



School of Engineering
*Information
Technology Program*

ITP 215 Introduction to 3D Modeling, Animation, and Visual Effects

Units: 2

Spring 2019 – Tuesdays/Thursdays 10am-11:50am

Location: KAP 107

Course notes and resources on Blackboard.usc.edu.

Instructor: Lance Winkel

Office: OHE 530 H

Office Hours:

Mondays: 2-3:20pm

Tuesdays: 8am-9:50am

Thursdays: 8am-9:50am

Contact Info: winkel@usc.edu, 213.740.9959.

I check email daily and will reply within 24 hours.

IT Help for Viterbi Labs and Resources:

<https://vsoeweb.vsoe.usc.edu/helpdeskpro/>

ITP Office:

OHE 412, Monday – Friday, 9am-5pm.

<http://itp.usc.edu>

Course Description

An applied introduction to the techniques used for modeling, animating, texturing, lighting, rendering, and creating 3D content for games, cinematics, visual effects, animation, and visualizations.

Learning Objectives

Gain a thorough applied foundation in the practice of 3D modeling, animation, surfacing, and special effects. Understand the processes involved in the creation of 3D content for animation, games, entertainment, and design. Use industry leading software and tools to explore the production cycle of animation, how pipelines are implemented to support the production process, and how to manage vision, budget, and time constraints. Develop an understanding of the diverse methods available for achieving similar results and the decision-making processes involved at various stages of project development. Gain insight into the differences among the various animation tools. Understanding the opportunities and tracks in the field of 3D animation.

Prerequisite(s): None.

Co-Requisite(s): None.

Concurrent Enrollment: None.

Recommended Preparation: Knowledge of any 2D graphics, paint, drawing, or CAD program is recommended but not required.

Course Notes

Lecture slides, notes, and course resources will be posted on Blackboard.usc.edu.

Technological Proficiency and Hardware/Software Required

Understanding of either Mac or Windows operating systems and general software use.

Autodesk provides free academic licenses of the Maya software that we will be using for this course.

Adobe Cloud provides discounted academic accounts but is not required if using lab computers.

Houdini, V-Ray, Nuke, and other software packages may be useful, but are not required.

ITP also offers remote desktop access for students enrolled in ITP courses. Adobe software is available on the Enhanced Desktop for students in select graphics and media intensive courses. Information about the

<https://mydesktop.vlab.usc.edu/>

ITP offers Open Labs which are posted at <https://itp.usc.edu/current-students/open-lab-schedule/>

Instructions are posted on Blackboard.usc.edu.

Required Readings and Supplementary Materials

Recommended:

Autodesk Maya 2018 Basics Guide by Kelly Murdock

SDC Publications, ISBN: 978-1630571122

Course slides are available on Blackboard.usc.edu

Autodesk Maya Online Documentation at knowledge.autodesk.com

Lynda.com via Blackboard.usc.edu

Learning Resources for other tools like V-Ray, Preform, and Houdini can be found on Lynda or at their specific sites:

V-Ray <https://www.lynda.com/V-Ray-training-tutorials/1173-0.html>

Houdini <https://www.sidefx.com/learn/collections/quickstart-houdinis-interface/>

Description and Assessment of Assignments

Consult the Assignment posting on Blackboard.

Grading Breakdown

Planets = 10 points
Cityscape 1 of 7 = 10 points
Cityscape 2 of 7 = 10 points
Cityscape 3 of 7 = 10 points
Cityscape 4 of 7 = 10 points
Cityscape 5 of 7 = 10 points
Cityscape 6 of 7 = 10 points
Cityscape 7 of 7 – Finished Rendered = 20 points
Chess Animation 1 of 3 = 10 points
Chess Model 3D Printable = 10 points
Chess Animation 2 of 3 = 10 points
Chess Animation 3 of 3 – Finished Rendered = 20 points
Final project = 60 points
Final Exam = 30 points
Participation = 30 points
Total = 260 points

Grading Scale (Example)

Course final grades will be determined using the following scale

A	95-100
A-	90-94
B+	87-89
B	83-86
B-	80-82
C+	77-79
C	73-76
C-	70-72
D+	67-69
D	63-66
D-	60-62
F	59 and below

Assignment Rubrics

Assignment details and grading rubric will be posted along with the assignment as it is posted. Students with questions are encouraged to attend office hours for critique and to make sure they are understanding the scope of the assignments as detailed.

Assignment Submission Policy

All homework will be submitted on Blackboard. Detailed instructions and resources for each assignment will be posted on Blackboard along. <http://blackboard.usc.edu>

Grading Timeline

Grades will be posted within a calendar week after the submission due date.

