CS411 – Computer Graphics **Last Updated -** 03/18/02
Course Manager – Dr. Gady Agam, Assistant Professor
3 credit hours; elective for CS & CPE; 150 min. lecture each week

Current Catalog Description - Overview of display devices and applications. Vector graphics in two and three dimensions. Image generation, representation, and manipulation. Homogeneous coordinates. Modeling and hidden line elimination. Introduction to raster graphics. Perspective and parallel projections. Prerequisites: CS 331 or CS401 or CS403. (3-0-3)

Textbook

- D. Hearn and M.P. Baker, *Computer Graphics*, 2nd ed., Prentice-Hall, 1997
- M. Woo, J. Neider, et al., *OpenGL 1.2 Programming Guide*, 3rd ed. Addison-Wesley, 1999

References - other textbooks or materials

- none

Course Goals - The following are the main objectives of the course:

- Provide overview of computer graphics.
- Provide understanding of basic concepts, mathematical models, techniques, and algorithms used in computer graphics in two and three dimensions.
- Exercise theoretical knowledge application by graphics programming with and without standard software libraries.

Students should be able to:

- Describe and understand the main areas of computer graphics, graphics software, and graphics hardware.
- Demonstrate an understanding of the basic concepts, mathematical models, techniques and algorithms relating to raster graphics. The students should be able to implement basic algorithms and modify them if necessary.
- Demonstrate an understanding of the basic concepts, syntax, and techniques behind the openGL graphics library. The students should be able to writh graphics programs by using this software library.
- Demonstrate an understanding of the basic concepts, mathematical models, techniques and algorithms relating to 2D and 3D modeling and viewing. The students should be able to implement basic algorithms and modify them if necessary. They should be able to use openGL in this context.
- Demonstrate an understanding of the basic concepts, mathematical models, techniques and algorithms relating to 3D object representation. The students should be able to implement basic algorithms and modify them if necessary.
- Demonstrate an understanding of the basic concepts, mathematical models, techniques and algorithms relating to Color. The students should be able to implement basic algorithms and modify them if necessary.
- Demonstrate an understanding of the basic concepts, mathematical models, techniques and algorithms relating to Illumination models and surface rendering. The students should be able to implement basic algorithms and modify them if necessary. They should be able to use openGL in this context.

Prerequisites by Topic

- Math - Calculus, Linear algebra
- Programming - Data structures and algorithms, C/C++

Major Topics Covered in Course

1. Introduction: overview of computer graphics, overview of graphics hardware and software. 1.5 hours
2. Raster graphics: line and conic sections drawings, area filling, character generation, image 6 hours

operations, object attributes, antialiasing.

3. Introduction to graphics programming with OpenGL: overview, concepts, syntax, libraries, basic drawing, state management.	3 hours
4. 2D modeling and viewing: geometric transformations, homogeneous coordinates, affine transformation, line and polygon display.	6 hours
5. 3D modeling and viewing: 3D transformations, the 3D viewing pipeline, projections, clipping, visible surface detection, hierarchical modeling.	9 hours
6. 3D object representation: polygonal surfaces, quadric surfaces, cubic splines, Bezier curves and surfaces, B-spline curves and surfaces, NURBS, CSG, octrees, BSP trees, other representations.	9 hours
7. Color: displaying light intensities, dithering, color models, LUTs, blending.	3 hours
8. Illumination models and surface rendering: basic illumination models, polygon rendering, ray tracing, texture and bump mapping.	6 hours
Midterm Exam	1.5 hours
Final Exam	-
	45 hours

Laboratory projects (specify number of weeks on each)

- In each programming assignment, in order to implement a specified set of requirements, the students need to analyze the problem, select basic algorithms, compute mathematical entities, possibly modify the selected algorithms, select data structures suitable for representing and accessing graphics information and mathematical entities, design the information flow, design user interaction, and evaluate the obtained results.

Estimate CSAB Category Content in Credit Hours

	CORE	ADVANCED		CORE	ADVANCED
Data Structures			Computer Organization and Architecture		
Algorithms			Concepts of Programming Languages		
Software Design			Graphics and Visual Computing	3	

Oral and Written Communications - Every student is required to submit at least __0___ written reports (not including exams, tests, quizzes, or commented programs) of typically __0___ pages and to make __0___ oral presentations of typically __0___ minutes duration. Include only material that is graded for grammar, spelling, style, and so forth, as well as for technical content, completeness, and accuracy.

- none

Social and Ethical Issues - Please list the topics that address the social and ethical implications of computing covered in all course sections. Estimate the class time spent on each topic. In what ways are the students in this course graded on their understanding of these topics (e.g., test questions, essays, oral presentations, and so forth)?

- none

Theoretical Foundations - Please list the types of theoretical material covered, and estimate the time devoted to such coverage in contact (lecture and lab) hours.

- Raster graphics, 6 hours
- 2D modeling and viewing, 6 hours
- 3D modeling and viewing, 9 hours
- 3D object representation, 9 hours
- Color, 3 hours
- Illumination models and surface rendering (6 hours)

Problem Analysis - Please describe the problem analysis experiences common to all course sections.

- Based on the understanding of basic concepts, mathematical models, techniques and algorithms the students are given programming assignments. In each programming assignment, in order to implement a specified set of requirements, the students need to analyze the problem, select basic algorithms, compute mathematical entities, and possibly modify the selected algorithms. Other problem analysis aspects are addressed as well by questions regarding the taught material (concepts, mathematical models, techniques and algorithms).

Solution Design - Please describe the design experiences common to all course sections.

- Based on the understanding of basic concepts, mathematical models, techniques and algorithms the students are given programming assignments. In the implementation of each programming assignment, in order to implement a specified set of requirements, the students have to select data structures suitable for representing and accessing graphics information and mathematical entities, design the information flow, design user interaction, and evaluate the obtained results.

Other Course Information

- Additional Suggested Course Assignments
  - none
- Planned Course Enhancements
  - Consider making Linear Algebra required course to the BS in CS degree. Either replace "MATH251-multi-variate and vector calculus" or the current Math Elective in the curriculum.