in a couple of lines.)
(5.0 Marks)

5.d. (i) What do the following layers in a CNN do?

a) Convolution layer **2 Marks**

b) Max pooling **2Marks**

(ii) What is a feature map? **1Mark** (5.0 Marks)