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RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B.Sc. (General) Degree in Applied Sciences
Second Year - Semester II Examination – February/March 2019

COM 2304 – COMPUTER GRAPHICS & IMAGE PROCESSING

Time: Three (3) hours

Examination Index No: _____

Important Instructions:

- This paper has 4 questions in 15 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					

1.

a) Which frequency bands are used for lithography and angiography? (2 Marks)

b) Calculate the number of kilobytes required for storing an image consists of 64×32 samples each in 128 grey levels. Show all steps. (4 Marks)

c) *"Computer vision is the transformation of data from a still or video camera into either a decision or a new representation."* Explain the underlined terms of the above computer vision definition by using suitable examples. (4 Marks)

d) Sketch a diagram of a typical computer graphic system. Clearly label the components and signal flow. (8 Marks)

e) State how does false contouring affect the intensity resolution. (2 Marks)

f) *"Image will always lose some quality at each time interpolation is performed during the image resizing."* Justify the above statement using a suitable diagram of nearest neighbor interpolation method. (5 Marks)

2.

a) What will happen if the quantization levels are doubled without changing the sampling levels during the digital image formation? (2 Mark)

b) Draw a flow chart to demonstrate the steps of frequency domain filtering and state the main difference between the high pass filtering and low pass filtering. (6 Marks)

c) Apply morphological erosion operation for the image depicted in following table using the given structuring elements. Assume black pixels represent ON pixels (0) and white pixels represent OFF pixels (255). By analyzing the output, state the name of most suitable structuring element(s) for eroding the given image. Justify your answer.

(9 Marks)

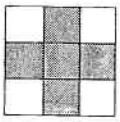
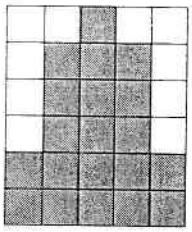
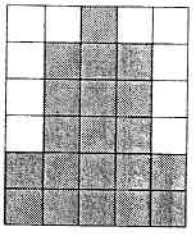
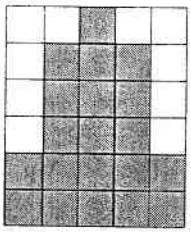
Square Shaped Structuring Element	Cross Shaped Structuring Element	Custom Structuring Element
		
Image 	Image 	Image 
Erosion Result	Erosion Result	Erosion Result
Recommended Structuring Element and Justification		

Figure 1 depicts an intensity histogram of a gray scale image (f) with dynamic range between 0 and 100 intensities.

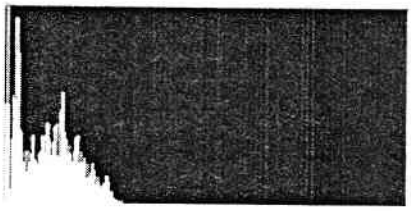


Figure 1: Intensity Histogram

d) State the visual quality of the input image f by analyzing the intensity histogram shown in Figure 1. (2 Marks)

e) Intensity transformation can express as $s = T(r)$ where, transformation T maps a pixel value r in input source image f into a pixel value s in output image g. Assume the transformation function $s = 2.55r$ has been applied to the dynamic range of input image f to enhance it. Sketch a graph of r vs. s showing the impact of this proposed transformation function. (4 Marks)

f) What will happen after applying the following function to the output image g obtained in question 2 part e.

$$g(x,y)=\begin{cases}255\ if\ f(x,y)>100\\ 0\ if\ f(x,y)\le 100\end{cases},$$

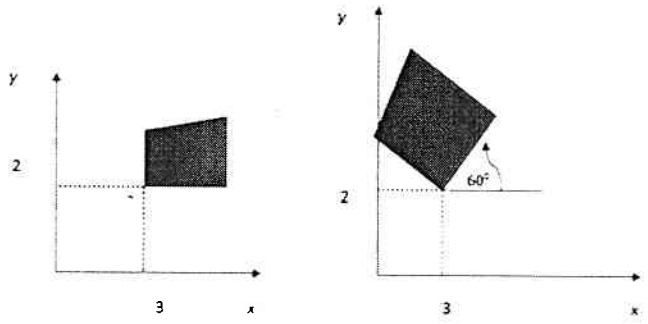
where x and y denotes the spatial coordinates. **(2 Marks)**

