

# Introduction to Computer Graphics

CAP 4730/CAP5726, Spring 2014  
Department of Computer Science, Florida State University

## Class time and location

Tuesday and Thursday, 12:30 PM - 1:45 PM, 2400 Health and Wellness Center (HWC)

## Instructor

- Instructor: Xiuwen Liu (pronounced as Shu-wen Lea-l)
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- Home page: <http://www.cs.fsu.edu/~liux>
- Office: 166 Love Building; Phone: (850) 644-0050
- Office Hours: Tuesday and Thursday, 11:00 AM - 12:00 noon and by appointments

## Class Home Page

<http://www.cs.fsu.edu/~liux/courses/graphics-2014/index.html>.

This web site contains the up-to-date information related to this class such as news, announcements, assignments, lecture notes, and useful links to resources that are helpful to this class. Besides the web pages, Blackboard will be used to communicate changes and updates and post grades for this class; in particular, I will send emails using email addresses in the Blackboard system and **please make sure that your email address on record is current**. Note that some of the contents require authentication and use the following information when asked:

## Rationale

With the advances in computer hardware, graphics hardware (such as graphics processing units), graphics algorithms, and modeling, computer graphics, especially photo realistic computer graphics, has been used widely in video games, cartoons, film special effects (such as generating photo realistic and consistent components for frames), computer-generated imagery, augmented reality systems, virtual reality systems (such as video conferencing systems), computer-aided design/computer-aided manufacturing, and medical imaging applications. In addition, computer graphics has become essential in scientific visualization to gain insights and intuitive understanding. Furthermore, computer graphics algorithms are becoming an integral part of computer vision algorithms to infer three dimensional models from images and videos in the Bayesian inference framework. Due to extensive commercial applications of computer graphics, there is also a strong industry that uses and produces computer graphics and related techniques.

## Course Description

This course covers fundamental principles and algorithms underlying computer graphics, including line drawing algorithms, circle/ellipse drawing algorithms, triangle and polygon rasterization, 2D geometrical transformation, 3D geometric transformations, viewing in 3D (orthographic projection and perspective projection), hidden surface elimination algorithms, surface shading, ray tracing, graphics pipeline (including clipping), texture mapping, and brief coverage of advanced topics (computer animation, image-based rendering, and global illumination). It will also provide a brief introduction to OpenGL. This course is intended for

senior computer science students and graduate students who are interested in computer graphics related careers or in learning and applying computer graphics techniques.

## Prerequisites

COP 4530 – Data Structures, Algorithms, and Generic Programming; proficient programming in C/C++ (but mainly C); basic knowledge and understanding of linear algebra operations, especially matrix manipulation operations; basic working knowledge of computer architecture

## Course Objectives

Upon successful completion of this course of study, the student will:

- Know how to model a raster display and the color space;
- Know how to implement line drawing efficiently using the midpoint algorithm;
- Know how to implement circle drawing efficiently using the midpoint algorithm;
- Know how to implement triangle polygon rasterization algorithms;
- Know how to implement antialiasing for lines and circles;
- Know how to model and implement 2D and 3D transformations such as translation, scaling, shearing, rotation, and affine transformations;
- Know how to inverse transformation matrices and understand coordinate transformations;
- Know how to model and implement orthographic projections and how to apply orthographic projections;
- Know how to model and implement perspective projections and how to specify and apply perspective projections;
- Know how to model and implement diffuse shading, Gouraud shading, and Phong shading;
- Know how to implement Z-buffer algorithm for hidden surface elimination;
- Know how to implement BSP (binary space partitioning) tree algorithm for hidden surface elimination;
- Know how to implement a ray tracer (**optional for undergraduate students**);
- Know how to model and implement shadows, specular reflection, and refraction (**optional for undergraduate students**);
- Know how to model and implement texture mapping in OpenGL;
- Know how to implement clipping and a full graphics pipeline;
- Know how to achieve the tradeoff between visual realism and computation and how to choose appropriate algorithms for applications.

## Textbook and Course Materials

Required textbook, “*Fundamentals of Computer Graphics*”, 3<sup>rd</sup> Edition, A K Peters, 2009, by Peter Shirley and Steve Marschner with Michael Ashikhmin, Michael Gleicher, Naty Hoffman, Garrett Johnson, Tamara Munzner, Erik Reinhard, Kelvin Sung, William B. Thompson, Peter Willemsen, and Brian Wyvill; ISBN: 978-1-56881-469-8. Note: The second edition of the textbook (2005) will be sufficient (even though chapter orders are different).

In addition to the textbook, papers and notes from the literature will be distributed along the lectures, including the following journals and conference proceedings:

- *ACM Transactions on Graphics*
- *IEEE Transactions on Visualization and Computer Graphics*
- *Proceedings of the SIGGRAPH Conference*

- *Proceedings of the European Association for Computer Graphic*

## Student Responsibilities

Attendance is required for this class. Unless you obtain prior consent of the instructor, missing classes will be used as bases for attendance grading. In case that it is necessary to skip a class, students are responsible to make up missed materials. Participation of in-class discussions and activities is also required. All submitted assignments and projects must be done by the author(s). It is a violation of the Academic Honor Code to submit other's work and the instructor of this course takes the violations very seriously.

Excused absences include documented illness, deaths in the immediate family and other documented crises, call to active military duty or jury duty, religious holy days, and official University activities. Accommodations for these excused absences will be made and will do so in a way that does not penalize students who have a valid excuse. Consideration will also be given to students whose dependent children experience serious illness.

