University of Petra		
Faculty of Information Technology		كلية تكنولوجيا المعلومات
Department of Virtual & Augmented Reality		قسم الواقع الافتراضي والمعزز

Course Syllabus (Online/ Blended courses)
Instructor Form

Year: 2024/2025 **Semester:(2)**

Course No.	Course Title	Prerequisite	Co-requisite	Credit Hours Lectures / Lab.	Equivalent hours in NQF	Course level according to NQF
607471	***Computer Graphics for Virtual Reality***	(607233 &104121)	-	***Lecture: 3 Lab: 0***	***70***	***6***

Course Form		Course Model		
☒ Blended	☐ Online	☒ 2+1	☐ 1+1	☐ 1+2

Learning Management System Platform	**Moodle**
URL to access the platform	**Moodle** **Microsoft Teams**
Link to tutorial videos to access the platform and technical help	**Moodle Tutorial:** **Moodle Mobile Tutorial:** **Microsoft Teams Tutorial:**

Instructor Name	E-mail	Office No.	Office ext.
Dr Jamak Zraqou	Jamak.Zraqou@uop.edu.jo	7328	*7328*

Office Hours	Platform used	Link to the office hours platform

Coordinator's Name:	*Dr Jamal Zraqou*

Course Description	This course introduces the principles of designing 3D graphics applications using OpenGL. Students will learn basic shading and lighting modeling and will study some algorithms for rasterization and clipping. The course covers theory and practical aspects.

Course Objectives

- Understand the fundamental principles of computer graphics and its applications.
- Gain proficiency in designing 3D graphics applications using OpenGL.
- Learn basic shading and lighting modeling techniques.
- Study algorithms for rasterization and clipping in computer graphics.
- Develop practical skills in implementing computer graphics algorithms using OpenGL.
- Explore advanced topics such as texture mapping, hidden surface removal, and ray tracing.
- Acquire knowledge of 3D animation techniques and keyframe interpolation.
- Gain an introduction to virtual reality concepts and implementations.

Course Intended Learning Outcomes (ILOs) and their Alignment with Program ILOs, Teaching and Learning Methods, and Assessment Methods:

Upon successful completion of this course, students are expected to achieve the following learning outcomes:

Course ILOs	Program ILOs	Teaching and Learning Method	Assessment Method
Knowledge (K)			
K1) Understand the principles and concepts of computer graphics, including 2D and 3D graphics, coordinate systems, and transformations.	V&AR-6.1	Interactive lectures	Mid Exam
K2) Understand transformations in 3D space, including hierarchical modeling and perspective projection.	V&AR-6.1	Interactive lectures	Mid Exam
Intellectual Skills (I)			
I1) Demonstrate proficiency in using OpenGL for designing 3D graphics applications.	V&AR-6.3	Interactive lectures	Final Exam
I2) Analyze and implement algorithms for rasterization and clipping to efficiently render graphics	V&AR-6.4	Interactive lectures	Final Exam
Practical skills (P)			
P1) Apply shading and lighting models to create realistic renderings of 3D objects.	V&AR-6.2	Practical presentation	Homework - Rubric
Transferable Skills (T)			
T1) Demonstrate effective communication skills in presenting and explaining graphics concepts, techniques, and solutions to peers and stakeholders.	V&AR-3.1	Practical presentation Homework	Project - Rubric
Competencies (C)*			
Communication skills	C3		Final exam
Technical Proficiency	C6		Project rubric

Course Schedule:

Topic Number	Week	Topics Details	Reference	ILO No.	Tasks required from students	Teaching activities *
1	1	**Introduction to Computer Graphics** • Introduction to 2D graphics and coordinate systems • Transformation matrices: translation, rotation, scaling • Applying transformations to 2D objects using OpenGL	Ch1	K1	Interactive Lectures	**(Synchronous)**
2	2	**2D Graphics and Transformations** • Introduction to 2D graphics and coordinate systems • Transformation matrices: translation, rotation, scaling • Applying transformations to 2D objects using OpenGL	Ch1	K2	Interactive Lectures	**(Synchronous)**
3	3	**3D Graphics and Transformations** • Introduction to 3D graphics and coordinate systems • 3D transformations: translation, rotation, scaling • Applying transformations to 3D objects using OpenGL	Ch2	K1, P1	Presentation Slides	**(Asynchronous)**
4	4	**Shading and Lighting Models** • Basic shading models: flat shading, Gouraud shading, Phong shading • Introduction to lighting models and calculations • Implementing shading and lighting in OpenGL	Ch3	K1, P1	Interactive Lectures	**(Synchronous)**
5	5	**Rasterization Algorithms** • Introduction to rasterization and scan-conversion techniques • Line rasterization algorithms: DDA, Bresenham's line algorithm • Polygon rasterization: scanline algorithm	Ch4	K1	Interactive Lectures	**(Asynchronous)**

6	**6**	**Clipping Algorithms** • Introduction to clipping and its importance in computer graphics. • Cohen-Sutherland line clipping algorithm • Sutherland-Hodgman polygon clipping algorithm	Ch6 + Ch7	I1	Interactive Lectures	**(Synchronous)**
7	**7**	**Texture Mapping** • Introduction to texture mapping and its applications • Texture coordinates and mapping techniques • Implementing texture mapping in OpenGL	Ch7	K1	Interactive Lectures	**(Synchronous)**
8	**8**	**Transformations in 3D Space** • Homogeneous coordinates and transformations • Composite transformations and hierarchical modeling • Implementing complex transformations in OpenGL	Ch8	K1	Offline Presentation	**(Asynchronous)**
9	**9**	**Perspective Projection** • Introduction to perspective projection • Perspective projection matrix and its calculation • Implementing perspective projection in OpenGL	Lecture notes	K1	Interactive Lectures	**(Synchronous)**
10	**10**	**Hidden Surface Removal** • Introduction to hidden surface removal techniques • Depth-buffer algorithm (Z-buffer) • Back-face culling and other visibility algorithms	Lecture notes	K1	Interactive Lectures	**(Asynchronous)**
11	**11**	**Introduction to Ray Tracing** • Basic principles of ray tracing • Ray-object intersection calculations • Implementing simple ray tracing algorithms	Lecture notes	K1	Interactive Lectures	**(Synchronous)**
12	**12**	**Advanced Lighting and Shading Techniques** • Advanced lighting models: Phong reflection model, Blinn-Phong model • Shadows and reflection/refraction effects • Implementing advanced lighting and shading techniques	Lecture notes	I1	Offline Slides	**(Asynchronous)**

13	**13**	**3D Animation and Keyframe Interpolation** • Introduction to 3D animation techniques • Keyframe interpolation and animation curves • Implementing 3D animation in OpenGL	Lecture notes	T1 P1	Interactive Lectures	**(Asynchronous)**
14	**14**	**Introduction to Virtual Reality** • Overview of virtual reality (VR) concepts • VR devices and technologies • Implementing basic VR interactions in OpenGL	Lecture notes	I1	Interactive Lectures	**(Asynchronous)**
15	**15**	**Review and Final Project** • Review of key concepts covered throughout the course • Final project: designing and implementing a 3D graphics application using OpenGL		P1	Interactive Lectures	**(Synchronous)**

Assessment Methods and Grading System:

Assessment method	Grade	Metrics/ Rubrics/ Expected performance
I. Individual Work		
Assignments	**20%**	Rubrics
Activities	**10%**	Project
Mid Exam	**30%**	Online exam.
A Comprehensive Final examination	**40%**	Online exam.
Total		
	100%	

Learning References and Resources

1- Textbook (s):

Computer Graphics: Principles and Practice" by James D. Foley, Andries van Dam, Steven K. Feiner, John F. Hughes, 5th Edition, 2020.