3.

a) State why the homogeneous coordinate system was devised. (2 Marks)

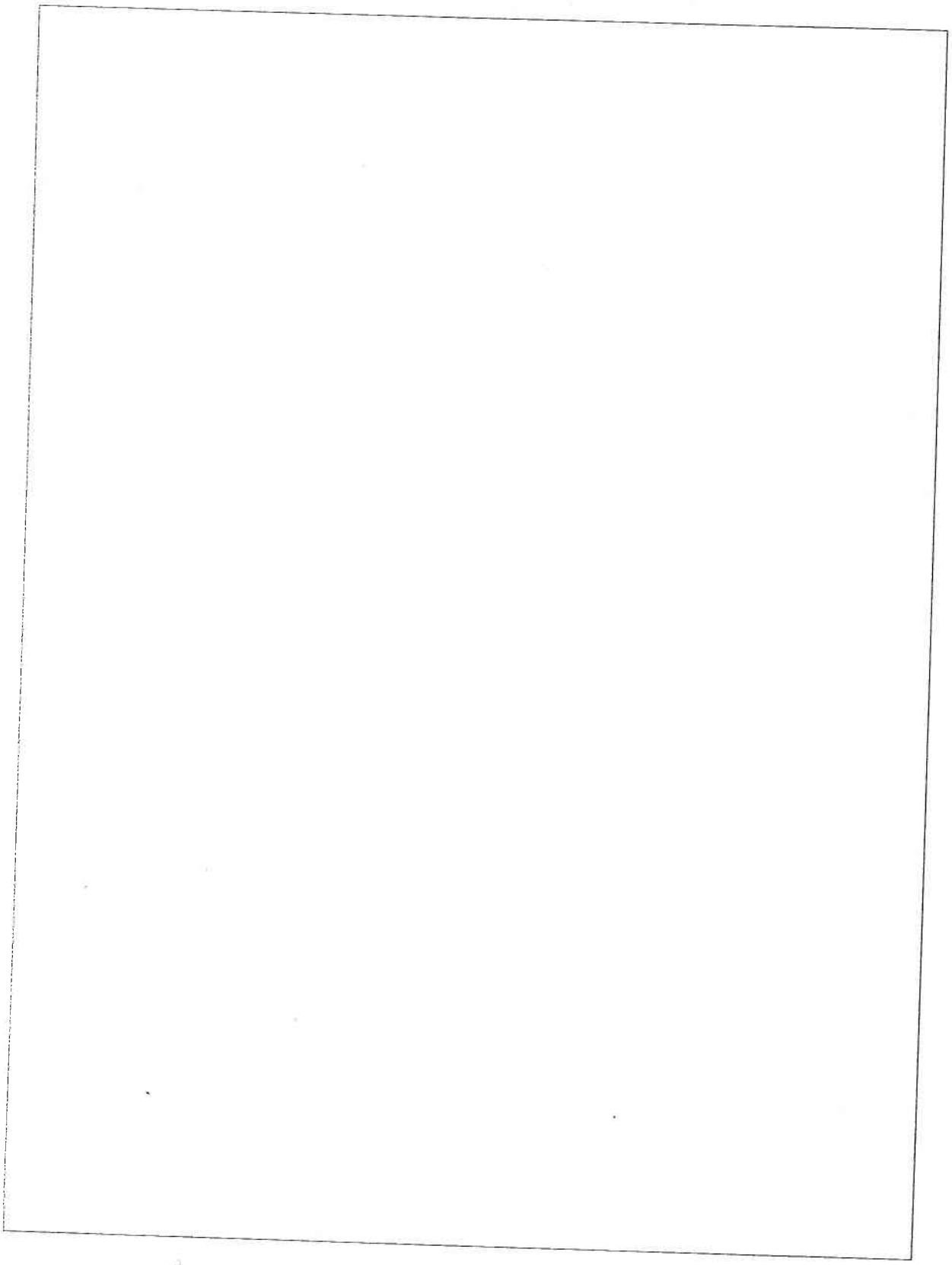
b) Briefly explain how appeal and exaggeration are important in animation. (4 Marks)

c) Justify how to perform following 2D transformation depicted in Figure 2 using homogeneous coordinates. Assume that the points are represented as column vectors. "Rotating a polygon modeled at x coordinate 3 and y coordinate 2 by 60^0 degrees anti-clockwise and scale it 1.5 times." (7 Marks)



