# PAPER XII (B): COMPUTER GRAPHICS

**Comprehensive Question Bank (All Units)**

*Strictly mapped to the syllabus requirements: 20 Questions (1 Mark), 15 Questions (2 Marks), 10 Questions (5 Marks), and 5 Questions (8 Marks) per Unit.*

## UNIT-I: Introduction & Graphics Systems Overview

### *A. Short Questions (1 Mark Each)*

**Q1.** What is computer graphics?

**Q2.** Define refresh rate in cathode ray tubes.

**Q3.** What is a pixel?

**Q4.** What is aspect ratio?

**Q5.** What does CRT stand for?

**Q6.** Define persistence in the context of CRT phosphors.

**Q7.** What is a raster-scan system?

**Q8.** What is a frame buffer?

**Q9.** Name any two common hardware input devices used in graphics applications.

**Q10.** What is a hard-copy device?

**Q11.** Define resolution of a display system.

**Q12.** What is a random-scan (vector) display system?

**Q13.** What is bitmap graphics?

**Q14.** What is pixmap graphics?

**Q15.** Name one popular graphics software standard or API.

**Q16.** What is the purpose of an electron gun in a CRT?

**Q17.** What is a shadow mask in a color CRT monitor?

**Q18.** What is the function of the video controller in a raster system?

**Q19.** Define the term 'horizontal retrace'.

**Q20.** What is 'vertical retrace'?

### *B. Brief Answer Questions (2 Marks Each)*

**Q1.** Differentiate between Raster Scan and Random Scan displays.

**Q2.** Explain the concept of aspect ratio with an example.

**Q3.** What is the role of a frame buffer in a raster system?

**Q4.** Briefly explain the working principle of an optical mouse.

**Q5.** List any four application areas of computer graphics.

**Q6.** What is the beam-penetration method for color CRTs?

**Q7.** What is a shadow-mask method? Mention its drawback.

**Q8.** Explain the difference between bitmap and pixmap representation.

**Q9.** What is application software in computer graphics?

**Q10.** Define a graphics package or API and name two examples.

**Q11.** What is a digitizer? State its primary application.

**Q12.** Explain the importance of refresh rate in reducing flicker.

**Q13.** What are hard-copy devices? Contrast printers and plotters.

**Q14.** State the function of a lookup table (LUT) in a video controller.

**Q15.** What is interlacing in raster display systems?

### *C. Analytical/Detailed Questions (5 Marks Each)*

**Q1.** Explain the architecture and working principle of a CRT monitor with a neat diagram structure.

**Q2.** Describe the basic operation of a Raster-Scan display system with a block diagram.

**Q3.** Explain the complete configuration and workflow of a Random-Scan display system.

**Q4.** Discuss the primary functions and components of a standard graphics software package.

**Q5.** Explain the technical challenges and methods for producing color in CRT systems.

**Q6.** Describe any three innovative graphical input devices and their functional logic.

**Q7.** What is a frame buffer? Calculate the memory required for a 1024x768 frame buffer with 24-bit color depth.

**Q8.** Compare and contrast the primary benefits and drawbacks of vector versus raster graphics architectures.

**Q9.** Explain the function and operational pipeline of a typical video controller.

**Q10.** Discuss different classifications of hard-copy output devices used in computer design automation.

### *D. Long Essay/Extensive Questions (8 Marks Each)*

**Q1.** Provide a comprehensive survey of computer graphics applications across scientific, commercial, and entertainment fields.

**Q2.** Detailed Analysis: Compare the architecture, display processing, advantage, and disadvantage of Raster Scan Systems vs. Random Scan Systems.

**Q3.** Elaborate on the structural technology, physical working mechanism, and color generation strategies (beam penetration and shadow mask) of video display devices.

**Q4.** Discuss the role, layout, and operations of Graphics Software, including the distinction between application packages and graphics functions.

**Q5.** Explain the detailed operation of a display processor (graphics controller) in a raster system and how it offloads work from the CPU.

