



Course Name: Computer Graphics and Game Design

Course Number: CS 451

Credits: 2-0-2-3

Prerequisites: Experience in writing computer-code.

Intended for: B.Tech. (all branches) II/III/IV year

Distribution: Elective for B.Tech. II/III/IV year

Preamble: Creating video games is an endeavor that lies at the merger of two main disciplines, viz., computer programming and creating artwork. This course aims to focus on the former aspect via design and development of 2D games. The architecture of a modern game consists of subcomponents such as the graphics engine, the physics engine, the audio engine, etc., which are orchestrated by the game logic. This logic assumes the form of a number of scripts that run asynchronously and in an even-driven manner. The course will introduce all these components of game development in a hands-on manner wherein the students will write a 2D game as part of lab exercises. The course is intended to bridge the rich talent pool in engineering academia, with the vast gaming industry which has grown manifold in the last two decades.

Learning outcome: After taking this course, students will

1. be familiar with the workflow for creating 2D video games.
2. understand different types/genres of video games and the components thereof.
3. be familiar with all the steps of creating a 2D game.
4. get hands-on experience with game engines, e.g., Unity.
5. be familiar with usage of subcomponents of game engines such as graphics, physics and audio engines.
6. be able to write scripts which control the behavior of different game components.
7. get familiarity with creating game assets such as sprites, tiles, textures and audio.
8. be able to create realistic scenes and environments.
9. be able to design, write and deploy 2D video games.

Course modules:

1. *Introduction:* **(5 hours)**
Motivation; Types of games, Different aspects of game design; Different components in a game; Game engines; Geometric primitives, 2D and 3D linear transforms, Homogeneous matrices; Examples of games.
2. *Sprites and animation:* **(6 hours)**
Different image formats; Polygon file formats; Creating sprites; Rigging; Animations using sprite-sheets; Animations using keyframes; Animation controllers.
3. *Level design:* **(6 hours)**
Scenes; Tiles, visual continuity in tiles; Adding objects to scene; Prefabs; Lighting, RGB space, transparency, texture mapping; Collectibles; Navigation and pathfinding.



4. *World interaction:* (6 hours)
Physics engines; Gravity simulation; Rigid body interaction; Collisions.
5. *User interface:* (3 hours)
Layout; Menu system; Visual components; Event system; Skins.
6. *Audio:* (2 hours)
Audio assets; Different audio formats; Audio mixing.

Lab exercises:

Lab to be conducted on a 2-hour slot, in tandem with the theory course so the topics for problems given in the lab are already initiated in the theory class. The topics taught in the theory course shall be appropriately sequenced for synchronization with the laboratory. The students will progressively design and write a 2D video game as part of the lab.

Lab1-2: Installation of a game engine, e.g., Unity, familiarization of the GUI. Conceptualize the theme for a 2D game.

Lab3-4: Character design, sprites, movement and character control.

Lab5-7: Level design: design of the world in form of tiles along with interactive and collectible objects.

Lab8-9: Design of interaction between the player and the world, optionally using the physics engine.

Lab9-11: Design of menus and user interaction in mobile platform.

Lab12: Insert audio.

Textbooks:

1. Nystrom Robert, *Game Programming Patterns*, 3rd edition, Genever Benning, 2014

Reference Books:

1. Paris Buttfield-Addison et al., *Unity Game Development Cookbook: Essentials for Every Game*, 1st Edition, O'Reilly Media, 2019