Title (Units): **COMP4025 Interactive Computer Graphics (3,2,2)**

Course Aims: Students will learn (i) the mathematical foundation and algorithms for creating computer graphics including transformation, rendering, and (ii) the algorithms for enabling Human-Object interaction in virtual environment. Students will also gain practical experience on these topics by using graphics application programming interface (API) and develop a graphics application prototype.

Prerequisite: MATH1205 Discrete Math
COMP2015 Data Structures and Algorithms

Course Intended Learning Outcomes (CILOs):
Upon successful completion of this course, students should be able to:

No.	Course Intended Learning Outcomes (CILOs)
	Knowledge
1	Describe the complete process in building a computer graphics system
2	Explain and describe the concept and algorithm in the 3D geometric transformation and viewing
3	Explain and describe the concept and algorithm in rendering
4	Describe the concept and algorithms in computer vision and computer graphics for enabling Human-Object interaction in virtual environment
	Professional Skill
5	Develop a complete graphics application using a graphics programming interface

Calendar Description: Students will learn (i) the mathematical foundation and algorithms for creating computer graphics including transformation, rendering, and (ii) the algorithms for enabling Human-Object interaction in virtual environment. Students will also gain practical experience on these topics by using graphics application programming interface (API) and develop a graphics application prototype.

Teaching and Learning Activities (TLAs):

CILOs	Type of TLA
1-4	Students will learn the principles and algorithms of computer graphics through lectures.
1-4	Students will have hands on experience to deeper understanding of the algorithms through laboratory session, laboratory exercises and assignment(s).
5	Students will apply and integrate the learnt algorithms, with their new ideas for developing an interactive graphics application through group project.

Assessment:

No.	Assessment Methods	Weighting	CILOs to be addressed	Description of Assessment Tasks
1	Continuous Assessment	50%	1-5	Students are required to develop a complete graphics application using a graphics application programming interface in a small team. 40% is allocated for the group project. The remaining 10% is allocated for assignment(s) and/or mid-term test.
2	Examination	50%	1-4	The final examination is designed to evaluate students' understanding in different parts. The questions will include fundamental, analytic and design types in order to distinguish different levels of understanding of computer graphics.

Assessment Rubrics:

Excellent (A)	• Achieve the first four CILOs, demonstrating a good mastery of both the theoretical and practical aspects of computer graphics.

	• Demonstrate a thorough understanding of the mathematics in computer graphics by developing complicated 3D interactive graphics using a series of transformation and viewing matrices. • Able to develop 3D computer graphics with realistic lighting and texturing effects, and pay sufficient considerations in their computational complexities. • Demonstrate an excellent self-learning capability by bringing new techniques into the group project.
Good (B)	• Achieve the first four CILOs, demonstrating a good understanding of the concepts involved in computer graphics. • Demonstrate a good understanding of the mathematics in computer graphics by developing basic 3D interactive graphics using a couple of transformation and viewing matrices. • Able to develop 3D computer graphics with realistic lighting and texturing effects, but lack sufficient considerations in their computational complexities. • Demonstrate a good self-learning capability by bringing new techniques into the group project.
Satisfactory (C)	• Achieve the first four CILOs, demonstrating a basic level of understanding of the concepts in computer graphics. • Demonstrate a basic understanding of the mathematics in computer graphics by developing basic 3D interactive graphics using a couple of transformation and viewing matrices. • Able to develop 3D computer graphics with not-so-realistic lighting and texturing effects, and lack sufficient considerations in their computational complexities. • Rely on the given laboratory materials to complete the group project.
Marginal Pass (D)	• Achieve the first four CILOs, demonstrating a minimal level of understanding of the concepts involved in computer graphics. • Have a limited understanding of the mathematics in computer graphics. • Able to develop 3D computer graphics with not-so-realistic lighting and texturing effects, and lack any considerations in their computational complexities. • Rely heavily on the given laboratory materials to complete the group project.
Fail (F)	• Achieve less than four of the CILOs, and have little understanding of the concepts involved in computer graphics. • Unable to develop basic 3D interactive graphics using transformation and viewing matrices • Unable to apply lighting and texturing effects. • Do not complete the group project.

Course Content and CILOs Mapping:

Content		**CILO No.**
I	Fundamentals of the Graphics Pipeline Architecture	1, 5
II	Geometric Transformations and Clipping	2, 5
III	Lighting and Rendering	3, 5
IV	Interaction and Advanced Techniques	4, 5

References:

- F. Ganovelli, M. Corsini, S. Pattanaik, M. Di Benedetto, Introduction to Computer Graphics: A Practical Learning Approach, CRC Press, 2014.
- Edward Angel and Dave Shreiner, Interactive Computer Graphics with WebGL, 7th edition, Addison Wesley, 2014.
- Steven J. Gortler, Foundations of 3D Computer Graphics, The MIT Press, 2012.
- Jos Dirksen, Three.js Cookbook, Packt Publishing, 2015.
- Nandy Abhishek, Leap motion for developers. Apress, 2017.
- Rui Wang, Augmented Reality with Kinect, Packt Publishing, 2013.

- Mike Bailey, Steve Cunningham, Graphics Shaders: Theory and Practice, 2nd Edition, A K Peters/CRC Press, 2011.

Course Content:

Topic

I. Fundamentals of the Graphics Pipeline Architecture
   A. The programmable 3D graphics pipeline
   B. 3D geometric primitives and vectors
   C. Curves and surfaces

II. Geometric Transformations and Clipping
   A. Coordinate systems and transformations
   B. Camera and projection transformations
   C. Clipping and rasterization

III. Lighting and Rendering
   A. Lighting and shading
   B. Texture mapping

IV. Interaction and Advanced Techniques
   A. Motion sensing devices
   B. Introduction to computer vision
   C. Global illumination and ray tracing