COURSE SYLLABUS

Academic year 2024-2025

1. Programme Information

1.1. Higher education institution	**Lucian Blaga University of Sibiu**
1.2. Faculty	Faculty of Engineering
1.3. Department	Department of Computer Science and Electrical and Electronics Engineering
1.4. Field of study	Computer Science and Information Technology
1.5. Level of study[1]	Master
1.6. Programme of study/qualification	ADVANCED COMPUTING SYSTEMS

2. Course Information

2.1. Name of course	Advanced Computer Graphics	Code	ACS.202.RO
2.2. Course coordinator	Assoc. Prof. Rodica BACIU, PhD		
2.3. Seminar/laboratory coordinator	conf. dr. ing. Rodica BACIU		

2.4. Year of study[2]	1	2.5. Semester[3]	2	2.6. Evaluation form[4]	E
2.7. Course type[5]	O	2.8. The formative category of the course[6]			R

3. Estimated Total Time

3.1. Course Extension within the Curriculum – Number of Hours per Week					
3.1.a. Lecture	3.1.b. Seminar	3.1.c. Laboratory	3.1.d. Project	3.1.e. Other	Total
1		1			**2**
3.2. Course Extension within the Curriculum – Total Number of Hours within the Curriculum					
3.2.a. Lecture	3.2.b. Seminar	3.2.c. Laboratory	3.2.d. Project	3.2.e. Other	Total[7]
14		14			**28**

Time Distribution for Individual Study[8]	**Hours**
Learning by using course materials, references and personal notes	5
Additional learning by using library facilities, electronic databases and on-site information	5
Preparing seminars / laboratories, homework, portfolios and essays	28
Tutorial activities[9]	7
Exams[10]	2
3.3. Total Individual Study Hours[11] *($NOSI_{sem}$)*	**47**
3.4. Total Hours in the Curriculum *($NOAD_{sem}$)*	**28**
3.5. Total Hours per Semester[12] *($NOAD_{sem} + NOSI_{sem}$)*	**75**
3.6. No. of Hours / ECTS	**25**
3.7. Number of credits[13]	**3**

4. Prerequisites (if needed)

4.1. Courses that must be successfully completed first (from the curriculum)[14]	Programming Languages, Linear Algebra, Analytical and Differential Geometry, Physics, Data Structures, Algorithms Analysis and Design, Computer Assisted Graphics, Image Processing
4.2. Competencies	• Using OpenGL library • Programming in C++

5. Conditions (where applicable)

5.1. For course/lectures[15]	Board, video projector, Powerpoint presentation, written books, Google Meet, Google Classroom, Google Drive.
5.2. For practical activities (lab/sem/pr/app)[16]	OpenGL Library, GLUT Library, GLU Library, GLAUX Library, Visual Study C++, Google Meet, Google Classroom, Google Drive.

6. Specific competencies acquired[17]

Number of credits assigned to the discipline[18]		3	Credits distribution by competencies[19]
6.1. Professional competencies	PC14	disseminates results to the scientific community	1
	PC15	conducts scientific research	1
6.2. Transversal competencies	TC2	manages personal development	1

7. Course objectives (resulted from developed competencies)

7.1. Main course objective	This advanced course demonstrates sophisticated and novel computer graphics programming techniques, implemented in C using the widely available OpenGL library. The course explains the concepts and demonstrates the techniques required to generate images of greater realism and utility.
7.2. Specific course objectives	The course helps students achieve two goals: •They gain a deeper insight into computer graphics concepts and OpenGL functionality, •They expand their "tool-box" of useful OpenGL techniques.

8. Content

8.1 Lectures[20]		**Teaching methods[21]**	**Hours**
Lecture 1	**Modelling** Decomposition and Tessellation. Generating Model Normals. Triangle stripping.	Exposition, use of video projector, discussions with students	1 hour
Lecture 2	**Modelling** Capping Clipped Solids with the Stencil Buffers. Constructive Solid Geometry with the Stencil Buffers.	Exposition, use of video projector, discussions with students	1 hour
Lecture 3	**Geometry and Transformations** Stereo Viewing. Depth of field. The Z Coordinate and Perspective Projection.	Exposition, use of video projector, discussions with students	1 hour

