Fr. Conceicao Rodrigues College Of Engineering

Father Agnel Ashram, Bandstand, Bandra-west, Mumbai-50

Department of Computer Engineering

S.E. (Computer A) (semester III)

(2022-2023)

Course Outcomes & Assessment Plan

Subject: Computer Graphics (CSC 305)

Subject code: CSC305

Teacher-in-charge: Prof. Sushma Nagdeote

Academic Term: July – October 2022

Subject: Credits-5

Syllabus:

1. **Introduction and Overview of Graphics System:**

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.

2. **Output Primitives:**

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

3. **Two Dimensional Geometric Transformations**

Basic transformations: Translation, Scaling, Rotation, Matrix representation and Homogeneous Coordinate, Composite transformation, Other transformations: Reflection and Shear.

4. **Two Dimensional Viewing and Clipping**

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

5. **Three Dimensional Object Representations, Geometric Transformations and 3D Viewing**

3D Transformations: Translation, Rotation, Scaling and Reflection Composite

transformations: Rotation about an arbitrary axis Projections – Parallel, Perspective. (Matrix Representation) Bezier Curve, B-Spline Curve, Fractal-Geometry: Fractal Dimension, Koch Curve

6. Visible Surface Detection and Animation

Visible Surface Detection:Classification of Visible Surface Detection algorithm, Back Surface detection method, Depth Buffer method,Area Subdivision method Animation: Introduction to Animation,TraditionalAnimation Techniques,Principles of Animation,Key framing: Character and Facial Animation, Deformation, Motion capture

Text Books:

1. Hearn &Baker,"Computer Graphics C version", 2nd Edition, PearsonPublication
2. James D. Foley, Andries van Dam, Steven K Feiner, John F. Hughes, "Computer Graphics Principles and Practice in C", 2ndEdition, Pearson Publication
3. Samit Bhattacharya,"Computer Graphics",Oxford Publication

Reference Books:

1. D. Rogers, "Procedural Elements for Computer Graphics", Tata McGraw-HillPublications.
2. Zhigang Xiang, Roy Plastock, "Computer Graphics", Schaum"s Outlines McGraw-HillEducation
3. Rajesh K. Maurya,"Computer Graphics",Wiley India Publication.
4. F.S.Hill, "Computer Graphics using OpenGL", Third edition, Pearson Publications

Course Objectives:

1. To equip students with the fundamental knowledge and basic technical competence in the field ofcomputer graphics.
2. To emphasize on implementation aspect of Computer Graphics Algorithms.
3. To prepare the student for advance areas like Image Processing or Computer Vision or Virtual Realityand professional avenues in the field of Computer Graphics.

Course Outcomes:

Upon completion of this course students will be able to:

CSC305.1: Implement geometric output primitive algorithm. (Apply)
CSC305.2: Apply transformations on graphical objects in two and three dimension. (Apply)
CSC305.3: Apply various clipping algorithms on graphical objects. (Apply)
CSC305.4: Explain viewing and Modelling techniques in 2D and 3D. (Comprehension)
CSC305.5: Develop real world computer Graphics based project in a Team (Apply)

Course outcomes Target:

CSC305.1 : 2.5
CSC305.2 : 2.5
CSC305.3 : 2.5
CSC305.4 : 2.5

CSC305.5 : 2.5

Mapping of CO and PO/PSO

Relationship of course outcomes with program outcomes: Indicate 1 (low importance), 2 (Moderate Importance) or 3(High Importance) in respective mapping cell.

