RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B.Sc. (General) Degree in Applied Sciences
Second Year - Semester II Examination – November/ December 2016

COM 2304 – COMPUTER GRAPHICS AND IMAGE PROCESSING

Time: Three (3) hours

Examination Index No: _____

Important Instructions:

- This paper has 4 questions in 14 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:

	Question numbers				Total Marks
Questions	1	2	3	4	
Marks					

Question 1

Write short answers

a) Briefly explain how **Artificial Intelligence** and **Image Processing** are related to Computer Vision. (2 Marks)

b) Why it is important to study/ analyze about the **Image Source** as an initial stage of Image processing application development? (3 Marks)

c) What are the three basic quantities used to describe the properties of a chromatic light source? (3 Marks)

d) Justify the following statement using suitable examples; "Depending on the nature of the source, illumination energy is reflected from, or transmitted through, objects." (4 Marks)

e) State two techniques used to convert the continuous sensed data into digital form during the digital image creation. (2 Marks)

f) What is meant by **Scan Conversion** in computer graphic systems? (2 Marks)

g) Compare CRT and LCD monitors using the given criteria (3 Marks)

Criteria	CRT	LCD
Size		
Power Consumption		
Image forming		

h) What is meant by **Image Enhancement**? Why it is problem oriented? (4 Marks)

Image Enhancement:

Why it is problem oriented?

i) What is meant by **Image Interpolation**? (2 Marks)

Question 2

a) List down five possible sources for image **Noise**. (5 Marks)

b) Explain the operation of following non linear filters (4 Marks)

Max Filter	Min Filter

c) Figure 1 depicts an image strip extracted along the horizontal direction of a digital image given as $f(x, y)$ where x and y are coordinate points. Each cell represents a single pixel of the image strip and the values indicate the intensities. Apply following first order derivative function to the image strip to detect the edges.

1st order derivative of the image function ($f(x, y)$) is as follows: $\frac{\partial f}{\partial x} = f(x+1) - f(x)$

Clearly state the values of the given image strip after applying the 1st order derivative. Explain the behavior of derivatives in the areas of constant intensity and intensity ramps. (7 Marks)

5	5	4	3	2	1	0	0	0	6	0	0	0	0	1	3	1	0	0	0	0	7	7	7	7

Figure 1: Image Strip

d) Write a short note on "**Adaptive Thresholding**". (5 Marks)

e) Figure 2 (a) and (b) depict two binary images. Explain the structural changes which can occur in these images after applying the Erosion operations for Figure 2 (a) and Dilation operation for Figure 2 (b). (4 Marks)

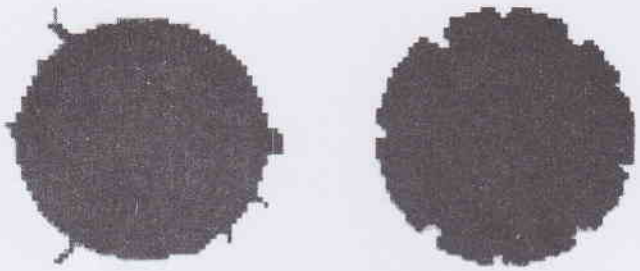


Figure 2 – Binary Images

Erosion for Figure 2 (a)	Dilation for Figure 2 (b)

Question 3

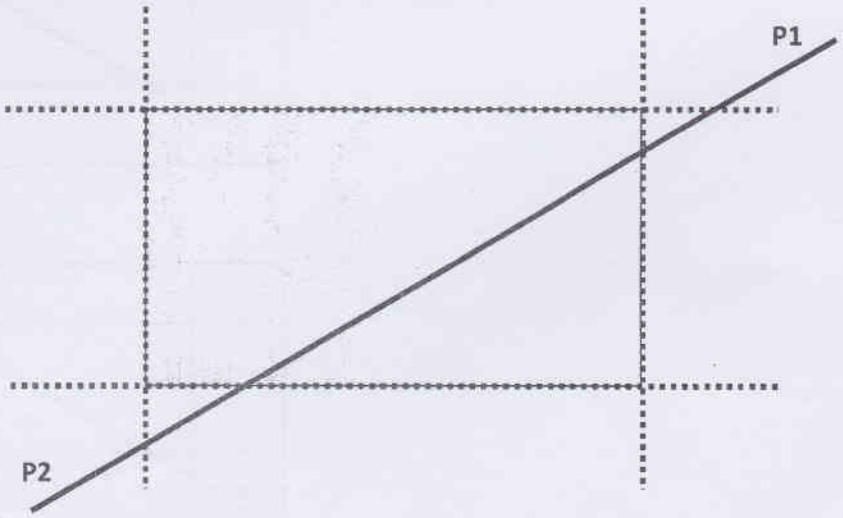
a) How many **Key Frames** are required for a 4 minutes length cartoon video which has 20 frames per second? Note that it has been produced with 10 in-between frames per key frame. (2 Marks)

b) Explain how the following features will provide a more natural action for an animation. (2 Marks)

