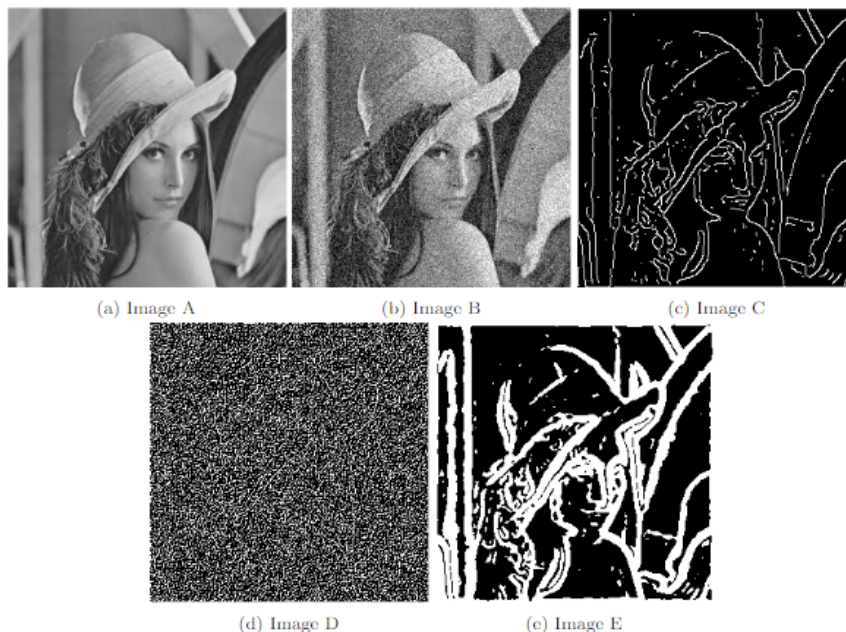


**Machine Vision (MCTE 4323)**  
**Sem 1, 2022/ 2023**  
**Assignment**

**QUESTION 1 (13 MARKS)**

- a) Explain the differences between the operation of convolution and correlation on an image. Why convolution is a more preferred method compared to correlation in image processing and recognition? (2 marks)
- b) If you convolve an image with filter H1 and then convolve the result with filter H2, does it give you the same result as when you first convolve with H2 and then with H1? (2 marks)
- c) In the operation of convolution in image processing and convolutional neural networks, sometimes it is desirable to retain the original dimension of the input image. Conversely, the convolutional operation tends to produce output of smaller size. Using an example of an image of size  $6 \times 6$  and convolutional kernel of size  $3 \times 3$ , propose two techniques to ensure that the output size is the same as the input size. (4 marks)
- d) Explain why the equation of line  $y=mx + c$  could lead to a mathematical flaw in hough parameter space? (2 marks)
- e) In Figure 1, Image A is the original image. To obtain Image B, we added some white noises to A. Three students have been asked to perform Canny edge detection on Image B as a pre-processing to a computer vision algorithm. Images C, D, and E are their final edge detection results. Only one student correctly answered the question. Which is the correct result? Explain for the other two images, what needs to be done in order to get good edge detection result. (3 marks)



## QUESTION 2 (12 marks)

- a) Show how the projection of a point in a planar scene at world coordinates  $(X, Y)$  to pixel coordinates  $(u, v)$  in an image plane can be represented using a planar affine camera model. (2 marks)
- b) A pinhole camera is described to have a camera matrix,  $P$  with a 3D point in homogeneous coordinates  $X = [0 \ 4 \ 8 \ 1]^T$ .

$$P = \begin{bmatrix} 5 & -14 & 2 & 17 \\ -10 & -5 & -10 & 50 \\ 10 & 2 & -11 & 19 \end{bmatrix}$$

- i. What are the Cartesian coordinates of the point  $X$  in 3D? (2 marks)
- ii. Determine the Cartesian coordinates,  $(u, v)$  of the projection  $X$ . (3 marks)
- c) Under what conditions is the use of an affine transformation appropriate when viewing a planar scene? (3 marks)
- d) How many degrees of freedom are there to solve for in (a), and what is the minimum number of calibration points needed to estimate the calibration parameters? (2 marks)