SIE 481/581 Design for Additive Manufacturing
Time & Location: M&Wed 12-1:15PM, ENGR 301

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Office Hours: 10-10:50am Tu/Thu

Course Description

This course is an introduction to the engineering design process with a focus on understanding constraints and opportunities associated with additive manufacturing (AM). Students will gain an understanding of how to exploit AM to manufacture parts with complex geometry, while also considering economic viability and manufacturability. Opportunities and constraints associated with various AM technologies, from fused-filament fabrication (often called 3D printing) to metal AM processes, will be surveyed. The course will culminate in a hands-on design project where students will use design-for-additive-manufacturing (DfAM) frameworks and tools to design a novel product. This course aims to promote creativity and critical thinking, which are necessary to effectively use AM technology in the context of product design.

Course Objectives

During this course, students will develop an understanding of manufacturing processes constraints and learn to identify opportunities associated with additive manufacturing. Students will apply their knowledge of manufacturing processes, materials, and computer-aided design tools to design and manufacture a new part or product using additive manufacturing processes.

Expected Learning Outcomes

By taking this course, both undergraduate and graduate students will possess the capability to:

- Explain the engineering design process and discuss how systematic methodologies and strategies can promote improved design outcomes
- Identify and quantify economic, geometric, and material property constraints associated with parts made using AM technologies
- Discuss and analyze opportunities to exploit geometric freedoms enabled by AM technologies
- Apply DfAM methodologies and tools to develop solutions to practical design problems

For graduate students, additional assignments will be given for advanced learning outcomes:

- Explain interactions between part geometry, material, quality, and AM process constraints
- Investigate and report on emerging applications and technologies related to AM

Course Prerequisites or Co-requisites

SIE majors: Advanced Standing; SIE 383 / Other ENGR majors: Advanced Standing; (AME 211 OR BE 221) AND (AME 324A OR MSE 370)). Advanced standing is required before taking this course. For Advanced Standing of undergraduate students, please visit the webpage for detail information to obtain the advanced standing: http://sie.engr.arizona.edu/advanced-standing.

Course Structure

The format of the course is a combination of lecture, in-class discussion, and group projects. Student attendance and active participation in class discussions and team projects is required. All students will participate in a semester-long project in small groups. Each team will use design-for-additive-manufacturing frameworks and tools to design a novel product of their choosing. The deliverables for this project include two progress reports, two presentations, a final report, and a 3D printed prototype of your team's design. **Graduate students** will be required to present and lead one class discussion during the semester on a relevant research topic. Graduate students will also be required to complete a take-home supplement to the midterm exam.

Grading Scale and Policies:

Tasks	**Weight (%)**	
	Undergraduate	**Graduate**
Class participation	10	10
HW assignments	35	20
Midterm exam	20	20
Midterm exam take-home supplement	N/A	5
Team project		
• Progress reports	10	10
• Preliminary design review presentations	5	5
• Final presentation & report	20	20
Research presentation & discussion	N/A	10
Total	100	100

Late homework will be subject to a 50% penalty and can only be submitted up to one week late. All students will receive one "free" late homework without penalty. Plan on only using this free late assignment for when you really need it, due to illness or unexpected emergency.

Percentage	**Letter Grade**
90% – 100%	**A**
80% – 89%	**B**
70% – 79%	**C**
60% – 69%	**D**
<60%	**E**

Scheduled Topics/Activities:

	Topic	Assignments

Week 1	Engineering design process; Intro to additive manufacturing processes	
Week 2	AM process parameters; DfAM frameworks; Teaming	Assignment 1
Week 3	AM design variables; Needs finding	
Week 4	Economic viability of AM; Interview procedures	Assignment 2
Week 5	Opportunities for AM (Complexity; part consolidation); Ideation	
Week 6	Opportunities for AM (Lattice structures)	Assignment 3
Week 7	Opportunities for AM (Customization)	Progress Report I
Week 8	Midterm; Concept selection	
Week 9	Project preliminary design reviews; Prototyping	
Week 10	Opportunities for AM (Multi-material and multi-functional DfAM)	Assignment 4
Week 11	Dimensional accuracy and material property considerations	
Week 12	Geometry constraints and manufacturability analysis for AM	Assignment 5
Week 13	Topology optimization/Generative design	Progress Report II
Week 14	Topology optimization/Generative design II	
Week 15	Additional DfAM research topics	
Week 16	Project presentations and wrap up	Final report

Final project
There is no final exam in this course. The final project report and presentation will be due in the last week of class. The UA's policy on final exams is available at: https://registrar.arizona.edu/faculty-staff-resources/room-class-scheduling/schedule-classes/final-exams

Required Texts or Readings:
There is no required textbook for this course. Required articles and other texts will be made available on D2L.

