



**RAJARATA UNIVERSITY OF SRI LANKA**  
**FACULTY OF APPLIED SCIENCES**

**B.Sc. (General) Degree in Information and Communication Technology**  
**Second Year - Semester I Examination – June/July 2018**

**ICT 2403 – GRAPHICS AND IMAGE PROCESSING**

**Time: Three (3) hours**

**Examination Index No:** 3574.

**Important Instructions:**

- This paper has 4 questions on 18 pages.
- Answer all questions (25 marks each).
- Write your answers in English using the space provided in this question paper.
- Do not tear off any part of this question paper.
- Note that questions appear on both sides of the paper.
- If a page is not printed, please inform the supervisor immediately.

**To be completed by the examiners:**

Marks	Question number				Total Marks
	1	2	3	4	

**Question 1**

- a) Compute how many gray levels are there in an image file with 18 kilobytes and  $48 \times 48$  sample size. Show all steps. (2 Marks)

- b) What is the difference between Spatial Resolution and Intensity Resolution? (2 Marks)

- c) Why it is important to use more neighbor pixels for Interpolation algorithms? (2 Marks)

- d) Convert RGB color (100, 200, 50) to CMYK model. Show all steps. (4 Marks)

- e) Scan Conversion is the major task of display processor. Briefly explain the steps in Scan Conversion. (2 Marks)

- f) What is the organizational difference between the Color Lookup Table and Direct Storage Scheme methods used in the frame buffer? (2 Marks)

- g) What type of lines can be detected by the filters depicted in Figure 1 (a), (b) and (c)? (6 Marks)

-1	-1	-1
2	2	2
-1	-1	-1

(a)

-1	-1	2
-1	2	-1
2	-1	-1

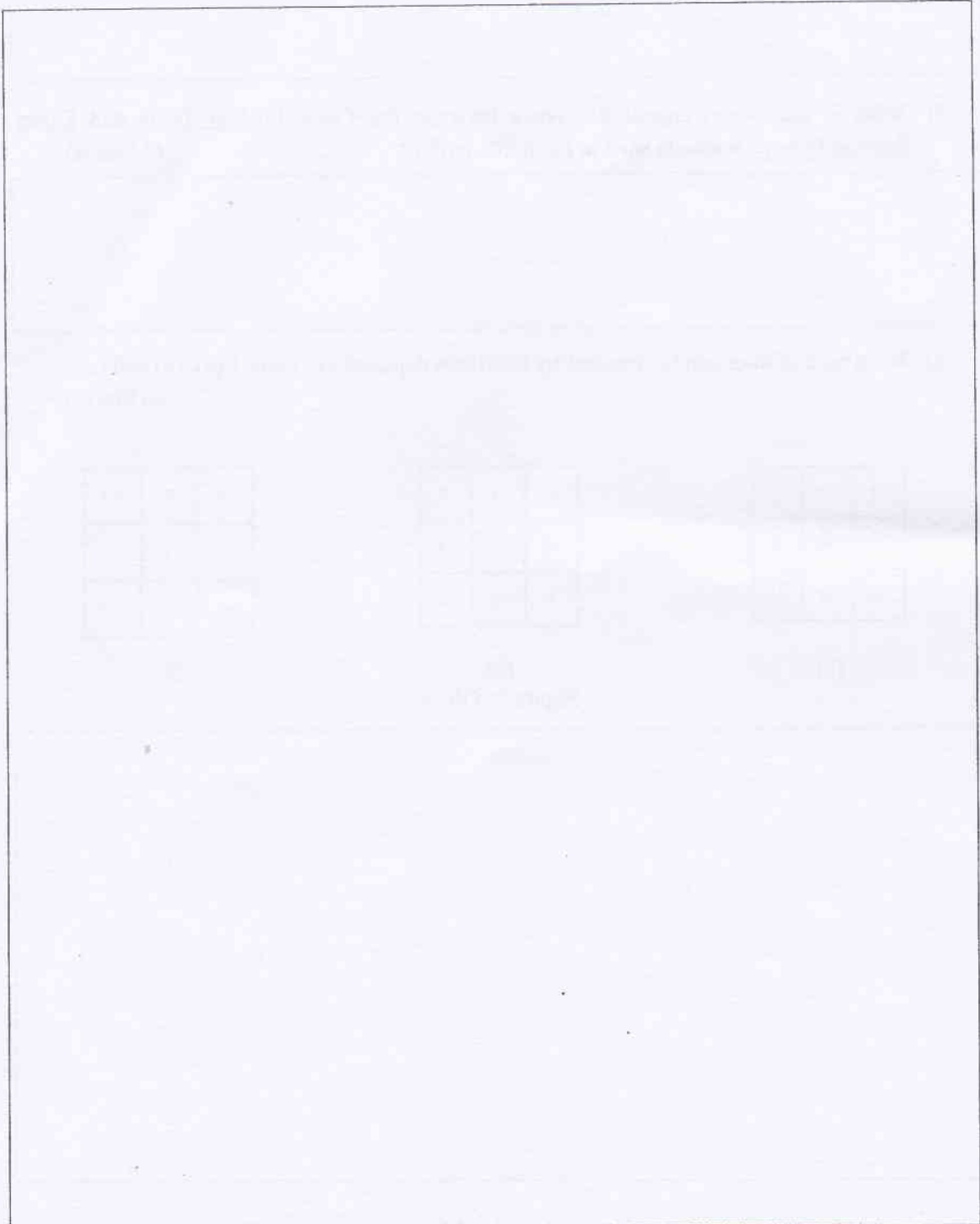
(b)