2- References:

1. OpenGL Programming Guide: The Official Guide to Learning OpenGL, Version 4.6" by John Kessenich, Graham Sellers, and Dave Shreiner Publisher: Addison-Wesley Professional, 9th Edition, 2021.
2. "Real-Time Rendering" by Tomas Akenine-Möller, Eric Haines, and Naty Hoffmanm,CRC Press, 4th Edition, 2018.
    1. "Computer Graphics: From Pixels to Programmable Graphics Hardware" by David H. Eberly
    2. Publisher: CRC Press, 3rd Edition, 2020

3- Other Resources:
Lectures Notes
4- Links , apps, tools, online services, websites

Requirements of the Course

- Good at programming and design
- GPU with at least 8GB RAM

Course Policies[1]

- Attendance Policy: University regulations apply to attendance.
- Academic Honesty: Academic dishonesty is an unacceptable mode of conduct and will not be tolerated in any form at the University of Petra. All people involved in academic dishonesty and plagiarism in any form will be disciplined in accordance with the University's rules and regulations.

Approved by	Name	Date	Signature
Head of Department			
Faculty Dean			

[1] Additional information may be added in this section according to the nature of the course.

Topics Design:

Topic Number **:	1		
Topic / Chapter title:	Setting up the OpenGL with VS 2022.		
Learning Outcomes targeted:	Prepare the main framework to run the tutorials and quizzes.		
Resources/ Materials: **(Video, Web, game, PDF…)**	Video https://youtu.be/HzFatL3WT6g		
Teaching methods **(including Teaching Mode)**	• Watching the video and perform what is in it.		
Assessment Method: (Survey, Quiz, Exam, case study... etc.) * Students should be given clear written instructions of what is required, how to submit, and evaluation criteria. * Students should be given feedback after each evaluation.			
Assessment Method Type	**Grade**	**Rubric/ performance**	**Course ILO**

Sending the first assignment in VS2022	2	Run the homework with free errors using the configured library.	P1
Interactions & collaboration: (including Student Engagement)			
Student-to-student interactions	No		
Instructor-to- student interactions	• Grade the homework		
Student self assessment:	•		
Self-based learning	•		
Student collaboration			
Teaching flow **(Describe, step by step, how the lesson will be developed)**			
Estimated time	**Activity**		
4 Minutes	1. OpenGL installation in VS2022		

** Topic number matches the numbers in the course schedule

Topic Number **:	2		
Topic / Chapter title:	Graphics and Transformations		
Learning Outcomes targeted:	• Introduction to 3D graphics and coordinate systems • transformations: translation, rotation, scaling • Applying transformations to 3D objects using OpenGL		
Resources/ Materials: **(Video, Web, game, PDF…)**	Power Point		
Teaching methods **(including Teaching Mode)**	• Asynchronous /Presentation Slides		
Assessment Method: (Survey, Quiz, Exam, case study, etc.) * Students should be given clear written instructions on what is required, how to submit, and the evaluation criteria. * Students should be given feedback after each evaluation.			
Assessment Method Type	**Grade**	**Rubric/ performance**	**Course ILO**
Homework#2	2	Drawing Lines from the left corner to a curved shape.	K1, P1

Interactions & collaboration: (including Student Engagement)			
Student-to-student interactions			
Instructor-to- student interactions	• Grading the homework		
Student self assessment:	•		
Self-based learning	•		
Student collaboration			
Teaching flow **(Describe, step by step, how the lesson will be developed)**			
Estimated time	**Activity**		
10 Minutes	Practice the drawing using the OpenGL		

Topic Number **:	3		
Topic / Chapter title:	Rasterization Algorithms		
Learning Outcomes targeted:	• Introduction to rasterization and scan-conversion techniques • Line rasterization algorithms: DDA, Bresenham's line algorithm • Polygon rasterization: scanline algorithm		
Resources/ Materials: **(Video, Web, game, PDF…)**	Power Point Slides		
Teaching methods **(including Teaching Mode)**	• Asynchronous		
Assessment Method: (Survey, Quiz, Exam, case study... etc) * Students should be given clear written instructions of what is required, how to submit, and evaluation criteria. * Students should be given feedback after each evaluation.			
Assessment Method Type	**Grade**	**Rubric/ performance**	**Course ILO**
Homework#3	2		K1

