Lahore University of Management Sciences

CS 353 – Game Design and Development

Summer 2024

To understand how to navigate course outlines, consult: How to Use a Course Outline (http://surl.li/gpvuw)

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Room No.	
Office Hours	By appointment
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Secretary/TA	
TA Office Hours	
Course URL (if any)	
Support Services	LUMS offers a range of academic and other services to support students. These are mentioned below, and you are encouraged to use these in addition to in-class assistance from course staff. For a complete list of campus support services available for you click here (https://advising.lums.edu.pk/#supportservices)

Course Basics				
Credit Hours	3			
Lecture(s)	Nbr of Lec(s) Per Week	4	Duration	90 minutes
Recitation/Lab (per week)	Nbr of Lec(s) Per Week		Duration	
Tutorial (per week)	Nbr of Lec(s) Per Week		Duration	

Course Distribution	
Core	
Elective	
Open for Student Category	All
Close for Student Category	None

COURSE DESCRIPTION

This course will introduce students to fundamental principles of game design and development. The course will conclude with a team-based project that will require students to design and implement a game of their choice using C# in the Unity game engine. Some Unity concepts will be explained in class, but students will be required to learn the engine outside class hours.

COURSE PREREQUISITE(S)

- CS 100 (Computational Problem Solving)
- MATH 120 (Linear Algebra with Differential Equations)
- CS 200 (Introduction to Programming) - Optional

COURSE OBJECTIVES

- To teach students fundamental game design and development principles.
- Apply theoretical knowledge to the development of a playable game.

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Learning Outcomes	
	At the completion of the course, students should be able to understand: • the difference between game design and game development • the game design document and its importance • the process of making game rules and mechanics • the core game loop, and designs of progression and emergence • how to build game economies and balance the game • how to design the game world, game characters, and game levels • camera projections and perspectives, and their gameplay implications • the creation of art assets, and game polish elements such as VFX and SFX • essential game math such as dot and cross products, and quaternion rotations • collision detections and ray casting • game development patterns such as singleton, observer, and object pooling, and other optimization techniques • the graphics render pipelines in modern game engines • lighting and shading, and shader programs • AI as it is applied to games in the form of pathfinding and decision-making • procedural level and map generation techniques

Grading Breakup and Policy

Quizzes: 20% (in class, announced)
Game concept overview document: 5%
Draft game design document: 10%
Full game design document: 20%
Game prototype 1: 5%
Game prototype 2: 10%
Final game demo: 20%
Group peer review: 10%

Below, we describe how each type of assessment will be conducted:

Quizzes: quizzes will be announced, will take place during class timings, and will include topics covered in the course until the day of the quiz.

Game concept overview document: this is a 1-page document, the contents of which will be explained in class. The document will be graded based on clear exposition of the proposed project game. The genre and high-level concept will be locked at the time of this document's submission, to allow time for the game's development.

Draft game design document: this is that portion of the game design document that will contain those portions of game design that will have been studied in class until the day this document is due: core mechanics will not be included in this draft document.

Full game design document: this is the final game design document with all game elements fully described. As will be explained in class, it is the role of game designers to fully specify design decisions with numbers, equations, or charts, as appropriate; in this document, it will not be sufficient to describe, for example, a Tower Defense game as having a "tower that buffs nearby towers". The document must clearly specify the distance and buff percentage. Providing general statements will reflect in the assigned grade. The document may exceed 10 pages if necessary to describe the game completely, but a large game is not advised due to the limited time available.

Game prototype 1: the prototype must compile without errors. It should accept player control, have the camera working, and the core game loop should have been implemented. It will be a playable game, but with placeholder art and no level transitions, including no main menu screen that transitions to the actual game. To prevent plagiarism, the full project folder, including C# code and Unity project file, must be submitted on a USB stick or via an online drive link; failure to provide this will result in no marks being awarded to the team.

Game prototype 2: the prototype must compile without errors. Key art and sound have been implemented; note that due to the limited time available, students are encouraged to use high-quality CC0 license art and sound assets available freely online – some links will be provided in class. There should be meaningful progress from Game Prototype 1: there should be further layering of game loops, and game balance should have been achieved. To prevent plagiarism, the full project folder, including C# code and Unity project file, must be submitted on a USB stick or via an online drive link; failure to provide this will result in no marks being awarded to the team.

Final game demo: the final build should compile without errors. There should be meaningful progress from Game Prototype 2: the game should

be a polished product, it should have an operational user interface, and the menu and game scene transitions should be working To prevent plagiarism, the full project folder, including C# code and Unity project file, must be submitted on a USB stick or via an online drive link; failure to provide this will result in no marks being awarded to the team.