Expected result

Figure 2: Model for 2D transformation



d) Apply Sutherland-Hodgeman polygon clipping algorithm to clip the polygon (P, Q, R, S) shown in the clipping window (A, B, C, D) of Figure 3. (8 Marks)

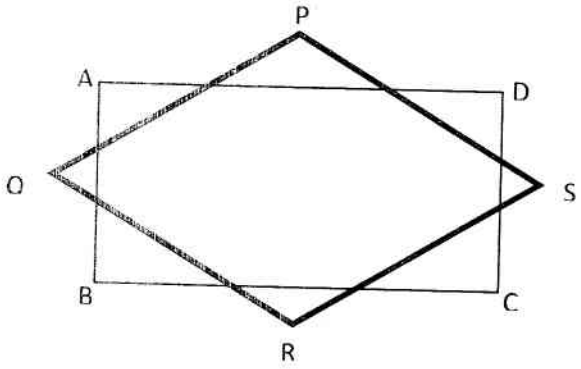
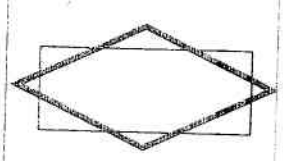
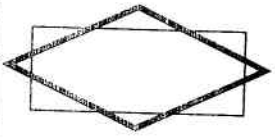
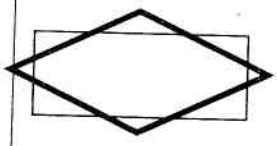
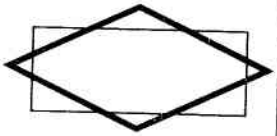


Figure 3: Model for clipping

Cleary draw the clipping result according to the clipping edge using the table given below (Clearly indicate the vertex labels).

Input	Left clipper (AB)	Right Clipper (CD)		Bottom Clipper (BC)		Top Clipper (AD)	
		input		input		input	
[P, Q]							
[Q, R]							
[R,S]							
[S,P]							
	Clipping Result 1	Clipping Result 2		Clipping Result 3		Clipping Result 4	
							

e) Write a short note on "Animation Creation Process". (4 Marks)

4.

a) What are the four primitive types in OpenCV computer vision library? (2 Marks)

b) State the mathematical definitions of following OpenCV threshold operations. (5 Marks)

Threshold Binary	
Threshold Binary, Inverted	
Truncate	
Threshold to Zero	
Threshold to Zero, Inverted	

c) Comment on following OpenCV code segments. (4 Marks)

`cvCircle(src1,centre,radius,color,6,8);`
`cvFilter2D(image, image, &kernel, cvPoint(-1,-1));`
`cvSmooth(image,gaussianImage,CV_GAUSSIAN,3,3);`

d) State suitable OpenCV function names, which could use to implement the following image processing operations. (6 Marks)

Description	Operation
To execute a black hat operation:	
To remove impulse noise:	
To create a binary image from a gray scale image:	
To keep pixel position:	
To detect the edges of a digital image based on hysteresis technique:	
To create a slider:	

e) Formalize an algorithm to count the number of yeast cells contained in a particular medium using an image taken by a light microscope. Figure 4 depicts a sample image in grayscale. Bright patches represent the nucleus of yeast cells and gray regions around the nucleus represent the plasma. Note that your proposed algorithm must be based on edge based segmentation technique. (8 Marks)

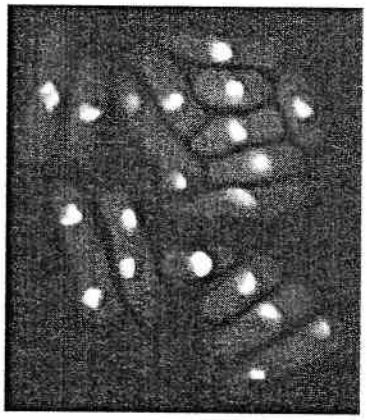


Figure 4: Light microscope image of Yeast cells

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