Course Outline	
COMP7110 Computer Graphic (2/2)	**Study Program** Computer Science
Effective Date 01 February 2018	**Revision** 2

1. Course Description

This course offers an in-depth exploration of fundamental concepts in 2D and 3D computer graphics. It introduces 2D raster graphics techniques, including scan conversion, image processing, interaction techniques and user interface design. The bulk of the course is devoted to 3D modeling, geometric transformations, and 3D viewing and rendering. C++ and the graphics library OpenGL are used throughout the course, as is shader programming on the GPU, taught from the first lab onwards. The final project is typically a small group project specified and implemented by the group using shaders to create special effects.

2. Graduate Competency

Each course in the study program contributes to the graduate competencies that are divided into employability and entrepreneurial skills and study program specific outcomes, in which students need to have demonstrated by the time they complete their course.

BINUS University employability and entrepreneurial skills consist of planning and organizing, problem solving and decision making, self management, team work, communication, and initiative and enterprise.

2.1. Employability and Entrepreneurial Skills

Aspect	Key Behaviour

2.2. Study Program Specific Outcomes

Study Program Specific Outcomes
Able to construct a solution by applying current technologies
Able to classify criteria and specifications appropriate to specific problems, plan strategies for their solution and construct software system development

3. Topics

- Introduction to Computer Graphics
- Open Graphic Library OpenGL 3.x
- 2D and 3D Geometri Transformation
- 3D Viewing I
- 3D Viewing II
- Color Models
- Topics for Final Project: Overview
- Image Processing and ANTIALIASING
- Rasterization (Scan Conversion)
- Line and POLYGON Clipping
- Lighting and Illumination Models
- TEXTURE MAPPING
- Basic of C++
- Basic of OpenGL
- GLUT Basic Operation
- GLUT Images

- Creating Game Using GLUT (1)
- Creating Game Using GLUT I (2)
- Creating Game Using GLUT (3)
- User Interface
- Audio Sound
- Gameplay

4. Learning Outcomes

On successful completion of this course, student will be able to:

- LO 1: Define Computer graphics system and architectures
- LO 2: Explain Graphics with openGL and viewing in graphics programming
- LO 3: Apply Raster graphics, clipping, graphics transformation, illumination, lighting, shading, texture,and object modelling algorithms in 2D/3D
- LO 4: Analyze Raster graphics, clipping, graphics transformation, illumination, lighting, shading, texture, and object modelling algorithms in 2D/3D
- LO 5: Construct Raster graphics, clipping, graphics transformation, illumination, lighting, shading, texture, and object modelling algorithms in 2D/3D

5. Teaching And Learning Strategies

In this course, the lecturers might deploy several teaching learning strategies, including Demonstration, Project Work, Lecture, and Individual and Team Assignment.

6. Textbooks and Other Resources

6.1 Textbooks

1. Edward Angel. (2012). ***Interactive computer graphics : a top-down approach with shader- based OPENGL***. 06. Pearson Education. Boston. ISBN: 9780273752264.

The book in the first list is a must to have for each student.

6.2 Other Resources

1. http://www.apps.binusmaya.binus.ac.id/CMS/CourseDetailAll.aspx?id=Z1258&id2=1
2. http://www.ogldev.atspace.co.uk/www/tutorial26/tutorial26.html
3. http://www.learnopengl.com
4. http://www.learnopengl.com
5. http://www.learnopengl.com
6. http://www.opengl-tutorial.org/intermediate-tutorials/tutorial-13-normal-mapping/#tangent-and-bitangent
7. http://www.learnopengl.com
8. http://www.cs.brown.edu/courses/cs123/lectures.shtml
9. http://www.raw.githubusercontent.com/Overv/Open.GL/master/ebook/ModernOpenGLGuide.pdf
10. http://www.cs.brown.edu/courses/cs123/lectures.shtml
11. http://www.cs.brown.edu/courses/cs123/lectures/CS123_12_Clipping_10.12.17.pptx
12. http://www.cs.brown.edu/courses/cs123/lectures/CS123_15_Illumination_10.24.17.pptx
13. http://www.cs.brown.edu/courses/cs123/lectures/CS123_23_Texture_Mapping_10.31.17.pptx
14. http://www.learnopengl.com
15. http://www.learnopengl.com
16. http://www.learnopengl.com
17. http://www.learnopengl.com
18. http://www.learnopengl.com/#!Advanced-Lighting/Deferred-Shading
19. http://www.learnopengl.com
20. http://www.learnopengl.com
21. http://www.learnopengl.com

