National University of Engineering (UNI)
School of Artificial Intelligence
Syllabus 2027-I

1. COURSE

CS351. Topics in Computer Graphics (Elective)

2. GENERAL INFORMATION

2.1 Course	:	CS351. Topics in Computer Graphics
2.2 Semester	:	10th Semester.
2.3 Credits	:	3
2.4 Hours	:	2 HT; 2 HP;
2.5 Duration of the period	:	16 weeks
2.6 Type of course	:	Elective
2.7 Learning modality	:	Face to face
2.8 Prerrequisites	:	CS251. Computer graphics . (7th Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Modern computer graphics go beyond simple image generation, encompassing real-time interaction, physical simulation, and immersive environments. This course explores advanced topics in the graphics pipeline, focusing on programmable shading, complex geometric modeling, and computer animation. Additionally, it addresses the intersection of graphics with physical computing and the ethical implications of synthetic content generation.

5. GOALS

- Master advanced shader programming and non-photorealistic rendering.
- Implement physically-based simulations and complex animations.
- Design immersive and interactive experiences using tangible computing.
- Evaluate the ethical and societal impact of computer-generated imagery.

6. COMPETENCES

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

AG-C11) Use of Tools: Applies modern computing tools in problem solving. (Usage)

7. TOPICS

Unit 1: Shading and Advanced Rendering (12 hours)	
Competences Expected: AG-C09,AG-C11	
Topics	**Learning Outcomes**
• Advanced shading: physically based shading, subsurface 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**], [**Shirley2021**]	

Unit 2: Geometric Modeling (10 hours)	
Competences Expected: AG-C09,AG-C11	
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**]	

Unit 3: Computer Animation (8 hours)	
Competences Expected: AG-C09,AG-C11	
Topics	**Learning Outcomes**
• Animation principles: timing, spacing, anticipation, follow-through • Keyframe animation and interpolation • Procedural animation: particle systems, flocking, physics-based • Character animation: skeletal animation, skinning, inverse kinematics • Motion capture and retargeting	• Apply animation principles to create believable motion [Apply] • Implement keyframe animation with interpolation techniques [Implement] • Create procedural animations such as particle systems or physics-based simulations [Create] • Implement character animation using skeletal systems and skinning [Implement] • Process motion capture data for animation retargeting [Implement]
Readings : [**Parent2012**]	

Unit 4: Simulation (8 hours)	
Competences Expected: AG-C09,AG-C11	
Topics	**Learning Outcomes**
• Physics-based simulation: rigid bodies, fluids, cloth • Numerical methods for simulation: integration, collision detection • Real-time simulation constraints and optimizations • Applications in games, visual effects, and scientific visualization	• Implement physics-based simulations for rigid bodies or fluids [Implement] • Apply numerical integration methods for dynamic simulations [Apply] • Optimize simulations for real-time performance [Create] • Develop simulations for specific applications such as games or scientific visualization [Create]
Readings : [**Parent2012**]	

Unit 5: Immersion (5 hours)	
Competences Expected: AG-C09,AG-C11	
Topics	**Learning Outcomes**
• Virtual reality (VR) and augmented reality (AR) concepts • Immersive display technologies: head-mounted displays, CAVEs • Tracking and input for immersive environments • Presence and comfort in immersive systems	• Explain the core concepts and differences between VR and AR [Explain] • Evaluate immersive display technologies and their applications [Evaluate] • Implement tracking and input solutions for immersive environments [Implement] • Design immersive experiences that maximize presence and minimize discomfort [Design]
Readings : [**LaValle2023**]	

Unit 6: Interaction (5 hours)	
Competences Expected: AG-C09,AG-C11	
Topics	**Learning Outcomes**
• Interaction paradigms: direct manipulation, gesture-based, tangible • User interface design for graphics applications • Multimodal interaction: combining visual, auditory, haptic feedback • Evaluation of interaction techniques: usability, user experience	• Compare different interaction paradigms and their suitability for various tasks [Compare] • Design user interfaces for graphics-intensive applications [Design] • Implement multimodal interaction systems incorporating multiple feedback channels [Implement] • Conduct usability evaluations of interaction techniques [Evaluate]
Readings : [**LaValle2023**]	

Unit 7: Tangible/Physical Computing (8 hours)	
Competences Expected: AG-C09,AG-C11	
Topics	**Learning Outcomes**
• Tangible interfaces and physical computing • Sensors and actuators for interactive systems • Embedded systems for interactive art and design • Interactive installations and environments	• Design tangible interfaces that bridge physical and digital interactions [Design] • Integrate sensors and actuators to create responsive systems [Integrate] • Develop embedded systems for interactive art or design projects [Create] • Create interactive installations that engage users in physical spaces [Create]
Readings : [**Noble2012**]	

Unit 8: Society, Ethics, and the Profession (8 hours)	
Competences Expected: AG-C09,AG-C11	
Topics	**Learning Outcomes**
• Ethical considerations in graphics and interaction: representation, accessibility, privacy • Social impact of immersive technologies and visualization • Professional practice in graphics and interactive industries	• Analyze ethical issues related to representation, accessibility, and privacy in graphics and interaction [Analyze] • Discuss the social implications of immersive technologies and data visualization [Debate] • Describe professional practices and standards in graphics and interactive industries [Describe]
Readings : [**Marschner2021**]	

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

********* EVALUATION MISSING ********

10. BASIC BIBLIOGRAPHY