Group peer review: to ensure that all project team members put in a high level of effort, group members will provide individual, detailed feedback of tasks that each team member was assigned and completed. If a team member's peers are unanimous in pointing out shirking, this will be reflected in this category of the final grade.

Examination Detail	
Midterm Exam	Yes/No: No Combine Separate: Duration: Preferred Date: Exam Specifications:
Final Exam	Yes/No: No Combine Separate: Duration: Exam Specifications:

Campus supports & Key university policies

Campus Supports

Students are strongly encouraged to meet course instructors and TA's during office hours for assistance in course-content, understand the course's expectations from enrolled students, etc. Beyond the course, students are also encouraged to use a variety of other resources. (Instructors are also encouraged to refer students to these resources when needed.) These resources include Counseling and Psychological Services/CAPS (for mental health), LUMS Medical Center/LMC (for physical health), Office of Accessibility & Inclusion/ OAI (for long-term disabilities), advising staff dedicated to supporting and guiding students in each school, online resources (https://advising.lums.edu.pk/advising-resources), etc. To view all support services, their specific role as well as contact information click here (https://advising.lums.edu.pk/#supportservices).

Academic Honesty/Plagiarism

LUMS has zero tolerance for academic dishonesty. Students are responsible for upholding academic integrity. If unsure, refer to the student handbook and consult with instructors/teaching assistants. To check for plagiarism before essay submission, use similarity@lums.edu.pk. Consult the following resources: 1) Academic and Intellectual Integrity (http://surl.li/gpvwb), and 2) Understanding and Avoiding Plagiarism (http://surl.li/gpvwo).

LUMS Academic Accommodations/ Petitions policy

Long-term medical conditions are accommodated through the Office of Accessibility & Inclusion (OAI). Short-term emergencies that impact studies are either handled by the course instructor or Student Support Services (SSS). For more information, please see Missed Instrument or 'Petition' FAQs for students and faculty (https://rb.gy/8sj1h)

LUMS Sexual Harassment Policy

LUMS and this class are a harassment-free zone. No behavior that makes someone uncomfortable or negatively impacts the class or individual's potential will be tolerated.

To report sexual harassment experienced or observed in class, please contact me. For further support or to file a complaint, contact OAI at oai@lums.edu.pk or harassment@lums.edu.pk. You may choose to file an informal or formal complaint to put an end to the offending behavior. You can also call their Anti-Harassment helpline at 042-35608877 for advice or concerns. *For more information: Harassment, Bullying & Other Interpersonal Misconduct: Presentation (http://surl.li/gpvwt)*

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COURSE OVERVIEW			
Week/ Lecture/ Module	Topics	Recommended Readings	Assessments
Introduction			
1	Introduction, game design vs development, industry structure, game genres, social issues		
2	Unity essentials		
Game Design			
3	Game design document, ideation, story and narrative		
4	Player character design		
5	Camera projection and perspective, control		**Game concept overview document**
6	World and level design		
7	Combat mechanisms and enemy character design		**Quiz 1**
8	Gameplay challenges and actions, game loops		
9	Core mechanics, progression and emergence		**Draft game design document**
10	Game economy, game balance, feedback loops		
Game Graphics			
11	Visual language, 3D models and textures, rigging and animation, user interface		**Quiz 2**
12	Vectors, coordinate spaces, matrices, transforms		
13	Polar coordinates, rotations, quaternions		**Final game design document**
14	Rays, planes, collisions		
15	Graphics render pipeline, lighting, shaders		**Quiz 3**
Game Development			
16	Development optimizations		
17	AI – kinematic and dynamic movements		**Game prototype 1**
18	AI – graphs, Dijkstra pathfinding		
19	AI – A* pathfinding, heuristics, navigation meshes		**Quiz 4**
20	AI – decision tree, FSM, behavior tree		
21	AI – goal-oriented behavior, game tree, influence map		**Game prototype 2**
22	Procedural content generation – Perlin noise for landscapes, binary space partitioning and cellular automata for dungeon creation		
23	Game demos		**Final game demo** **Project peer review**
24	Game demos		**Final game demo** **Project peer review**

Textbook(s)/Supplementary Readings
Reference Texts (Optional): Fundamentals of Game Design, 3rd Edition, Ernest Adams Game Mechanics – Advanced Game Design, Ernest Adams and Joris Dormans 3D Math Primer for Graphics and Game Development, 2nd Edition, Fletcher Dunn and Ian Parberry Fundamentals of Computer Graphics, 5th Edition, Steve Marschner and Peter Shirley Real-time Collision Detection, 1st Edition, Christer Ericson AI for Games, 3rd Edition, Ian Millington Game Engine Architecture, 3rd Edition, Jason Gregory

Please note that the syllabus above is tentative and can be subject to some changes.