7. Schedule

Theory

Session/ Mode	Related LO	Topics	References
1 F2F	LO 1	Introduction to Computer Graphics - What is Computer Graphics (CG) - Conceptual model for Interactive CG - Application models - Graphic system and graphic library - Geometric modeling - Sample-based vs Geometric-based graphics - Use of Graphics system	- Introduction to Computer Graphic - Interactive computer graphics : a top-down approach with shader- based OPENGL, Chapter 01 - Learn OpenGL 3.4 tutorial, http://www.learnopengl.com
2 F2F	LO 1 LO 2	Open Graphic Library OpenGL 3.x - What is OpenGL - Setup OpenGL project - OpenGL evolution - OpenGL Shaders - OpenGL rendering pipeline	- Open Graphic Library OpenGL 3.x - Interactive computer graphics : a top-down approach with shader- based OPENGL, Chapter 02 - Learn OpenGL 3.4 tutorial, http://www.learnopengl.com - Modern OpenGL Guide, http://www.raw.githubusercontent.com/Overv/Open.GL/master/ebook/ModernOpenGLGuide.pdf
3 F2F	LO 1 LO 2 LO 3	2D and 3D Geometri Transformation - What is Geometric Transformation - Scaling and Rotation in 2D - Transformation into Homogeneous coordinate system - Composition transformations - 3D geometric transformations	- 2D and 3D Geometri Transformation - Interactive computer graphics : a top-down approach with shader- based OPENGL, Chapter 02 - 2D Transformation, http://www.apps.binusmaya.binus.ac.id/CMS/CourseDetailAll.aspx?id=Z1258&id2=1 - Learn OpenGL 3.4 tutorial, http://www.learnopengl.com
4 GSLC	LO 2 LO 3	3D Viewing I - Camera in rendering process - Viewing volume - Constructing view volume - Orientation : Look and Up vectors - Aspect ratio and viewing angles - Near and Far clipping plane	- 3D Viewing I - Interactive computer graphics : a top-down approach with shader- based OPENGL, Chapter 04 - Learn OpenGL 3.4 tutorial, http://www.learnopengl.com
5 F2F	LO 1 LO 2 LO 3	3D Viewing II - Finding u, v, and w - Normalization transformation (paralel) - Normalization transformation (perspective) - Windowing transformation - Final words	- 3D Viewing II - Interactive computer graphics : a top-down approach with shader- based OPENGL, Chapter 4 - Learn OpenGL 3.4 tutorial, http://www.learnopengl.com
6 F2F	LO 2 LO 3	Color Models - Color and Colorimetry terms - Tristimulus theory - CIE Chromacity diagram - Color space - Color models fro Raster Graphic	- Color Models - Interactive computer graphics : a top-down approach with shader- based OPENGL, Chapter 04 - Learn OpenGL 3.4 tutorial, http://www.learnopengl.com - Color II,

			http://www.cs.brown.edu/courses/cs123/lectures.shtml
7 F2F	LO 2 LO 3	Topics for Final Project: Overview - Normal mapping - Deferred lighting/Shading - High Dynamic Range (HDR) - Shadow mapping - Tenselation shaders - UI for Graphic Application	- Topics for Final Project: Overview - Interactive computer graphics : a top-down approach with shader- based OPENGL, Chapter 1-7 - Normal textures, http://www.opengl-tutorial.org/intermediate-tutorials/tutorial-13-normal-mapping/#tangent-and-bitangent - Learn OpenGL 3.4 tutorial, http://www.learnopengl.com - Deferred Shading, http://www.learnopengl.com/#!Advanced-Lighting/Deferred-Shading - Normal Mapping, http://www.ogldev.atspace.co.uk/www/tutorial26/tutorial26.html
8 GSLC	LO 1 LO 2 LO 3	Image Processing and ANTIALIASING - Modeling an image - Discrete and continuous images - Pixels - Image processing pipeline - Some examples of Image Processing	- Image Processing and ANTIALIASING - Interactive computer graphics : a top-down approach with shader- based OPENGL, Chapter 06 - Learn OpenGL 3.4 tutorial, http://www.learnopengl.com
9 F2F	LO 2 LO 3 LO 4	Rasterization (Scan Conversion) - Rasterization process - DDA Line Rasterization - Mid-Point Algorithm for Lines - Mid-Point Algorithm for Circles - Mid-Point Algorithm for Ellipse	- Rasterization (Scan Conversion) - Interactive computer graphics : a top-down approach with shader- based OPENGL, Rasterization - Scan Conversion, http://www.cs.brown.edu/courses/cs123/lectures.shtml - Learn OpenGL 3.4 tutorial, http://www.learnopengl.com
10 F2F	LO 2 LO 3 LO 4	Line and POLYGON Clipping - Concept of Line and Polygon clipping - Cohen-Sutherland line clipping - Cyrus-Beck line clipping - Sutherland-Hodgeman polygon clipping - Weiler-Atherton polygon clipping	- Line and POLYGON Clipping - Interactive computer graphics : a top-down approach with shader- based OPENGL, Line and POLYGON Clipping - Clipping, http://www.cs.brown.edu/courses/cs123/lectures/CS123_12_Clipping_10.12.17.pptx
11 F2F	LO 2 LO 3 LO 4 LO 5	Lighting and Illumination Models - What is Light - Illumination Model: Non-Global vs Global - Illumination and Shading - Reflectance Models - Shading Models: Gouraud, Phong, Blinn-Phong	- Lighting and Illumination Models - Interactive computer graphics : a top-down approach with shader- based OPENGL, Chapter 05