Additional Policies

- Make-up policy for exams: To make up for a missed exam, the student must provide a satisfactory reason (as determined by the instructor) along with proper documentation. Make-up exams are generally only offered in emergency situations.
- Before logging off a computer, students must ensure that they have saved any work to either a USB drive or a service such as Dropbox. Any work saved to the computer will be erased after restarting the computer. ITP is not responsible for any work lost.
- ITP offers Open Lab use for all students enrolled in ITP classes. These open labs are held beginning the second week of classes through the last week of classes. Hours are listed at: <https://itp.usc.edu/current-students/open-lab-schedule/>

Course Schedule: A Weekly Breakdown

Week 1 Tuesday – Syllabus and Course Introduction

- Survey of student and 3D animation experience
- Overview of course plan and objectives
- Autodesk Student Software and Licensing
- Lab Policies and Procedures
- Online resources: Highend3d.com, Learning-Maya.com, knowledge.autodesk.com, Lynda.com
- Supplemental learning resources and recommended reading

Reading

Maya Basics Guide – Chapter 1 and 2
Review slides and course notes on Blackboard

Project

Make an Autodesk account. Download and install Maya 2018 from Autodesk

Week 1 Thursday – Syllabus and Course Introduction

- Introduction to the Maya GUI
- Configuring the user interface including hotkeys, interface color, marking menus, display modes, etc.
- Adjusting cameras, displays, and viewports
- Basic object creation
- Core 3D Concepts (XYZ, RGB)
- Cartesian Coordinates
- Right handed rule
- Basic 3D transforms (translation, rotation, scaling) and animation
- Maya's Online Help

Project

Using the provided planets scene file, animate the orbit and revolution of each of the planets, moons around the solar system. Learn familiarity with the Maya interfaces, including object selection, navigation, setting animation keys, and basic transforms. Save the scene and submit it to blackboard.

Week 2 Tuesday – Creating a 3D scene from primitives

- Further introduction to the Maya GUI
- Optimizing the interface for working efficiently
- Polygon components (vertices, edges, faces)
- Creating and editing geometry from primitives
- How modeling primitives relate to modern construction techniques
- Understanding form, function, and structure

Reading

Maya Basics Guide – Chapter 3 and 6
Review slides and course notes on Blackboard

Project

Cityscape (Week 1 of 7) - Create a metropolitan landscape from primitives and simple hierarchies. At least three separate building made with only polygon primitives, duplication, grouping, and parenting. Attempt to faithfully reproduce the most important details. See blackboard for specific details.

Week 2 Thursday – Creating a 3D scene from primitives

- Arrayed Duplication
- Groups and Hierarchies

- Parent nodes
- Offset transforms
- Duplication vs. Instancing

Project

Cityscape (Week 1 of 7) – Continued

Week 3 Tuesday – Polygon mesh editing tools

- Additive vs. subtractive modeling
- Manually manipulating component
- Selection strategies for selecting and isolating component transform
- Splitting polygons vs. deleting edges

Reading

Maya Basics Guide – Chapter 3 and 6

Review slides and course notes on Blackboard

Project

Cityscape (Week 2 of 7) - Populate the scene with at least three new sculpted polygon objects. These should complement the primitive models from the previous turn-in. For this phase of production, we are focusing on sculpting through mesh editing techniques as detailed in class. One object should be a vehicle of some form. See blackboard for specific details.

Week 3 Thursday – Polygon mesh editing extrusion

- Polygon extrusion
- Understanding the differences between tools and commands
- Using the show manipulator tool to influence and control extrusion
- Other hybrid tools (bevel, wedge, cut faces, etc)
- Building sample model from blueprint or technical reference

Project

Cityscape (Week 2 of 7) – Continued

Week 4 Tuesday – Materials and Texturing

- Overview of the rendering pipeline
- Fundamental formulas and math functions (normal, tangents, cosines)
- Defining nodes and attributes
- Introduction to materials and shading groups
- Basic rendering nodes and attributes
- Lambert shader
- Building off of lambert with phong and blinn shaders

Reading

Maya Basics Guide – Chapter 7

Review slides and course notes on Blackboard

Project

Cityscape (Week 3 of 7) - Assign materials to the objects with the scene. Use the material properties to convey the appropriate type of physical look for the various surfaces in your scene. Stone, metal, glass, wood, earth, sky, plastic, marble, etc. Make sure to include at least three materials that have 'specular' shading properties, at least one surface shader, and at least one material that uses incandescence. See blackboard for specific details.

