

B.E. INFORMATION TECHNOLOGY 2ND YEAR-2ND SEMESTER EXAMINATION- 2025**Subject: Graphics and Geometric Modeling****Time: 3 hrs.****Full Marks: 100***(Note: Answers of all parts of a question should be written together.)*

CO1 (15)	Q.1 Answer (a) and any one from (b) and (c): a. Consider a circle with center at (20, 15) and radius 25 units. Using both the Bresenham and Midpoint algorithms, generate all points of the circle in the 1st octant and calculate the time complexity of each algorithm based on the number of pixel calculations needed. 7+1 b. - Consider a non-interlaced raster monitor with a resolution of n by m (m scan lines and n pixels per scan line), a refresh rate of r frames per second, a horizontal retrace time of $t_{horizontal}$ and a vertical retrace time of $t_{vertical}$. What is the fraction of the total refresh time per frame spent in retrace of the electron beam? - How long would it take to load a 640 by 480 frame buffer with 12 bits per pixel, if 10^5 bits can be transferred per second? How long would it take to load a 24-bit per pixel frame buffer with a resolution of 1280 by 1024 using this same transfer rate? 3+4 c. - Use the midpoint method to derive decision parameters for generating points along a straight-line path with the slope in the range $0 < m < 1$. Show that the midpoint decision parameters are the same as those in the Bresenham line algorithm. - Suppose you have a system with a 12 inch by 14 inch video monitor that can display 120 pixels per inch. If memory is organized in one byte words, the starting frame buffer address is 0, and each pixel is assigned 4 bits of storage, what is the frame buffer address of the pixel with screen coordinates (x, y)? 3+4
CO2 (25)	Q.2 Answer (a) and any one from (b) and (c): a. - Design a cubic Bezier curve represented by the control points $p_1(-8, 0, 0)$, $p_2(-4, 5, 0)$, $p_3(4, -5, 0)$, and $p_4(8, 0, 0)$. - A cubic splined curve has start and end point at (20, 0) and (7, 2) respectively. The tangent vectors at start and end points meet at (18, 9). Determine the Hermit cubic spline curve and hence find out its mid-point. - Compute and sketch the Bézier blending functions for a cubic Bézier curve. Indicate their intersection points and discuss their properties. 6+7+6 b. - A B-spline curve has the knot vector $\{0, 0, 0, 0, 1, 2, 3, 4, 4, 4, 4\}$. Determine the degree of the curve and the number of control points used to define it. - If a B-spline curve has order 4 and 6 control points, how many segments does it contain, and how many control points influence each segment, and what is the degree of the curve? 3+3 c. - What do C^0, C^1, and C^2 continuity mean in spline interpolation, and how do they affect the smoothness of the curve? - Construct the full knot vector for a B-spline curve of degree 3 using 4 control points. 3+3
CO3 (25)	Q.4 Answer (a) and any one from (b) and (c): a. The lower left-hand corner and upper right-hand corner of a rectangular window are at (-3, 1) and (2, 6) respectively. Using Sutherland-Cohen algorithm, check and find the visibility portion of the line segments AB, BC and CD for A(-4, 2), B(-1, 7), C(-1, 5), and D(-2, 3) in the clipping window. 10 b. - A triangle having vertices (0, 3, 3), (3, 3, 0), and (3, 0, 3), is rotated 60° around a point (2, 2, 2). Find the new coordinates of the rectangle. - Prove that the multiplication of transformation matrices for each of the following sequences is commutative: i) Two successive rotations, ii) Two successive translations, iii) Two successive scalings. - Describe vanishing points and their function in perspective systems. 6+6+3 c. - Vertices of a triangle are (2, 4, 4), (1, 4, 2), and (4, 4, 2). Find the new coordinates of the triangle when it is rotated 45° about X, Y and Z-axis (separately). - Prove that the product of two 2D rotation matrices $R(\theta_1)$ and $R(\theta_2)$ results in a rotation matrix $R(\theta_1 + \theta_2)$. Explain multi-point perspective and its typical applications. - Reflection is a special case of rotation- justify your answer. How does translation affect the rotation of an object about a point? 6+(3+2)+(2+2)

CO4 (15)	Q.4 Answer any one: a. - Find out RGB and YIQ color vectors whose equivalent CMY vector is (0.2, 0.4, 0.6). What does this say about color inversion? Among HSV and HLS, which is better for image editing and why? - Discuss the strengths and weaknesses of rasterization and ray tracing techniques. Compare the use of these techniques in real-time rendering and high-quality rendering. - How do half-toning and dithering technique differ in terms of their visual effects and application? - Discuss the differences you might expect to see in the appearance of specular reflections modeled with $(N.H)^{ns}$ compared to specular reflections modeled with $(V.R)^{ns}$. (3+3)+(2+3)+2+2 b. - Explain how to convert a color from the RGB model to both CMY and YIQ models. What are the essential components of the 3D rendering? - Compare ambient light, diffuse reflection, and specular reflection in illumination models in terms of description, appearance, depending factors, strength, and weakness. - Differentiate between Ray-casting, Ray tracing and Rediosity as rendering approach, strength, and weakness. - Describe the role of depth peeling in managing transparency in 3D rendering. How does it improve the rendering of complex transparent objects? (2+2)+4+3+(2+2)
CO5 (13)	Q.5 Answer any one: a. - Compare the structures and applications of quadrees and octrees in spatial data representation. State the role of a scene graph in organizing and managing objects within a 3D modeling environment. - Explain the concept of content modeling in UX/UI design. In what ways can wireframes support or enhance the content modeling process? Provide relevant examples to justify your explanation. - Compare the usefulness of polygon meshes with CSG in representing complex solids. What are the limitations of using wireframe models in 3D modeling and visualization? Discuss how CSG operations can be applied in 3D modeling with the help of appropriate examples. 4+4+5 b. - Find the total length after n^{th} order of Koch Curve fractal where number of segments and scaling factor are 6 and $1/3$ respectively. Also find the fractal dimension. - Describe the purpose of the firing plane in ray-casting when used to implement CSG operations. How is ray-casting utilized in the implementation of CSG operations? Illustrate its role with a typical use case. - How to raycast octree for closest leaf node? What is the fastest way to insert and move a rectangle object into a linear octree? 4+5+4
CO6 (7)	Q.6 Answer any one: a. In what ways does VR enhance user experience compared to traditional 3D environments? How can VR be integrated with AR to create a mixed reality experience? Why might AR be a more suitable option for creative professionals compared to VR? Support your argument with examples. 2+2+3 b. Outline the standard process involved in creating a morphing sequence. What functions does a 3D visualizer perform in multimedia applications? List and briefly describe common authoring metaphors used in multimedia systems. 2+2+3

Course Outcomes

CO1: Describe fundamental terms of computer graphics and input-output devices of Computer Graphics and Explain the algorithms for Raster scan Graphics.

CO2: Illustrate curve and surface representation and drawing algorithms.

CO3: Compute 2D and 3D Geometric transformations and apply viewing algorithms in typical cases.

CO4: Describe color representation and rendering mechanisms of images.

CO5: Describe Object representation and Illustrate Geometric Modeling.

CO6: Discuss various topics of advanced computer graphics such as fractals, animations, morphing etc.