## UNIT-II: Graphics Output Primitives & Attributes

### *A. Short Questions (1 Mark Each)*

**Q1.** What is an output primitive?

**Q2.** What is the equation of a straight line in slope-intercept form?

**Q3.** What is the primary condition for a line to be horizontal?

**Q4.** State the basic mathematical equation of a circle centered at the origin.

**Q5.** What is an attribute parameter in computer graphics?

**Q6.** Name the line-drawing algorithm that uses only integer arithmetic.

**Q7.** What is pixel addressing?

**Q8.** What is a filled-area primitive?

**Q9.** Define the term 'curve attribute'.

**Q10.** What does DDA stand for in line drawing?

**Q11.** State the implicit equation of an ellipse.

**Q12.** What is a solid-fill attribute?

**Q13.** What is the purpose of the boundary-fill algorithm?

**Q14.** What is the flood-fill algorithm used for?

**Q15.** Define line width attribute.

**Q16.** What is a soft-fill method?

**Q17.** What is inside-outside testing in polygon filling?

**Q18.** What is a brush style attribute in line drawing?

**Q19.** What is an un-aliased line primitive?

**Q20.** What is scan-line polygon filling?

### *B. Brief Answer Questions (2 Marks Each)*

**Q1.** What are the major disadvantages of the DDA line-drawing algorithm?

**Q2.** State the main advantage of Bresenham's line algorithm over DDA.

**Q3.** Explain the structural difference between Boundary-Fill and Flood-Fill methods.

**Q4.** What is eight-way symmetry of a circle? How does it help in circle generation?

**Q5.** Define line attributes: Line type, Line width, and Line color.

**Q6.** What is the odd-parity rule (or even-odd rule) for finding interior points of a polygon?

**Q7.** Explain the concept of area-fill attributes.

**Q8.** What are the limitations of a basic boundary-fill algorithm when dealing with irregular boundaries?

**Q9.** Explain the concept of four-connected vs eight-connected regions.

**Q10.** What is a point attribute? Give an example.

**Q11.** Define curve attributes and list two examples.

**Q12.** Write the decision variable expression used in Midpoint Circle Algorithm.

**Q13.** What is the significance of the Scan-Line algorithm for area filling?

**Q14.** How does pixel phase/position affect line rendering attributes?

**Q15.** Explain what a patterned fill attribute is.

### *C. Analytical/Detailed Questions (5 Marks Each)*

**Q1.** Derive and explain the step-by-step Digital Differential Analyzer (DDA) line-drawing algorithm.

**Q2.** Explain Bresenham's line drawing algorithm for a line with a positive slope less than 1.

**Q3.** Discuss the Midpoint Circle Generation algorithm along with its mathematical derivation.

**Q4.** Explain the Boundary-Fill algorithm for both 4-connected and 8-connected regions with a recursive workflow.

**Q5.** Describe the Flood-Fill algorithm and specify where it is preferred over the Boundary-Fill approach.

**Q6.** Explain the scan-line polygon filling algorithm with its Active Edge Table (AET) structure.

**Q7.** Discuss various line attributes and describe how line width can be implemented practically using pixels.

**Q8.** Explain methods for filling areas that have highly irregular boundaries or soft color variations.

**Q9.** Detail the Midpoint Ellipse Generation algorithm for the first quadrant region.

**Q10.** Explain the winding-number rule for inside-outside area definition and compare it with the odd-even rule.

### *D. Long Essay/Extensive Questions (8 Marks Each)*

**Q1.** Complete Derivation: Develop the mathematical logic and write the operational steps of Bresenham's Line Drawing Algorithm for all slopes.

**Q2.** Elaborate on Circle Generation Mechanics: Derive the complete mathematical model and framework for the Midpoint Circle Algorithm.

**Q3.** Discuss in detail the Scan-Line Polygon Fill Algorithm, showing how the Edge Table (ET) and Active Edge Table (AET) are maintained.

**Q4.** Comprehensive Study on Attributes: Analyze all types of graphics primitive attributes (point, line, curve, and fill area) and implementation techniques.

**Q5.** Provide a comprehensive comparative analysis of Area Fill Methods, including Recursive Boundary-Fill, Flood-Fill, and Scan-Line methods for irregular boundaries.