Required Materials:
Access to a basic fused-filament fabrication 3D printer is highly recommended due to the hands-on nature of this course. Your instructor will help you identify appropriate 3D printers available for student use on campus or in your local community during the first week of class. (There are a wide variety of makerspaces and organizations that offer 3D printing, including CATalyst, the University of Arizona's library 3D printing service, some UPS stores, Xerocraft, and many public libraries. Low-cost 3D printers are also widely available for purchase.)

We will use CAD, CAM, and CAE software as part of this course. The software packages we will use are free to UArizona students. Instructions for downloading and using the relevant software will be provided in class.

University IT Support:
For course videos and online support: support@engr.arizona.edu
Yuma Campus IT support: Alberto Urbieta, asu@email.arizona.edu

Course Drop Policy: The UA's policy concerning Class Attendance, Participation, and Administrative Drops is available at:

http://catalog.arizona.edu/policy/class-attendance-participation-and-administrative-drop

Religious Reasons: The UA policy regarding absences for any sincerely held religious belief, observance or practice will be accommodated where reasonable, http://policy.arizona.edu/human-resources/religious-accommodation-policy.

Pre-Approved Absences: Absences pre-approved by the UA Dean of Students (or Dean Designee) will be honored. See: https://deanofstudents.arizona.edu/absences

Threatening Behavior Policy

The UA Threatening Behavior by Students Policy prohibits threats of physical harm to any member of the University community, including to oneself. See http://policy.arizona.edu/education-and-student-affairs/threatening-behavior- students.

Accessibility and Accommodations

Our goal in this classroom is that learning experiences be as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, please let me know immediately so that we can discuss options. You are also welcomed to contact the Disability Resource Center (520-621-3268) to establish reasonable accommodations. For additional information on the Disability Resource Center and reasonable accommodations, please visit http://drc.arizona.edu.

If you have reasonable accommodations, please plan to meet with me by appointment or during office hours to discuss accommodations and how my course requirements and activities may impact your ability to fully participate.

Please be aware that the accessible table and chairs in this room should remain available for students who find that standard classroom seating is not usable.

Code of Academic Integrity

Students are encouraged to share intellectual views and discuss freely the principles and applications of course materials. However, graded work/exercises must be the product of independent effort unless otherwise instructed. Students are expected to adhere to the UA Code of Academic Integrity as described in the UA General Catalog. See: http://deanofstudents.arizona.edu/academic-integrity/students/academic-integrity.

The University Libraries have some excellent tips for avoiding plagiarism, available at http://new.library.arizona.edu/research/citing/plagiarism.

*Selling notes and/or other course materials to other students or to a third party for resale is **not** permitted without the instructor's express written consent*. Violations to this and other course rules are subject to the Code of Academic Integrity and may result in course sanctions. Additionally, students who use D2L or UA e-mail to sell or buy these copyrighted materials are subject to Code of Conduct Violations for misuse of student e-mail addresses. This conduct may also constitute copyright infringement.

Classroom behavior policy

To foster a positive learning environment, the use of cell phones or mobile devices during class is not allowed.

Additional Resources for Students

UA Academic policies and procedures are available at http://catalog.arizona.edu/policies

Student Assistance and Advocacy information is available at
http://deanofstudents.arizona.edu/student-assistance/students/student-assistance

Confidentiality of Student Records
http://www.registrar.arizona.edu/personal-information/family-educational-rights-and-privacy-act-1974-ferpa?topic=ferpa

Subject to Change Statement
Information contained in the course syllabus, other than the grade and absence policy, may be subject to change with advance notice, as deemed appropriate by the instructor.

UA Nondiscrimination and Anti-Harassment Policy:
The University is committed to creating and maintaining an environment free of discrimination, see: http://policy.arizona.edu/human-resources/nondiscrimination-%20and-anti-harassment-policy. Our classroom is a place where everyone is encouraged to express well-formed opinions and their reasons for those opinions. We also want to create a tolerant and open environment where such opinions can be expressed without resorting to bullying or discrimination of others. UA Academic policies and procedures are available at http://catalog.arizona.edu/policies. Student Assistance and Advocacy information is available at http://deanofstudents.arizona.edu/student-assistance/students/student-assistance