

**COURSE NAME: COMPUTER GRAPHICS****COURSE CODE:****SEMESTER: IV****Scheme:**

Course Title	Computer Graphics			Course Type		Integrated			
Course Code				Class					
Instruction delivery	Activity	Credits	Credit Hours	Total Number of Classes per Semester				Assessment in Weightage	
	Lecture	3	3						
	Tutorial	0	0	Theory	Tutorial	Practical	Self-study	CIE	SEE
	Practical	1	2						
	Self-study	0	0						
	Total	4	5	45	0	15		50%	50%
Names Course Instructors	Course Lead		Mr. Rajkamal Kishor Gupta						
	Theory					Practical			
	1. Ms Pragya Agarwal 2. Ms R. Sathiya Priya 3. Ms R. Radhika 4. Dr. Suresh Kumar N. 5. Ms Suman Devi 6. Mr R. Muthuganesh 7. Ms Alisha Banga 8. Ms Indrakumari 9. Mr Damodharan D. 10. Mr Atul Kumar Singh 11. Ms Priyanka Shukla 12. Mr V. Gokul Rajan 13. Ms Nidhi Agarwal 14. Dr. Ashish Kumar Srivastava 15. Mr Hradesh Kumar 16. Mr Arun Kumar 17. Ms Ragini Kumari 18. Dr Sanjeev Kumar Punia					1. Ms Pragya Agarwal 2. Ms R. Sathiya Priya 3. Ms R. Radhika 4. Dr. Suresh Kumar N. 5. Ms Suman Devi 6. Mr R. Muthuganesh 7. Ms Alisha Banga 8. Ms Indrakumari 9. Mr Damodharan D. 10. Mr Atul Kumar Singh 11. Ms Priyanka Shukla 12. Mr V. Gokul Rajan 13. Ms Nidhi Agarwal 14. Dr. Ashish Kumar Srivastava 15. Mr Hradesh Kumar 16. Mr Arun Kumar 17. Ms Ragini Kumari 18. Dr Sanjeev Kumar Punia			

## **COURSE OVERVIEW:**

This course focuses on 2D and 3D interactive and non-interactive graphics. This course studies the principles underlying the generation and display of 2D and 3D computer graphics. In this course topics include geometric modeling, 3D viewing and projection, lighting and shading, color, and the use of one or more technologies and packages such as OpenGL, and Blender. Course requirements usually include exam and several programming or written homework assignments.

## **COURSE OBJECTIVES:**

1. To provide a comprehensive introduction to computer graphics leading to the ability to understand contemporary terminology, progress, issues, and trends.
2. To understand computer graphics techniques (2-D/3-D), focusing on 3D modelling, image synthesis, and rendering.
3. Introduce geometric transformations, geometric algorithms, software systems (OpenGL), 3D object models (surface, volume and implicit), visible surface algorithms, image synthesis, shading and mapping, ray tracing, radiosity, global illumination, photon mapping, and anti-aliasing.
4. To explore the interdisciplinary nature of computer graphics which is emphasized in the wide variety of examples and applications.

## **COURSE OUTCOMES:**

<b>COs</b>	<b>CO Statement</b>
CO1	Understands the principles and techniques of computer graphics, e.g., the graphics pipeline, Line drawing algorithms and circle generation.
CO2	Apply the relevant mathematics to facilitate computer graphics, e.g., 2D and 3D rotations using both vector algebra, geometrical transformations
CO3	Analyze the concept of projections using homogeneous co-ordinations and curves & surfaces.
CO4	Develop of computer games, information visualization, and business applications with computer graphics concepts.