-1	2	-1
-1	2	-1
-1	2	-1

(c)

Figure 1: Filters

- 4
- h) Sketch a diagram of a typical Computer Vision System. Clearly mark all the implementation units in the image processing component within the same diagram and label the data flow among the components clearly. (5 Marks)



## Question 2

- a) Apply given smoothing filters for the four center pixels of the given image depicted in Figure 2(a). Use the given convolution kernel depicted in Figure 2(b) appropriately. (8 Marks)

10	11	15	10
20	255	0	15
10	50	45	10
10	15	11	10

(a) Image

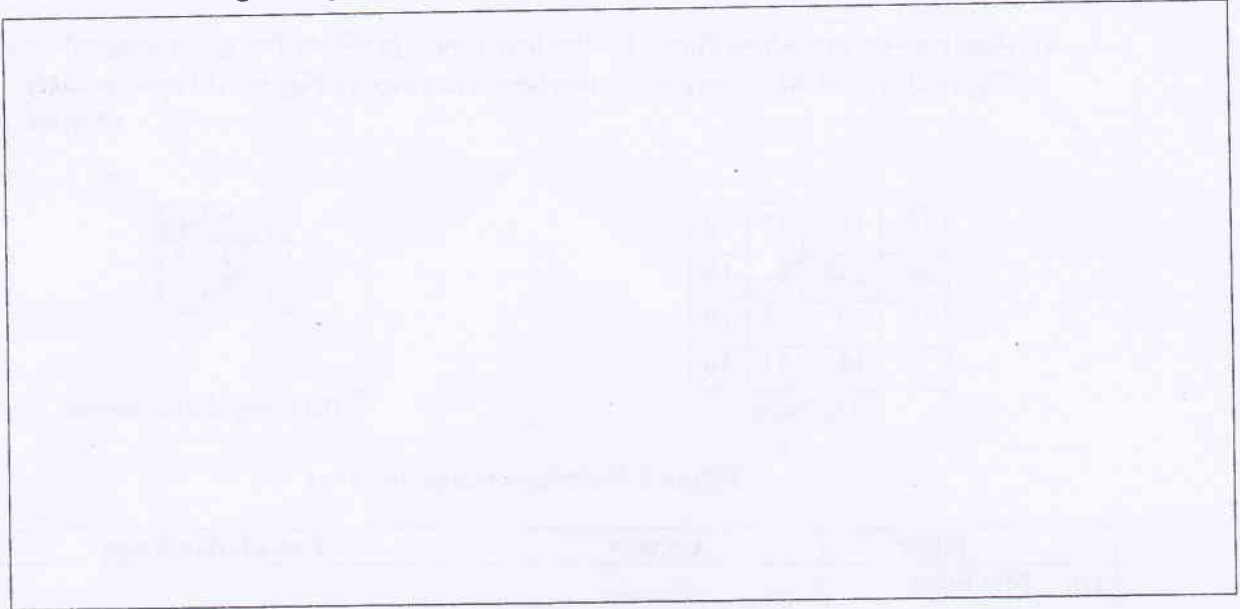
1	2	1
2	4	2
1	2	1

(b) Convolution kernel

Figure 2: Reference image for filters

Filter	Answer	Calculation Steps																
(i) Min Filter	<table><tr><td>10</td><td>11</td><td>15</td><td>10</td></tr><tr><td>20</td><td></td><td></td><td>15</td></tr><tr><td>10</td><td></td><td></td><td>10</td></tr><tr><td>10</td><td>15</td><td>11</td><td>10</td></tr></table>	10	11	15	10	20			15	10			10	10	15	11	10	
10	11	15	10															
20			15															
10			10															
10	15	11	10															
(ii) Median Filter	<table><tr><td>10</td><td>11</td><td>15</td><td>10</td></tr><tr><td>20</td><td></td><td></td><td>15</td></tr><tr><td>10</td><td></td><td></td><td>10</td></tr><tr><td>10</td><td>15</td><td>11</td><td>10</td></tr></table>	10	11	15	10	20			15	10			10	10	15	11	10	
10	11	15	10															
20			15															
10			10															
10	15	11	10															
