1. (20) A structuring element has been decomposed into two smaller structuring elements. Find this structuring element if the three smaller structuring elements are the following:

(a) *
   *
(b) *

2. (40) An image contains a number of well-separated fiducial marks or targets in the shape of a ’+’ in which the vertical line is 5 pixels high and the horizontal line is 5 pixels wide. Also present in the image is a set of horizontal lines with a width of two pixels and a separation of five pixels. The background variations are substantial with a dynamic range of 64:1. The objects have a gray-scale value which is 75% of the local background. Devise an algorithm that will detect the location of the targets and print out their centroids. The only programs available are LUT, ERODE, DILATE, BDIF, RL, CONNECT, and BLBAT. Do not worry about the exact syntax for using these programs. Indicate what operations are being performed. Also, estimate the minimum number of gray levels necessary to detect the dark objects regardless of the illumination level anywhere in this image.

3. (20) Generate the blobs in a compressed data format for the given binary image using four- and eight-connectivity. A '*' indicates that the pixel is on.

1 . . . * . * . * . * * * . . . * * . . . . . . . . . . . * . * .
2 . . * * . . . * . . . . . . * . . . . . . . . . . . . * * * . .
3 * * * * . . . . . . . . * . . . . . . . . * * * . . . . . .
4 . . * * * * . . . . . . . . * . . . . . . . * * . . . . . . . .

4. (20) A CCD camera observes a scene illuminated by an incandescent illumination source. Unfortunately, no matter how carefully the camera is focused, a sharp focus cannot be obtained. Describe at least two factors which may account for the poor focus.