KATHMANDU UNIVERSITY
End Semester Examination
February/March, 2025

Marks Scored:

Level : B.E.
Year : III

Course : COMP 342
Semester : II

Exam Roll No. :

Time: 30 mins.

F. M. : 10

Registration No.:

Date : 03 MAR 2025

SECTION "A"

[20 Q. × 0.5 = 10 marks]

Choose and Mark [X] in the most appropriate option from each set of choices

1. Which of the given applications of computer graphics uses a combination of 3D modeling packages, texture mapping, drawing programs, and CAD Software to create pictures?
   [ ] Entertainment [ ] Computer Art
   [ ] Computer-aided design (CAD) [ ] Presentation Graphics

2. For a line from (4, 2) to (8, 6), what are the increments for x and y in the DDA algorithm?
   [ ] $\Delta x=0.5, \Delta y=0.5$ [ ] $\Delta x=0.8, \Delta y=0.4$ [ ] $\Delta x=1, \Delta y=1$ [ ] $\Delta x=1, \Delta y=0.5$

3. In the midpoint circle algorithm, what is the initial value of the decision parameter $\mathbf{P_0}$, if the starting point of the circle in **(-r, 0)**, where **r** is the radius of the circle?
   [ ] r - 1 [ ] r + 1 [ ] 1 - r [ ] 0

4. If the vertical retrace time is 1 millisecond and the refresh rate is 60 Hz, what is the percentage of time spent on vertical retrace in one refresh cycle?
   [ ] 1 % [ ] 6 % [ ] 10 % [ ] 60 %

5. Which of the following holds true for Random Scan Display System:
   a. Uses interlacing
   b. Refresh rate depends directly on picture complexity
   c. Scan conversion is not required
   [ ] a & b [ ] a & c [ ] b & c [ ] a, b &c

6. In rasterization, if a triangle occupies 100 pixels on the screen and the pixel processing rate of the GPU is 2.5 billion pixels per second, how long does it take to render the triangle?
   [ ] 25 ns [ ] 40 ns [ ] 50 ns [ ] 75 ns

7. The result of rotating a point (2, 0) by 90 degrees clockwise about the origin is:
   [ ] (2, 0) [ ] (0, 2) [ ] (0, -2) [ ] (-2, 0)

8. Which of the following holds true for 2D shear transformation:
   a. Distorts the shape of an object
   b. Composed of internal layers that had been caused to slide over each other
   c. Changes one coordinate values and keeps the next coordinate same
   [ ] a & b [ ] b &c [ ] a & c [ ] a, b & c

9. In a 2D transformation using homogeneous coordinates, a point (x, y) is represented as (x, y, 1). After applying a translation matrix, the new coordinates of the point are (5, 7). What is the translation vector used in this transformation?
   [ ] (5, 7) [ ] (4, 6) [ ] (1, 1) [ ] (0, 0)

10. What is the maximum number of iterations required by the Cohen-Sutherland algorithm to clip a line segment?
    [ ] 1 [ ] 2 [ ] 3 [ ] 4

11. What is the primary goal of viewing transformation in computer graphics?
[ ] To control the rotation and scaling of objects
[ ] To map world coordinates into a specific coordinate system for rendering
[ ] To ensure that all objects fit within the screen space
[ ] To color and texture objects based on their position

12. Which of the following 3D transformation technique doesn't consider view plane while undergoing transformation?
a. Reflection
b. Rotation
c. Scaling
[ ] a only [ ] b only [ ] c only [ ] a, b &c

13. In perspective projection, a point **P(x, y, z)** in 3D space is projected onto a plane at **z = d** using the projection matrix. What will be the projected coordinates **P′ (x′, y′)** if d=1 and projection reference point is taken to be at the viewing-coordinate origin?
[ ] $x' = x/z, y'=y/z$ [ ] $x' = x/d, y'=y/d$
[ ] $x' = x \times z, y'=y \times z$ [ ] $x' = x + z, y'=y + z$

14. In the context of back face detection, if the normal vector of a polygon is **N=(1, 2, 3)** and the view vector is **V=(1, −1, 1)**, what will be the result of the dot product for back face detection?
[ ] 4 [ ] 0 [ ] -2 [ ] 2

15. In the Scan line Algorithm for visible surface detection, what is typically used to determine which surfaces are visible for each scan line?
[ ] Sorting surfaces based on the Z-depth
[ ] Comparing the Z-values at each pixel along the scan line
[ ] Casting rays along the scan line
[ ] Using the object's surface normal