(iii) Mean Filter	<table><tr><td>10</td><td>11</td><td>15</td><td>10</td></tr><tr><td>20</td><td></td><td></td><td>15</td></tr><tr><td>10</td><td></td><td></td><td>10</td></tr><tr><td>10</td><td>15</td><td>11</td><td>10</td></tr></table>	10	11	15	10	20			15	10			10	10	15	11	10	
10	11	15	10															
20			15															
10			10															
10	15	11	10															
(iv) Gaussian Filter	<table><tr><td>10</td><td>11</td><td>15</td><td>10</td></tr><tr><td>20</td><td></td><td></td><td>15</td></tr><tr><td>10</td><td></td><td></td><td>10</td></tr><tr><td>10</td><td>15</td><td>11</td><td>10</td></tr></table>	10	11	15	10	20			15	10			10	10	15	11	10	
10	11	15	10															
20			15															
10			10															
10	15	11	10															

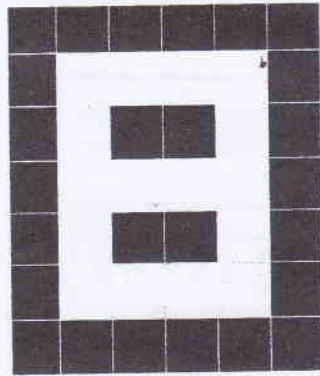
- b) Assume that the image shown in Figure 2(a) suffers from the Salt and Pepper noise. According to the results obtained for the Question 2 part (a) which filter is most suitable for reducing the reported noise? Justify the reason. (3 Marks)



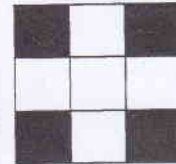
- c) Explain the objective and the effect of Contrast Stretching using an intensity histogram modeled for a gray scale image. Clearly state your assumptions (2 Marks)



- d) Apply  $(f \bullet s)-f$  morphological operation for the image depicted in Figure 3 (a) using the structuring element given in Figure 3(b). Assume that  $f$  denotes the selected image in Figure 3(a) and  $s$  denotes the structuring element shown in Figure 3(b). Further, the black pixels represent OFF pixels (0) and white pixels represent ON pixels (255). Show all intermediate steps. (6 Marks)



