

**Module 1**

**Chapter 1 : Introduction and Overview of Graphics System 1-1 to 1-28**

**Syllabus :**  
 Definition and Representative uses of computer graphics, Overview of coordinate system, Definition of scan conversion, rasterization and rendering.  
 Raster scan & random scan displays, Architecture of raster graphics system with display processor, Architecture of random scan systems.

1.1	Introduction .....	1-1
1.2	Graphics Primitives .....	1-2
1.2.1	Lines .....	1-2
1.2.2	Line Segments.....	1-3
1.2.3	Vectors .....	1-3
1.3	Applications of Computer Graphics.....	1-4
1.4	Overview of the Coordinate System.....	1-7
1.4.1	Introduction.....	1-7
1.4.2	Cartesian Coordinate System.....	1-8
1.4.3	Polar Coordinate System.....	1-9
1.4.4	Spherical Coordinate System .....	1-10
1.4.5	Cylindrical Coordinate System .....	1-10
1.5	Basic Terminology.....	1-11
1.5.1	Scan Conversion .....	1-11
1.5.2	Rasterization.....	1-11
1.5.3	Rendering .....	1-12
1.5.4	Pixel.....	1-12
1.5.5	Resolution.....	1-13
1.5.6	Aspect Ratio .....	1-13
1.5.7	Frame Buffer.....	1-14
1.6	Display Devices.....	1-14
1.6.1	Cathode Ray Tube.....	1-15
1.6.2	Raster Scan Display .....	1-16
1.6.3	Random Scan Display .....	1-19
1.6.4	Raster Scan vs. Random Scan .....	1-19
1.6.5	Color CRT Monitors .....	1-20
1.6.5.1	Beam Penetration Method.....	1-20
1.6.5.2	Shadow Mask Method .....	1-20

1.6.6	Direct-View Storage Tubes.....	1-21
1.6.7	Flat Panel Display.....	1-22
1.6.7.1	LCD .....	1-23
1.6.7.2	LED.....	1-23
1.6.7.3	Plasma Panels.....	1-24
1.6.7.4	Electroluminescent Displays.....	1-24
1.6.8	Comparison of CRT, LCD, Plasma and OLED Displays .....	1-25
1.7	Architecture of Raster Scan Systems .....	1-26
1.7.1	Video Controller.....	1-26
1.8	Architecture of Random Scan Systems .....	1-28

**Module 2**

**Chapter 2 : Output Primitives 2-1 to 2-47**

**Syllabus :**  
 Scan conversions of point, line, circle and ellipse : DDA algorithm and Bresenham algorithm for line drawing, midpoint algorithm for circle, midpoint algorithm for ellipse drawing (Mathematical derivation for above algorithms is expected)  
 Aliasing, Antialiasing techniques like Pre and post filtering, super sampling, and pixel phasing).

2.1	Scan Conversion.....	2-1
2.1.1	What is Scan Conversion?.....	2-1
2.1.2	Line and Line Segment.....	2-2
2.1.3	Qualities of Good Line Drawing Algorithms .....	2-3
2.2	Line Drawing Algorithms .....	2-3
2.2.1	DDA Line Drawing Algorithm .....	2-3
2.2.1.1	Working Mechanism.....	2-4
2.2.1.2	Algorithm .....	2-7
2.2.1.3	Pros and Cons.....	2-8
2.2.1.4	Examples.....	2-9
2.2.2	Bresenham Line Drawing Algorithm .....	2-17
2.2.2.1	Working Mechanism.....	2-17
2.2.2.2	Algorithm .....	2-19
2.2.2.3	Pros and Cons.....	2-20
2.2.2.4	Examples.....	2-21
2.2.3	DDA vs. Bresenham Line Drawing Algorithm .....	2-28
2.3	Circle Drawing Algorithm.....	2-29
2.3.1	Midpoint Circle Drawing Algorithm.....	2-29
2.3.1.1	Working Mechanism.....	2-29

2.3.1.2	Algorithm .....	2-31
2.3.1.3	Pros and Cons .....	2-32
2.3.1.4	Example .....	2-32
2.4	Midpoint Ellipse Drawing Algorithm .....	2-35
2.4.1	Working Mechanism .....	2-35
2.4.2	Algorithm .....	2-40
2.4.3	Pros and Cons .....	2-41
2.4.4	Example .....	2-41
2.5	Aliasing .....	2-42
2.6	Anti-aliasing .....	2-43
2.6.1	Pre Filtering .....	2-43
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2.6.3	Super Sampling .....	2-44
2.6.4	Pixel Phasing .....	2-46

**Chapter 3 : Filled Area Primitives**

**3-1 to 3-16**

**Syllabus :**

**Filled Area Primitive :** Scan line Polygon Fill algorithm, Inside outside tests, Boundary Fill and Flood fill algorithm.

