Course Title: Computer Graphics
Course no: CSC209
Nature of the Course: Theory + Lab
Semester: III

Full Marks: 60+20+20
Pass Marks: 24 +8+8
Credit Hrs: 3

Course Description: The course coversconcepts of graphics hardware, software, and applications,data structures for representing 2D and 3D geometric objects, drawing algorithms for graphical objects, techniques for representing and manipulating geometric objects, illumination and lighting models, and concept of virtual reality.

Course Objectives: The objective of this course is to understand the theoretical foundation as wellas the practical applications of 2D and 3D graphics.

Detail Syllabus

Chapter / Units	Teaching Methodology	Teaching Hours
Unit 1: Introduction of Computer Graphics 1.1 A Brief Overview of Computer Graphics, Areas of applications 1.2 Graphics Hardware: Display Technology, Architecture of Raster-Scan Displays, Interlaced refresh procedure, refresh buffer, frame buffer, Vector Displays, Display Processors, Hard copy devices. Input Devices 1.3 Graphics Software: Software standards, Coordinate Representations, PHIGS Workstations, Need of machine independent graphics language 1.4 Human visual system: basic of how we perceived the world, strength and weakness of the human visual system 1.5 Color models: RGB, CMYK, HVS, XYZ	**Class Lecture**	**3 Hours**
2. Scan Conversion Algorithm 2.1 Scan Converting a Point and a straight Line: DDA Line Algorithm, Bresenham's Line Algorithm 2.2 Scan Converting Circle and Ellipse :Mid Point Circle and Ellipse Algorithm 2.3 Area Filling: Scan Line Polygon fill Algorithm,Inside-outside Test,Scan line fill of Curved Boundary area, Boundary-fill and Flood-fill algorithm	**Class Lecture + Lab Session**	**6 Hours**

3.Two-Dimensional Geometric Transformations 3.1 Two-Dimensional translation, Rotation,Scaling, Reflection and Shearing 3.2 Homogeneous Coordinate and 2D Composite Transformations. Transformation between Co-ordinate Systems 3.3 Two Dimensional Viewing: Viewing pipeline,Window to viewport coordinate transformation 3.4 Clipping: Point,Lines(Cohen Sutherland line clipping,Liang-BarskyLineClipping),Polygon Clipping(Sutherland Hodgeman polygon clipping)	**Class Lecture + Lab Session**	**5 Hours**
4. Three-Dimensional Geometric Transformation 4.1 Three-Dimensional translation, Rotation,Scaling, Reflection and Shearing 4.2 Three-Dimensional Composite Transformations 4.3 Three-Dimensional Viewing: Viewing pipeline, world to screen viewing transformation, Projection concepts(Orthographic, parallel,perspective projections)	**Class Lecture + Lab Session**	**5 Hours**
5. 3D Objects Representation 5.1 Representing Surfaces: Boundary and Space partitioning 5.1.1 Polygon Surface: Polygon tables , Surface normal and Spatial orientation of surfaces, Plane equations, Polygon meshes 5.1.2 Wireframe Representation 5.1.3 Blobby Objects 5.2 Representing Curves: Parametric Cubic Curves, Spline Representation,Cubic spline interpolation, Hermite Curves,Bezier and B-spline Curve and surface, Fractals and its applications 5.3 Quadric Surface: Sphere and Ellipsoid	**Class Lecture + Lab Session**	**7 Hours**
6. Solid Modeling 6.1 Solids and solid modeling, boundary point, interior point, closure 6.2 Sweep ,Boundary and Spatial-Partitioning Representation	**Class Lecture**	**4 Hours**

6.3 Binary Space Partition Trees (BSP) 6.4 Octree Representation		
7. Visible Surface Detections 7.1 Visible surface and hidden surface, Coherence for visibility 7.2 Image Space and Object Space Techniques 7.3 Back Face Detection, Depth Buffer (Z-buffer), A-Buffer and Scan-Line Algorithms 7.4 Depth Sorting Method (Painter's Algorithm) 7.5 BSP tree Method, Octree and Ray Tracing	**Class Lecture + Lab Session**	**5 Hours**
8. Illumination Models and Surface Rendering Techniques 8.1 Defining Realism, Image Synthesis Validation, challenges in computing light, optics model 8.2 Basic Illumination Models:Ambientlight, Diffuse reflection,Specular reflection and Phong model 8.3 Intensity attenuation and Color consideration ,Transparency,Shadows 8.4 Polygon Rendering Methods : Constant intensity shading, Gouraud shading , Phong Shading and Fast Phong Shading, Real time vs offline rendering	**Class Lecture**	**5 Hours**
9. Introduction to Virtual Reality 9.1 Concept of Virtual reality 9.2 Virtual Reality Components of VR System, Types of VR System, 3D Position Trackers, Navigation and Manipulation Interfaces 9.3 Visual computation in virtual reality 9.4 Augmented Reality 9.5 Application of VR	**Class Lecture**	**2 Hours**
10. Introduction to OpenGL 10.1Introduction, Callback functions, Color commands, Drawings pixels, lines, polygons using OpenGL, OpenGL and Direct X APIs - key differences, Viewing, Lighting and reflectance model	**Class Lecture + Lab Session**	**3 Hours**