			- Illumination, http://www.cs.brown.edu/courses/cs123/lectures/CS123_15_Illumination_10.24.17.pptx - Learn OpenGL 3.4 tutorial, http://www.learnopengl.com
12 GSLC	LO 3 LO 4 LO 5	TEXTURE MAPPING - Texture mapping overview - Mapping techniques - Texture mapping style - Complex geometry - Com[plex geometry in real application - Computation of barycentric coordinates - FINAL PROJECT: GROUP PRESENTATION (pertemuan 13)	- Texture Mapping - Interactive computer graphics : a top-down approach with shader- based OPENGL, Chapter 5 - Texture Mapping, http://www.cs.brown.edu/courses/cs123/lectures/CS123_23_Texture_Mapping_10.31.17.pptx - Learn OpenGL 3.4 tutorial, http://www.learnopengl.com
13 F2F	LO 3 LO 4 LO 5	TEXTURE MAPPING - Texture mapping overview - Mapping techniques - Texture mapping style - Complex geometry - Com[plex geometry in real application - Computation of barycentric coordinates - FINAL PROJECT: GROUP PRESENTATION (pertemuan 13)	- Texture Mapping - Interactive computer graphics : a top-down approach with shader- based OPENGL, Chapter 5 - Texture Mapping, http://www.cs.brown.edu/courses/cs123/lectures/CS123_23_Texture_Mapping_10.31.17.pptx - Learn OpenGL 3.4 tutorial, http://www.learnopengl.com

Practicum

Session/ Mode	Related LO	Topics	References
1 F2F	LO 1 LO 2	Basic of C++ - File Management - OOP Concept - Vector and Hashmap - Singleton Design Pattern	- Basic of C++
2 F2F	LO 1 LO 2	Basic of OpenGL - Basic Configuration of OpenGL - Creating Basic Shapes (i.e. Line, Triangle, Oval, Polygon)	- Basic of OpenGL
3 F2F	LO 1 LO 2	GLUT Basic Operation - Input System (i.e. Mouse, Keyboard, Special Key) - Application Main Loop (i.e. Callback Function)	- GLUT Basic Operation
4 F2F	LO 1 LO 2	GLUT Images - Load Image - Sprite Slicing	- GLUT Images
5 F2F	LO 3 LO 4 LO 5	Creating Game Using GLUT (1) - Framework Introduction (i.e. Input System, Load Images) - Asset Manager	- Creating Game Using GLUT
6 F2F	LO 3 LO 4 LO 5	Creating Game Using GLUT I (2) - Creating Animation - Animation Controller	- Creating Game Using GLUT
7 F2F	LO 3 LO 4	Creating Game Using GLUT I (2) - Creating Animation	- Creating Game Using GLUT

	LO 5	- Animation Controller	
8 F2F	LO 3 LO 4 LO 5	Creating Game Using GLUT (3) - Collision (i.e. Create, Detect, Test) - Scene Management (i.e. Create, Change)	- Creating Game Using GLUT
9 F2F	LO 3 LO 4 LO 5	User Interface - Camera Projection - Font & Color	- User Interface
10 F2F	LO 3 LO 4 LO 5	Audio Sound - Import Audio - Implement Audio (i.e. Play, Pause, Stop)	- Audio Sound
11 F2F	LO 1 LO 2 LO 3 LO 4 LO 5	Gameplay - Creating Game Logic - Write & Read File (i.e. Hi-Score) - Project Collection	- Gameplay
12 F2F	LO 1 LO 2 LO 3 LO 4 LO 5	Gameplay - Creating Game Logic - Write & Read File (i.e. Hi-Score) - Project Collection	- Gameplay