Week 4 Thursday – Basic Texturing

- Introduction to textures
- Defining textures vs. materials
- Assigning textures to material attributes

- Texture nodes and utility nodes
- Sourced vs. procedural texture nodes and concepts for mathematically generated texturing.
- Understanding the four categories of shading nodes and how they work together to shape the rendered scene.

Project

Cityscape (Week 3 of 7) – Continued

Week 5 Tuesday – Texturing and UV Coordinate Space

- Understanding UV texture space
- Simple UV projection
- Similarities between manipulating UV coordinates and polygon components
- General workflow for UV unwrapping and export to image manipulation software.
- Best practices for solving texture wrapping problems on complex objects.

Reading

Maya Basics Guide – Chapter 7 and 8

Review slides and course notes on Blackboard

Project

Cityscape (Week 4 of 7) - Assign textures to the objects with the scene. A fully UV unwrapped vehicle or objects to support accurate texturing. Use the mesh projection tools and UV texture editor menus to manually align and sort out any problem UV areas for clean texturing. Use image editing programs to make sourced textures for color, bump, specular, and incandescence attributes. See blackboard for specific details.

Week 5 Thursday – Texturing Pipeline and Texture Painting

- Types of textures (color, specular, bump, and incandescence)
- Exporting UV template
- Creating textures using image manipulation software
- Techniques for layer-based image manipulation
- Assigning textures to material attributes
- Reference libraries and resources for textures and materials

Project

Cityscape (Week 4 of 7) - Continued

Week 6 Tuesday – Overview of cameras and optics

- Overview of cameras, terms and techniques
- The mathematics of perspective in optics
- Industry standards
- Maya's virtual camera and settings
- Camera setup
- Film gate, aperture, aspect ratio, lens focal length, angle of view, zoom vs. prime lenses, frame rate, and other standards
- Overview of camera history, manufacturers, and providers

Reading

Maya Basics Guide – Chapter 9

Review slides and course notes on Blackboard

Project

Cityscape (Week 5 of 7) – Setup a custom camera in Maya. Set it up with appropriate film gate, lens, and working settings. Use the camera's viewport as a director's viewfinder to layout and arrange the various assets of your city into the scene as a complex environment. See blackboard for specific details.

Week 6 Thursday – Cameras in 3D

- Cinematography references
- Good and bad camerawork and composition
- Laying out and populating a 3D scene
- Animating a camera
- Graph editor curves
- The Five C's, Cinematography, Fundamental techniques for good camera work

Project

Cityscape (Week 5 of 7) – Continued

Week 7 Tuesday – Lighting in 3D

- The application of lighting in 3D
- Types of lights and their uses
- Comparing different 3D light objects (directional, spot, point, and area)
- Ray traced and depth mapped shadows
- Soft shadows, penumbra, falloff, and other phenomena
- Using the Render Settings window to prepare a scene for lighting
- Memory efficiency and pipeline specific differences of each renderer

Reading

Maya Basics Guide – Chapter 10

Review slides and course notes on Blackboard

Project

Cityscape (Week 6 of 7) - Light the scene to establish a specific mood. Lighting reference will help to achieve the best possible emotional context and exposure quality for the scene. Animate the camera so that it makes a well-controlled cinematic camera move. Choreograph the vehicle's animation so that it travels in relation to the camera through a 10 second shot. See blackboard for specific details.

Week 7 Thursday – Animating a vehicle

- Review key framing techniques
- Animating with basic hierarchies
- Using parent – child relationships to further enhance animation capabilities
- Techniques to produce better performance
- Animating props and cameras
- Using the Render Settings window to prepare a scene for render

Project

Cityscape (Week 6 of 7) – Continued

Week 8 Tuesday – Rendering

- Rendering image sequences from Maya
- Proper naming conventions (name.#.ext, etc.)
- Importing image sequences into post production and compositing programs
- Creating QuickTime movies
- Understanding compression codecs, quality, compression, file size
- Industry specific examples of why you only render image sequences (never render movie files!)

Reading

Maya Basics Guide – Chapter 13

Review slides and course notes on Blackboard

Project

Cityscape (Week 7 of 7) – Setup the animated scene for rendering. Render the scene out as a sequence of images and then import the sequence into the post compositing program for final QuickTime output. See blackboard for specific details.

