ADVM 0003D - DESIGN FOR ADDITIVE MANUFACTURING - 3D PRINTING

Catalog Description

Formerly known as DES 3D
Hours: 90 (36 lecture, 54 laboratory)
Description: Introduction to design for 3D printing through machine operation and use of design software to create geometric models to satisfy defined requirements. Introduction to product design process and exploration of additive manufacturing (3D printings) impact on that process, as well as manufacturing. Designed for students with no prior experience with 3D printing or design. (not transferable)

Course Student Learning Outcomes

- CSLO #1: Apply the steps of the design process and concurrent engineering principles.
- CSLO #2: Operate a 3D printer unassisted and troubleshoot common issues.
- CSLO #3: Create a 3D solid model suitable for 3D printing keeping in mind constraints and advantages of technology.
- CSLO #4: Perform basic analysis of a STL File to determine suitability for 3D printing.
- CSLO #5: Be conversant of 3DP technology and current trends.

Effective Term

Fall 2022

Course Type

Credit - Degree-applicable

Contact Hours

90

Outside of Class Hours

72

Total Student Learning Hours

162

Course Objectives

Lecture Objectives:
I. 3D Printing Basic Principles
A. Establish the fundamental concepts to work with 3 dimensional Cartesian Coordinates
B. Define 3DP and establish the general steps from concept to physical product
C. Define common slicing parameters
II. Printer Operation
A. Explain Material Extrusion as a method of 3DP
B. Discuss STL files and the manner of file creation
C. Explain operation of Software to alter parameters and generate 3D prints
D. Explain best practices for use of current 3D Printing machines
III. 3D Modeling I/STL Files (Part 1)
A. Describe basic concepts for object creation in a 3-dimensional space
B. Explain best practices for creating 3D objects from 2D profiles
C. Discuss STL file creation
IV. 3D Modeling I/STL Files (Part 2)
A. Discuss and establish best practices for creating extrusions
B. Discuss and establish best practices for creating revolves
C. Discuss common pitfalls in STL file creation
V. Types of 3D Printing/Design Considerations
A. Define 7 main methods of 3D printing
B. Explain positives and negatives of different methodologies
C. Specifically explain design considerations as related to Material Extrusion methodologies
VI. 3D Printing and the Design Process/Prototyping I
A. Define the steps of the design process
B. Explain how 3DP fits into and enhances the design process
C. Define Prototyping as it relates to the design process
D. Discuss advantages of 3DP in prototyping
VII. STL Files
A. Define the basic structure and function of STL files
B. Discuss common techniques to check and validate STL files
C. Describe common errors in STL files
D. Discuss proper orientation before printing
VIII. 3D Design Fundamentals (Part 1)
A. Discuss benefits of Parametric Modelers and other methodologies
B. Explain best practices for 2D sketches
IX. 3D Design Fundamentals (Part 2)
A. Explain the parent/child relationship between Features and Sketches
B. Define design intent and demonstrate its implementation in modeling
C. Explain the benefits of communicating design intent through sketches or features
D. Discuss the importance of Feature Order
X. Tolerancing & Design for Manufacturing
A. Explain machine dimensional limits and precision of manufacturing equipment
B. Discuss importance of machine limitations in design
C. Explain 3D printing specific design limits and advantages
D. Discuss 3DP-specific advantages in parts and assemblies
XI. Prototyping II
A. Explain aims of prototyping process
B. Establish metrics to evaluate fitness of prototype
C. Explain Class project parameters
XII. 3D Modeling II
A. Discuss advanced modeling techniques(Sweeps, Lofts, etc.)
B. Discuss Surface Modeling and other creation methods
C. Discuss commercial CAD/object creation options
XIII. External 3D model repositories/3D Scanning
A. Identify common 3D model repositories and requirements for use
B. Establish best practices for using external models
C. Define common file formats used in repositories
D. Discuss current state of 3D Scanning
XIV. 3D Embosses and Additional Techniques
A. Discuss workflow to produce Image embossed 3D print
B. Explore alternative workflows for custom 3D prints
Laboratory Objectives:
I. 3D Printing Basic Principles
A. Demonstrate the fundamental concepts to work with 3 dimensional Cartesian Coordinates
B. Demonstrate 3DP and establish the general steps from concept to physical product
II. Printer Operation