	PO1 (Engg Know)	PO2 (Ana)	PO3 (Design)	PO4 (investiga)	PO5 (tools)	PO6 (engg Soci)	PO7 (Env)	PO8 (Eth)	PO9 (ind Team)	PO10 (comm.)	PO11 (PM)	PO12 (life Long)	PSO1	PSO2
CSC305.1	3	3	2											
CSC305.2	3	3	2											
CSC305.3	3													
CSC305.4	3	3	3											
CSC305.5	3	3	3		2					3				
Total	15	12	10		2					3				
CO –PO Matrix	3	3	2.5		2					3				

Justification of PO to CO mapping

Course Outcome	Competency	Performance Indicator
CSC305.1	1.3 Demonstrate competence in engineering fundamentals	1.3.1 Apply engineering fundamentals
	2.1 Demonstrate an ability to identify and formulate complex engineering problem	2.1.3 Identify mathematical algorithmic knowledge that applies to a given problem
	2.4 Demonstrate an ability to execute a solution process and analyze results	2.4.1 Applies engineering mathematics to implement the solution
CSC305.2	1.3 Demonstrate competence in engineering fundamentals	1.3.1 Apply engineering fundamentals
	2.1 Demonstrate an ability to identify and formulate complex engineering problem	2.1.3 Identify mathematical algorithmic knowledge that applies to a given problem
	2.4 Demonstrate an ability to execute a solution process and analyze results	2.4.1 Applies engineering mathematics to implement the solution
CSC305.3	1.1 Demonstrate competence in mathematical modelling	1.1.1 Apply the knowledge of discrete structures, linear algebra, statistics and numerical techniques to solve problems
CSC305.4	1.3 Demonstrate competence in engineering fundamentals	1.3.1 Apply engineering fundamentals
	2.3 Demonstrate an ability to formulate and interpret a model	2.3.1 Able to apply computer engineering principles to formulate modules of a system with required applicability and performance.
	2.4 Demonstrate an ability to execute a solution process and analyze results	2.4.1 Applies engineering mathematics to implement the solution
	5.2 Demonstrate an ability to select and apply discipline-specific tools, techniques and resources	5.2.2 Demonstrate proficiency in using discipline-specific tools

CSC305.5	1.3 Demonstrate competence in engineering fundamentals	1.3.1 Apply engineering fundamentals
	1.4 Demonstrate competence in specialized engineering knowledge to the program	1.4.1 Apply theory and principles of Computer Science and engineering to solve an engineering problem
	1.4 Demonstrate competence in specialized engineering knowledge to the program	1.4.1 Apply theory and principles of Computer Science and engineering to solve an engineering problem

CO Assessment Tools:

CSC305.1: Implement geometric output primitive algorithm. (Apply)

Direct Methods (80%):

Test + Assignment + Lab + End sem

CO1dm = 0.2T + 0.2A + 0.2Lab + 0.2UTh + 0.2UPr.

Indirect Method (20%): Course Exit Survey

Direct Methods	Weightage	Target	Date	Marks
Test 1	0.2	70% students will score minimum 70% marks (i.6. 6.3 or more out of 9M)	07-09-2022	Q1,2,3,4 (20M)
Assignment1	0.1	70% students will score minimum 75% marks (i.e. 7.5 or more out of 10)	12-09-2022	10M
Lab	0.1	60% students will score minimum 75% marks (i.6. 30 or more out of 40)	Lab 1,2,3,4,5	50M
Uni Theory exam	0.40	60% students will score minimum 60% marks (i.6. 48 or more out of 80)		80M
Uni. Practical Exam	0.20	60% students will score minimum 70% marks (i.6. 17.5 or more out of 25)		25M

CSC305.2: Apply transformations on graphical objects in two and three dimension. (Apply)

Direct Methods (80%): Test + Assignment + Lab + End sem

CO2dm = 0.2T + 0.2A + 0.2Lab + 0.2UTh + 0.2UPr.

Indirect Method (20%): Course Exit Survey

Direct Methods	Weightage	Target	Date	Marks
Test 2	0.2	70% students will score minimum 70% marks (i.6. 6.3 or more out of 9M)	19-10-2022	Q1 (7M)
Assignment2	0.1	70% students will score minimum 75% marks (i.e. 7.5 or more out of 10)	12-10-2020	05
Lab	0.1	60% students will score minimum 75% marks (i.6. 45 or more out of 60)	Lab 6,7	20M
Uni Theory exam	0.40	60% students will score minimum 60% marks (i.6. 48 or more out of 80)		80M
Uni. Practical Exam	0.20	60% students will score minimum 70% marks (i.6. 17.5 or more out of 25)		25M

CSC305.3: Apply various clipping algorithms on graphical objects. (Apply)

Direct Methods (80%): Test + Assignment + Practical + End sem T

CO3dm = 0.2T + 0.2A + 0.2Lab + 0.2UTh + 0.2UPr.