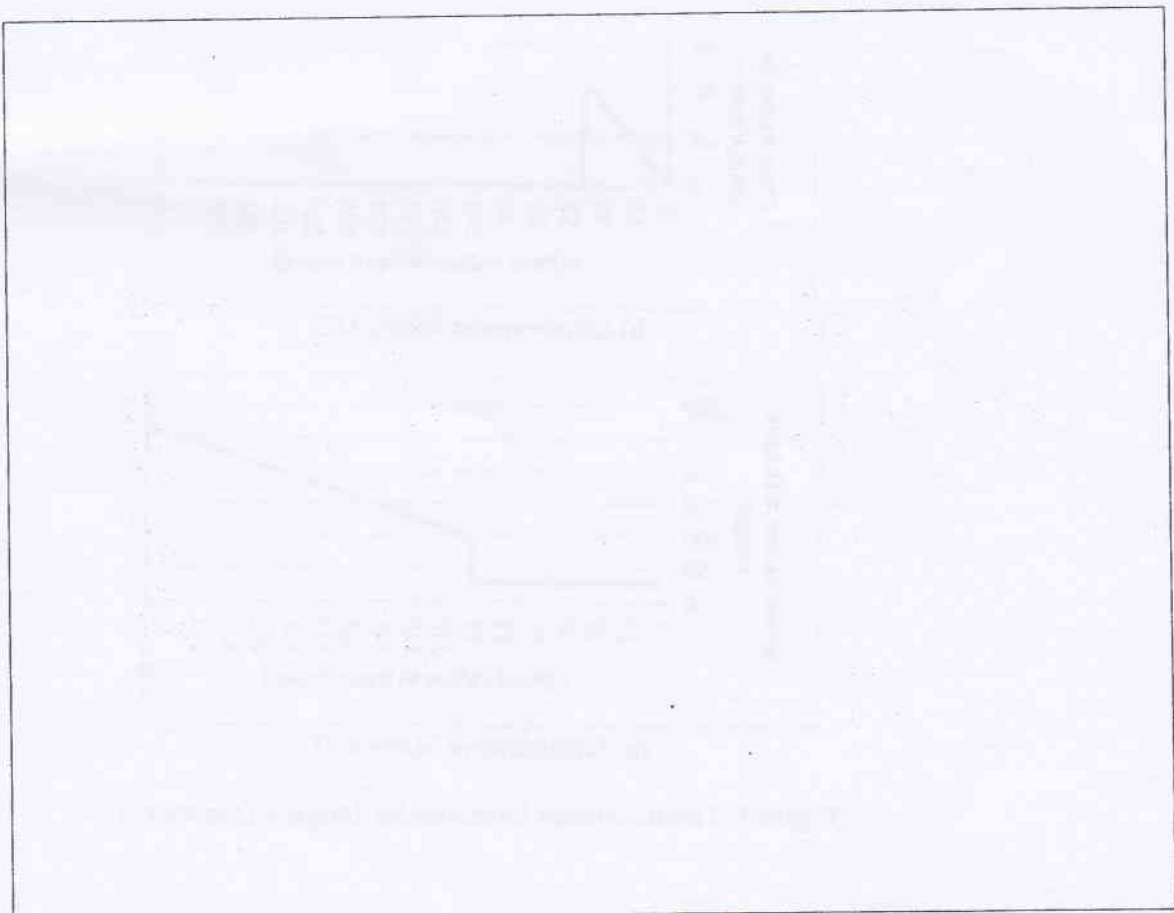
(a) Image



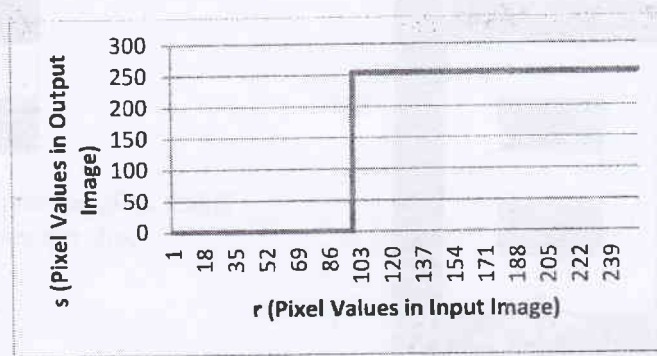
Black cells represents OFF (0) cells and White cells represents ON (255) cells.

(b) Square shape structuring element

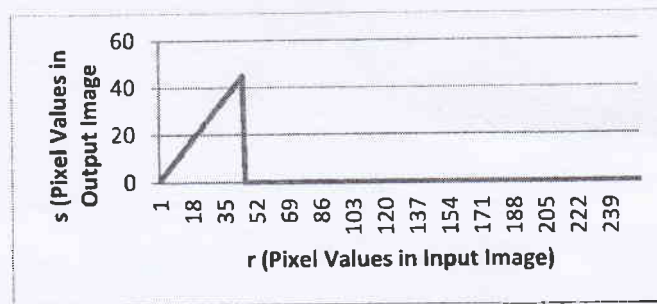
Figure 3: Image for Applying Morphological operations



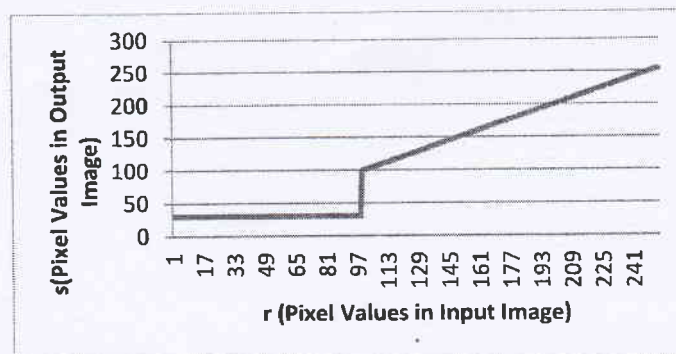
Intensity transformation can be expressed as  $s = T(r)$  where, transformation  $T$  maps a pixel value  $r$  in an input source image into a pixel value  $s$  in an output image. Graphs shown in Figure 4(a), (b) and (c) depict the three transformation functions proposed as some image enhancement methods. Assume that the input image is in gray scale. Answer Question 2 part (e) to (f) by analyzing the graphs given in Figure 4.



