جامعة الملك عبدالله
للعلوم والتقنية
King Abdullah University of
Science and Technology

Course Syllabus: Computer Graphics - CS 248

Division	Computer, Electrical and Mathematical Sciences & Engineering
Course Number	CS 248
Course Title	Computer Graphics
Academic Semester	Fall
Academic Year	2019/2020
Semester Start Date	08/25/2019
Semester End Date	12/10/2019
Class Schedule (Days & Time)	02:30 PM - 04:00 PM | Mon Thu

Instructor(s)

Name	Email	Phone	Office Location	Office Hours
Ivan Viola	IVAN.VIOLA@KAUST.EDU.SA	+966128080617	2115, 1, Al-Khawarizmi (bldg. 1)	Please make an appointment via email.

Teaching Assistant(s)

Name	Email
TBD	TBD

Course Information

Comprehensive Course Description	The Computer Graphics course teaches the fundamentals of computer graphics based on the book "Fundamentals of Computer Graphics, 4th Edition by Steve Marschner and Peter Shirley". The course first reviews the basic mathematical background necessary for computer graphics. Then fundamental computer graphics methods are being presented, such as the graphics pipeline, ray tracing, surface shading, and texturing. After the basal computer graphics knowledge fundamental theoretical background from signal processing and sampling are explained necessary for comprehension of further more advanced computer graphics topics. Advanced topics will include: computer animation, global illumination, light, color, introduction to visual perception and tone mapping, as well as global illumination, hardware-accellerated rasterization graphics, computer graphics in games and visualization. This fundamental knowledge will be taught in a form of frontal lectures and its understanding will be tested by a written exam at the end of the semester. The exam will constitute 50% of the final grade. The other 50% will come from the practical implementation of programing assignments, described below. These assignments will be explained to the teacher in an interview to verify the genuinity of the programmed code. Afterward, students will show their implementation and results in a form of a 15 minute presentation to the other participants of the course.
Course Description from Program Guide	Basic topics: linear algebra for computer graphics, 2D and 3D transformations, mesh data structures, viewing and camera models, local shading models, texturing, shader programming. Advanced topics: color, radiometry, real-time rendering, bump mapping, environment mapping, bounding volumes, hierarchical data structures, collision detection, parametric curves, ray tracing, photon mapping, path tracing, anti- aliasing, reaction-diffusion, scanning, normal estimation, ransac, quaternions, displays.
Goals and Objectives	There are three main learning objectives: learning the fundamentals of computer graphics; learning to program computer graphics algorithms; learning the mathematics behind computer graphics;
Required Knowledge	Linear algebra and calculus; programming; writing medium sized programs in C++ (500 - 2000 lines of code);
Reference Texts	Fundamentals of Computer Graphics, 4th Edition, Peter Shirley, Steve Marschner, A K Peters/CRC Press, 2015

Method of evaluation	**50.00**% - Homework /Assignments **50.00**% - Final exam
Nature of the assignments	There will be four assignments. 1. Implementation of a software ray caster: The task is to implement a software raycaster that casts the rays from the viewpoint through a viewing plane's pixel centers into the scene. The scene consists of few analytically defined solid primitives such as spheres, cylinders, boxes, etc. The light and camera position are fixed and so are the scene elements. For illumination model the Phong illumination model should be used. (12.5%) 2. Implementation of interactive viewing parameters, lights, and scene elements: Built on the top of the previous assignment, make the every setting adjustable through parameter settings. All the scene elements should be possible to change position and orientation and scale, if applicable. The camera should implement the arcball metaphor around the scene center, with additional zoom in and out functionality. The light position and scene elements position and orientation should be adjustable directly in the 3D scene through picking. (12.5%) 3. Software based rasterization: Implement a CPU-based rasterizer, where the vertices are drawn clipped onto the display, edges are drawn with a Bresenham algorithm and the faces are drawn with a scanline algorithm with interpolated normals, shaded with the Phong shading illumination model. (12.5%) 4. Advanced version of a software or hardware based ray-tracing with importance sampling, advanced material properties, secondary rays, animated objects, area lights, bounding volume hierarchies. (12.5%)
Course Policies	Late assignments will receive a grade penalty. The assignment deadlines will be detailed at the beginning of the course.
Additional Information	The course textbook can be viewed online at: https://learning.oreilly.com/library/view/fundamentals-of-computer/9781482229417/

Tentative Course Schedule *(Time, topic/emphasis & resources)*		
Week	**Lectures**	**Topic**
1	Mon 08/26/2019 Thu 08/29/2019	Course Organization Chapter 1: Introduction to Computer Graphics Chapter 2: Miscellaneous Math
2	Mon 09/02/2019 Thu 09/05/2019	no courses this week
3	Mon 09/09/2019 Thu 09/12/2019	Chapter 2: Miscellaneous Math (cont.) Chapter 3: Raster Images
4	Mon 09/16/2019 Thu 09/19/2019	Chapter 4: Ray Tracing Chapter 5: Linear Algebra Chapter 6: Transformation Matrices
5	Mon 09/23/2019 Thu 09/26/2019	Chapter 7: Viewing Chapter 8: The Graphics Pipeline
6	Mon 09/30/2019 Thu 10/03/2019	Chapter 9: Signal Processing Chapter 10: Surface Shading
7	Mon 10/07/2019 Thu 10/10/2019	Chapter 11: Texture Mapping Chapter 12: Data Structures for Graphics
8	Mon 10/14/2019 Thu 10/17/2019	Chapter 13: More Ray Tracing Chapter 14: Sampling Chapter 15: Curves
9	Mon 10/21/2019 Thu 10/24/2019	no courses this week
10	Mon 10/28/2019 Thu 10/31/2019	Chapter 16: Computer Animation Chapter 17: Using Graphics Hardware
11	Mon 11/04/2019 Thu 11/07/2019	Chapter 18: Light Chapter 19: Color Chapter 20: Visual Perception
12	Mon 11/11/2019 Thu 11/14/2019	Chapter 21: Tone Reproduction Chapter 22: Implicit Modeling
13	Mon 11/18/2019 Thu 11/21/2019	Chapter 23: Global Illumination Chapter 24: Reflection Models
14	Mon 11/25/2019 Thu 11/28/2019	Chapter 25: Computer Graphics in Games Chapter 26: Visualization
15	Mon 12/02/2019 Thu 12/05/2019	Advanced Shader Programming (framebuffer objects, render to texture, environment mapping, geometry and tessellation shaders, compute shaders, and advanced illumination shaders)
16	Mon 12/09/2019	Exam

Note

The instructor reserves the right to make changes to this syllabus as necessary.