CO No.	Bloom's Taxonomy Level (BTL)					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1	✓	✓	✗	✗	✗	✗
CO2	✓	✗	✓	✗	✗	✗
CO3	✓	✗	✗	✓	✗	✗
CO4	✓	✗	✗	✗	✓	✓

## PROGRAM OUTCOMES

- PO1:** Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- PO2:** Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- PO3:** Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
- PO4:** Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
- PO5:** Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
- PO6:** The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- PO7:** Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development
- PO8:** Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- PO9:** Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- PO10:** Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to

comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**PO11:** Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**PO12:** Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Programme specifics outcome (PSO):** (if any)

**PSO1:** PSO1 Able to analyze, design and implement sustainable and ethical solutions in the field of computer science.

**PSO2:** PSO2 Able to use problem solving skills to develop efficient algorithmic solutions.

**COURSE ARTICULATION MATRIX:**

Cos	POs												PSOs	
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
<b>CO1</b>	3	2	1	-	1	-	-	-	-	-	-	-	2	1
<b>CO2</b>	3	3	2	-	2	-	-	-	-	-	-	-	3	3
<b>CO3</b>	3	2	1	-	1	-	-	-	-	-	-	-	1	2
<b>CO4</b>	2	3	3	2	2	1	-	-	2	-	1	-	3	3

## **COURSE ASSESSMENT:**

<b>Assessment Tools</b>	<b>Quiz1/AAT</b>	<b>CAT1</b>	<b>QUIZ2/AAT</b>	<b>CAT2</b>	<b>LAB</b>	<b>LAB Test</b>	<b>Course-Based Project</b>	<b>Total CIE Marks</b>	<b>SEE</b>
<b>Integrate</b>	<b>A1</b>	<b>A2</b>	<b>A3</b>	<b>A4</b>					
	NA	30	NA	30	20	20	0	100	100

**CAT:** Continuous Assessment Test; **SEE:** Semester End Examination; **ETE:** End Term Examination; **A1-Assessment-1**

### **Rubrics for Practical IA:**

<b>S. No</b>	<b>Rubrics – Parts</b>	<b>Marks</b>
1	Performance	2
2	Result	3
3	File	2
4	Viva	3
Total		10

## COURSE CONTENT:

Topic	Content
THEORY	<p><b>Fundamentals:</b> Types of computer graphics, Graphic Displays- Random scan displays, Raster scan displays, Frame buffer and video controller, Points and lines, Line drawing algorithms, Circle generating algorithms, Midpoint circle generating algorithm, and introduction to parallel version of these algorithms.</p> <p><b>Transformations:</b> Basic transformation, Matrix representations and homogenous coordinates, Composite transformations, Reflections and shearing. Windowing and Clipping: Viewing pipeline, Viewing transformations, 2-D Clipping algorithms-Line clipping algorithms such as Cohen Sutherland line clipping algorithm, Liang Barsky algorithm, Line clipping against non-rectangular clip windows; Polygon clipping – Sutherland Hodgeman polygon clipping, Curve clipping, Text clipping.</p> <p><b>Three Dimensional:</b> 3-D geometric primitives, 3-D Object representation, 3-D Transformation, 3-D viewing, projections, 3-D Clipping.</p> <p><b>Curves and Surfaces:</b> Quadric surfaces, Spheres, Ellipsoid, Blobby objects, Introductory concepts of Spline, Bspline and Bezier curves and surfaces.</p> <p><b>Hidden Lines and Illumination models:</b> Hidden Lines and Surfaces: Back Face Detection algorithm, Depth buffer method, A-buffer method, Scan line method, basic illumination models – Ambient light, Diffuse reflection, Specular reflection, Intensity Attenuation, Color consideration, Transparency and Shadows.</p>
PRACTICAL	<ol style="list-style-type: none"> <li>Using different graphics functions available for text formatting, write a program for displaying text in different sizes, different colors, font styles</li> <li>Implement the DDA algorithm for drawing lines.</li> <li>Write a program to input the line coordinates from the user to generate a line using Bresenham's algorithm. (programmers are expected to shift the origin to the center of the screen and divide the screen into required quadrants)</li> <li>Write a program to generate a complete moving wheel using Midpoint circle drawing algorithm and Bresenham's circle drawing algorithm.</li> <li>Write a program to generate a complete moving wheel using Bresenham's circle drawing algorithm.</li> <li>Write a program to draw two concentric circles using any circle drawing algorithm.</li> <li>Write a program to draw a rectangle. The four vertices of it should be entered by the end user.</li> <li>Write a program to draw a bar graph using C/C++ in computer graphics.</li> <li>Write a program to draw an ellipse.</li> <li>Write a program to draw different shapes like polygons, stars, triangles, ellipses, squares, rectangles etc.</li> </ol>