Lecture 4	**Texture Mapping** Mipmap Generation. Filtering. Anisotropic Texture Filtering. Paging Textures. Billboards. Texture Coordinate Generation.	Exposition, use of video projector, discussions with students	1 hour
Lecture 5	**Texture Mapping** Colour Coding and Contouring. Projective Textures. 3D Textures. Line Integral Convolution with Texture. Procedural Texture Generation.	Exposition, use of video projector, discussions with students	1 hour
Lecture 6	**Blending** Compositing. Advanced Blending. Blending with the Accumulation Buffer.	Exposition, use of video projector, discussions with students	1 hour
Lecture 7	**Antialiasing** Line and Point Antialiasing. Polygon Antialiasing. Antialiasing with Textures. Antialiasing with the Accumulation Buffer.	Exposition, use of video projector, discussions with students	1 hour
Lecture 8	**Lighting** Phong Shading. Light Maps. Other Lighting Models. Global Illumination. Choosing Materials Properties.	Exposition, use of video projector, discussions with students	1 hour
Lecture 9	**Scene Realism** Motion Blur. Depth of Field. Reflections and Refractions. Creating Shadows.	Exposition, use of video projector, discussions with students	1 hour
Lecture 10	**Transparency** Screen-Door Transparency. Alpha Blending. Sorting. Using the Alpha Function. Using Mulisampling.	Exposition, use of video projector, discussions with students	1 hour
Lecture 11	**Natural Phenomena** Smoke. Vapour Trails. Fire. Explosions. Clouds. Water. Light Points. Other Atmospheric Effects. Particle Systems.	Exposition, use of video projector, discussions with students	1 hour
Lecture 12	**Image Processing** The Pixel Transfer Pipeline. The Framebuffer and Per-Fragment operations. Colours and Colour Spaces. Convolutions. Image Warping.	Exposition, use of video projector, discussions with students	1 hour
Lecture 13	**Using the Stencil Buffer** Dissolve with Stencil. Decaling with Stencil. Finding Depth Complexity with the Stencil Buffer. Compositing Images with Depth.	Exposition, use of video projector, discussions with students	1 hour
Lecture 14	**Line Rendering Techniques** Wireframe Models. Hidden Lines. Haloed Lines. Silhouette Edges.	Exposition, use of video projector, discussions with students	1 hour
		Total lecture hours:	

8.2.b. Laboratory		**Teaching methods**[22]	**Hours**
Laboratory 1	Constructive Solid Geometry with the Stencil Buffers in OpenGL.	Discussions, debates, code analysis, code implementation	1 hour
Laboratory 2	Computing the Transforms in OpenGL.	Discussions, debates, code analysis, code implementation	1 hour
Laboratory 3	Billboards.	Discussions, debates, code analysis, code implementation	1 hour
Laboratory 4	How to Project a Texture in OpenGL.	Discussions, debates, code analysis, code implementation	1 hour
Laboratory 5	Spectral Synthesis. Turbulence.	Discussions, debates, code analysis, code implementation	1 hour
Laboratory 6	Blending with the Accumulation Buffer in OpenGL.	Discussions, debates, code analysis, code implementation	1 hour

Laboratory 7	Antialiasing with the accumulation Buffer.	Discussions, debates, code analysis, code implementation	1 hour
Laboratory 8	2D Texture Light Maps. 3d Texture Light Maps.	Discussions, debates, code analysis, code implementation	1 hour
Laboratory 9	Modelling Material Smoothness.	Discussions, debates, code analysis, code implementation	1 hour
Laboratory 10	Motion Blur.	Discussions, debates, code analysis, code implementation	1 hour
Laboratory 11	Planar Reflections and Refraction Using the Stencil Buffer.	Discussions, debates, code analysis, code implementation	1 hour
Laboratory 12	Creating Shadows.	Discussions, debates, code analysis, code implementation	1 hour
Laboratory 13	Transparency.	Discussions, debates, code analysis, code implementation	1 hour
Laboratory 14	The Imaging Subset in OpenGL.	Discussions, debates, code analysis, code implementation	
		Total laboratory hours:	

9. Bibliography

9.1. Recommended Bibliography	Baciu, R., Volovici,D., Sisteme de prelucrare grafică, Editura Microinformatica, Cluj-Napoca 1999.
	Baciu, R., Programarea aplicaţiilor grafice 3D cu OpenGL, Editura Albastră, Cluj-Napoca, 2005.
	Baciu, R., Advanced Computer Graphics- Advanced Computer Graphics using OpenGL, Editura Techno Media, Sibiu, 2012 (I.S.B.N. 978-606-616-074-2) (459 slide-uri).
9.2. Additional Bibliography	Hearn, Donald, Backer,M. Pauline, Computer Graphics, Prentice-Hall, Inc, Englewood Cliffs, New Jersy, 1986
	David Blythe (Silicon Graphics) and Tom McReynolds (Gigapixel), Advanced Graphics Programming Techniques Using OpenGL, SIGGRAPH 2000 Course 32 (http://www.bluevoid.com/opengl/sig00/advanced00/notes/notes.html)
	Foley,J., A.vanDame, Feiner, S.K., Hughes, J.F., Computer Graphics: principles and practice, Addison Wesley Publishing Company, second edition, 1993.
	OpenGL Architecture Rewiew Board, OpenGL Reference Manual, Addison-Wesley, Menlo Park, 1993. (http://www.glprogramming.com/blue/)
	Neider, J., Davis, T., Woo, M., OpenGL Programming Guide, Addison-Wesley, Menlo Park, 1993. (http://www.glprogramming.com/red/)
	Mark Segal, Kurt Akeley, The OpenGL Graphics System: A Specification, Silicon Graphics, 1992-2002 (https://www.opengl.org/documentation/specs/version1.1/glspec1.1/)
	Richard S. Wright, Jr., Benjamin Lipchak, Nicholas Haemel, OpenGL Superbible 4th ed.: comprehensive tutorial and reference, Addison Wesley Publishing Company, 2007

10. Conjunction of the discipline's content with the expectations of the epistemic community, professional associations and significant employers of the specific study program[23]

Knowledge of the principles of programming a graphical applications and knowledge of how to use the OpenGL library will allow graduates to adapt to the requirements of employers and others graphics libraries or programming environment.

