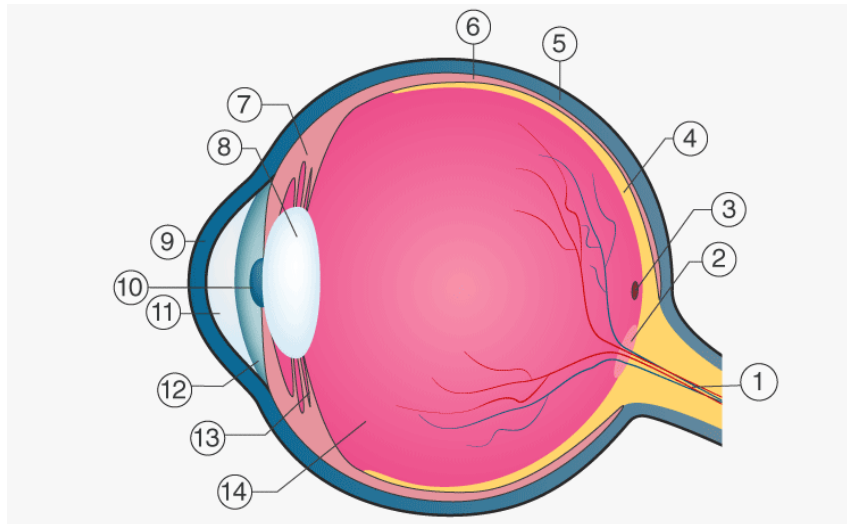


Name and Surname:

NIA

1. Please answer the following questions related to human visual system:
 - a. Fill the gaps in the following human eye representation (ONLY THE NUMBERS INDICATED IN THE TABLE) (1 point)



1	OPTIC NERVE
4	RETINA
8	LENS
10	PUPIL

- b. Which structures are responsible for night vision? Where are they located? (0.5 points)

Rods are responsible for night vision. They are located in the lateral parts of the fovea, very few in the center.

2 (1 point). Define the different levels of image processing/vision, giving an example of which structures or applications can be obtained from each of them.

Low level vision: extraction of basic image structures (edges, corners)

Mid level vision: integration of structures detected by low level vision. Example of application: object detection and segmentation

High level vision: integration of cognitive aspects. Example of application: image classification, object recognition

3 (1 point). Please define what depth of field is. Related to this concept, is the following sentence ("The less aperture, the smaller depth of field") true? If it is not the case, can you explain why?

Range of positions in which the object is correctly focused (size of an image point is equal or smaller to confusion circle)

The sentence is false: having a high aperture leads to a reduced depth of field

4 (1 point). Please provide a brief explanation of the concept of quantization. Which problems can we arise in later processing stages if we have a low quantization?

Discretization in amplitude / weight: it determines the number of bits we will use to represent the information.

Low quantization implies having less detail in our images, which can lead to a defective output of the image processing methods, particularly in classification/recognition.

5 (1 point). Explain what look up tables are. Include in the explanation which type of filtering they implement and an example of use.

Indexation vector to represent more complex and non-linear transformations.

A potential example of use could be in production lines to enhance specific intensity values associated to some defects and mitigate some others. It is different from thresholding in a way such the indexed values can be completely random and still work.

6 (1 point) What is image smoothing? Please specify at least two filtering methods that can perform image smoothing, stressing the main differences among them. Which are the benefits and drawbacks of image smoothing?

Modification of the intensity values of the image in a way such intensity profiles are flattened. It is useful to remove small noise particles but, in extrema cases, it can also lead to an undesired modification of the content of the objects (boundaries and inner content).

Two methods: mean filter, median filter, image addition (to remove noise mainly). Differences related to the type of filtering (non-linear vs. linear).

7. (1 point) Perform the following convolution operation. Calculate only the values of the positions highlighted in the original matrix.

2	4	2	4	1
5	3	3	6	3
4	5	2	3	3
3	4	4	7	4
2	2	3	4	5

*

5	2	3
4	4	7
2	3	4

New values:

5 → 79

3 → 120

4 → 113

8 (1 point) What is correlation? Why do we use it in image processing? How can we transform convolution into correlation?

Linear filter similar to convolution (here the kernel is not flipped). It is particularly useful for pattern matching and to calculate similarity between to images.

$$f(x, y) \circ h(x, y) = f(x, y) * h(-x, -y)$$

9 (1.5 points). Perform closing operation over the following binary image using the following structure element. Please indicate the output of each intermediate stage.

