

Department of Computer Science & Engineering

University of Asia Pacific (UAP)

Program: B.Sc. in Computer Science and Engineering

Final Examination

Spring 2021

4th Year 2nd Semester

Course Code: CSE 425

Course Title: Computer Graphics

Credits: 3

Full Marks: 120* (Written)

Duration: 2 Hours

* Total Marks of Final Examination: 150 (Written: 120 + Viva: 30)

Instructions:

1. There are **Four (4)** Questions. Answer all of them. All questions are of equal value. Part marks are shown in the margins.
2. Non-programmable calculators are allowed.

1. a) How a **parabola** can be drawn using affine combination? Calculate the x and y coordinates of two points on the parabola at $t = a$ and $t = b$. **10**

Where,

$a = \text{last two digits of your ID} \% 5 + 2$,

$b = a + 2$,

If the last two digits of your id is 01, then $a = 3$, $b = 5$

Therefore, you have to calculate the coordinates of the point at $t = 3$ and $t = 5$.

- b) The point $P(x, y)$ is coplanar to the triangle defined by three vertices $A(2, r + 2)$, $B(3, r + 4)$ and $C(4, r + 5)$. Calculate the coordinate of $P(x, y)$ using Barycentric Coordinates if $\alpha = 0.1$ and $\beta = 0.2$. **10**

Where, **$r = \text{Last two digits of your ID}$**

- c) Consider a polygon in 4D homogeneous space where, $P_1(10, 10, 40, w)$, $P_2(20, 50, 60, w)$, $P_3(70, 70, 90, w)$, $P_4(100, 110, 190, w)$, $P_5(120, 60, 200, w)$, are the five vertices of the polygon where **$w = (\text{Last two digits of your ID}) + 3$** . **10**

- i. Determine the coordinates of P_1, P_2, P_3, P_4, P_5 , of the polygon in 3D space.
- ii. Draw the polygon (only using x and y coordinates) before and after the transformation.

2. a) Estimate the new position of a triangle, with vertices $A(2, 3)$, $B(5, 6)$, $C(10, 2)$ after performing a θ° rotation, where **$\theta = \text{last two digits of your ID} + 35$** . **5 + 10 = 15**

- i. About the origin and
- ii. About a point $P(-3, 5)$.

- b) i) Suppose the following matrix is a 3D rotation matrix which performs rotation of a certain angle about y-axis. Identify what is wrong with this matrix?

5x3=
15

Rotation Matrix about y-axis

$$\begin{bmatrix} 0.5 & 0 & -0.707 & 0 \\ 0 & 1 & 0 & 0 \\ 0.866 & 0 & 0.5 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

- ii) Suppose the following matrix is a 2D translation matrix which performs translation of a 2D point from one position to another. Identify what is wrong with this matrix?

$$\begin{bmatrix} Tx & 0 & 0 \\ 0 & Ty & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

- iii) A triangle with vertices A (5, 5), B (10, 10), C (15, 5) is scaled with scaling factor of (2, 3) as follows. Do you think the following operation will produce expected result? If not, explain why?

$$\begin{bmatrix} 5 & 10 & 15 \\ 5 & 10 & 5 \\ 1 & 1 & 1 \end{bmatrix} \times \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 2 & 3 & 1 \end{bmatrix}$$

3. For the triangle between points R1, R2, R3 and the viewport defined by $X_{\min} = -4$, $X_{\max} = 11$, $Y_{\min} = -3$, $Y_{\max} = 7$, answer the following questions using Cohen Sutherland algorithm.

10+
10+
10
= 30

- Calculate the region code of R1 (0, a), R2 (3, b), R3(5, c).
- Categorize each line (R1R2, R2R3, R3R1) if they are inside or outside or intersecting the viewport.
- Find the coordinates (x and y) of intersection points.

Where **a = Last two digits of your ID % 5**

b = Last two digits of your ID % 7

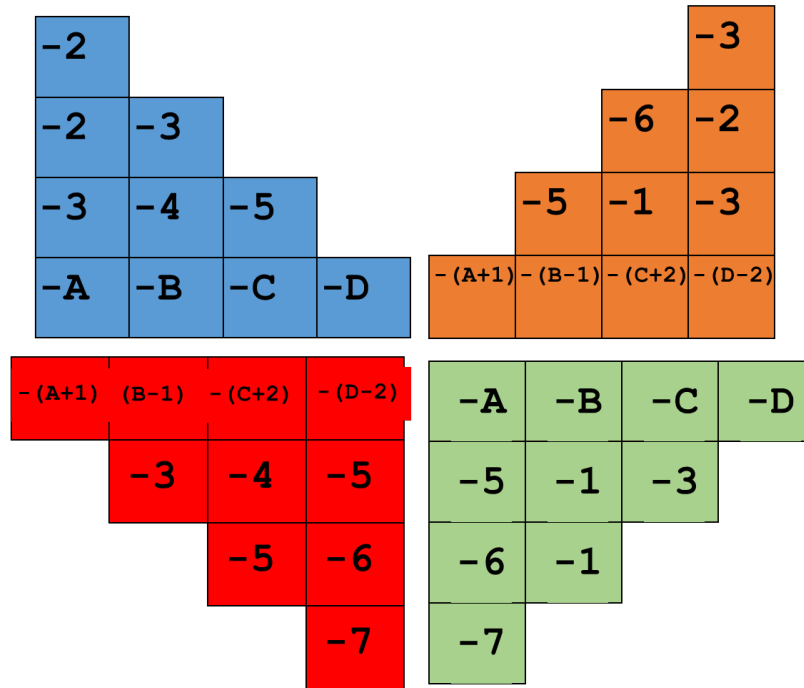
c = Last two digits of your ID % 11

4. a) Distinguish the back facing surfaces from the given normal vectors of the surfaces: S1 (-4, 3, -3), S2 (6, -3, -8), S3 (9, 2, -10), and S4 (-4, -11, 11); if the viewpoint is on the +z axis looking at the origin.

5

- b) Following triangles (Z-value of each pixel is given) are present in a scene. What will be the output after applying Z-Buffering algorithm?

15



Where,

A = Last two digits of your ID % 5

B = Last two digits of your ID % 7

C = Last two digits of your ID % 2

D = Last two digits of your ID % 3

- c) Convert the HSI coordinate of a color at (**a°**, **b**, **c**) into RGB color space where

10

$$a = 160^\circ - (\text{Last 2 digits of your ID})^0$$

$$b = (\text{Last 2 digits of your ID}) / (\text{Last 2 digits of your ID} + 5)$$

$$c = (\text{Last 2 digits of your ID}) / (\text{Last 2 digits of your ID} + 10)$$

OR

- a) Calculate the amount of directed (specular) reflection if the angle between reflected light ray and viewing vector, $\phi = 10^\circ$ and surface property parameter, $e = 5$.

5

- b) You are given the center of a circle $C = (0,0)$ and radius $R = A$.

10+5=

Where,

15

$$A = (\text{Last two digits of your ID \% 13} + 5)$$

- Now use Bresenham's circle drawing algorithm to identify next four pixels.
- Calculate the other seven points, found by symmetry with respect to the last (4th) pixel locations calculated from i).

- c) Differentiate among Flat Shading, Gouraud Shading, and Phong Shading.

10