## UNIT-III: Geometric Transformations (2-D & 3-D)

### *A. Short Questions (1 Mark Each)*

**Q1.** What is a geometric transformation?

**Q2.** Write the 2D translation vector form.

**Q3.** Define scaling transformation.

**Q4.** What is a homogeneous coordinate system?

**Q5.** Why do we use a 3x3 matrix for 2D transformations instead of a 2x2 matrix?

**Q6.** What is fixed-point scaling?

**Q7.** What is a reflection transformation?

**Q8.** Define the term 'shear transformation'.

**Q9.** Write the 2D rotation matrix for an angle theta clockwise.

**Q10.** What is a composite transformation?

**Q11.** State the 3D translation matrix representation.

**Q12.** What is the dimension of a 3D homogeneous transformation matrix?

**Q13.** What is rigid-body transformation?

**Q14.** Name the transformation that alters the shape of an object as if it slid along an axis.

**Q15.** What is reflection about the line y = x?

**Q16.** State the scaling matrix in 3D graphics.

**Q17.** What is an inverse transformation?

**Q18.** What is the identity matrix for 3D graphics?

**Q19.** Define rotation about an arbitrary point in 2D.

**Q20.** What is uniform scaling?

### *B. Brief Answer Questions (2 Marks Each)*

**Q1.** Write the matrix representations for 2D translation and 2D scaling using homogeneous coordinates.

**Q2.** Why is the multiplication of transformation matrices preferred over individual coordinates transformations?

**Q3.** Explain the term 'homogeneous coordinates' and its advantages in computer graphics.

**Q4.** Differentiate between uniform scaling and non-uniform scaling.

**Q5.** What is shear transformation? Give its matrix form along the X-axis.

**Q6.** Explain reflection with respect to the origin in 2D graphics.

**Q7.** Express 3D scaling in matrix form with respect to the coordinate origin.

**Q8.** What is an affine transformation?

**Q9.** How can a 2D rotation about an arbitrary point be performed using basic transformations?

**Q10.** Write down the matrix for 2D reflection about the X-axis.

**Q11.** Define 3D rotation and state its complexity compared to 2D rotation.

**Q12.** Explain how the order of matrix multiplication affects composite transformations.

**Q13.** What is directional shear? Provide an example.

**Q14.** Show how to invert a translation matrix.

**Q15.** Show the mathematical representation of a 3D translation vector.

### *C. Analytical/Detailed Questions (5 Marks Each)*

**Q1.** Explain the three basic 2D transformations (Translation, Rotation, Scaling) along with their matrix expressions.

**Q2.** What are homogeneous coordinates? Show how they allow composite transformations via matrix multiplication.

**Q3.** Derive the composite matrix for 2D rotation about a user-specified arbitrary pivot point.

**Q4.** Explain 2D reflection transformations with respect to coordinate axes, origin, and the line $y = x$.

**Q5.** Discuss X-axis and Y-axis shear transformations in 2D with their geometric impacts and matrices.

**Q6.** Extend 2D transformations to 3D: Explain 3D Translation and 3D Scaling with their homogeneous matrices.

**Q7.** Describe the process and matrix derivations for 3D rotation about the primary coordinate axes (X, Y, Z).

**Q8.** Show mathematically that two successive translations are commutative.

**Q9.** Derive the composite transformation matrix for scaling an object with respect to a fixed point.

**Q10.** Explain how 3D reflection is performed across the XY, YZ, and XZ planes with appropriate matrices.

### *D. Long Essay/Extensive Questions (8 Marks Each)*

**Q1.** Comprehensive Derivation: Derive the complete step-by-step composite transformation matrix for 2D rotation about an arbitrary point (xr, yr).

**Q2.** Elaborate on 3D Transformations: Discuss the detailed matrix framework for 3D Translation, Scaling, Reflection, and Shear in homogeneous coordinates.

**Q3.** Mathematical Proofs: Prove that two successive 2D rotations are additive and that general 2D scaling transformations are commutative.

**Q4.** Formulate the complete algorithmic and mathematical steps required to rotate a 3D object about an arbitrary axis parallel to one of the coordinate axes.

**Q5.** Analyze the complete taxonomy of Geometric Transformations in computer graphics, focusing on how homogeneous coordinates resolve non-linear translation operations.

