Summary
This course covers advanced 3D graphics techniques for realistic image synthesis. Students will learn how light interacts with objects in our world, and how to recreate these phenomena in a computer simulation to create synthetic images that are indistinguishable from photographs.

Content
This is a project-based course: students will initially receive a basic software package that lacks most rendering-related functionality.
Over the course of the semester, we will discuss a variety of concepts and tools including the basic physical quantities, how light interacts with surfaces, and how to solve the resulting mathematical problem numerically to create realistic images. Advanced topics include participating media, material models for sub-surface light transport, and Markov Chain Monte Carlo Methods.
Each major topic is accompanied by an assignment so that students can implement solution algorithms and obtain practical experience with these techniques within their own software framework.
Towards the end of the course, students will realize a self-directed final project that extends their rendering software with additional features of their own choosing. The objective of the final project is to create a single image of both technical and artistic merit that is entered into a rendering competition and judged by an independent panel of computer graphics experts.

Learning Prerequisites
Required courses
Nothing

Recommended courses
Introduction to Computer Graphics

Important concepts to start the course
We will rely on calculus, linear algebra and use basic concepts of algorithms and data structures. Students are expected to be familiar with the C++ programming language that is used in the programming assignments.
Learning Outcomes
By the end of the course, the student must be able to:
• Recognize and understand the physical quantities of light transport and be able to perform basic computations using pencil+paper
• Explain a range of surface and subsurface material models
• Explain the rendering and radiative transfer equation and show how to construct Monte Carlo methods to solve them
• Design and implement an advanced rendering system based on Monte Carlo integration
• Assess / Evaluate the performance and conceptual limits of the implemented simulation code

Teaching methods
Lectures, interactive demos, theory and programming exercises, programming project, project tutoring

Expected student activities
The student are expected to study the provided reading material and actively participate in class. They should prepare and resolve the exercises, prepare and carry out the programming project.

Assessment methods
Intermediate assignments (40%), final project (60%)

Resources
Bibliography
A list of books will be provided at the beginning of the class

Notes/Handbook
Slides and online resources will be provided in class

Websites
• https://rgl.epfl.ch/courses/ACG22

Moodle Link
• https://go.epfl.ch/CS-440