## Assignments and Projects

About five short homework assignments (whose purpose is to help you understand the topics visually and do the programming assignments) will be given along the lectures and they need to be turned in. There will be three programming projects (there will be **one additional programming project for graduate students**) in C/C++ using some basic functions in OpenGL. There will be a midterm exam and a final exam.

## Grading Policy

Grades will be determined as follows:

Assignment	Points	Assignment	Points
Class Attendance and Participation	5 %	Midterm Exam	15 %
Homework Assignments	15 %	Final Exam	25 %
Programming Assignments	40 %		

Grading will be based on the weighted average as specified above and the following scale will be used (suppose the weighted average is  $S$  in 100 scale)

Score	Grade	Score	Grade	Score	Grade
$93 \leq S$	A	$80 \leq S < 83$	B-	$67 \leq S < 70$	D+
$90 \leq S < 93$	A-	$77 \leq S < 80$	C+	$63 \leq S < 67$	D
$87 \leq S < 90$	B+	$73 \leq S < 77$	C	$60 \leq S < 63$	D-
$83 \leq S < 87$	B	$70 \leq S < 73$	C-	$S < 60$	F
$80 \leq S$	Satisfactory for CAP5726 students	$70 \leq S$	Satisfactory for CAP4730 students		

## Late Penalties

Homework assignments are due at the beginning of the class on the due date and homework assignments turned in late, but before the beginning of the next scheduled class will be penalized by 10%; homework assignments that are more than one class period late will **NOT** be accepted. Programming assignments are due at the specified time and there will be a 2 % late penalty for each 24 hour period and they will NOT be accepted when they are more than one week late.

### **Submission and Return Policy**

All tests/assignments/projects/homework will be returned as soon as possible after grading but no later than two weeks from the due date.

### **Tentative Schedule**

- Weeks 1-2: Introduction (Chapter 1, 3.1-3.4, (Optional: Chapters 21 and 22))
  - General introduction to computer graphics.
  - Fundamental problems and computational approaches in computer graphics.
  - Raster displays, image formats, reading, and writing images.
  - A brief introduction to color modeling and perception.
  - Introduction to OpenGL.
- Weeks 2-3: Line drawing algorithms and triangle rasterization algorithms (8.1.1-8.1.3).
- Weeks 3-4: Transformation matrices (Chapter 6).
- Weeks 5-6: Viewing in three dimensional (Chapter 7).
- Weeks 7-8: Surface shading (Chapter 9).
  - Advanced reflection models (Optional – Chapters 20 and 25)
- Week 9: Midterm exam/Hidden surface elimination (8.2.3, 12.4).
- Week 10: Spring break.
- Weeks 11-12: Ray tracing (Chapters 4 and 13).
- Week 13: Texture mapping (Chapter 11).
- Week 14: A graphics pipeline (Chapter 8).
- Week 15: Selected advanced topics (Chapters 18, 19, 17, 26, and 24).
- Week 16: Case studies and class summary.
- Final exam week: Final exam (Tuesday, April 29, 10:00-12:00 noon).

### **Academic Honor Code**

The Florida State University Academic Honor Policy outlines the University's expectations for the integrity of students' academic work, the procedures for resolving alleged violations of those expectations, and the rights and responsibilities of students and faculty members throughout the process. Students are responsible for reading the Academic Honor Policy and for living up to their pledge to “. . . be honest and truthful and . . . [to] strive for personal and institutional integrity at Florida State University.” (Florida State University Academic Honor Policy, found at <http://dof.fsu.edu/honorpolicy.htm>)

Assignments/projects/exams are to be done individually, unless specified otherwise. It is a violation of the Academic Honor Code to take credit for the work done by other people. It is also a violation to assist another person in violating the Code (See the FSU Student Handbook for penalties for violations of the Honor Code). The judgment for the violation of the Academic Honor Code will be done by the instructor and a third party member (another faculty member in the Computer Science Department not involved in this course). Once the judgment is made, the

case is closed and no arguments from the involved parties will be heard. Examples of cheating behaviors include:

- ❖ Discuss the solution for a homework question.
- ❖ Copy programs for programming assignments.
- ❖ Use and submit existing programs/reports on the world wide web as written assignments.
- ❖ Submit programs/reports/assignments done by a third party, including hired and contracted.
- ❖ Plagiarize sentences/paragraphs from others without giving the appropriate references. Plagiarism is a serious intellectual crime and the consequences can be very substantial.

Penalty for violating the Academic Honor Code: A 0 grade for the particular assignment/quiz/exam and a reduction of one letter grade in the final grade for all parties involved for each occurrence. A report will be sent to the department chairman for further administrative actions.

## **Accommodation for Disabilities**

Students with disabilities needing academic accommodations should: 1) register with and provide documentation to the Student Disability Resource Center (SDRC), and 2) bring a letter to the instructor indicating the need for accommodation and what type. This should be done within the first week of class. *This syllabus and other class materials are available in alternative format upon request.*

For more information about services available to FSU students with disabilities, contact the Assistant Dean of Students:

Student Disability Resource Center  
97 Woodward Avenue, South  
108 Student Services Building  
Florida State University  
Tallahassee, FL 32306-4167  
(850) 644-9566 (voice)  
(850) 644-8504 (TDD)  
[sdrc@admin.fsu.edu](mailto:sdrc@admin.fsu.edu) <http://www.disabilitycenter.fsu.edu/>