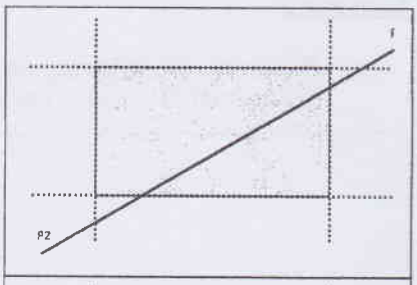
Straight ahead animation:

Staging:

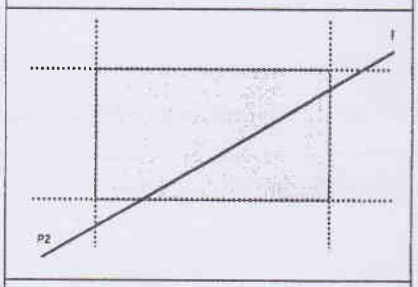
c) Apply **Cohen-Sutherland Line Clipping** algorithm for clipping the following P_1P_2 line. Cleary show the algorithm steps and intersection points at clipping boundaries of the viewport. Sketch the clipping results in all iterations separately. Shaded area represents the viewport. (8 Marks)



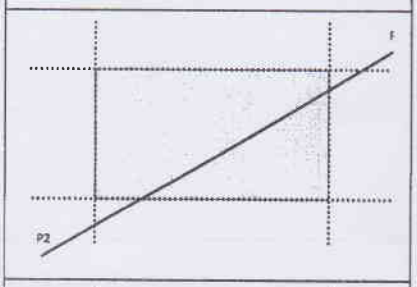
Iteration 01



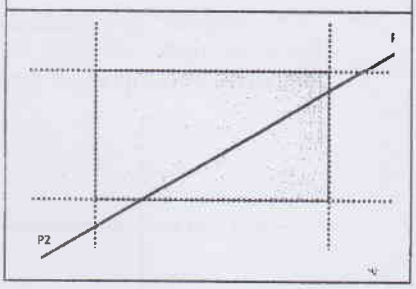
Iteration 02



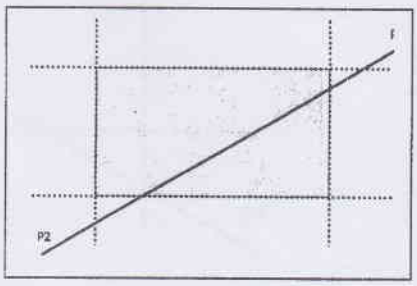
Iteration 03



Iteration 04



Iteration 05

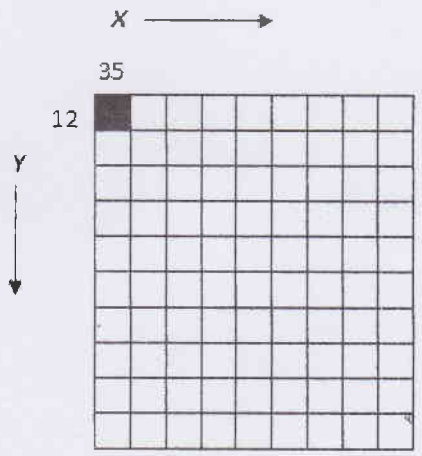


Cohen-Sutherland Line Clipping Algorithm:

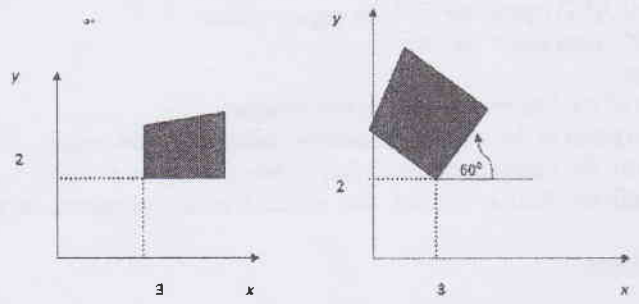
Step 1 – Assign a region code for each endpoints.
Step 2 – If both endpoints have a region code 0000 then accept this line.
Step 3 – Else, perform the logical AND operation for both region codes.
Step 3.1 – If the result is not 0000, then reject the line.
Step 3.2 – Else you need clipping.
Step 3.2.1 – Choose an endpoint of the line that is outside the window.
Step 3.2.2 – Find the intersection point at the window boundary (base on region code).
Step 3.2.3 – Replace endpoint with the intersection point and update the region code.
Step 3.2.4 – Repeat step 2 until we find a clipped line either trivially accepted or trivially rejected.
Step 4 – Repeat step 1 for other lines.