Interactions & collaboration: (including Student Engagement)	
Student-to-student interactions	
Instructor-to- student interactions	• Homework submission in Moodle
Student self-assessment:	•
Self-based learning	•
Student collaboration	
Teaching flow **(Describe, step by step, how the lesson will be developed)**	
Estimated time	**Activity**
10 Minutes	• Implementing the Line rasterization algorithms: DDA, Bresenham's line algorithm
10 Minutes	• Implementing the Polygon rasterization: scanline algorithm

Topic Number **:	4
Topic / Chapter title:	**Transformations in 3D Space**
Learning Outcomes targeted:	• Homogeneous coordinates and transformations • Composite transformations and hierarchical modeling • Implementing complex transformations in OpenGL
Resources/ Materials: **(Video, Web, game, PDF…)**	Power Point Slides
Teaching methods **(including Teaching Mode)**	• Asynchronous

Assessment Method: (Survey, Quiz, Exam, case study... etc)

* Students should be given clear written instructions of what is required, how to submit, and evaluation criteria.
* Students should be given feedback after each evaluation.

Assessment Method Type	Grade	Rubric/ performance	Course ILO
Homework#4	2		K1

Interactions & collaboration: (including Student Engagement)

Student-to-student interactions	
Instructor-to- student interactions	• Homework submission in Moodle
Student self-assessment:	•
Self-based learning	•
Student collaboration	
Teaching flow **(Describe, step by step, how the lesson will be developed)**	
Estimated time	**Activity**
10 Minutes	Implementing complex transformations in OpenGL

Topic Number **:	5
Topic / Chapter title:	**Hidden Surface Removal**
Learning Outcomes targeted:	• Introduction to hidden surface removal techniques • Depth-buffer algorithm (Z-buffer) • Back-face culling and other visibility algorithms
Resources/ Materials: **(Video, Web, game, PDF…)**	Power Point Slides
Teaching methods **(including Teaching Mode)**	• Asynchronous

Assessment Method: (Survey, Quiz, Exam, case study... etc)

* Students should be given clear written instructions of what is required, how to submit, and evaluation criteria.
* Students should be given feedback after each evaluation.

Assessment Method Type	**Grade**	**Rubric/ performance**	**Course ILO**
Homework#5	2		P1

Interactions & collaboration: (including Student Engagement)	
Student-to-student interactions	
Instructor-to- student interactions	• Homework submission in Moodle

Student self-assessment:	•
Self-based learning	•
Student collaboration	
Teaching flow **(Describe, step by step, how the lesson will be developed)**	
Estimated time	**Activity**
10 Minutes	Implementing the back-face culling and other visibility algorithms

Topic Number **:	6		
Topic / Chapter title:	**Advanced Lighting and Shading Techniques**		
Learning Outcomes targeted:	• Advanced lighting models: Phong reflection model, Blinn-Phong model • Shadows and reflection/refraction effects • Implementing advanced lighting and shading techniques		
Resources/ Materials: **(Video, Web, game, PDF…)**	Power Point Slides		
Teaching methods **(including Teaching Mode)**	• Asynchronous		
Assessment Method: (Survey, Quiz, Exam, case study... etc) * Students should be given clear written instructions of what is required, how to submit, and evaluation criteria. * Students should be given feedback after each evaluation.			
Assessment Method Type	**Grade**	**Rubric/ performance**	**Course ILO**
Quiz	5		P1
Interactions & collaboration: (including Student Engagement)			
Student-to-student interactions			
Instructor-to- student interactions	• Quiz in Moodle		
Student self-assessment:	•		

Self-based learning	•
Student collaboration	
Teaching flow **(Describe, step by step, how the lesson will be developed)**	
Estimated time	**Activity**
10 Minutes	Implementing lighting and shading