(a) Enhancement Method 01



(b) Enhancement Method 02



(c) Enhancement Method 03

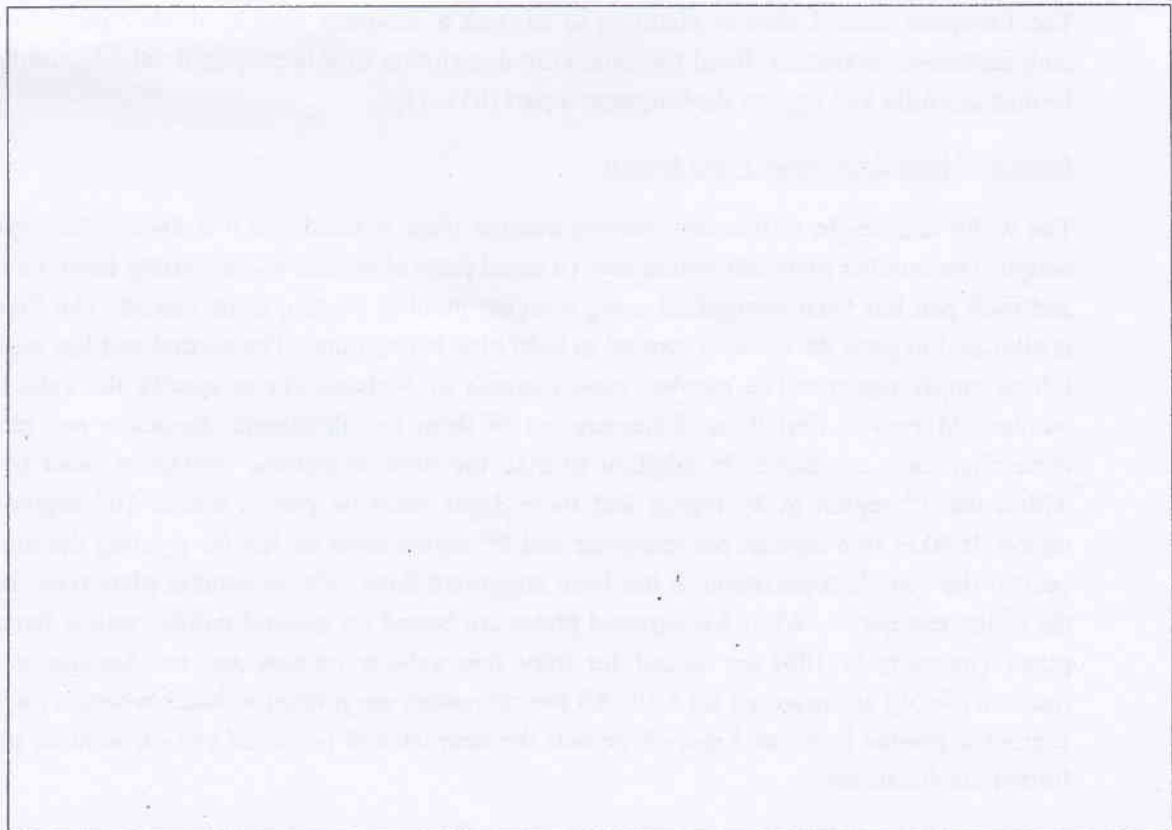
Figure 4: Transformation Functions for Image Enhancement



- e) Justify the three transformation functions used in the three enhancement methods.  
(3 Marks)



- f) Briefly explain how these transformation functions visualize the output images.  
(3 Marks)



### Question 3

- a) Image segmentation can be defined as a process that partition the entire spatial region occupied by an image  $R$  into  $n$  sub regions denoted as  $R_1, R_2, R_3, \dots, R_n$ . State five properties of image segmentation using the notations given in this definition.

(5 Marks)

The European State Union is planning to suggest a common vehicle number plate format for their associated countries. Read the following description of this proposed vehicle number plate format carefully and answer the Question 3 part (b) to (f).