11. Evaluation

Activity Type	11.1 Evaluation Criteria	11.2 Evaluation Methods		11.3 Percentage in the Final Grade	Obs.[24]
11.4a Exam / Colloquy	• Theoretical and practical knowledge acquired (quantity, correctness, accuracy)	Tests during the semester[25]:	%	90%	CPE, CEF
		Homework:	30%		
		Other activities[26]:	%		
		Final evaluation:	60%		
11.4c Laboratory	• Knowledge of the equipment, how to use specific tools; evaluation of tools, processing and interpretation of results	• Written questionnaire • Oral response • Laboratory notebook, experimental works, reports, etc. • Practical demonstration		10%	CPE, CEF
11.5 Minimum performance standard[27] OpenGL.		The student must implement an application using			

The Course Syllabus will encompass components adapted to persons with special educational needs (SEN – people with disabilities and people with high potential), depending on their type and degree, at the level of all curricular elements (skills, objectives, contents, teaching methods, alternative assessment), in order to ensure fair opportunities in the academic training of all students, paying close attention to individual learning needs.

Filling Date: 10.09.2024

Department Acceptance Date: 16.09.2024

	Academic Rank, Title, First Name, Last Name	Signature
Course Teacher	Assoc. Prof. Rodica BACIU, PhD	
Study Program Coordinator	Prof. Adrian FLOREA, PhD	
Head of Department	Assoc. Prof. Radu George CREȚULESCU, PhD	
Dean	Prof. Maria VINȚAN, PhD	

[1] *Bachelor / Master*
[2] *1-4 for bachelor, 1-2 for master*
[3] *1-8 for bachelor, 1-3 for master*
[4] *Exam, colloquium or VP A/R - from the curriculum*
[5] *Course type: R = Compulsory course; E = Elective course; O = Optional course*
[6] *Formative category: S = Specialty; F = Fundamental; C = Complementary; I = Fully assisted; P = Partially assisted; N = Unassisted*
[7] *Equal to 14 weeks x number of hours from point 3.1 (similar to 3.2.a.b.c.)*
[8] *The following lines refer to individual study; the total is completed at point 3.37.*
[9] *Between 7 and 14 hours*
[10] *Between 2 and 6 hours*
[11] *The sum of the values from the previous lines, which refer to individual study.*
[12] *The sum (3.5.) between the number of hours of direct teaching activity (NOAD) and the number of hours of individual study (NOSI) must be equal to the number of credits assigned to the discipline (point 3.7) x no. hours per credit (3.6.)*
[13] *The credit number is computed according to the following formula, being rounded to whole neighbouring values (either by subtraction or addition*

$$No.credits = \frac{NOCpSpD \times C_C + NOApSpD \times C_A}{TOCpSdP \times C_C + TOApSdP \times C_A} \times 30\ credits$$

Where:

- NOCpSpD = Number of lecture hours / week / discipline for which the credits are calculated
- NOApSpD = Number of application hours (sem./lab./pro.) / week / discipline for which the credits are calculated
- TOCpSdP = Total number of course hours / week in the Curriculum
- TOApSdP = Total number of application hours (sem./lab./pro.) / week in the Curriculum
- C_C/C_A = Course coefficients / applications calculated according to the table

Coefficients	**Course**	**Applications (S/L/P)**
Bachelor	2	1
Master	2,5	1,5
Bachelor - foreign language	2,5	1,25

[14] *The courses that should have been previously completed or equivalent will be mentioned*
[15] *Board, video projector, flipchart, specific teaching materials, online platforms, etc.*
[16] *Computing technology, software packages, experimental stands, online platforms, etc.*
[17] *Competences from the Grids related to the description of the study program, adapted to the specifics of the discipline*
[18] *From the curriculum*
[19] *The credits allocated to the course are distributed across professional and transversal competences according to the specifics of the discipline*
[20] *Chapter and paragraph titles*
[21] *Exposition, lecture, board presentation of the studied topic, use of video projector, discussions with students (for each chapter, if applicable)*
[22] *Practical demonstration, exercise, experiment*
[23] *The relationship with other disciplines, the usefulness of the discipline on the labour market*
[24] *CPE – Conditions Exam Participation; nCPE – Does Not Condition Exam Participation; CEF - Conditions Final Evaluation; N/A – not applicable*
[25] *The number of tests and the weeks in which they will be taken will be specified*
[26] *Scientific circles, professional competitions, etc.*
[27] *The minimum performance standard in the competence grid of the study program is customized to the specifics of the discipline, if applicable*