Week 8 Thursday – History of 3D Computer Graphics

- Why Tron is the most important movie in the history of mankind... or at least a monumental first step for 3D
- How small steps created an industry
- The hurdles and limitations of early 3D
- Trace the major innovations of 3D and technology over the last 30 years, from early experiments through the modern production and business models of today.
- Mergers, acquisitions, trends, and the future

Project

Cityscape (Week 7 of 7) – Continued

Week 9 Tuesday – NURBS Overview

- Non-Uniform Rational B-Splines
- Curve based modeling within the scope of production
- NURBS in contrast to polygons
- Modeling concepts and workflow for NURBS
- Defining NURBS and NURBS components
- Control Vertices, Control Hulls, Curve Degree, Spans/Sections
- Making sense of NURBS mathematics ($\#CVs = Degree + \#Spans$)
- Advantages to NURBS in modern production

Reading

Maya Basics Guide – Chapter 4 and 5

Review slides and course notes on Blackboard

Project

Chess Animation (Week 1 of 3) – Add image planes to your profile orthographic cameras as modeling reference. Use NURBS curves to define the profile and contours for the objects. Use curve editing and surfacing operations to build out the shape of the chess pieces in NURBS. Then convert to polygons for any remaining detailing. Build at least two different chess pieces using NURBS and/or polygon techniques. See blackboard for specific details.

Week 9 Thursday – NURBS and spline-based modeling

- Working with NURBS Curves
- Curve editing, Attachment, Detachment, and Rebuilding
- Uniform vs. Non-Uniform curves
- Converting curves into surfaces
- Using revolve to form the chess shape from a profile
- Best practices for NURBS to polygon conversion
- Boolean modeling techniques
- Construction history
- Essential steps to prepare a character model for animation

Project

Chess Animation (Week 1 of 3) – Continued

Week 10 Tuesday – Basic character setup

- Non-linear deformers
- Curve, Bend, Twist, Wave, Sine, Squash
- Understanding deformation order
- Approaches for restructuring the deformation order for proper performance behavior
- Hierarchies for animation

Reading

Maya Basics Guide – Chapter 11
Review slides and course notes on Blackboard

Project

Chess Animation (Week 2 of 3) – Clean up the models for animation. Use animation deformers to enable the models to perform as necessary for the animation sequence that is to follow. Begin animating at least two of the chess pieces through a 5 - 10 second animation. See blackboard for specific details.

Week 10 Thursday – Advanced character setup concepts

- Advanced controller setups
- Adding custom attributes to Maya nodes
- Driving automation by connecting attributes
- Input and Outputs, and the connection editor

Project

Chess Animation (Week 2 of 3) – Continued

Week 11 Tuesday – Animating a simple character

- Planning a performance
- The importance of acting out a performance
- Key framing tools and techniques
- Using the Graph Editor
- The relationship between motion curves and nuances of movement
- Understanding motion curves, keys, and tangents

Reading

Maya Basics Guide – Review Chapters 10, 11, and 13
Review slides and course notes on Blackboard

Project

Chess Animation (Week 3 of 3) - Finish animating the chess pieces and render the scene using the same procedures as we used at the end of the previous project. See blackboard for specific details.

Week 11 Thursday – Refining the performance

- Refining and further developing an animation
- Isolating erroneous movement behavior
- Fine tuning the timing and performance
- More Graph Editor

Project

Chess Animation (Week 3 of 3) – Continued

Week 12 Tuesday – The Final Project

- Solve any animation problems with the Chess Animation
- Adding texture to a deforming character mesh
- Lighting for animation
- Discuss the Final Project
- Overview of the remaining timeline for the class

Reading

Maya Basics Guide – Chapter 12
Review slides and course notes on Blackboard

Project

Final Project: Discuss the final project. Final project listed at bottom of syllabus. Also see blackboard for specific details. Due at the start of our Finals Week class session. In-class screening and critique will follow. Progress checks will be due each week.

Week 12 Thursday – Posing a character

- Animating a full human character using a pre-rigged character rig
- Setting motion keys across arrays of joints and skeletons
- The importance of pose in expressing character personality
- Blocking in a performance

Project

Continue Final Project.

Week 13 Tuesday – Animating a character

- IK – Inverse Kinematics
- FK – Forward Kinematics
- Understanding the fundamental differences between animating IK and FK hierarchies.
- How and where to apply IK and FK to movement and articulation problems
- Working with a rig

Reading

Maya Basics Guide – Chapter 14

Review slides and course notes on Blackboard

Project

Final Project Proposals Due & Progress Check

Week 13 Thursday – Advanced Rendering topics

- Batch Rendering
- Command line rendering
- Rendering across multiple machines
- Networked, farmed, and distributed rendering
- Types of renderers

Project

Continue Final Project.