A. Utilize 3D Printer Display and Menus
B. Demonstrate Changing Filament
C. Demonstrate Machine Best Practices
D. Utilize Software to run a Print
III. 3D Modeling I/STL Files (Part 1)
A. Demonstrate Changing Part orientation
B. Utilize Slicer Settings
C. Demonstrate Infill/Support Material
IV. 3D Modeling I/STL Files (Part 2)
A. Design for Support Material
B. Demonstrate appropriate Wall thickness consideration
C. Calculate/ Manage Print time
V. Types of 3D Printing/Design Considerations
A. Analyze and Identify FDM Advantages
B. Analyze and Identify FDM Disadvantages
VI. 3D Printing and the Design Process/Prototyping I
A. Produce a suitable prototype
B. Evaluate prototypes
VII. STL Files
A. Analyze and identify Common STL Errors
B. Demonstrate appropriate Repair tactics
VIII. 3D Design Fundamentals I
A. Demonstrate use of Parametric Design
B. Utilize Feature Based Modeling
IX. 3D Design Fundamentals II
A. Demonstrate Digital Sculpting/Surface modeling
B. Resolve irregular shapes
X. Tolerancing and Design for Manufacturing
A. Demonstrate Difference between design dimensions and actual
B. Design for Manufacturing methodologies
C. Analyze and identify Dimensional repeatability
XI. Prototyping II
A. Demonstrate Prototype process
B. Develop Project plan
XII. 3D Modeling II
A. Utilize Commercial 3D Modeling Tools(ex: SolidWorks, Inventor)
B. Demonstrate Similarities between products
C. Utilize 3D printing tie-ins
XIII. External repositories
A. Utilize External repositories and resources
B. Utilize Common file formats and conversion
XIV. 3D Embosses
A. Utilize Vector Graphics Files
B. Convert electronic data to path
C. Create Solid from Path

General Education Information

- Approved College Associate Degree GE Applicability
- CSU GE Applicability (Recommended-requires CSU approval)
- Cal-GETC Applicability (Recommended - Requires External Approval)
- IGETC Applicability (Recommended-requires CSU/UC approval)

Articulation Information
Methods of Evaluation

- Classroom Discussions
  - Example: Describe how 3D Printing influences the design process. Explain which steps of the design process are affected most by utilizing 3D Printing. Discussion and or presentation of facts, research. Instructor assesses oral presentation utilizing rubric for complete understanding.
- Objective Examinations
  - Example: Q: Identify the stages of the design process and describe what happens in each. This will be assessed utilizing a traditional written test. Graded via rubric or key.
- Projects
  - Example: The laboratory assignments/projects are examples to assess the depth of topic coverage and critical analysis for each student. Instructor evaluates and examines the 3D printed objects versus desired output (design intent, fit form, and function). Student generated lab reports along with quality assurance data will be evaluated by the instructor to determine success level of each project. Graded based on industry standards.
- Skill Demonstrations
  - Example: Analyze the model as it is presented. Determine what you should change about this model to make it more suitable for printing. Student performs quality assurance documentation of produced 3D printed objects and submits lab report with parts. Lab reports and parts measured and compared by instructor. Grade based on industry standards.

Repeatable

No

Methods of Instruction

- Laboratory
- Lecture/Discussion
- Distance Learning

Lab:

1. The instructor will guide students by example through the demonstration of performance based outcomes. Students will demonstrate the practical application of setup, execution, troubleshooting and quality assurance aspects of various forms of 3D printing. Students will setup and run a 3D print on the 3D printer that will conform to the drawing specifications for the physical development of the part. Lab objectives will be assessed by measurement of the physically produced components in comparison to the drawing guidelines.

Lecture:

1. The instructor will present to the students during lecture/ presentation/discussion engineering design methodology that the student will synthesize and apply to assigned problems and then formulate a solution utilizing correct engineering design methods. Students will discuss various setup methods for additive manufacturing technology and develop individual set up guidelines for their individual 3D models. Lecture objectives will be assessed during the discussion sessions and students will prove mastery by developing a functional set up plan.

Typical Out of Class Assignments
Reading Assignments

1. Based upon 3D methodologies researched and examined, determine most suitable method for prototyping object and justify decision. 2. Based upon the research pages assigned, what would be the most

desirable orientation to print this object to reduce print time and/or reduce support material needed and why?

Writing, Problem Solving or Performance

1. Analyze and identify errors in the supplied STL file; resolve these errors through manipulation of the model file, stl file or 3D printer control software to make it suitable to print. 2. Draw an object to satisfy the supplied constraints that will be able to print without support material.

Other (Term projects, research papers, portfolios, etc.)

1. Design and 3D print a prototype to solve an engineering problem. 2. Develop a portfolio that contains samples of semester assignments to show potential employers the engineering design concepts studied.

Required Materials

Other materials and-or supplies required of students that contribute to the cost of the course.

Custom Course Pack