Indirect Method (20%): Course Exit Survey

Direct Methods	Weightage	Target	Date	Marks
Test 2	0.2	70% students will score minimum 70% marks (i.4.2>= or more out of 6)	19-10-2022	Q.2. (7 M)

Assignment2	0.1	70% students will score minimum 75% marks (i.e. 7.5 or more out of 10)	12-10-2020	10M
Lab	0.1	60% students will score minimum 75% marks (i.6. 22.5 or more out of 30)	Lab 8	10M
Uni Theory exam	0.40	60% students will score minimum 60% marks (i.6. 48 or more out of 80)		80M
Uni. Practical Exam	0.20	60% students will score minimum 70% marks (i.6. 17.5 or more out of 25)		25M

CSC305.4: Explain viewing and Modelling techniques in 2D and 3D. (Comprehension)

Direct Methods (80%): Test + Assignment + End sem

CO4dm = 0.3T + 0.3A + 0.2Lab + 0.2UTh + 0.2UPr.

Indirect Method (20%): Course Exit Survey

Direct Methods	Weightage	Target	Date	Marks
Test 2	0.2	70% students will score minimum 70% marks (i.6. 6 or more out of 10)	19-10-2022	Q.3 (6M)
Assignment2	0.1	70% students will score minimum 75% marks (i.e. 7.5 or more out of 10)	12-10-2020	05
Lab	0.1	60% students will score minimum 75% marks (i.6. 22.5 or more out of 30)	Lab 9, 10	20M
Uni Theory exam	0.40	60% students will score minimum 60% marks (i.6. 48 or more out of 80)		80M
Uni. Practical Exam	0.20	60% students will score minimum 70% marks (i.6. 17.5 or more out of 25)		25M

CSC404.5: Develop real world computer Graphics based project in a Team (Apply)

Direct Methods	Weightage	Target	Date	Marks
Mini Project	0.4	70% students will score minimum 75% marks (i.e. 15 or more out of 20)		20M
Uni Theory exam	0.4	60% students will score minimum 60% marks (i.6. 48 or more out of 80)		80M
Uni. Practical Exam	0.2	60% students will score minimum 70% marks (i.6. 17.5 or more out of 25)		25M

Direct Methods (80%): MiniProject + End Sem Th + End sem Pr

CO5dm = 0.7MP + 0.1UTh + 0.1UPr.

Indirect Method (20%): Course Exit Survey

Content Beyond Syllabus:

Augmented Reality and Virtual Reality: Online resources

Curriculum Gap:

No Gap

Assignment and Course Project:

Two assignments will be distributed to the students as per schedule.

The Mini project that covers design and implementation of important Computer graphics concepts of this course and some contents beyond syllabus is allotted to the students in groups. The students' progress on their project will be discussed in the practical session. Finally, at the time of submission the students will present the demonstration of their project.

Rubrics for assessment of Mini Project:

Indicator	Very Poor	Poor	Average	Good	Excellent
Timeline - Maintainsproject deadline (2)	Project not done (0)	More than two session late (0.5)	Two sessions late (1)	One session late (1.5)	Early or on time (2)
Complexity of the chosen problem (4)	N/A	Simple (1)	Moderate (2)	Complex(3)	Too Complex(4)
Completeness (6)	N/A	< 40% complete (1)	~ 60% complete (2)	~ 80% complete (3-4)	100% complete (5-6)
Project specific Technical Features (4)	N/A	60-65% of features (1)	65-70%of features (2)	70-80% of features(3)	Most of the features taught(4)
Project Report (4)	N/A	Poor organization, Major content missing, Not as per guidelines.	Good organization , Few of the project aspects missing (2)	Well organized, Major aspects of the project covered, as per guide lines (3)	Very well organized , covering major and minute details of the project , as per guidelines (4)

