C1-R4: ADVANCED COMPUTER GRAPHICS

NOTE:

1. **Answer question 1 and any FOUR from questions 2 to 7.**
2. **Parts of the same question should be answered together and in the same sequence.**

Time: 3 Hours **Total Marks: 100**

1.

a) Present a method to generate thick line segments.
b) What is aliasing? Present a method for antialiasing.
c) What are the two basic methods of character generation? Explain them.
d) Describe a LED Monitor.
e) Digitize, using Breshenham's line algorithm, a rasterized line from (10,12) to (20,18) on a screen. Depict it on a Cartesian graph.
f) Define graphics primitives. Mention some typical graphics primitives.
g) When 8-way symmetry is used to acquire a full circle from pixel coordinates generated for the 0° to 45° octant, some pixels are plotted twice. This phenomenon is sometimes referred to as overstrike. Identify the positions in the given example, where overstrike occurs.

(7x4)

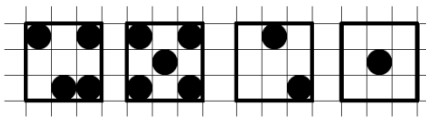
2.

a) Let a convex clipping polygon ABCD be defined by the vertices as: A(5, 5), B(20, 2), C(16, 10), D(10, 10); and a line P1P2 be defined by the coordinates: P1(1,2) and P2(23, 12). Use Cyrus Beck clipping algorithm to perform external clipping. Find out for each intersection, the parameter '*t*' whether it is "entering" or "leaving" and finally determine which parameters for '*t*' are of interest only, stating reasons for their selection.
b) In the general case of an n-sided polygon, how many intersections have to be performed, at most, for every line to be displayed?
c) Elaborate a method to determine whether a given point *P* is inside or outside the view volume.

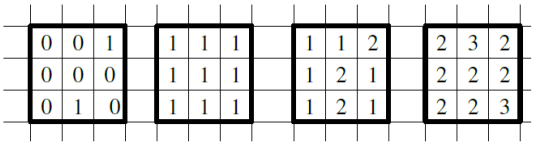
(8+2+8)

3.

a) Ordered dithering means that a gray value is approximated by different patterns like these:



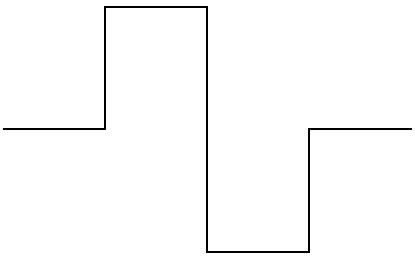
For imaging devices being that are able to display a small number of gray levels, an extension had been proposed that not only consist of black and white pixels like shown above but that consists of shades of gray depicted by some patterns as shown below:



Explain how to use these gray-level patterns, if the resolution of an image must not be increased. Also, with respect to the Floyd-Steinberg dithering algorithm for gray-scale images, discuss method so the approach be extended to handle colour images?

b) What is digital halftoning? Give the method for performing single-level halftoing.

c) Derive the formula for finding fractal dimensions. Considering the 0L system for representing fractals, with the given graphical meanings of F (forward movement), + (turn right by 90°), - (turn left by 90°), give the string for the generator, given in following figure. Further, also draw the next level.



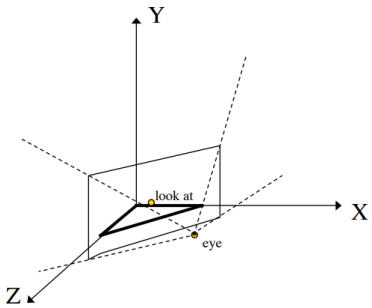
(8+4+6)

4.

a) Derive the composite transformation for performing rotation about arbitrary axis in 3D. Further, extend it to perform reflection through an arbitrary plane.

b) For the given triangle as shown in the figure below, present the final rendered image coordinates for performing 3D viewing. The parameters are:

Object: triangle A(0,0,0), B(1,0,0), C(0,0,1) Eye: (3,1,3)
Look at point: (2,1,2) Up vector (0,1,0)
near = 0.1, far = 10
fovy = 45 degrees aspect = 2.0
viewport: 200x100 pixels

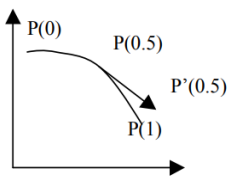


(10+8)

5.

a) What are the advantages of Parametric cubic curves? What is the difference between parametric continuity and geometric continuity?

b) Find the curve parameters given that the user specifies the following 4 parameters of: 2 end points; midpoint, tangent at midpoint.



Determine if the following curves are C0, C1, G1 continuous A(u) = (u, u^2) and B(u) = ($2u$+1, u^3+4u+1) for u in between [0,1]. Show using graph.

c) Sketch a parametric Cubic curve defined by the following 4 points, and give the basis matrix, basis functions and a sketch of the basis functions.

The points are $P(0) = P_1$, $P(1/3) = P_2$, $p(2/3) = P_3$, $P(1) = P_4$.

(6+8+4)

6.

a) Write pseudocode for Binary Space Partition (BSP) tree.

b) What is ray tracing? Give its basic algorithm and explanation.

c) Describe the Back-face detection algorithm in detail.

(6+6+6)

7.

a) What is the difference between various components of ambient, diffuse, and specular reflection?

b) Light a triangle P_1 P_2 P_3 using the Phong Illumination model. The values are given below:

$P_1 = (1,1,1)^T$, $P_2 = (0,2,1)^T$, $P_3 = (0,0,1)^T$

$k_a = 0.7$ $k_{diff} = 0.9$ $k_{spec} = 0.6$ $n = 10$

white ambient intensity = 0.1; white point light position = $(1,1,5)^T$,

white point light intensity = 0.5 ; viewer = $(1,2,5)^T$

i) What's the intensity at the centroid of the triangle, $P = (0.333,1,1)^T$?

ii) What if the object were coloured?

c) Transform the colour with RGB components (255, 0, 0) to CIE chromaticity coordinates.

(6+6+6)