CIS 736: Computer Graphics

Spring 2011

**Hours**: 3 hours; 3 hour extended course project option (CIS 598, 690, 798, 890) available

**Prerequisite**: CIS 300 and knowledge of C/C++ programming. Background in **precalculus (trigonometry and analytic geometry) and basic matrix algebra (Math 551)** recommended. A first course in computer graphics is *not* required for CIS 636, but is recommended for CIS 736.

**Textbook:** Eberly, D. H. (2006). *3D Game Engine Design: A Practical Approach to Real-Time Computer Graphics, 2nd edition.* San Francisco, CA: Morgan Kaufmann. ISBN: 0122290631

**Venue**: MWF 10:30 – 11:20, Room 127 Nichols Hall (Lecture) and Room 128 Nichols Hall (Lab)

**Instructor**: William H. Hsu, Department of Computing and Information Sciences

Office: 213 Nichols Hall URL: <http://www.cis.ksu.edu/~bhsu> E-mail: bhsu@ksu.edu

Phone (Google Voice: office/home/cell): +1 785 236 8247 TA: Ming Yang, 218 Nichols Hall

Instructional e-mail alias (use for instructor and TA): CIS736TA-L@listserv.ksu.edu

**Office hours:** 12:30 – 13:30 Monday, Friday; 09:00 – 10:00 Wednesday; 09:30 – 10:30 Tuesday; by appointment

**K-State Online (KSOL) page:** <http://bit.ly/eVizrE>

**Course web page**: <http://www.kddresearch.org/Courses/CIS736/>

**Camtasia lectures**: Linked from course web page (<http://bit.ly/eILaFl>) and KSOL

**Course Description**

This course provides intermediate background in computer graphics for graduate and advanced undergraduate students. After a brief review of basic principles of graphics display systems (clipping, view normalization, 3D graphics data structures), the course will cover fundamental topics in realistic rendering: shading and illumination, texture and bump mapping, visible surface determination, multipass rendering, particle systems, physically-based modeling, and basics of animation. The last part of the course will focus on a small number of advanced topics of interest, such as fractals, scientific and information visualization, curve and surface modeling, ray tracing, radiosity (photon maps), or character modeling.

**Course Requirements**

**Homework**: 8 of 10 programming and written assignments – 5 written, 5 programming (**16**%)

**Paper reviews**: 2 written reviews (1-2 pages) of short (10-15 page) research papers (**4%**)

**Labs and class participation**: attendance (**2**%), in-class discussion (**4**%), peer review (**2**%), labs (**7%**)

**Examinations**: two hour exams (10% each, **20%** total), 1 final exam (**25**%)

**Computer language(s)**: C/C++, C#, and Java (any of these permitted for term programming project); OpenGL, other graphics libraries and packages (e.g., *Ogre3D*, *Maya 9 aka Maya 2011*) to be taught and used

**Project**: term programming project for all students (**20**%); additional term paper or project extension option for graduate students and advanced undergraduates

**References (to be placed on reserve in K-State CIS Library)**

* Orange Book 3e (ISBN: 032163`7631), SuperBible *aka* Blue Book 5e (ISBN: 0321712617), formerly Cyan Book
* OpenGL Architecture Review Board, Shreiner, D. & The Khronos OpenGL ARB Working Group (2009). *OpenGL® Programming Guide: The Official Guide to Learning OpenGL®, Versions 3.0 and 3.1, 7th edition.*  Reading, MA: Addison-Wesley. ISBN: 0321552628
* Angel, E. (2008). *Interactive Computer Graphics: A Top-Down Approach with OpenGL, 5th edition*. Reading, MA: Addison-Wesley. ISBN: 0321535863 (with *OpenGL: A Primer, 3rd edition*, 2007, ISBN: 0321398114)
* Hearn, D. O. & Baker, M. P. (2003). *Computer Graphics with OpenGL, 3rd edition.* Englewood Cliffs, NJ: Prentice-Hall. ISBN: 0130153907.
* Foley, J. D., VanDam, A., Feiner, S. K., & Hughes, J. F. (1991). *Computer Graphics: Principles and Practice, 2nd Edition in C* *.* Reading, MA: Addison-Wesley. ISBN: 0201848406