16. Which of the following terms represents the constant factor in the Phong illumination model that accounts for light that is scattered uniformly in all directions?
[ ] Ambient reflection [ ] Diffuse reflection
[ ] Specular reflection [ ] Emissive reflection

17. Which of the following types of light source in computer graphics does not have a specific position but radiates light in all directions?
[ ] Point light [ ] Distributed light [ ] Ambient light [ ] Spot light

18. In which polygon rendering technique, we determine the average unit normal vector at each polygon vertex
a. Constant Intensity
b. Gouraud
c. Phong
[ ] a & b [ ] a & c [ ] b & c [ ] b only

19. In the **HSV** color model, the **Saturation (S)** component represents which of the following?
[ ] The intensity of the color
[ ] The brightness of the color
[ ] The distance from the center of the color wheel
[ ] The purity or vividness of the color

20. In which step of animation sequence detailed drawing of the scene at certain time is done?
[ ] Storyboard layout [ ] Object definitions
[ ] Key-frame specifications [ ] Generation of in-between frames

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F. M. : 40

SECTION "B"
[6 Q. × 4 = 24 marks]

Attempt ANY SIX questions.

1. What is computer Graphics? Discuss how computer graphics is used in telemedicine applications, where doctors use 3D models and imaging data to consult with patients remotely. [1+3]

2. If a graphics card has a memory bandwidth of 48 GB/s and each pixel requires 4 bytes of memory (32 bits), how many pixels can be rendered per second? Describe run length encoding techniques with suitable example? [2+2]

3. Reflect the diamond-shaped polygon whose vertices are A(-1, 0), B(0, -2), C(1, 0), and D(0, 2) about the horizontal line y =2 ? Find the condition under which we can switch the order of a rotation and a simultaneous shearing and still get the same result? [2+2]

4. In 2D computer graphics, you are given a window with a rectangular viewport. The window's coordinates range from (0, 0) to (10, 10), and the viewport's coordinates range from (0, 0) to (400, 400). You are tasked with mapping the window coordinates to the viewport coordinates using the **viewing transformation**. If a point in the window has coordinates $\mathbf{P_w}$ **(5, 5)** what will be the new coordinates $\mathbf{P_v(x_v, y_v)}$ of this point in the viewport? Clip a line with coordinates L1 [Starting (1, 3), End (9, 5)] against a rectangular window with dimension R [Lower Left (2, 2), Upper Right (8, 6)] using Liang Barsky line clipping algorithm? [1+3]

5. What two steps are required to determine whether any given points $\mathbf{P_1}(x_1, y_1, z_1)$, obscures another point $\mathbf{P_2}(x_2, y_2, z_2)$? Explain how does the A-buffer algorithm determine which surfaces are hidden with an example and also write is advantage compare to Depth buffer method? [1+3]

6. A surface point is illuminated by a single light source with the following parameters:
   - Ambient reflection coefficient $(\mathbf{K_a}) = 0.2$
   - Diffuse reflection coefficient $(\mathbf{K_d}) = 0.6$
   - Specular reflection coefficient $(\mathbf{K_s}) = 0.5$
   - Light intensity $(\mathbf{I}) = 100$
   - Ambient light intensity $(\mathbf{I_a}) = 50$
   - The angle between the light direction and the normal = 45°
   - The angle between the reflection direction and the viewer direction = 30°
   - Shininess constant $(n_s) = 10$

   Calculate the total intensity at the surface point. [4]

7. Write Short notes on: [2+2]
   a. YIQ Color model b. Morphing

P.T.O.

SECTION "C"

[2 Q. × 8 = 16 marks]

Attempt ANY TWO questions.

8. Derive all the required decision parameters and write an algorithm for drawing one region of an ellipse with semi major and semi minor axis as $\mathbf{R_X}$, $\mathbf{R_Y}$, and starting from $\mathbf{(-R_X, 0)}$ using Midpoint algorithm and also derive the boundary condition of two different regions? Digitize a line with end points A (2, 3) and B (10, 8) using Bresenham line drawing algorithm? (6+2)

9. Describe one point, two point and three point Perspective projections with an example? Derive 3D composite transformation matrix for rotating a 3D object about an arbitrary axis by an angle θ^o using homogeneous coordinate? ***(Make necessary assumptions) (Actual rotation θ^o should be performed on Y-axis)*** [Matrix multiplication not needed]

10.
   a. What are the drawbacks of using Gouraud Shading model? Describe phong shading with supporting mathematical relation? [1+2]
   b. Reflect the point **P (4, 5)** about the line **y=x+2** [All the transformations matrix needs to be represented using homogeneous coordinate system] [5]