Rutgers University, Department of Electrical and Computer Engineering
ABET COURSE SYLLABUS
COURSE: 14:332:474

Course Catalog Description: 14:332:474 – Introduction to Computer Graphics (3) Computer display systems, algorithms and languages for interactive computer graphics. 3D coordinate frame transformations. Vector, curve and surface generation. Lighting, Illumination and Shading. Camera models and image based rendering.

Pre-Requisite Courses: 14:332:252

Co-Requisite Courses: None.

Pre-Requisite by Topic:

1. Analytic geometry
2. Vectors
3. Matrices
4. Data structures
5. Computer programming in C++.

Textbook & Materials: Hill, Francis and Kelley, Stephen, *Computer Graphics Using OpenGL* (3rd Edition) 2006.
Shreiner, et al, *OpenGL Programming Guide: The Official Guide to Learning OpenGL, Versions 4.1 (8th Edition)*, 8th Ed., Addison-Wesley, 2011. (recommended)

Overall Educational Objective: To develop an understanding of the algorithms and fundamental techniques for generating and modifying pictures with a digital computer, including the handling of color, and the generation of visible-surface projections of three dimensional scenes, for applications in science, engineering, and the entertainment world.

Course Learning Outcomes: A student who successfully fulfills the course requirements will have demonstrated:

1. an ability to understand the algorithms and fundamental techniques for generating and modifying pictures with a digital computer
2. an ability to understand the handling of color, and the generation of visible-surface projections of three dimensional scenes, for applications in science, engineering, and the entertainment world.
3. an ability to understand the computer graphics rendering pipeline
4. an ability to understand various shading models including Phong shading and its relation to Lambertian reflectance, specular reflectance and real-world materials
5. an ability to write rendering algorithms using OpenGL
6. an ability to write interactive human-computer interfaces using OpenGL

7. an ability to develop algorithms for 3D motion and interaction of virtual objects

How Course Outcomes are Assessed:
HW Problems (15 %)
Exams (55 %)
Final Project (30 %)

N = none S = Supportive H = highly related

Outcome	Level	Proficiency assessed by
(a) an ability to apply knowledge of Mathematics, science, and engineering	H	HW Problems, Exams
(b) an ability to design and conduct experiments and interpret data	S	HW and Exams
(c) an ability to design a system, component or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	S	
(d) an ability to function as part of a multi-disciplinary team	N	
(e) an ability to identify, formulate, and solve ECE problems	H	HW Problems, Exams
(f) an understanding of professional and ethical responsibility	N	
(g) an ability to communicate in written and oral form	S	HW Problems
(h) the broad education necessary to understand the impact of electrical and computer engineering solutions in a global, economic, environmental, and societal context	N	
(i) a recognition of the need for, and an ability to engage in life-long learning	S	Home-work, discussions during lectures
(j) a knowledge of contemporary issues	N	
(k) an ability to use the techniques, skills, and modern engineering tools necessary for electrical and computer engineering practice	H	HW Problems, Exams
Basic disciplines in Electrical Engineering	S	HW Problems, Exams
Depth in Electrical Engineering	S	HW Problems, Exams
Basic disciplines in Computer Engineering	S	P-Spice Simulations
Depth in Computer Engineering	H	Design Problems
Laboratory equipment and software tools	S	HW Problems, Mid-Term Exams
Variety of instruction formats	S	Lecture, office hour discussions

Topics Covered week by week:

Week 1: Introduction, What is computer graphics? Review of computer graphics hardware and graphics, processing units (GPU). Curves, surfaces and polygonal mesh representations.
Week 2: 2D graphics, scan conversion, anti-aliasing, clipping, polygonal fill algorithms.
Week 3: Curves, polynomial curves, Bezier curves, spline fitting.
Week 4: 3D Polygonal objects, coordinate frame transformations, rotations, translations, scaling, homogenous transformations.
Week 5: Camera models, perspective viewing, window-viewport transformations.
Week 6: 3D Rendering pipeline, OpenGL implementation of rendering pipeline, clipping against a 3D window in both parallel and perspective projection.
Week 7: Midterm Examination, Curve and surface design. Bezier and B-spline bicubic surfaces.
Week 8: Illumination and reflectance: shading models, light source models.
Week 9: Texture mapping, texture synthesis. Advanced reflectance models, bidirectional reflectance distribution function.
Week 11: Color theory, RGB color model, basic concepts; Additive and subtractive colors. Color interpolation.
Week 12: Hidden-surface and hidden-line line algorithms, Front & back surfaces, order of visibility, hidden-line determination
Week 13: Hidden-surface determination, Z-buffer, Ray tracing, High realism displays
Week 14: Transparency, shadows, radiosity.
Week 15: Introduction to image-based rendering.
Week 16: Final Examination

Computer Usage: Computer programs in C++

Laboratory Experiences: A substantial project is required involving extensive computer programming and testing.

Design Experiences: Moderate

Independent Learning Experiences: 1. Home-Work

Contribution to the Professional Component:
(a) College-level mathematics and basic sciences: 0.25 credit hours
(b) Engineering Topics (Science and/or Design): 2.75 credit hours
(c) General Education: 0 credit hours
Total credits: 3
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