**Additional bibliography (excerpted in course notes and handouts)**

* Tufte, E. R. (2006). *Beautiful Evidence.* Cheshire, CT: Graphics Press.
* Tufte, E. R. (1997). *Visual Explanations: Images and Quantities, Evidence and Narrative*. Cheshire, CT: Graphics Press.
* Card, S. K., MacKinlay, J. D., & Schneiderman, B. (1999). *Readings in Information Visualization: Using Vision to Think*. San Francisco, CA: Morgan Kaufmann.
* Barnsley, M. F. (1993). *Fractals Everywhere, 2nd Edition*. Burlington, MA: Academic Press.
* Books on Flash, Maya, and Ogre 3D – to be announced

## **Course Calendar and Syllabus**

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| **Lecture** | **Date** | **Topic** | **Primary Source(s)** |
| 0 | Wed 19 Jan 2011 | Course Overview | Chapter 1, Eberly 2e |
| **1** | **Fri 21 Jan 2011** | **CG Refresher: Transformations; Lab 0** | **Sections (§) 2.1, 2.2** |
| 2 | Mon 24 Jan 2011 | Viewing 1; Linear and Affine Transformations | § 2.2.3 – 2.2.4, 2.8 |
| 3 | Wed 26 Jan 2011 | Viewing 2; Parametric Equations | § 2.3 esp. 2.3.4; FVFH slides |
| 4 | Fri 28 Jan 2011 | Lab 1a: 3-D Refresher; Flash, GL, Direct3D | Chapters 2, 16[[1]](#footnote-1), Angel *Primer*  |
| 5 | Mon 31 Jan 2011 | Viewing 3: Scene Graphs: State, MVT | § 2.3; 2.6, 2.7; 4.1 – 4.3 |
| 6 | Wed 02 Feb 2011 | Scan Conversion 1: Lines & Antialiasing | § 2.5.1, 3.1; FVFH slides |
| **7** | **Fri 04 Feb 2011** | **Viewing 4: Clipping, Culling, OBBs; Lab 1b**  | **§ 2.3.5, 2.4, 3.1.3** |
| 8 | Mon 07 Feb 2011 | Scan Conversion 2: Polygons, Clipping Intro | § 2.4, 2.5 esp. 2.5.4, 3.1.6 |
| 9 | Wed 09 Feb 2011 | Surface Detail 1: Phong Illumination | § 2.5, 2.6.1 – 2.6.2, 4.3.2, 20.2 |
| **10** | **Fri 11 Feb 2011** | **Lab 2a: Direct3D / DirectX Intro** | **§ 2.7, Direct3D handout** |
| 11 | Mon 14 Feb 2011 | Surface Detail 2: OGLSL; Many Mappings | § 2.6.3, 20.3 – 20.4, *Primer* |
| 12 | Wed 16 Feb 2011 | Surface Detail 3: Advanced Texture Mapping | § 20.5 – 20.13 |
| **13** | **Fri 18 Feb 2011** | **Surface Detail 4: Pixel/Vertex Shad.; Lab 2b** | **§ 3.1** |
| 14 | Mon 21 Feb 2011 | Surface Detail 5: Writing Shaders; RenderMan | § 3.2 – 3.4, Direct3D handout |
| 15 | Wed 23 Feb 2011 | Demos 1: CGA; Scene Graphs: Traversal | § 4.4 – 4.7, **CGA handout** |
| **16** | **Fri 25 Feb 2011** | **Lab 3a: Alpha in Flash *vs.* GL, Direct3D** | **§ 2.6, 20.1, *Primer***  |
| **17** | **Mon 28 Feb 2011** | **Animation 1: Keyframes, Interpolation** | **§ 5.1 – 5.2, OGLSL handout** |
|  | **Wed 02 Mar 2011** | **Exam 1 review; Hour Exam 1 (evening)** | **Chapters 1 – 4, 16, 20** |
| **18** | **Fri 04 Mar 2011** | **Scene Graphs: Rendering; Lab 3b: OGLSL**  | § 11.1, **mesh handout** |
| **19** | **Mon 07 Mar 2011** | **Demos 2: SFX; Inverse Kinematics** | **§ 5.3 – 5.5,CGA handout** |
