Spring 2020

CHE 722-102: Additive Manufacturing and Applications

Murat Guvendiren

CHE 722 – Additive Manufacturing and Applications
Spring 2020
Otto H. York Department of Chemical and Materials Engineering - NJIT

Instructor

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Office Hours: Wednesday 2-3 PM (Appointment Only)

Course Description

This course summarizes additive manufacturing technologies and current (and emerging) applications. Technologies including extrusion-based printing, droplet-based printing, powder-based printing, and vat photopolymerization printing will be discussed in detail with respect to printing parameters, printable materials, and end-product properties. Students will learn how to select the proper printing technology and materials for particular applications. This course will be composed of a lecture and a hands-on laboratory session, during which students will create 3D designs and print functional prototypes. Students will be challenged every week to develop innovative and functioning 3D printed components.

Teaching Assistant: Andrew House (anh3@njit.edu)

Prerequisites: CHE 624 Transport Phenomena and CHE 626 Mathematical Methods in Chemical Engineering. ***Other equivalent courses can be acceptable for engineering students from other departments with the permission of the instructor.***

Student Learning Outcomes

1. Identify key 3D printing technologies, and corresponding major industry segments
2. Identify key material properties for 3D printability for each printing technique
3. Develop the ability to assess printing methods and materials (inks) for specific applications
4. Develop ability to design and 3D print devices/tools to meet desired needs with realistic constrains for 3D printing
5. Manufacture devices and tools using 3D printing
6. Identify future applications and opportunities of 3D printing
7. Assess the 3D printing industry and the global effects of 3D printing particularly on engineering manufacturing
8. Develop presentation skills and foster team work
9. Ability to communicate effectively through written reports and oral presentations
10. Develop ability to search literature for peer-reviewed articles, and learn critical reading

11. Identify economic, environmental and societal issues related to Additive Manufacturing.
12. Effectively present technical and engineering problems to a "lay audience"

Learning Materials/Tools

Reference Text Books:

- Additive Manufacturing Technologies – 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, by Ian Gibson, David Rosen, and Brent Stucker, Second Edition, Springer, New York.
- 3D Printing and Additive Manufacturing – Principles and Applications, by Chee Kai Chua and Kah Fai Leong, The 4th Edition, World Scientific.

Required CAD Software: Autodesk Fusion 360 (cloud-based CAD Design software). Fusion 360 is free for students. You are required to download this software in your OWN laptop. If you don't have a laptop, please contact Dr. Guvendiren.

System requirements: https://goo.gl/gUWyqi

Download page: https://www.autodesk.com/products/fusion-360/students-teachers-educators

Required Slicing Software: Flashprint software will be used for silicing the digital images for 3D printing. Our lab is equipped with Flashforge Inventor Dual Extrusion 3D Printer.

Link: https://flashforge-usa.com/pages/download

When to Download: These software are not required in the first week of the class. So please wait to download them. More detailed information will be provided in the first day of class.

Other Learning Material: PowerPoint presentations for each lecture will be posted on the Moodle webpage. Students are strongly encouraged to take notes during the lectures and integrate their notes into the provided documentation after each lecture.

Calculator: A scientific calculator is required.

Laboratory Materials/Supplies: All the materials and supplies needed for the laboratory section of the course will be provided by the Department. Students may be expected to SHARE some of the items.

Rules and Expectations during the Lectures/Labs

- **ABSOLUTELY No cell phones, no video/audio recording, and NO FOOD allowed any time during the lecture.** Laptops will be used when instructed for the lectures (to be announced).
- Please come to the class before the lecture starts or at least ON TIME. Under no circumstances, you should distract your peers and the instructor.
- Students are expected to come to class having read the assigned material, completed the assignment, and well prepared to engage in dialogue regarding the assigned material. All reading and other preparatory assignments must be completed by their due date(s).
- There will be **NO MAKE-UP**. If your absence is justified by a letter from Dean of Students Office, the missed activity may be forfeited.

Academic Integrity: Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect

your educational investment by knowing and following the academic code of integrity policy that is found at: http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf.

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university. If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu"

Disability Support Services: NJIT provides disability support services in the campus. If you need accommodations due to a disability please contact Chantonette Lyles, Associate Director of Disability Support Services, Fenster Hall Room 260 to discuss your specific needs. A Letter of Accommodation Eligibility from the Disability Support Services office authorizing your accommodations will be required.

Course Format: The course will consist of a lecture and a hands-on laboratory session with extensive participation between students and the instructor. The following is the tentative Course Schedule.

Detailed Course Schedule

Course schedule is tentative and may change throughout the term. **Dates** are also tentative and may be subjected to change. **The instructor will communicate any changes.**

Month	Day	Topics
Jan	22	Introduction to Additive Manufacturing
Jan	29	Software for Additive Manufacturing Lab: Fusion360 Workshop
Feb	5	Software for Additive Manufacturing Lab: Fusion360 Software Workshop – Design Project 1
Feb	12	Extrusion-based printing Lab: Design Project 1
Feb	19	Vat-photopolymerization printing / **Student Presentations** Lab: Design Project 2
Feb	26	Droplet-based printing / **Student Presentations** Lab: Design Project 2
Mar	4	Powder-based printing / **Student Presentations** Lab: Design Project 3
Mar	11	Bioprinting / **Student Presentations** Lab: Design Project 3
Mar	18	**SPRING RECESS**
Mar	25	Bioprinting Workshop / **Student Presentations** Lab: Design Project 4
Apr	1	Future of 3D Printing Lab: Design Project 4
Apr	8	3D Printing Industry - **Group Presentations** Lab: Final Project
Apr	15	Impact of low-cost and open source systems Lab: Final Project
Apr	22	Final Project Workshop
Apr	29	Final Project Presentations

Design Challenges: Students will be grouped into teams (rotating for every challenge) and will develop functional digital designs and 3D print these designs (and show their function). Usually you will have two weeks to return your design (determined by the Instructor and announced before the assignment of the project). Late designs (up to a week) will be accepted but you will receive half the credit.

Final Project: Each team will be given a Final Design Project, and will be required to come up with a simple but creative design (a tool or a device, TBD). Each team will be required to prepare a written report and present their design process by the end of the course. No late returns are excepted.

Grading Criteria

- Paper Presentations 15%
- Group Presentation 10%
- Design Challenges 40%
- Final Project 35%
    - Printed Device 10%
    - Written Report 10%
    - Presentation 15%

Grading will be based on:

A:	90 – 100%
B+:	85 – 89%
B:	80 – 84%
C+:	70 – 79%
C:	60 – 69%
D:	50 – 59%
F:	0 – 49%