Rubrics for Assignment Grading:

Indicator	Very Poor	Poor	Average	Good	Excellent
Timeline (2)	Assignment not submitted (0)	More than two session late (0.5)	Two sessions late (1)	One session late (1.5)	Early or on time (2)
Organization (2)	N/A	Very poor readability and not structured (0.5)	Poor readability and somewhat structured (1)	Readable with one or two mistakes and structured (1.5)	Very well written and structured without any mistakes (2)
Level of content (4)	N/A	Major points are omitted or addressed minimally (1)	All major topics are covered, the information is accurate.(2)	Most major and some minor criteria are included. Information is Accurate (3)	All major and minor criteria are covered and are accurate. (4)
Depth and breadth discussion (2)	N/A	None in evidence; superficial at most (0.5)	Minor points/information may be missing and discussion is minimal (1)	Discussion centers on some of the points and covers them adequately (1.5)	Information is presented in depth and is accurate (2)

Assignment1:

CSC305.1: Implement geometric output primitive algorithm

Q.1. Differentiate between Vector scan display and Raster scan display.
Q.2. Derive the expression for decision parameters used in Bresenham's Mid point Circle algorithm.
Q.3. Compute points in region 1 and region 2 for the ellipse centered at (0,0) with $r_x = 8$ and $r_y = 6$
Q.4. Explain inside and outside test for polygon

Assignment 2:

CSC305.2: Apply transformations on graphical objects in two and three dimension. (Apply)

- **Questions on 3D transformation:**

1. A triangle is defined by 3 vertices A (0,2,1), B (2,3,0) and C (1,2,1). Find the final coordinates after it is rotated by 45 degrees in counter clockwise direction around a line joining (0,0,0) to (1,1,1).

CSC305.4: Explain viewing techniques in 2D and 3D.

- **Questions on 2D and 3D viewing**

1. Given the line end points p1(-15,5) and p2(8,30), window is defined as (Xwmin, Ywmin) = (-10,-10) and (Xwmax, Ywmax) = (20,20), clip the above line Using Liang Barsky line clipping algorithm.
2. Explain 3D viewing pipeline with suitable diagrams.
3. Given the line end points p1(-15,5) and p2(8,30), window is defined as (Xwmin, Ywmin) = (-10,-10) and (Xwmax, Ywmax) = (20,20), clip the above line Using Cohen-sudherland line clipping algorithm.

List of Experiments with CO mapping:

No.	Title	CO
1	a. Implementation of DDA (Digital Differential Analyzer) algorithm. b. Implementation of Bresenham Line Drawing algorithm	CSC305.1
2	Implementation of mid-point circle generation algorithm.	CSC305.1
3	Implementation of mid-point ellipse drawing algorithm.	CSC305.1
4	Implementation of Fill (seed fill) algorithm. a) Boundary fill b) Flood fill	CSC305.1
5	To fill the polygon using scanline polygon filling algorithm	CSC305.1
6	To Perform 2D Basic Transformations of 2D Object. Perform a) Translation b) scaling c) Rotation	CSC305.2
7	To implement Reflection and shear on 2D objects.	CSC305.2
8	To implement a) Cohen – Sutherland Line Clipping algorithm b) Liang-Barsky Line Clipping Algorithm	CSC305.3
9	Implementing Bezier curves	CSC305.4
10	Fractal generation	CSC305.4
11	CG Mini project	CSC305.5
12	Performing the translation of 3D object (Demonstration)	CSC305.2

Rubrics for Practical Evaluation

Sr. No	Performance Indicator	Below average	Average	Good	Excellent	Marks
1	On time Submission (2)	-	Submitted after deadline (1)	Early or on time submission(2)		
2	Test cases and output (4)	Incorrect output (1)	Expected output is verified only forfew test cases (2)	Expected output is Verified for all test cases but is not presentable (3)	Expected output is obtained for all test cases. Presentable and easy to follow (4)	
3	Coding efficiency (2)	The code is not structured at all.(0)	The code is structured but not efficient (1)	The code is structured and efficient. (2)	-	
4	Knowledge(2)	Basic concepts not clear (0)	Understood the basic concepts (1)	Could explain the concept with suitable example (1.5)	Could relate the theory with real world application(2)	
Total Marks						