#### Proposed Vehicle Number Plate format

The width and height of this new vehicle number plate is fixed and it is 48cm width and 16cm height. The number plate can divide into 16 equal parts along the width starting from the left side and each part has been recognized using a region number starting from 1 to 16. The first region is allocated to print the country symbol in light blue background. The second and last regions are left as empty regions. The number plate consists of 6 characters to specify the vehicle serial number. Moreover, first three characters out of them are alphabetic characters and remaining three characters are digits. In addition to that, the three alphabetic characters must be placed within the 3<sup>rd</sup> region to 8<sup>th</sup> region and three digits must be placed within 10<sup>th</sup> region to 15<sup>th</sup> region. It takes two regions per character and 9<sup>th</sup> region must be left for printing the month and year of the vehicle registration. It has been suggested three vehicle number plate types based on the utility categories. White background plates are issued for general public, yellow background plates (intensity is 100) are issued for duty free vehicle owners and red background plates (intensity is 50) are reserved for VIP. All the characters are printed in black whereas the country symbol is printed in white. Figure 5 depicts the templates of proposed vehicle number plates for further clarifications.

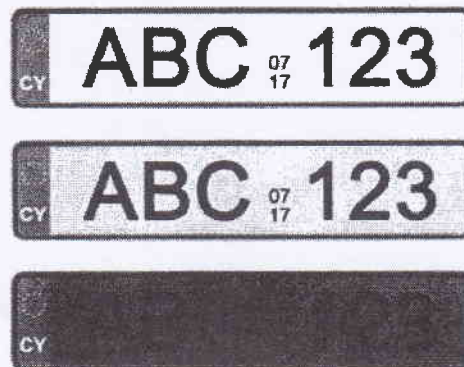


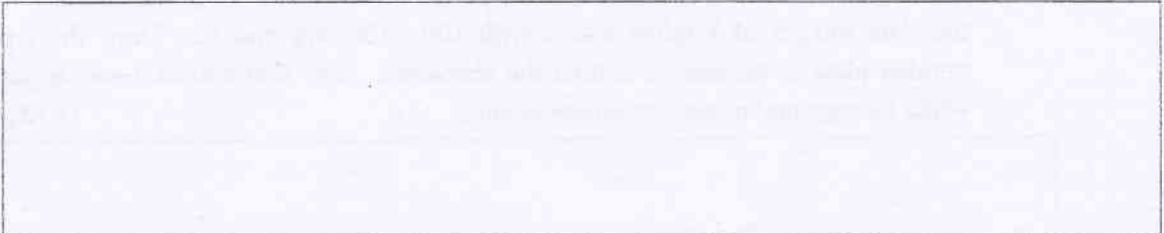
Figure 5: Templates of Proposed Vehicle Number Plates

- b) Suppose you are asked to develop an automated number plate recognition system for these new vehicle number plates using Image Processing. State Histogram based analysis method to recognize the utility category of the vehicle number plates. Assume that the input image depicts the number plate region only. (3 Marks)



- d) Write the main steps of an algorithm that can be used to recognize the alphabetic characters extracted in the Question 3 part (c) using an **image processing approach**. Note that you have to use threshold functions for your algorithm appropriately and those must be indicated in your answer clearly. Assume that you are given 26 black and white template images of English letters with  $100 \times 100$  size and you know the type of the number plate to be used to extract the characters. Note that a black letter appears in the white background of each template image. (6 Marks)

- 13
- e) Assume that the input number plate images are degraded from non-uniform illumination. State a negative consequence occurs during the number plate recognition due to this reported degradation. (2 Marks)



- f) Name a direct image pre-processing method which can be used to get rid from the negative consequence mentioned in the Question 3 part (e). (2 Marks)



#### Question 4

- a) Apply Sutherland-Hodgeman Polygon Clipping Algorithm to clip the polygon (O, P, Q, R, S, T) shown in the clipping window (A, B, C, D) of the image depicted in Figure 6. Clearly draw the clipping results according to the clipping boundaries and indicate the new vertex labels formed at the iterations. (11 Marks)