11. Write a program to draw any 2-D object and perform the transformations on it according to the input parameters from the user, namely: Translation, Rotation or Scaling.
12. Write a program to draw any 2-D object and perform the transformations on it according to the input parameters from the user, namely: Shearing and Reflection.
13. Write a program to perform clipping on a line against the clip window using cohen sutherland line clipping algorithm. The output must be twofold showing the before clipping and after clipping images
14. Write a program to implement Liang-Barsky 2D Line clipping.
15. Write a program to draw a house like figure and perform the following operations. a. Scaling about the origin followed by translation. b. Scaling with reference to an arbitrary point.
16. Write a program inscribed and circumscribed circles in triangle.
17. Write a program to draw a concave polygon and fill it with desired color using scan fill algorithm.
18. Write a program to generate Hilbert Curve using concept of fractals.
19. Draw a moving cycle using computer graphics programming in C/C++.
20. Write a program to make a digital clock using C/C++ in computer graphics.
21. Write a program to draw a Pie Chart using C/C++ in Computer Graphics.
22. Write a program that performs a countdown for 30 seconds.
23. Write a program to implement bouncing ball animation in C/C++ using computer graphics.
24. Write a program to implement moving car animation in C/C++ using computer graphics.
25. Write a program to draw a smiling face that appears at random positions on the screen using Computer Graphics animation.
26. Write a C program to generate a captcha which is a random string generated.
27. Write a program to draw a 3-D Bar Graph.
28. Write a C program to draw a tan graph using graphics.
29. Write a C program to draw a Sine wave graph using graphics.
30. Write a C program to draw a Cosine wave graph using graphics.
31. Write a C program to draw stars in night sky using graphics.
32. Write a program to draw any 3-D object and perform the translation on it according to the input parameters from the user.
33. Write a program to draw any 3-D object and perform the rotation on it according to the input parameters from the user.
34. Write a program to draw any 3-D object and perform the scaling on it according to the input parameters from the user.
35. Write a program to draw Sunrise and Sunset.

**Lesson Plan for Theory:**

<b>L. No.</b>	<b>Topic To Covered</b>	<b>Skill</b>
1	Introduction, Types of computer graphics	Understanding Basic of Computer Graphics
2	Graphic Displays- Random scan displays,Raster scan displays	
3	Frame buffer and video controller	
4	Points and lines	
5	Line drawing algorithms(DDA)	Learning Line Drawing Skill
6	Bresenhems Line Drawing algorithm	
7	Midpoint circle generating algorithm.	
8	Revision	
9	Basic transformation	Understanding Transformation Skill
10	Matrix representations and homogenous coordinates	
11	Composite transformations	
12	Reflections and shearing	
13	Windowing and Clipping: Viewing pipeline	
14	Viewing transformations	
15	2-D Clipping Algorithms	Concept of 2D Computer Graphics
16	Line clipping algorithms such as Cohen Sutherland line clipping algorithm	
17	Liang Barsky algorithm	
18	Line clipping against non-rectangular clip windows	
19	Polygon clipping – Sutherland Hodgeman polygon clipping	
20	Curve clipping, Text clipping.	
21	Revision	Concept of 3D Computer Graphics
22	3-D geometric primitives	
23	3-D Object representation	
24	3-D Transformation	
25	3-D viewing	
26	Projections	
27	3-D Clipping	
28	Revision	
29	Quadric surfaces, Spheres	Curves and Surfaces
30	Ellipsoid, Blobby objects	
31	Introductory concepts of Spline	
32	BSpline curves and surfaces.	
33	Bezier curves and surfaces.	
34	Revision	
35	Hidden Lines and Surfaces: Back Face Detection algorithm	Understanding Hidden line
36	Depth buffer method	