Text Books:

1. **Donald Hearne and M.Pauline Baker**, "Computer Graphics, C Versions." Prentice Hall

Reference Books:

1. **J.D. Foley, S.K. Feiner and J.F. Hughes**, "Computer Graphics – Principles and Practises" (Second Edition in C)
2. **R.K. Maurya**, "Computer Graphics with Virtual Reality", Wiley India
3. **F.S. Hill, Stephen M.Kelley**, "Computer Graphics using Open GL" Prentice Hall

Laboratory Works:

Students should be able to write program on the most of the contents listed in syllabus, using any known programming language (C, C++) in previous semester. Majorly, students should on computer graphics primitives like line, circle and ellipse drawing algorithm to hidden surface removal techniques. After completing the basic lab session the students must be able to design some project works like game, 3D rotation, screen saver etc. Some sample lab sessions can be as following:-

Unit 2 : Scan Conversions Algorithm (10 Hours)

- Study of Fundamental Graphics Functions
- Implementation of Line drawing algorithms: DDA Algorithm, Bresenham's Algorithm
- Implementation of Circle drawing algorithms: Bresenham's Algorithm, Mid-Point Algorithm

Unit 3 : Two-Dimensional Geometric Transformations (4 Hours)

- Simulation of 2D transformation, Rotation and Scaling
- Write a program to implement Cohen Sutherland line clipping algorithm

Unit 4 : Three-Dimensional Geometric Transformation (12 Hours)

- Write a program to perform shear transformation on a rectangle
- Write a program to perform 2D Transformation on a line
- Write a program to draw a car using in build graphics function and translate it from bottom left corner to right bottom corner of screen
- Write a program to draw a cube using in build library function and perform 3D transformations
  - Translations in x, y, z directions
  - Rotation by angle 450 about z axis, rotation by 600 about y-axis in succession.
  - Scaling in x-direction by a factor of 2, scaling in y- direction by a factor of 3

Unit 5 : 3D Objects Representation (4 Hours)

- Implementation of polygon tables.
- Write a program to draw Bezier curve, sphere

Unit 7 : Visible Surface Detections (10 Hours)

- Back face detection:- Implementation of Depth Buffer, A – Buffer, Scan-Line algorithm
- Implementation of rotation of 3D cube.

Unit 10 : Introduction to OpenGL (5 Hours)

- Event driven programming
- Point, Line and Polygon
- Drawing 3D objects

Model Question

Tribhuvan University

Institute of Science and Technology

Course Title: Computer Graphics — **Full Marks**: 60

Course No: CSC 209 — **Pass Marks**: 24

Level: B. Sc CSIT Second Year/ Third Semester — **Time**: 3 Hrs

Section A

Long Answer Questions

Attempt any *TWO* questions **[2 × 10 = 20]**

1. Explain the working details of DDA algorithm? Explain. Digitize a line with end points A(6,12) and B(10,5) using Bresenham's line drawing algorithm. [5 + 5]
2. How can polygons be clipped? Why is Phong shading also called Normal Vector Interpolation scheme? Explain. [5 + 5]
3. Given a window bordered by (1,2) at the lower left and (16,12) at the upper right, give the screen coordinates of a triangle with vertices (3,2), (10,7.5) and (5,5) when mapped into a viewport with corners (100,100) and (400,200). Provide accurate illustrations of the window, viewport, and the untransformed and transformed triangles with your answer. [10]

Section B

Short Answer Questions

Attempt any *EIGHT* questions **[8 × 5 = 40]**

4. How to animate a two dimensional figure using transformations? Explain with example. [5]
5. What are the key issues prevalent in producing a Virtual reality scene? Describe the Binary Space Partition tree. [2 + 3]
6. How can a polygon surface be filled using the Flood fill approach? Explain. [5]
7. What is the significance of vanishing points in Perspective Projection? Explain. [5]
8. Explain ambient light, diffuse reflection and specular reflection with examples. [5]
9. Compute the midpoint of the Bezier Curve with control points p_0 = (0,0,1), p_1 = (1,0,1) and p_2 = (1,2,0). [5]
10. How does a polygon can be created in OpenGL? Illustrate with an example. [5]
11. How does a video controller and a frame buffer jointly collaborate to produce graphical display on the screen, in case of a Raster Display? [5]
12. Write short notes on (Any TWO) [2.5 + 2.5]
    a. Polygon Tables
    b. Augmented Reality
    c. Painter's algorithm