d) Apply **Digital Differential Analyzer Algorithm** to draw line between (35, 12) and (47, 36) points. Find only first ten coordinate points of this line. Finally, color the given grid cells to visualize the line (origin is set as (35, 12) of this grid and is already marked in it). (8 Marks)

Step	X – Plotted Point	Y – Plotted Point	Rounded value
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			



e) Justify how to perform following 2D transformation. "Rotate a polygon modeled about x coordinates 3 and y coordinates 2 by 60^0 degrees and scale it by 1.5 times." (5 Marks)



Polygon at (3, 2) Point

Expected result

Question 04

a) State the suitable OpenCV function names used to implement following Image processing operations. (3 Marks)

Description	Operation
To detect the edges of a digital image based on the 1st order derivatives:	
To detect the edges of a digital image based on hysteresis technique:	
To set a region of interest in a digital image :	
To extract the video properties :	
To execute morphological gradient operation:	
To keep a RGB value:	

b) Comment on following OpenCV code segments. (5 Marks)

```
cvMatchTemplate (image,template,result, CV_TM_SQDIFF);

cvFilter2D(image, image, &kernel, cvPoint(-1,-1));

cvSmooth(image,gaussianImage,CV_GAUSSIAN,3,3);
```

c) Figure 3 depicts a microscopic view of Paramecium cell specimen. Write an algorithm to count the total number of cells in this specimen using image processing. Assume the average area of a Paramecium cell is 780 pixels. **(6 Marks)**

Figure 3 – Microscopic view of Paramecium Cells

d) Fill the blank code segments in the following C++ program which is written to count the eyes of the cartoon shapes depicted in image.jpg (Figure 4, left image). Note that this expected foreground can be extracted clearly using the binary threshold 29 (Figure 4, right image). Assume the given image.jpg is an 8 bit 3 channel image. Further, it has been displayed the image.jpg on "Image" window and threshold result in "Threshold" window. (11 Marks)

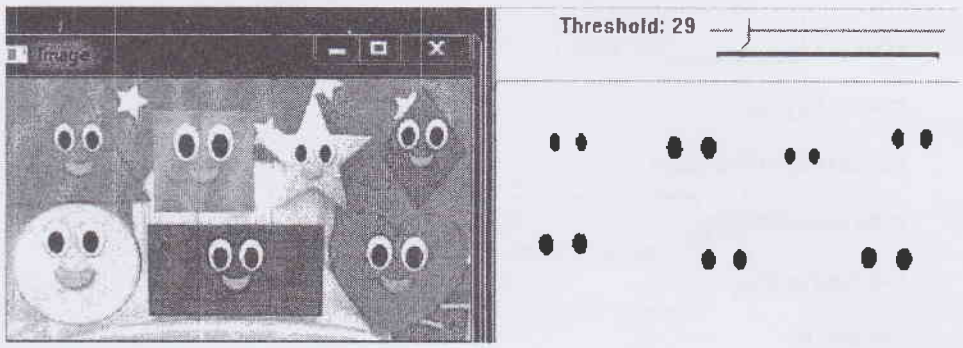


Figure 4 – Cartoon Image

```
#include <highgui.h>;
#include <cv.h>;
#include <stdio.h>

using namespace std;

int g_thresh = [    ];


int main ()
{
      IplImage* g_image = cvLoadImage([          ]);
      cvNamedWindow ("Image",1);
      cvShowImage([          ], g_image);

      cvNamedWindow ("Threshold Image",1);

      IplImage* g_gray = cvCreateImage ([          ],8,1);
      CvMemStorage* g_storage = cvCreateMemStorage (0);
      CvSeq* contours = 0;

      cvCvtColor ([          ],[          ],CV_BGR2GRAY);

      cvThreshold(g_gray, g_gray,[          ],[          ],CV_THRESH_BINARY);

      cvShowImage("Threshold Image",[          ]);
```

```
    int count = cvFindContours(          , g_storage,
                        &contours,sizeof(CvContour),
                                CV_RETR_LIST,CV_CHAIN_APPROX_SIMPLE,
                                        cvPoint(0,0));
    cout <<          << endl;
    cvWaitKey();
    cvDestroyAllWindows();
    cvReleaseImage(          );
    cvReleaseImage(          );
    return 0;
}
```

******** END ********