Course Exit Survey

Sr. No	Question	Strongly agree	Agree	Disagree	Strongly disagree
1	I am able to implement geometric output primitive algorithms.				
2	I am able to apply transformations on graphical objects in two and three dimension.				
3	I am able to apply various clipping algorithms on graphical objects..				
4	I am able to explain viewing and Modelling techniques in 2D and 3D.				
5	I am able to develop a project in a team.				

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Lesson Plan: COMPUTER GRAPHICS
Modes of Content Delivery:

I	Class Room Teaching	V	Self Learning Online Resources	Ix	Industry Visit
Ii	Tutorial	Vi	Slides	X	Group Discussion
Iii	Remedial Coaching	vii	Simulations/Demonstrations	Xi	Seminar
Iv	Lab Experiment	viii	Expert Lecture	Xii	Case Study

CLASS	SE Computer Engineering (A), Semester III		
Academic Term	July- October 2022		
Subject	**Computer Graphics (CSC305)**		
Periods (Hours) per week	***Lecture***	***3***	
	Practical		
	Tutorial		
Evaluation System		***Hours***	***Marks***
	Theory examination	3	80
	Internal Assessment	--	20
	Practical Examination	--	--
	Oral Examination	--	--
	Term work	--	--
	Total	--	100

Time Table	***Day***	***Time***
	Tuesday	9.45-10.45am
	Wednesday	9.45-10.45am
	Thursday	12.00-1.00pm

Lecture №	**Topics to be covered**	**PlannedDates**	**Actual Dates**	**Content Delivery Method/Learning Activities**
Module 1: Introduction				
1	Definition and Representative uses of computer graphics, classification of application areas, Overview of coordinate systems	25-07-2022	25-07-2022	Offline Teaching, PPT
2	Definition of scan conversion, Rasterization and rendering. Raster scan & random scan displays	27-07-2022	27-07-2022	Offline Teaching, PPT
3	Architecture of raster graphics system with display processor, Architecture of random scan systems.	28-07-2022	28-07-2022	Offline Teaching, PPT
Module 2: Output Primitives				

4	Introduction to Graphics primitives object.	02-08-2022	02-08-2022	Offline Teaching, PPT
5	DDA Line Drawing Algorithm.	03-08-2022	03-08-2022	Offline Teaching, PPT Lab Experiment, Demonstration
6	Bresenham's Line Drawing Algorithm.	04-08-2022	04-08-2022	Offline Teaching, PPT,LabExperiment, Demonstration
7	Parallel line Drawing Algorithm.	10-08-2022	10-08-2022	Offline Teaching, PPT
8	Mid-point Circle Drawing Algorithm.	11-08-2022	11-08-2022	Offline Teaching, PPT
9	Mid-point Circle DrawingAlgorithm.	17-08-2022	17-08-2022	Offline Teaching, PPT,Lab Experiment, Demonstration
10	Mid-point Ellipse DrawingAlgorithm.	18-08-2022	18-08-2022	Offline Teaching, PPT,Lab Experiment, Demonstration
11	Aliasing and anti-aliasing techniques	23-08-2022	23-08-2022	Offline Teaching, PPT
12	Filled area primitives: Scan linepolygon fill algorithm	24-08-2022	24-08-2022	Offline Teaching, PPT, Lab experiment, Demonstration
13	Inside-Outside Test Methods Boundary Fill Algorithm.	25-08-2022	25-08-2022	Offline Teaching, PPT
14	Flood Fill Algorithm. Examples for Practice.	30-08-2022	30-08-2022	Offline Teaching, PPT
Module 3: 2D Geometric transformations				
15	Basic transformations : Translation , Scaling , Rotation	08-09-2022	08-09-2022	Offline Teaching, PPT
16	Translation, Scaling, Rotation	13-09-2022	13-09-2022	Offline Teaching, PPT,Lab Experiment, Demonstration
17	Matrix representation & Homogeneous coordinates,	14-09-2022	14-09-2022	Offline Teaching, PPT
18	Composite transformations	15-09-2022	15-09-2022	Offline Teaching, PPT
19	Reflection, Shear	20-09-2022	20-09-2022	Offline Teaching, PPT
20	Raster methods for transformation	21-09-2022	21-09-2022	Offline Teaching, PPT
Module 4: 2D Viewing & Clipping				
21	Viewing transformation pipeline	22-09-2022	22-09-2022	Offline Teaching, PPT
22	Window to viewport coordinate transformation	27-09-2022	27-09-2022	Offline Teaching, PPT
23	Clipping: Point clipping, Lineclipping algorithms: Cohen-Sutherland	28-09-2022	28-09-2022	Offline Teaching, PPT
24	Line clipping algorithm: Liang-Barsky	29-09-2022	29-09-2022	Offline Teaching, PPT
25	Polygon Clipping Algorithm: Sutherland-Hodgeman, Weiler-Atherton	04-10-2022	04-10-2022	Offline Teaching, PPT

