Course Outline

DeAnza College

General Information

COURSE ID (CB01A AND CB01B)

DMT 54

COURSE TITLE (CB02)

3D Printing/Additive Manufacturing: Applications and Practice

COURSE CREDIT STATUS

Credit - Degree Applicable

EFFECTIVE TERM

Fall 2024

COURSE DESCRIPTION

The second in the Design and Manufacturing Technologies 3D printing and additive manufacturing (AM) curriculum sequence, this course builds upon foundational subject matter knowledge. Course topics include AM workflow and rapid prototyping, emphasizing project-based activities and assignments. Students will learn how to integrate AM into the product development life cycle from prototyping to production while exploring design for AM (DfAM), advanced materials, and state-of-the-art 3D printing and post-processing technologies. To implement assigned projects and activities, students are expected to have working knowledge of at least one parametric modeling CAD software application and produce functional designs.

FACULTY REQUIREMENTS

DISCIPLINE 1

Manufacturing Technology (Quality control, process control)

FSA

FHDA FSA - MACHINE TOOL TECH

COURSE FAMILY

Not Applicable

Course Justification

This course is a major employment preparation CTE course for our Design and Manufacturing Technologies program and is a CSU transferable course. It is intended to prepare students for work as a 3D printing technician in the additive manufacturing industry, as advised by our industry advisory committee. This advanced course is also part of the Additive Manufacturing Technology: 3D Design and Production certificate in the Design and Manufacturing Technologies program.

Foothill Equivalency

DOES THE COURSE HAVE A FOOTHILL EQUIVALENT?

No

FOOTHILL COURSE ID

Formerly Statement

Course Development Options

BASIC SKILL STATUS (CB08)

Course is not a basic skills course.

GRADE OPTIONS

- Letter Grade
- Pass/No Pass

REPEAT LIMIT

0

Transferability & Gen. Ed. Options

Information below is subject to change. For the official listing of courses, their approval dates, and transfer credit limitations, check the De Anza catalog (by academic year), ASSIST.ORG (https://assist.org/) and C-ID.NET (https://c-id.net/).

TRANSFERABILITY

Transferable to CSU only

Units and Hours

Summary

MINIMUM CREDIT UNITS	4.0
MAXIMUM CREDIT UNITS	4.0

Weekly Student Hours

Type	In Class	Out of Class
Lecture Hours	4.0	8.0
Laboratory Hours	0.0	0.0

Course Student Hours

COURSE DURATION (WEEKS)

12.0

HOURS PER UNIT DIVISOR

36.0

Course In-Class (Contact) Hours

LECTURE

48.0

LABORATORY

0.0

TOTAL

48.0

Course Out-of-Class Hours

LECTURE

96.0

LABORATORY

0.0

NA

0.0

TOTAL

96.0

Prerequisite(s)

DMT 53

Corequisite(s)

Advisory(ies)

Limitation(s) on Enrollment

Entrance Skill(s)

General Course Statement(s)

Methods of Instruction

Lecture and visual aids
In-class exploration of Internet sites
Discussion of assigned reading and problem solving performed in class
Quiz and examination review performed in class
Guest speakers
Collaborative learning and small group exercises
Homework
Lab assignments and extended projects

Assignments

A. Assigned readings from text, online resources, recorded and live demonstrations of advanced 3D printing processes, and research projects on selected topics in 3D printing/additive manufacturing (AM).
B. Activities to design and 3D print functional objects, evaluate the properties of various 3D print materials, and determine optimal print and post-processing technologies
C. In class projects to identify and evaluate material properties of 3D print media and the advantages and limitations of the different 3D printing process and technology.
D. Final project using CAD parametric modeling software to design and print functional objects within assigned 3D printing/additive manufacturing (AM) parameters. Complete post-processing, inspection, and non-destructive and destructive testing to validate part quality.

Methods of Evaluation

A. Practical examinations and research report to evaluate student understanding of 3D printing/additive manufacturing (AM) technology and design methodologies, assigned reading, and research projects.
B. Mid-term examination covering presented in-class and recorded demonstrations, lectures, assigned readings, independent research, and advanced AM design and fabrication projects. Exam will be evaluated on manufacturability of project design, optimization of 3D printing perimeters, and final project evaluation.
C. Assessment of final student project demonstrating comprehensive application of AM design considerations, production, post-processing, and product quality evaluation.

Essential Student Materials/Essential College Facilities

Essential Student Materials:

- None

Essential College Facilities:

- DMT 3D Printing/AM and CAD lab

Examples of Primary Texts and References

Author	Title	Publisher	Date/Edition	ISBN
Gibson, I Rose, D. Stucker, B. Khorasani M.	Additive Manufacturing Technologies	Springer	2021/3rd	978-3030561260
Bandyopadhyay, A. and Bose, S.	Additive Manufacturing, Second Edition	CRC Press	2021/2nd	9781032238593

Examples of Supporting Texts and References

None.

