Title (Units): **COMP 3080 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: COMP 1210 Data Structures and Algorithms
MATH 1140 Computational Mathematics

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

No.	Learning Outcomes (LOs)
	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 principle and algorithms for computer animation
5	Describe the concept and algorithms in computer vision and computer graphics for enabling human-object interaction in virtual environment
	Professional Skill
6	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.

Assessment:

No.	Assessment Methods	Weighting	Remarks
1	Continuous Assessment	50%	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%	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.

Rubrics:

Excellent (A)	• Achieve the first five 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 five 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 five 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 five 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 three 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.

Learning Outcomes and Weighting:

Content	**LO No.**
I. Introduction to Computer Graphics	1, 6
II. Geometric Transformations and Viewing	2, 6
III. Rendering	3, 6
IV. Computer Animation	4, 5, 6
V. Introduction to Computer Vision for Interactive Computer Graphics	5, 6
Group Project	6

References: 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.
Mike Bailey, Steve Cunningham, Graphics Shaders: Theory and Practice, 2nd Edition, A K Peters/CRC Press, 2011.
Ryan Henson Creighton, Unity 4.x Game Development by Example Beginner's Guide, Packt Publishing, 2013.
Joshua Noble, Programming Interactivity, 2nd Edition, O'Reilly Media, 2012.
Rick Parent, Computer Animation, Third Edition: Algorithms and Techniques, Morgan Kaufmann, 2012.
Rui Wang, Augmented Reality with Kinect, Packt Publishing, 2013.

Course Content in Outline:

Topic

I. Introduction to Computer Graphics
   A. Graphics hardware architectures and systems
   B. Graphics pipeline
   C. Shader programming

II. Geometric Transformations and Viewing
   A. Mathematical foundation for computer graphics
   B. Affine transformations in 3D (translation, rotation, scaling, shear)
   C. Homogeneous coordinates
   D. Camera and projective transformations
   E. From vertex to fragment

III. Rendering
   A. Local lighting model vs global lighting model
   B. Illumination and surface modeling
   C. Phong shading model
   D. Texture mapping
   E. Ray tracing

IV. Computer Animation
   A. Rigid body physics
   B. Collision detection
   C. Particle systems

V. Introduction to Computer Vision for Interactive Computer Graphics
   A. Object detection
   B. Video tracking
   C. Image registration
   D. Motion sensing devices
   E. Gesture and motion analysis