3.1	Polygon .....	3-1
3.1.1	Introduction to Polygon .....	3-1
3.1.2	Types of Polygon .....	3-1
3.1.2.1	Convex Polygon .....	3-1
3.1.2.2	Concave Polygon .....	3-2
3.1.2.3	Complex Polygon .....	3-2
3.2	Inside Outside Tests .....	3-2
3.2.1	Even-Odd Test .....	3-3
3.2.2	Winding Number Rule .....	3-4
3.3	Polygon Filling .....	3-4
3.3.1	Introduction .....	3-4
3.3.2	Pixel Connectivity .....	3-5
3.4	Boundary Fill .....	3-5
3.4.1	Working Mechanism .....	3-5
3.4.2	Algorithm .....	3-6
3.4.3	Pros and Cons .....	3-6
3.4.4	Example .....	3-7
3.5	Flood Fill .....	3-8

3.5.1	Working Mechanism.....	3-8
3.5.2	Algorithm .....	3-8
3.5.3	Pros and Cons.....	3-8
3.6	Optimization .....	3-9
3.7	Scan Line Fill .....	3-9
3.7.1	Working Principle .....	3-9
3.7.2	Algorithm .....	3-11
3.7.3	Pros and Cons.....	3-12
3.7.4	Example.....	3-12
3.8	Seed Fill vs Scan Line Algorithm .....	3-16

**Module 3**

**Chapter 4 : Two Dimensional Geometric Transformations 4-1 to 4-55**

**Syllabus :**  
 Basic transformations : Translation, Scaling, Rotation, Matrix representation and Homogeneous Coordinates, Composite transformation  
 Other transformations : Reflection and Shear

4.1	Introduction .....	4-1
4.2	Matrix Operations.....	4-2
4.2.1	Matrix Representation.....	4-2
4.2.2	Matrix Properties.....	4-3
4.2.3	Determinant of Matrix .....	4-3
4.2.4	Multiplying Two Matrices .....	4-3
4.3	Translation .....	4-4
4.4	Rotation.....	4-7
4.4.1	Rotation about Origin.....	4-7
4.4.2	Rotation with Respect to Reference Point.....	4-8
4.5	Scaling .....	4-12
4.5.1	Scaling with Respect to Origin.....	4-12
4.5.2	Scaling with Respect to Reference Point .....	4-13
4.5.3	Uniform vs. Non-Uniform Scaling .....	4-15
4.6	Matrix Representation and Homogeneous Coordinates .....	4-19
4.6.1	Translation .....	4-20
4.6.2	Scaling.....	4-20
4.6.3	Rotation .....	4-21

4.7	Composite Transformation.....	4-21
4.7.1	Successive Transformations .....	4-21
4.7.2	Examples.....	4-23
4.8	Reflection .....	4-27
4.8.1	Reflection about X - Axis (Y = 0 Line).....	4-28
4.8.2	Reflection about Y - Axis (X = 0 Line).....	4-28
4.8.3	Reflection about X = Y Axis .....	4-29
4.8.4	Reflection about X = - Y Axis .....	4-30
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4.8.6	Reflection about any Line $y = mx + c$ .....	4-31
4.8.7	Reflection about a Line Parallel to X-Axis.....	4-31
4.8.8	Reflection about a Line Parallel to Y-Axis.....	4-32
4.9	Shearing.....	4-35
4.9.1	X- Direction Shearing .....	4-35
4.9.2	Shearing about a Line Parallel to X-axis.....	4-36
4.9.3	Y- Direction Shearing .....	4-38
4.9.4	Shearing about a Line Parallel to Y-axis.....	4-39
4.10	Solved Examples .....	4-41

**Module 4**

**Chapter 5 : Two-Dimensional Viewing and Clipping** **5-1 to 5-39**

**Syllabus :**  
 Viewing transformation pipeline and Window to Viewport coordinate transformation  
 Clipping operations: Point clipping, Line clipping algorithms : Cohen-Sutherland, Liang : Barsky, Polygon Clipping Algorithms : Sutherland-Hodgeman, Weiler-Atherton.