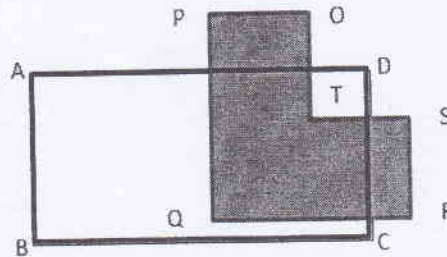
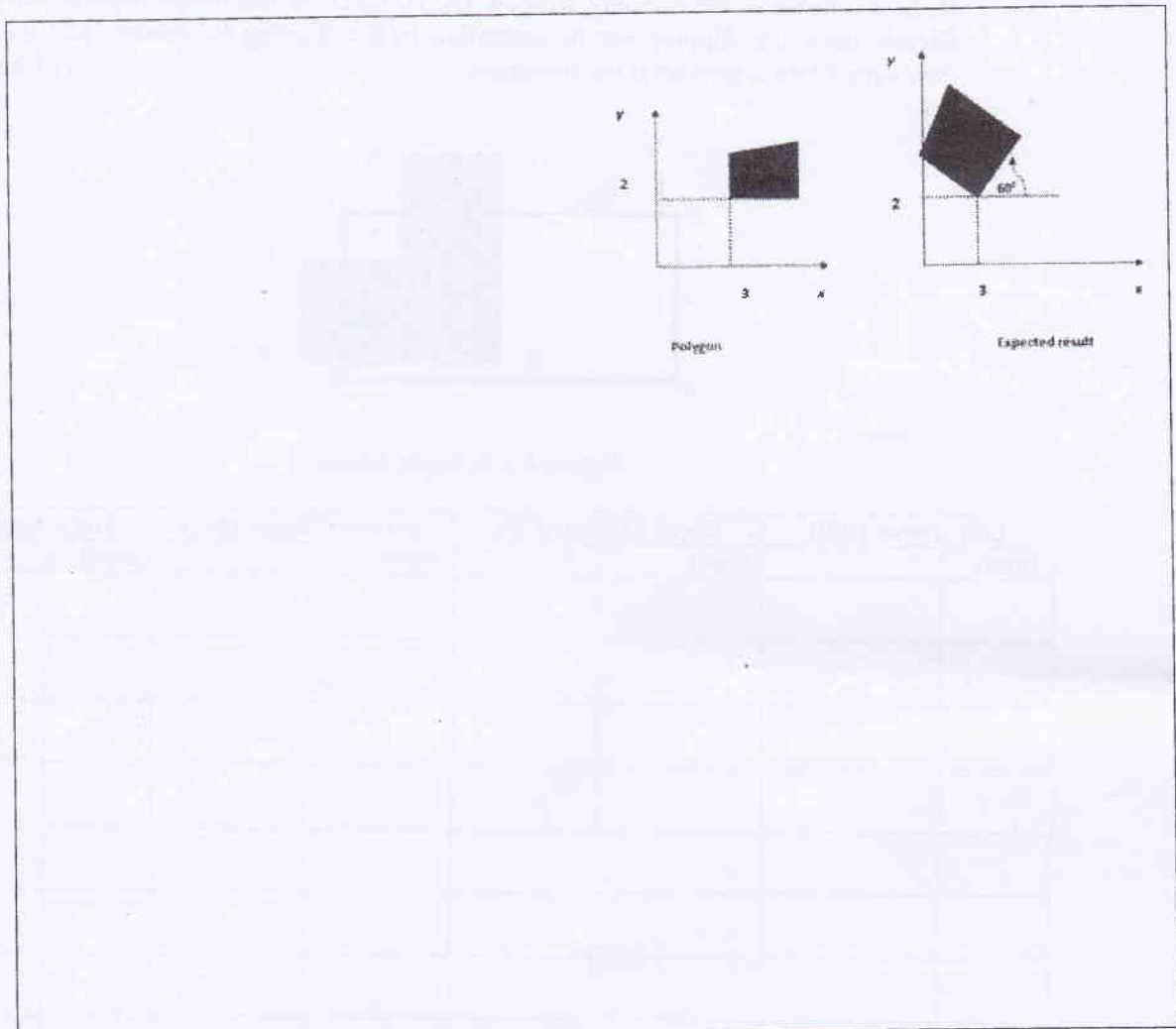


Figure 6 – Polygon Model

Left clipper (AB)		Right Clipper (CD)		Bottom Clipper (BC)		Top Clipper (AD)	
Input		input		input		input	
Clipping Result 1		Clipping Result 2		Clipping Result 3		Clipping Result 4	

- 13/16
- b) Justify how to perform following 2D transformation. "Rotate a polygon about (3, 2) by  $60^\circ$  degrees and scale it by 1.75 times". Assume the points are represented in a row vector. (4 Marks)



- c) Comment on following OpenCV code segments.