Learning Outcomes and Objectives

Course Objectives

- Apply knowledge of Occupational Health and Safety Administration (OSHA), Environmental Protection Agency (EPA), and International Standards Organization (ISO) workplace environmental health and safety standards.
- Differentiate the seven (7) ISO/ASTM 3D printing/additive manufacturing (AM) processes and their applications within the product design and fabrication lifecycle.
- Evaluate the major categories of AM/3D print media to determine optimal selections for individual applications and print processes.
- Analyze case studies of AM/3D printing applications across industry sectors with consideration of the advantages and limitations of each process.
- Create designs and parametric solid models of 3D parts and objects using Computer Aided Design (CAD) software.
- Apply the principles of Design for Additive Manufacturing (DfAM) to create manufacturable 3D products.
- Transform CAD designs to standard triangle language (STL) or 3D manufacturing format (3MF).
- Modify 3D object design using topology optimization and slicing software.
- Evaluate designs to determine optimal 3D print process and materials.
- Execute and monitor 3D printing process.
- Identify and resolve problems with the 3D printing process.
- Complete post-processing of 3D printed objects as determined by selected printer technology and materials.
- Conduct quality inspection of finished parts utilizing conventional and automated metrology technologies.
- Utilize 3D laser scanner to reverse engineer and inspect finished parts.

- Perform non-destructive and destructive testing of 3D printed parts.

CSLOs

- Apply advanced additive manufacturing design considerations and production techniques to create functional prototypes, usable objects, and parts.

Outline

A. Apply knowledge of Occupational Health and Safety Administration (OSHA), Environmental Protection Agency (EPA), and International Standards Organization (ISO) workplace environmental health and safety standards.
   1. Safety Data Sheets (SDS) for 3D printing materials
   2. Personal Protective Equipment (PPE) for handling 3D printing media
   3. Proper recycling and disposal methods of materials

B. Differentiate the seven (7) ISO/ASTM 3D printing/additive manufacturing (AM) processes and their applications within the product design and fabrication lifecycle.
   1. Material extrusion (MEX)
   2. Powder bed fusion (PBF)
   3. VAT photopolymerization (VPP)
   4. Material jetting (MJT)
   5. Binder jetting (BJT)
   6. Directed energy deposition (DED)
   7. Sheet lamination

C. Evaluate the major categories of AM/3D print media to determine optimal selections for individual applications and print processes.
   1. Polymers
   2. Nylon
   3. Metals
   4. Ceramics
   5. Composites

D. Analyze case studies of AM/3D printing applications across industry sectors with consideration of the advantages and limitations of each process.
   1. Aerospace and automotive
   2. Medical devices
   3. Energy and electronics
   4. IT and Industrial Internet of Things (IoT)
   5. Consumer products

E. Create designs and parametric solid models of 3D parts and objects using Computer Aided Design (CAD) software.
   1. Siemens NX
   2. PTC Creo Parametric
   3. SOLIDWORKS
   4. CATIA
   5. Autodesk Fusion 365

F. Apply the principles of Design for Additive Manufacturing (DfAM) to create manufacturable 3D products.
   1. Prioritize AM design and tolerancing considerations for part, assemble, geometry and surface features.
   2. Optimize freeform geometry considerations.
   3. Consider Form, Fit, and Function (F3) parameters for part, assembly, geometry, and surface features.

G. Transform CAD designs to standard triangle language (STL) or 3D manufacturing format (3MF).
   1. Export CAD designs
   2. Clean and repair mesh (STL/3MF) files.
   3. Create new or modify existing lattice structures.

H. Modify 3D object design using topology optimization and slicing software.
   1. Autodesk Netfabb
   2. Materialise Magics
   3. 3D Shop
   4. nTopology

I. Evaluate designs to determine optimal 3D print process and materials.
   1. Tensile strength
   2. Heat deflection properties
   3. ISO, EPA, FDA, ITAR, UL, and other industry product safety regulations

J. Execute and monitor 3D printing process.
   1. Inspect printer sensors, lenses, rollers, print heads, print chamber and resin vat.
   2. Build and optimize print supports.
   3. Pack and nest 2D and 3D printer build volume.
   4. Send design file to 3D printer.

K. Identify and resolve problems with the 3D printing process.
   1. â â â â â â â Perform routine printer maintenance to ensure proper operation.
   2. Evaluate print processes and identify equipment malfunctions.
   3. Troubleshoot problems with print cycle and make adjustments and repairs as required.

L. Complete post-processing of 3D printed objects as determined by selected printer technology and materials.
   1. MEX – Remove supports and finish rough surfaces.
   2. PBF – Media blast, smooth, and polish.
   3. VPP – Remove supports, sand, polish and spray.
   4. BJT – Metal electroplane, sand, sinter, machine and/or prime.
   5. MJT – Water jet, remove supports, apply metal inserts, prime and/or paint.
   6. DED – Anneal, machine, media blast, deburr, and/or prime.

M. Conduct quality inspection of finished parts utilizing conventional and automated metrology technologies.
   1. Complete surface, visual, and microscopic parts inspection.
   2. Utilize coordinate measuring machine (CMM) and 3D laser scanner to evaluate part geometry.

3. Analyze metrological characteristics of finished parts.

N. Utilize 3D laser scanner to reverse engineer and inspect finished parts.

1. Scan object and generate 3D image.
2. Construct digital 3D models.
3. Create geometric samples from the surface of an object.

O. Perform non-destructive and destructive testing of 3D printed parts.

1. Perform surface roughness testing and leak detection
2. Perform Rockwell hardness, tensile, and compression testing.