5.1	2D Viewing.....	5-1
5.1.1	Viewing Transformation Pipeline .....	5-1
5.1.2	Window to Viewport Coordinate Transformation .....	5-3
5.2	2D Clipping.....	5-5
5.3	Point Clipping .....	5-6
5.4	Line Clipping .....	5-7
5.4.1	Cohen - Sutherland Line Clipping Algorithm .....	5-8
5.4.1.1	Working Mechanism.....	5-8
5.4.1.2	Algorithm .....	5-10
5.4.1.3	Pros and Cons.....	5-11

5.4.1.4	Examples .....	5-11
5.4.2	Liang - Barsky Line Clipping Algorithm.....	5-19
5.4.2.1	Working Mechanism.....	5-19
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5.4.2.3	Pros and Cons.....	5-21
5.4.2.4	Example.....	5-21
5.5	Polygon Clipping .....	5-31
5.5.1	Sutherland-Hodgeman Polygon Clipping Algorithm .....	5-32
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5.5.1.3	Pros and Cons.....	5-34
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5.5.2.2	Pros and Cons.....	5-36
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**Module 5**

**Chapter 6 : 3D Transformation** **6-1 to 6-32**

<b>Syllabus :</b>		
Introduction, Translation, Rotation, Scaling, Reflection, Composite transformations, Rotation about an arbitrary axis		
6.1	3D Transformation .....	6-1
6.1.1	Introduction.....	6-1
6.1.2	3D Geometry .....	6-1
6.2	Translation .....	6-2
6.3	Scaling .....	6-3
6.3.1	Scaling with Respect to Origin.....	6-4
6.3.2	Scaling with Respect to Reference Point .....	6-4
6.4	Rotation.....	6-5
6.4.1	Rotation About Principal Axis .....	6-6
6.4.2	Rotation About Line Parallel to Principle Axis .....	6-7
6.4.3	Rotation About an Arbitrary Axis.....	6-8
6.5	Reflection.....	6-13
6.6	Shear.....	6-18

6.7	Composite Transformations .....	6-19
6.8	Solved Examples .....	6-20

**Chapter 7 : Projection** **7-1 to 7-27**

**Syllabus :**  
 Projections-Parallel, Perspective. (Matrix Representation)

7.1	Introduction .....	7-1
7.2	Parallel Projection .....	7-2
7.2.1	Oblique Parallel Projection .....	7-3
7.2.1.1	Cavalier Projection .....	7-4
7.2.1.2	Cabinet Projection .....	7-5
7.2.2	Orthographic Parallel Projection .....	7-5
7.2.2.1	Multiview Parallel Projection .....	7-5
7.2.2.2	Axonometric Parallel Projection .....	7-6
7.3	Perspective Projection .....	7-10
7.3.1	Vanishing Point.....	7-12
7.3.2	Single Point Perspective Projection.....	7-13
7.3.3	Two Point Perspective Projection .....	7-14
7.3.4	Three-Point Perspective Projection .....	7-15
7.4	Parallel vs. Perspective Projection.....	7-15
7.5	Orthographic vs. Isometric Projection .....	7-16
7.6	Solved Examples .....	7-16

**Chapter 8 : Curves and Fractals** **8-1 to 8-24**

**Syllabus :**  
 Bezier Curve, B-Spline Curve, Fractal-Geometry, Fractal Dimension, Koch Curve

8.1	Curves.....	8-1
8.1.1	Introduction.....	8-1
8.1.2	Interpolation and Approximation.....	8-1
8.1.3	Continuity.....	8-2
8.1.3.1	Geometric Continuity .....	8-3
8.1.3.2	Parametric Continuity .....	8-3
8.1.4	Bezier Curve .....	8-4
8.1.5	B-Spline Curve .....	8-14
8.1.6	Bezier Vs. B-Spline Curve .....	8-18

8.2	Fractals .....	8-18
8.2.1	Fractal-Geometry.....	8-18
8.2.2	Fractal Classification .....	8-19
8.2.3	Fractal Dimension.....	8-20
8.2.4	Koch Curve .....	8-22
8.2.5	Applications .....	8-23

**Module 6**

**Chapter 9 : Visible Surface Detection** **9-1 to 9-9**

**Syllabus :**  
 Visible Surface Detection : Classification of Visible Surface Detection algorithm, Back Surface detection method, Depth Buffer method, Area Subdivision method

9.1	Introduction .....	9-1
9.2	Classification of Visible Surface Detection Algorithm .....	9-1
9.3	Back Surface Detection Method.....	9-2
9.4	Depth Buffer Method .....	9-4
9.5	Area Subdivision Method .....	9-6

**Chapter 10 : Animation** **10-1 to 10-9**

**Syllabus :**  
 Introduction to Animation, Traditional Animation Techniques, Principles of Animation, Key framing : Character and Facial Animation, Deformation, Motion capture

10.1	Introduction .....	10-1
10.2	Traditional Animation Techniques.....	10-1
10.3	Principles of Animation .....	10-2
10.4	Keyframing : Character and Facial Animation.....	10-4
10.5	Deformation.....	10-5
10.5.1	Rigid Body Transformation .....	10-6
10.5.2	Deformation .....	10-7
10.5.2.1	Parameterized Deformation.....	10-7
10.5.2.2	Lattice Deformation.....	10-7
10.5.2.3	Composite Deformation.....	10-8
10.6	Motion Capture.....	10-8

➤ **Model Question Paper (End sem.)** ..... **M-1**