I059	**3D Computer Graphics**	L	S	E	ECTS
		2	1	2	7

Course objectives. Students shall learn and apply the basic algorithms for 3D modeling and real-time rendering using C++ programming language with OpenGL graphical programming library to render static and dynamic 3D scenes.

Course prerequisites. Introduction to Computer Science. Object-Oriented Programming, Linear algebra I, II

Syllabus.

1. Introduction. Basic concepts of computer graphics, drawing points, lines, and polygons; modeling with polygons; animation; introduction to OpenGL programming; GPU capabilities.
2. Transformations and viewing. Rendering pipeline, linear and affine transformations: translations and rotations, homogeneous coordinates, transformations in OpenGL. Viewing with orthographic and perspective transformations, projective geometry, pixelization.
3. Lightning, illuminations and shading. Phong lightning model. Lights and material properties in OpenGL. Cook-Torrance model.
4. Interpolations: linear, bilinear, spherical and hyperbolic interpolations.
5. Texture mappings. Texture coordinates, supersampling and jitter. Texture maps in OpenGL.
6. Color and its perception. Color representations: RGB and HSL.
7. Drawing curves: Bezier curves, B-Splines. Curves in OpenGL.
8. Ray Tracing: recursive ray tracing, reflection and transmission, distributed ray tracing, backwards ray tracing. Light intersections with geometric solids.
9. Animations and Kinetics. Representations of orientation, quaternions. Forward and inverse kinematics.

EXPECTED LEARNING OUTCOMES

No.	LEARNING OUTCOMES
1.	To explain and apply fundamental mathematical principles for generating 3D images using a computer.
2.	To apply appropriate shading techniques for the interaction between light and geometry.
3.	To define rendering pipeline for rendering 3D modelling technique.
4.	To apply different kinds of ray-tracing algorithms on generated 3D scenes.
5.	To explain the basic architecture of graphics processing units and functionality of OpenGL library.
6.	To develop simple graphical programs using OpenGL library.
7.	To create dynamical 3D scenes using OpenGL library.

COUPLING OF THE LEARNING OUTCOMES, TEACHING PROCESS ORGANIZATION AND THE EVALUATION OF THE TEACHING OUTCOMES

	ECTS				SCORE

TEACHING PROCESS ORGANIZATION		LEARNING OUTCOMES **	STUDENT ACTIVITY *	EVALUATION METHOD	min	max
Lecture attendance	1	1-6	Class attendance, discussion, solving the problems individually and in a team	Lists with signatures, observing the activity during the lectures	0	10
Homework	2	1-5	Solving the problems individually	Grading	18	30
Repeated exam	2	1-5	Revising	Grading, discussion	16	30
Final exam	2	7	Seminar presentation	Oral exam	16	30
TOTAL	7				50	100

Teaching methods and student assessment. During lectures students will be introduced to basic mathematical concepts in 3D computer graphics image synthesis. Different shading models for light interaction with geometric solids and scene rendering techniques for rasterization and ray tracing respectively will be demonstrated. Exercises will be held in specialized computer-based laboratories where students will learn how to model and draw simple 3D models using OpenGL graphical library. The final exam will be held after completion of lectures and exercises and it will contain a practical and an oral part. Successful participation in mid-term exams (or homework) replaces obligatory participation in the practical part of the exam. Students can influence their final grade if they actively participate in homework assignments during the semester. The oral part of the exam consists of public seminar presentation of graphical application programming project.

Can the course be taught in English: Yes

Basic literature:

1. S. Buss, „3D Computer Graphics: A mathematical approach with OpenGL“, Cambridge University Press, 2003.

Recommended literature:

1. G. Sellers, R.S.Wright, N. Haemel, „OpenGL Superbible: Comprehensive Tutorial and Reference“, Addison-Wesley Professional; 7 edition, 2015.
2. A. Watt, „3D Computer Graphics“, Addison Wesley, 2000.
3. S. J. Gortier, „Foundations of 3D Computer Graphics“, MIT Press, 2012
4. E. Angel, „Interactive Computer Graphics: A Top-Down Approach with Shader-Based OpenGL (6th Edition)“, Pearson; 6 Ed, 2011
5. L. Benstead, :“Beginning OpenGL Game Programming“, 2Ed, Cengage Learning PTR, 2009.