## UNIT-IV: Two-Dimensional Viewing & Clipping

### *A. Short Questions (1 Mark Each)*

**Q1.** What is 2D viewing?

**Q2.** Define the term 'clipping window'.

**Q3.** What is a viewport?

**Q4.** What is a viewing pipeline?

**Q5.** Define clipping in computer graphics.

**Q6.** What are the coordinates of a normalized viewport?

**Q7.** Name one popular line clipping algorithm.

**Q8.** What is a region code in the Cohen-Sutherland algorithm?

**Q9.** How many bits are used in the Cohen-Sutherland region code?

**Q10.** What does a region code of 0000 mean?

**Q11.** State the primary function of point clipping.

**Q12.** What is polygon clipping?

**Q13.** Name the polygon clipping algorithm that clips against one window boundary at a time.

**Q14.** What is a viewing transformation?

**Q15.** Define window-to-viewport transformation.

**Q16.** What is text clipping?

**Q17.** What bit operation determines if a line is completely outside the window in Cohen-Sutherland?

**Q18.** What is an entry/exit point in polygon clipping?

**Q19.** State the main advantage of the Liang-Barsky algorithm over Cohen-Sutherland.

**Q20.** What is a clipping boundary?

### *B. Brief Answer Questions (2 Marks Each)*

**Q1.** Distinguish between a window and a viewport.

**Q2.** Explain the general concept of the viewing pipeline in 2D graphics.

**Q3.** State the conditions under which a point (x, y) is saved or discarded during point clipping.

**Q4.** What are the four bit positions (Left, Right, Bottom, Top) in Cohen-Sutherland line clipping?

**Q5.** How does the Cohen-Sutherland algorithm determine if a line is trivially accepted?

**Q6.** How does the Cohen-Sutherland algorithm determine if a line is trivially rejected?

**Q7.** What is the basic strategy of the Sutherland-Hodgman polygon clipping algorithm?

**Q8.** Define the parameters used in the parametric equation of a line in the Liang-Barsky algorithm.

**Q9.** Why is polygon clipping more complex than line clipping?

**Q10.** Explain the concept of window-to-viewport scaling factor.

**Q11.** What are the four cases of vertex processing against a boundary in the Sutherland-Hodgman algorithm?

**Q12.** What is the significance of the mid-point subdivision algorithm?

**Q13.** Define interior clipping vs exterior clipping.

**Q14.** What happens to concave polygons during Sutherland-Hodgman clipping?

**Q15.** Explain why viewing transformation is necessary.

### *C. Analytical/Detailed Questions (5 Marks Each)*

**Q1.** Explain the 2D viewing pipeline from world coordinates to device coordinates with a block diagram.

**Q2.** Derive the mathematical formulation for Window-to-Viewport coordinate transformation equations.

**Q3.** Explain the Cohen-Sutherland line clipping algorithm, detailed region code assignment, and test criteria.

**Q4.** Describe the Liang-Barsky line clipping algorithm based on parametric line equations.

**Q5.** Explain the Sutherland-Hodgman polygon clipping algorithm and its four edge-clipping rules.

**Q6.** Discuss point clipping criteria and provide a clean algorithmic structure for execution.

**Q7.** Compare the operational efficiencies of the Cohen-Sutherland algorithm and the Liang-Barsky algorithm.

**Q8.** Explain how concave polygons create extraneous lines during Sutherland-Hodgman clipping and how to resolve them.

**Q9.** Describe the viewing transformation matrix sequence needed to map a window area into a viewport area.

**Q10.** Discuss the methods and logic used for structural text clipping and curve clipping.

### *D. Long Essay/Extensive Questions (8 Marks Each)*

**Q1.** Complete Algorithmic Analysis: Detail the complete Cohen-Sutherland Line Clipping Algorithm, including region code generation and intersection calculations.

**Q2.** Parametric Optimization: Provide an exhaustive explanation and derivation of the Liang-Barsky Line Clipping Algorithm, highlighting its efficiency benefits.

**Q3.** Polygon Processing Architecture: Formulate the step-by-step pipeline of the Sutherland-Hodgman Polygon Clipping Algorithm for a general polygon clipped against a rectangular window.

**Q4.** Mathematical Derivation: Derive the full transformation matrix for window-to-viewport mapping, ensuring correct scale and shift parameters are preserved.

**Q5.** Detailed Study on Two-Dimensional Viewing: Analyze the entire viewing environment, including coordinate normalization, clip windows, viewport clipping, and pipeline implementation.