37	A-buffer method	
38	Scan line method	
39	basic illumination models – Ambient light	Apply Illumination concept
40	Diffuse reflection, Specular reflection	
41	Intensity Attenuation, Color consideration	
42	Transparency and Shadows.	
43	Revision	
44	The advances and the latest trends in the course as well as the latest applications of the areas covered in the course. The latest research conducted in the areas covered in the course	Advance Studies
45	Discussion of some latest papers published in IEEE transactions and ACM transactions, Web of Science and SCOPUS indexed journals as well as high impact factor conferences as well as symposiums	

### Lesson Plan for Practical:

P. No	Topic	Skill
1	Write a program for drawing graphics primitives and color it.	Introduction of Computer Graphics
2	Write a program to divide screen into four region and draw circle, rectangle, arc and ellipse.	
3	Write a program for drawing a simple object.	Drawing and filling of Geometric Shapes
4	Write a program for drawing a line using DDA and Bresahnam's Line Drawing Algorithm.	
5	Write a program for drawing a following pattern(diamond in rectangle).	
6	Write a program to draw two concentric circles using any circle drawing algorithm.	
7	Write a program inscribed and circumscribed circles in triangle.	
8	Write a program to draw a concave polygon and fill it with desired color using scan fill algorithm.	Line clipping
9	Write a program to implement Cohen Sutherland line clipping algorithm.	
10	Write a program to draw 2-D object and perform following basic transformations, a) Scaling b) Translation c) Rotation. Use operator overloading.	2D Drawing and Transformation
11	Write a program to generate Hilbert Curve using concept of fractals.	Curves generation
12	Write a program to draw Sunrise and Sunset.	Image Drawing

## **BIBLIOGRAPHY**

### **TEXT BOOKS**

1. Computer Graphics C Version – Donald Hearn and M Pauline Baker, Pearson Education

### **REFERENCE BOOKS**

1. Computer Graphics – Amrendra N Sinha and Arun D Udai, TMH Publications
2. Computer Graphics: A Programming Approach – Steven Harrington, TMH Publications
3. Procedural Elements of Computer Graphics – Rogers, McGraw Hill

### **NPTEL COURSES**

1. Computer Graphics, IIT Delhi by Prof. Prem K Kalra, <https://nptel.ac.in/courses/106102063>
2. Introduction to Computer Graphics, IIT Delhi by Prof. Prem K Kalra, <https://nptel.ac.in/courses/106102065>
3. NOC:Computer Graphics, IIT Guwahati by Prof. Samit Bhattacharya, <https://nptel.ac.in/courses/106103224>
4. Computer Graphics, IIT Madras by Prof. Sukhendu Das, <https://nptel.ac.in/courses/106106090>

### **WEBSITES**

1. <https://www.javatpoint.com/computer-graphics-tutorial>
2. <https://www.geeksforgeeks.org/introduction-to-computer-graphics/>
3. [https://www.tutorialspoint.com/computer\\_graphics/computer\\_graphics\\_quick\\_guide.htm](https://www.tutorialspoint.com/computer_graphics/computer_graphics_quick_guide.htm)

### **YOUTUBE LINKS**

1. <https://www.youtube.com/playlist?list=PLrjkTql3jnm9cY0ijEyr2fPdwnH-0t8EY>
2. [https://www.youtube.com/playlist?list=PLYwpaL\\_SFmcAtxMe7ahYC4ZYjQHun\\_b-T](https://www.youtube.com/playlist?list=PLYwpaL_SFmcAtxMe7ahYC4ZYjQHun_b-T)