Week 14 Tuesday – Comparing Mental Ray, Arnold, V-Ray and other Rendering Special Topics

- Differences between the software and Mental Ray renderer
- Mental Ray Pipeline and Workflow
- Arnold Pipeline and Workflow
- V-Ray Pipeline and Workflow
- Renderman Pipeline and Workflow
- Final gathering
- Global Illumination
- Image based lighting (IBL) and High Dynamic Range Images (HDRI)

Project

Continue Final Project.

Week 14 Thursday – Dynamics and Particles

- Particle processing and scene setup
- Types of particles
- Fields, physics properties, and methods for achieving effects
- Materials and refining look

Project

Continue Final Project

Week 15 Tuesday – Final Project Viewing

- Viewing of Final Projects
- In class critique

Week 15 Thursday – Final Exam Review Day

- Review slides

Final Exam – (Tuesday, May 7, 11 am-1pm, KAP 107)

All students must attend Final Exam session!

Final Project:

Due Date:

Due at the start of the Final Exam Session for in-class viewing and critique
Tuesday, May 7, 11 am-1pm, KAP 107

Must be submitted onto Blackboard by due date.

Using any and all of the techniques we have covered in the class thus far, create a 20 second animated sequence consisting of at least four consecutive shots. You may do more if you feel ambitious.

A complete Final Project submission will consist of a finished rendered QuickTime movie file as well all Maya scene files, project folders, textures, and supporting materials.

QuickTime file should be Sorensen 3 codec; 640x480 minimum resolution, HD and other aspect ratios are okay.

- At least three new detailed assets must be built and showcased in this project.
 - o An asset can be anything from a building, to an environment, to a detailed prop, to a vehicle, or even a full character.
 - o In order to optimize your time, you may use any previous assets and models to supplement this project. If you are recycling assets in this way, make sure to significantly improve them so that they complement this new project (i.e. better texturing, shape language, edge topology, or detailing.)
- Demonstrate your best animation in the project
 - o Weight
 - o Timing
 - o Controlled key-framing
 - o Secondary animation.

The Final project is worth 60 points. Progress checks are due each week leading up to the deadline.

The Final project will be graded based on:

- Meets base requirements
 - o Total 20 seconds
 - o Four consecutive shots, rendered (5 points per rendered shot)
- Demonstrated effort (10 points)
- Complexity, range, and effective use of tools (10 points)
- Quality of the finished product
 - o Animation performance (10 points)
 - o Visual quality (10 points)

Have fun! Make awesome work!

Statement on Academic Conduct and Support Systems

Academic Conduct

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Part B, Section 11, “Behavior Violating University Standards” <https://policy.usc.edu/scampus-part-b/>. Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, <http://policy.usc.edu/scientific-misconduct>.

Support Systems

Student Counseling Services (SCS) - (213) 740-7711 – 24/7 on call

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention. <https://engemannshc.usc.edu/counseling/>

National Suicide Prevention Lifeline - 1-800-273-8255

Provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week. <http://www.suicidepreventionlifeline.org>

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-4900 - 24/7 on call

Free and confidential therapy services, workshops, and training for situations related to gender-based harm. <https://engemannshc.usc.edu/rsvp/>

Sexual Assault Resource Center

For more information about how to get help or help a survivor, rights, reporting options, and additional resources, visit the website: <http://sarc.usc.edu/>

Office of Equity and Diversity (OED)/Title IX Compliance – (213) 740-5086

Works with faculty, staff, visitors, applicants, and students around issues of protected class. <https://equity.usc.edu/>

Bias Assessment Response and Support

Incidents of bias, hate crimes and microaggressions need to be reported allowing for appropriate investigation and response. <https://studentaffairs.usc.edu/bias-assessment-response-support/>

The Office of Disability Services and Programs

Provides certification for students with disabilities and helps arrange relevant accommodations. <http://dsp.usc.edu>

Student Support and Advocacy – (213) 821-4710

Assists students and families in resolving complex issues adversely affecting their success as a student EX: personal, financial, and academic. <https://studentaffairs.usc.edu/ssa/>

Diversity at USC

Information on events, programs and training, the Diversity Task Force (including representatives for each school), chronology, participation, and various resources for students. <https://diversity.usc.edu/>

USC Emergency Information

Provides safety and other updates, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible, <http://emergency.usc.edu>

USC Department of Public Safety – 213-740-4321 (UPC) and 323-442-1000 (HSC) for 24-hour emergency assistance or to report a crime.

Provides overall safety to USC community. <http://dps.usc.edu>