| 20 | Wed 09 Mar 2011 | Demos 3: Bézier, NURBS; CSG, Solid Models | § 10.4, 11.3, 11.8, 12.2, 12.7 |
| **21** | **Fri 11 Mar 2011** | **Lab 4a: Animation Basics; Maya Modeling** | **Flash animation handout**  |
| 22 | Mon 21 Mar 2011 | Animation 2: Euler Angles *vs.* Quaternions | Chapter 17, esp. §17.1 – 17.2 |
| 23 | Wed 23 Mar 2011 | Demos 4: Modeling & Simulation; Smoothness | Chapter 101, 13[[2]](#footnote-2), §17.3 – 17.5 |
| **24** | **Fri 25 Mar 2011** | **Collisions 1: capsules/lozenges, Lab 4b**  | **§2.4.3, 8.1, GL handout** |
| 25 | Mon 28 Mar 2011 | Spatial Sorting: BSP and Portals | Chapter 6, esp. §6.1 |
| **26** | **Wed 30 Mar 2011** | **Demos 5: More CGA; Picking Modes** | **Chapter 72; § 8.4** |
| **27** | **Fri 01 Apr 2011** | **Lab 5a: Picking in OpenGL, Flash** | **§ 8.3 – 8.4; 4.2, 5.0, 5.6, 9.1** |
| 28 | Mon 04 Apr 2011 | Collisions 2: Dynamic, Particle Systems | § 9.1, particle system handout |
|  | **Wed 06 Apr 2011** | **Exam 2 review; Hour Exam 2 (evening)** | **Chapters 5 – 6, 72 – 8, 12, 17** |
| **29** | **Fri 08 Apr 2011** | **Lab 5b: Advanced Particle Systems** | **Particle system handout** |
| **30** | **Mon 11 Apr 2011** | **Animation 3: Control & IK, PBM** | **§ 5.3, CGA handout**  |
| 31 | Wed 13 Apr 2011 | Ray Tracing 1: intersections, recursion, trees | Chapter 14 |
| 32 | Fri 15 Apr 2011 | Lab 6a: Ray Tracing w/POV-Ray | RT handout |
| 33 | Mon 18 Apr 2011 | Ray Tracing 2: refraction, supersampling | Chapter 15, **RT handout** |
| 34 | Wed 20 Apr 2011 | Visualization 1: Graphical Integrity, Data-Ink | Tufte handout (1) |
| **35** | **Fri 22 Apr 2011** | **Lab 6b: More Ray Tracing** | **RT handout** |
| 36 | Mon 25 Apr 2011 | Visualization 2: Small Multiples, Macro/Micro | Tufte handout (2 & 4) |
| 37 | Wed 27 Apr 2011 | Fractals & fBm; Term Project Prep | **Color handout** |
| 38 | Fri 29 Apr 2011 | Lab 7: Fractals & Terrain Generation | **Fractals/Terrain handout**  |
| **39** | **Mon 02 May 2011** | **Visualization 3: Confections, HCI; Review 1** | Tufte handout (3) |
| **40** | **Wed 04 May 2011** | **Term project presentations 1; Review 2** | **–**  |
| 41 | Fri 06 May 2011 | Term project presentations 2 | – |
|  |  | **Final Exam 11:50 Tue 10 May 2011** | **Ch. 1 – 8, 10 – 15, 17, 20** |

Lightly-shaded entries denote the due date of a written problem set; heavily-shaded entries, that of a machine problem (programming assignment); blue-shaded entries, that of a paper review; and the green-shaded entry, that of the term project.

**Lab exercises are always due on the day before the next lab.**

**Green**, **blue** and **red** letters denote **exam review**, **exam**, and **exam solution review** dates.

1. Required for CIS 636 students; optional (refresher as needed) for CIS 736 students. [↑](#footnote-ref-1)
2. Required only for CIS 736 students. [↑](#footnote-ref-2)