



National University of Engineering (UNI)
School of Computer Science
Syllabus 2027-I

1. COURSE

CS251. Computer Graphics (Mandatory)

2. GENERAL INFORMATION

2.1 Course	: CS251. Computer Graphics
2.2 Semester	: 7 th Semester.
2.3 Credits	: 4
2.4 Hours	: 2 HT; 4 HP;
2.5 Duration of the period	: 16 weeks
2.6 Type of course	: Mandatory
2.7 Learning modality	: Face to face
2.8 Prerequisites	: MA202. Numerical Methods. (4 th Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Computer Graphics is a fundamental area of Computer Science that focuses on the mathematical and computational techniques for generating and manipulating images. This course provides students with the foundations of 2D and 3D modeling, rendering pipelines, and the physical principles of light and color, enabling them to develop high-performance visual applications, simulations, and interactive systems.

5. GOALS

- Understand the graphics pipeline and coordinate system transformations.
- Implement rendering algorithms for realistic and real-time visualization.
- Apply mathematical modeling to create and manipulate 3D objects.

6. COMPETENCES

AG-C07) Computing Knowledge: Applies knowledge of mathematics, science, and computing. (Usage)

AG-C08) Problem Analysis: Identifies, formulates, and analyzes complex computing problems. (Usage)

AG-C09) Design and Development of Solutions: Designs, implements, and evaluates solutions for complex computing problems. (Assessment)

7. TOPICS

Unit 1: Fundamental Concepts of Graphics and Interactive Techniques (16 hours)	
Competences Expected: AG-C07,AG-C08	
Topics	Learning Outcomes
• Overview of computer graphics pipeline and interactive systems • Basic rendering concepts: rasterization, ray tracing, shading models • Color theory and color spaces • Coordinate systems and transformations • Basic interaction techniques: input devices, event handling • Advanced rendering concepts: global illumination, physically based rendering • Graphics hardware and acceleration techniques • Human perception and visual cognition	• Explain the basic stages of the computer graphics pipeline [Explain] • Describe basic rendering techniques such as rasterization and ray tracing [Describe] • Apply color theory to design visually effective graphics [Apply] • Implement coordinate transformations for 2D and 3D graphics [Implement] • Design basic interactive applications using common input devices and event handling [Design] • Compare advanced rendering techniques such as global illumination and physically based rendering [Compare] • Analyze the role of graphics hardware in accelerating rendering tasks [Analyze] • Explain how human perception influences graphics and interaction design [Explain]
Readings : [Marschner2021], [Hearn2014]	

Unit 2: Applied Rendering and Techniques (16 hours)	
Competences Expected: AG-C09	
Topics	Learning Outcomes
• Rasterization algorithms: scan conversion, antialiasing • Ray tracing: acceleration structures, sampling, shading • Texture mapping and filtering • Shading models: Lambertian, Phong, BRDF • Advanced techniques: shadow mapping, environment mapping, deferred rendering	• Implement rasterization algorithms for primitive rendering [Implement] • Implement basic ray tracing with acceleration structures [Implement] • Apply texture mapping and filtering techniques to enhance visual realism [Apply] • Compare different shading models and their applications [Compare] • Implement advanced rendering techniques such as shadow mapping or deferred rendering [Implement]
Readings : [Marschner2021], [Hearn2014], [Angel2014]	

Unit 3: Geometric Modeling (16 hours)	
Competences Expected: AG-C08,AG-C09	
Topics	Learning Outcomes
• Geometric representations: polygons, curves, surfaces, implicit forms • Modeling techniques: splines, subdivision surfaces, constructive solid geometry • Procedural modeling and generation • Geometric algorithms: intersection, distance, decomposition	• Describe different geometric representations and their trade-offs [Describe] • Implement modeling techniques such as spline curves or subdivision surfaces [Implement] • Create procedural models using algorithms or rules [Create] • Apply geometric algorithms to solve problems like intersection testing or mesh processing [Apply]
Readings : [Marschner2021], [Angel2014]	

Unit 4: Visualization (16 hours)	
Competences Expected: AG-C09	
Topics	Learning Outcomes
• Principles of data visualization: perception, cognition, and effective encoding • Types of visualizations: scientific, information, geographical • Visualization techniques for multivariate, temporal, and hierarchical data • Interactive visualization and exploration • Evaluation of visualization effectiveness	• Apply principles of perception and cognition to design effective visualizations [Apply] • Select appropriate visualization techniques for different data types and tasks [Evaluate] • Implement interactive visualizations for data exploration [Implement] • Evaluate the effectiveness of a visualization using empirical methods [Evaluate]
Readings : [Marschner2021]	

Unit 5: Shading and Advanced Rendering (12 hours)	
Competences Expected: AG-C09	
Topics	Learning Outcomes
• Advanced shading: physically based shading, sub-surface scattering • Global illumination: radiosity, photon mapping, path tracing • Real-time rendering techniques: level of detail, culling, occlusion • GPU programming and shaders	• Implement advanced shading models for realistic materials [Implement] • Compare global illumination algorithms and their trade-offs [Compare] • Optimize real-time rendering using techniques like level of detail and culling [Create] • Develop GPU shaders for custom rendering effects [Create]
Readings : [Marschner2021], [Angel2014]	

8. WORKPLAN

8.1 Methodology

Individual and team participation is encouraged to present their ideas, motivating them with additional points in the different stages of the course evaluation.

8.2 Theory Sessions

The theory sessions are held in master classes with activities including active learning and roleplay to allow students to internalize the concepts.

8.3 Practical Sessions

The practical sessions are held in class where a series of exercises and/or practical concepts are developed through problem solving, problem solving, specific exercises and/or in application contexts.

9. EVALUATION SYSTEM

Theory Sessions:

The theory sessions are held in master classes with activities including active learning and roleplay to allow students to internalize the concepts.

Lab Sessions:

In order to verify their competences, several activities including active learning and roleplay will be developed during lab sessions.

Oral Presentations:

Individual and team participation is encouraged to present their ideas, motivating them with additional points in the different stages of the course evaluation.

Reading:

Throughout the course different readings are provided, which are evaluated. The average of the notes in the readings is considered as the mark of a qualified practice. The use of our virtual campus allows each student to access the course information, and interact outside the classroom with the teacher and with the other students.

The final grade NF depends on the following grades:

- PE : Partial Exam.
- FE : Final Exam.
- P : Permanent Evaluation (Average of practical work and graded assignments).

The final grade NF is calculated as follows:

$$NF = \frac{PE + FE + P}{3}$$

10. BASIC BIBLIOGRAPHY