Liverpool John Moores University

Title:	MATHEMATICS AND 3D COMPUTER GRAPHICS
Status:	Definitive
Code:	**5002MATHS** (103227)
Version Start Date:	01-08-2020
Owning School/Faculty:	Computer Science and Mathematics
Teaching School/Faculty:	Computer Science and Mathematics

Team	Leader
Sud Sudirman	Y

Academic Level:	FHEQ5	**Credit Value:**	24	**Total Delivered Hours:**	72
Total Learning Hours:	240	**Private Study:**	168		

Delivery Options
Course typically offered: Standard Year Long

Component	**Contact Hours**
Lecture	24
Tutorial	24
Workshop	24

Grading Basis: 40 %

Assessment Details

Category	**Short Description**	**Description**	**Weighting (%)**	**Exam Duration**
Artefacts	AS1	Procedural animation coursework.	50	
Artefacts	AS2	Complex 3D scenery coursework.	50	

Aims

To provide mathematical knowledge essential in complex 3D graphics and game software development.
To explain the principles of 3D computer graphics.
To develop skills in 3D computer graphics operations using modern 3D graphical API.

To develop specific programming skills related to computer graphics.

Learning Outcomes

After completing the module the student should be able to:

1 Demonstrate sound understanding of the mathematical concepts in 3D transformations, projection and field-of-view culling.

2 Implement complex 3D transformations and scene organization in computer programs.

3 Demonstrate sound understanding of the underpinning theory in texture mapping and lighting.

4 Implement multiple lightings and multiple textures mapping in 3D scenery

Learning Outcomes of Assessments

The assessment item list is assessed via the learning outcomes listed:

Procedural animation	1	2
Complex 3D scenery	3	4

Outline Syllabus

Linear Algebra: Revision on Linear Algebra, Solving simultaneous high dimensional linear equations, Linear Programming.
Revision on Vectors and Matrices: Mathematical and geometric definitions of vector, Vectors vs. Points, Vector additions, subtraction, and multiplications, Vector dot product and cross product, unit vector, Transforms and Matrices.
Polygon Meshes: Vertices, Edge and Faces, Graphics primitives, Indexed triangle mesh, surface normal.
Introduction to Programmable Graphics Pipeline using Shaders.
Theory of rotation in 3D and its implementation: Euler Angle, Axis-Angle and Quaternion (including Complex Numbers).
Theory of viewing and projection in 3D and their implementation: Specifying output window, Pixel aspect ratio, View Frustum, Field of View, and Zoom, Orthographic projection.
Coordinate space: Model, World and Camera space, Clip Space and Clip Matrix, Screen space.
3D Animation Techniques – Key-Frame, Skeletal, Morph-Target (Per Vertex), LERP and SLERP.
3D scene organization techniques.
Ray Tracing: Root Finding, Surface Intersections, and Normal vector calculations.
Illumination: RGB colour, Light sources, Diffuse and specular lighting, Standard local lighting model.
Illumination, Local Illumination vs. Global Illumination, Faking Global Illumination.
Discrete sampling techniques in computer graphics.
Texture Mapping: Diffuse, Specular and Normal mapping, Multi-Texturing and Blending, Rendering to a Texture.

Introduction to Derivation and Integration.
Bounding Volumes: AABB, OBB, Capsules, Spheres and how these work in Scenes and Collision Detection (Broad/Narrow Phase Collisions, Picking, Ray-Casting).

Learning Activities

Lectures incorporating demonstrations will be followed by tutor-led practical sessions. These will be supported by practical work in the laboratory.

Notes

This module teaches the mathematical principles in 3D computer graphics and their application in the development of 3D computer games. The module uses a modern graphics API such as OpenGL or DirectX to demonstrate how complex scenery can be constructed using a wide range of 3D graphical techniques. Students will be taught about the programmable pipeline, including shader implementations of lighting and texture calculations.