8. Evaluation

Theory

Assessment Activity	Weight	Learning Outcomes				
		1	2	3	4	5
Assignment	50%	√	√	√	√	√
Mid Exam	20%	√	√	√		
Final Exam	30%	√	√	√	√	√

Practicum

Assessment Activity	Weight	Learning Outcomes				
		1	2	3	4	5
Assigment	40%	√	√	√	√	√
Project	60%	√	√	√	√	√

Final Evaluation Score

Aspects	Weight
Theory	70%
Practicum	30%

9. A. Assessment Rubric (Study Program Specific Outcomes)

LO	Indicators	Proficiency Level			
		Excellent (85 – 100)	**Good (75 – 84)**	**Average (65 – 74)**	**Poor (<= 64)**
LO 1	1.1. Ability to define Graphics System	Clearly shown in Graphics system	Appropriately shown in Graphics System	Somewhat appropriately shown in Graphics System	Somewhat are not shown in Graphics System
	1.2. Ability to explain openGL graphics programming	Clearly shown in openGL graphics programming	Appropriately shown in openGL graphics programming	Somewhat appropriately shown in openGL graphics programming	Somewhat are not shown in openGL graphics programming
LO 2	2.1. Ability to explain graphics with viewing in graphics programming	Clearly shown graphics with viewing in graphics programming	Appropriately shown graphics with viewing in graphics programming	Somewhat appropriately shown graphics with viewing in graphics programming	Somewhat are not shown graphics with viewing in graphics programming
	2.2. Ability to explain openGL graphics programming	Clearly shown in openGL graphics programming	Appropriately shown in openGL graphics programming	Somewhat appropriately shown in openGL graphics programming	Somewhat are not shown in openGL graphics programming
LO 3	3.1. Ability to apply raster graphics, clipping, graphics transformation	Clearly shown in raster graphics, clipping, graphics transformation	Appropriately shown in raster graphics, clipping, graphics transformation	Somewhat appropriately shown in raster graphics, clipping, graphics transformation	Somewhat are not appropriately shown in raster graphics, clipping, graphics transformation
	3.2. Ability to apply illumination, lighting, shading, texture, 3D object modelling algorithms	Clearly shown in illumination, lighting, shading, texture, 3D object modelling algorithms	Appropriately shown in illumination, lighting, shading, texture, 3D object modelling algorithms	Somewhat appropriately shown in illumination, lighting, shading, texture, 3D object modelling algorithms	Somewhat are not shown in illumination, lighting, shading, texture, 3D object modelling algorithms
LO 4	4.1. Ability to analyse raster graphics, clipping, graphics transformation	Clearly shown in raster graphics, clipping, graphics transformation	Appropriately shown in raster graphics, clipping, graphics transformation	Somewhat appropriately shown in raster graphics, clipping, graphics transformation	Somewhat are not shown in raster graphics, clipping, graphics transformation

	4.2. Ability to analyze illumination, lighting, shading, texture, 3D object modelling algorithms	Clearly shown in illumination, lighting, shading, texture, 3D object modelling algorithms	Appropriately shown in illumination, lighting, shading, texture, 3D object modelling algorithms	Somewhat appropriately shown in illumination, lighting, shading, texture, 3D object modelling algorithms	Somewhat are not appropriately shown in illumination, lighting, shading, texture, 3D object modelling algorithms
LO 5	5.1. Ability to construct raster graphics , clipping, graphics transformation	Clearly shown in raster graphics, clipping, graphics transformation	Appropriately shown in raster graphics, clipping, graphics transformation	Somewhat appropriately shown in raster graphics, clipping, graphics transformation	Somewhat are not shown in raster graphics, clipping, graphics transformation
	5.2. Ability to construct illumination, lighting, shading, texture, 3D object modelling algorithms	Clearly shown in illumination, lighting, shading, texture, 3D object modelling algorithms	Appropriately shown in illumination, lighting, shading, texture, 3D object modelling algorithms	Somewhat appropriately shown in illumination, lighting, shading, texture, 3D object modelling algorithms	Somewhat are not appropriately shown in illumination, lighting, shading, texture, 3D object modelling algorithms

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