Topic Number **:	7		
Topic / Chapter title:	**3D Animation and Keyframe Interpolation**		
Learning Outcomes targeted:	• Introduction to 3D animation techniques		
Resources/ Materials: **(Video, Web, game, PDF…)**	Power Point Slides		
Teaching methods **(including Teaching Mode)**	• Asynchronous		
Assessment Method: (Survey, Quiz, Exam, case study... etc) * Students should be given clear written instructions of what is required, how to submit, and evaluation criteria. * Students should be given feedback after each evaluation.			
Assessment Method Type	**Grade**	**Rubric/ performance**	**Course ILO**
Case Study	-		T1, P1
Interactions & collaboration: (including Student Engagement)			
Student-to-student interactions			
Instructor-to- student interactions	• Case study submission in Moodle		
Student self-assessment:			
Self-based learning			
Student collaboration			

Teaching flow (Describe, step by step, how the lesson will be developed)	
Estimated time	**Activity**
10 Minutes	Implementing the back-face culling and other visibility algorithms

Topic Number **:	8
Topic / Chapter title:	**Continue/ 3D Animation and Keyframe Interpolation**
Learning Outcomes targeted:	• Keyframe interpolation and animation curves • Implementing 3D animation in OpenGL
Resources/ Materials: **(Video, Web, game, PDF…)**	Power Point Slides
Teaching methods **(including Teaching Mode)**	• Asynchronous

Assessment Method: (Survey, Quiz, Exam, case study... etc)

* Students should be given clear written instructions of what is required, how to submit, and evaluation criteria.
* Students should be given feedback after each evaluation.

Assessment Method Type	**Grade**	**Rubric/ performance**	**Course ILO**
Case Study	-		T1, P1

Interactions & collaboration: (including Student Engagement)	
Student-to-student interactions	
Instructor-to- student interactions	• Case study submission in Moodle
Student self-assessment:	•
Self-based learning	•
Student collaboration	

Teaching flow (Describe, step by step, how the lesson will be developed)	
Estimated time	**Activity**

10 Minutes	Implementing the back-face culling and other visibility algorithms

Topic Number **:	9		
Topic / Chapter title:	**Introduction to Virtual Reality (Part 1)**		
Learning Outcomes targeted:	• Overview of virtual reality (VR) concepts • VR devices and technologies • Implementing basic VR interactions in OpenGL		
Resources/ Materials: **(Video, Web, game, PDF…)**			
Teaching methods **(including Teaching Mode)**	• Asynchronous		
Assessment Method: (Survey, Quiz, Exam, case study... etc) * Students should be given clear written instructions of what is required, how to submit, and evaluation criteria. * Students should be given feedback after each evaluation.			
Assessment Method Type	**Grade**	**Rubric/ performance**	**Course ILO**
Case Study	-		I1
Interactions & collaboration: (including Student Engagement)			
Student-to-student interactions			
Instructor-to- student interactions	• Case study submission in Moodle		
Student self-assessment:	•		
Self-based learning	•		
Student collaboration			
Teaching flow **(Describe, step by step, how the lesson will be developed)**			
Estimated time	**Activity**		
10 Minutes	Unreal Engine Installation		

Topic Number **:	10
Topic / Chapter title:	**Introduction to Virtual Reality (Part 2)**
Learning Outcomes targeted:	• Implementing basic VR interactions in OpenGL
Resources/ Materials: **(Video, Web, game, PDF…)**	
Teaching methods **(including Teaching Mode)**	• Asynchronous

Assessment Method: (Survey, Quiz, Exam, case study... etc)

* Students should be given clear written instructions of what is required, how to submit, and evaluation criteria.
* Students should be given feedback after each evaluation.

Assessment Method Type	**Grade**	**Rubric/ performance**	**Course ILO**
Case Study	-		P1

Interactions & collaboration: (including Student Engagement)	
Student-to-student interactions	
Instructor-to- student interactions	• Case study submission in Moodle
Student self-assessment:	•
Self-based learning	•
Student collaboration	
Teaching flow **(Describe, step by step, how the lesson will be developed)**	
Estimated time	**Activity**
10 Minutes	Desing a simple VR environment

Approved by	Name	Date	Signature
Curriculum committee coordinator			
Faculty Dean/ Head of Department			