(3 Marks)

(i) `imwrite("threshold.jpg",dst);`

(ii) `cvtColor( src, dst, CV_BGR2GRAY );`

(iii) `equalizeHist( img,dst);`

17 16

Following C++ program is written to read the frames from a video file called "bike.avi" and write the same contents into another video file called "output.avi". Analyze the program carefully and answer the Question 4 part (d) to (g).

```
1. #include <opencv2/opencv.hpp>
2. #include <iostream>
3. int main()
4. {
5.     cv::namedWindow( "Frame to be burned", cv::WINDOW_AUTOSIZE );
6.     cv::VideoCapture capture;
7.     capture.open("bike.avi");
8.     double fps = capture.get( CV_CAP_PROP_FPS );
9.     cv::Size size(
        (int)capture.get( CV_CAP_PROP_FRAME_WIDTH ),
        (int)capture.get( CV_CAP_PROP_FRAME_HEIGHT )
    );
10.    cv::VideoWriter writer;
11.    writer.open( "output.avi", CV_FOURCC('M','J','P','G'), fps, size );
12.    cv::Mat bgr_frame;
13.    for(;;)
14.    {
15.        capture >> bgr_frame;
16.        if( bgr_frame.empty() )
17.            break;
18.        cv::imshow( "Frame to be burned", bgr_frame );
19.        writer << bgr_frame;
20.        char c = cv::waitKey(10);
21.        if( c == 27 )break;
22.    }
23.    capture.release();
24.    return 0;
25. }
```

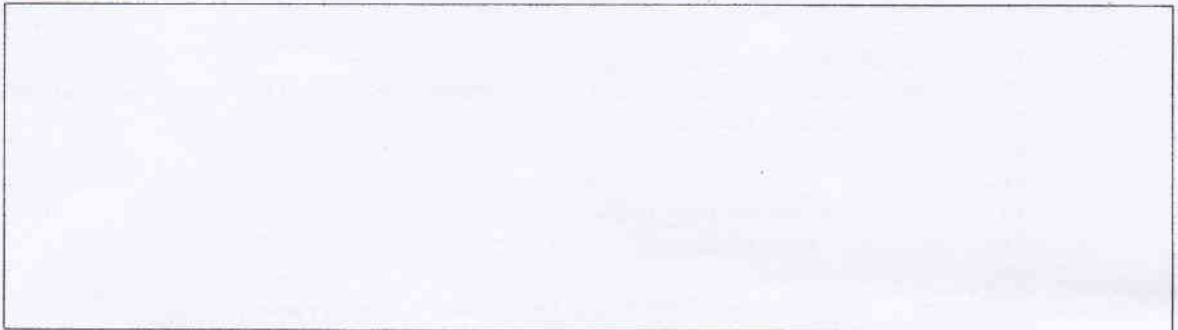
d) What is CV\_FOURCC() and how it has been used in this program? (2 Marks)



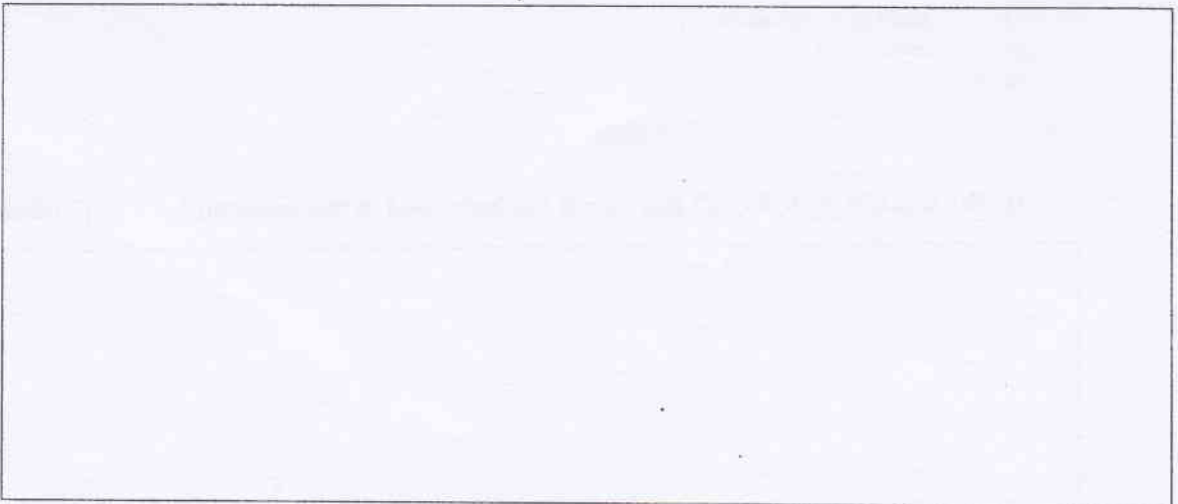
- e) State the name of variable(s) which must contain the same value(s) for both "bike.avi" and "output.avi" video files? (1 Mark)



- f) What is the functional difference between the statements in line 20 and 22? (2 Marks)



- g) Explain the changes you suggest for this program in order to obtain the gray scale view for the "output.avi". (2 Marks)



-- END --