Module 5 : Three Dimensional Geometric Transformations, Curves and Fractal Generation				
26	3D Transformations :Translation, Rotation , scaling, 3D Reflection	06-10-2022	06-10-2022	Offline Teaching, PPT
27	Composite transformations :Rotation about an arbitrary axis	11-10-2022	11-10-2022	Offline Teaching, PPT [Video1]
28	Composite transformations: reflection about arbitrary plane	12-10-2022	12-10-2022	Offline Teaching, PPT [Video 2]
29	3D transformation pipeline	12-10-2022	12-10-2022	Offline Teaching, PPT
30	Projections – Parallel , Perspective.(Matrix Representation)	13-10-2022	13-10-2022	Offline Teaching, PPT [Video3 , Video 4]
31	Bezier Curve , B-Spline Curve	13-10-2022	13-10-2022	Offline Teaching, PPT
32	Fractal Geometry: Fractal Dimension, Koch curve	20-10-2022	04-10-2022	Offline Teaching, PPT [Video 5]
Module 6 : Visible Surface Detection and Animation				
33	Visible Surface Detection:	20-10-2022	20-10-2022	Offline Teaching, PPT
34	Back Surface detection method, Depth Buffer method, Area Subdivision method	21-10-2022	21-10-2022	Offline Teaching, PPT
35,36	Animation: Introduction to Animation, Traditional Animation Techniques, Principles of Animation	21-10-2022	21-10-2022	Online Teaching, PPT

No. of Lecture Conducted = 36

Online Resources:

1) https://nptel.ac.in/courses/106/106/106106090/
2) https://www.gatevidyalay.com/2d-transformation-in-computer-graphics-translation- examples/
3) https://www.javatpoint.com/computer-graphics-tutorial

Link of Videos:

Sr. No.	Topic	Link
Video 1	3D rotation	https://www.youtube.com/watch?v=75o5pmeXUMo
Video 2	3D Reflection and Shear	https://www.youtube.com/watch?v=NajL_jbbSgg
Video 3	Perspective projections	https://www.youtube.com/watch?v=ROlHybuf7cs
Video 4	3D Projections	https://nptel.ac.in/courses/106/106/106106090/
Video 5	Applications of Fractals	https://www.khanacademy.org/partner-content/mit-k12/mit-math/v/what-is-a-fractal-and-what-are-they-good-for

Submitted By	**Approved By**
Prof. Sushma Nagdeote	ii) Dr. Sujata Deshmukh Sign:
Sign:	ii) Dr. B. S. Daga Sign:
	iii) Prof. Merly Thomas Sign:
	iv) Prof. Roshni Padate Sign:
	v) Prof. Kalpana Deorukhkar Sign:
Date of Submission:	**Date of Approval:**
Remarks by DQAC (if any)	

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