

University of Southern California
Daniel J. Epstein Department of Industrial and Systems Engineering

ISE 599: Advanced Topics in 3D Printing

Class Number 599, Units 3
Spring 2019

Course Syllabus

Course General:

The course meets Wednesday 6:30 ~ 9:10 pm.

Course Instructors:

Dr. Yong Chen, GER-201

Tel: 213-740-7829, Email: yongchen@usc.edu

Office Hours: Wednesday (2 - 5pm) or by appointment.

Course Description:

Rapidly advancing 3D printing or additive manufacturing (AM) technologies provide us a direct way of converting digital data into physical objects. Based on the AM processes, *rapid prototyping* (RP) and *rapid tooling* (RT) have been widely adopted as common practice in product development. In the past years, advances in material, process, and machine development have enabled AM processes to evolve from the prototyping stage to direct product manufacturing. Such *rapid manufacturing* (RM) capabilities will revolutionize industries such as aerospace, defense, biomedical, and jewelry to name a few. Understanding the advantages and limitations of AM technologies is important for future engineers in developing new engineering systems and identifying emerging opportunities in developing products for mass customization.

This course aims to help graduate students to understand the latest developments and critical challenges of 3D printing, and provide students with related techniques and practical experience in developing novel AM processes, equipments, and applications. This is a PhD level course that will be offered every other year. The targeting audience of the course is the graduate students who are interested in the latest development of 3D printing and would like to perform research and development related to advanced manufacturing. The course will also prepare graduate students for careers in academy, industrial research and development, and entrepreneurship.

The teaching of the course will use an active learning strategy. The students will read literatures, discuss current research problems, and identify possible contributes to the studied topics. Three course projects, including a paper review project, a technology survey project, and an application development project, are planned throughout the semester. Through them, the students are expected to gain deep understanding of additive manufacturing and the related technologies.

Prerequisites:

No formal prerequisites. Students are desired to take ISE511 and/or ISE510 before.

Textbook

Lecture notes will be given before classes.

Reference Books

- Bourell, Leu, and Rosen, *Roadmap for Additive Manufacturing*, NSF Workshop report, 2009.
- Gibson, Rosen, Stucker, *Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing*. Springer, 2009.
- Hopkinson, Hague, Dickens, *Rapid Manufacturing: An Industrial Revolution for the Digital Age*. Wiley, 2005.
- Gibson, *Advanced Manufacturing Technologies for Medical Applications*. Wiley, 2005.

Grading Policy:

The grading for the class will be determined using the following weights:

- Assignments..... 30%
- Literature review project..... 20%
- Technology survey project..... 15%
- Development project..... 25%
- Participation..... 10%
- Total Score.....100%

Problem Assignments: Students will be given ~2 weeks for each assignment, which will consist of solving problems that correspond to the materials covered in class.

Literature review project: The objective of the literature review projects is to help the students to learn how to identify and read literatures. Students will discuss the review topic with the professor. The project will be done with a presentation and a review report.

Technology survey project: The objective of the technology survey project is to help the students to understand potential applications and opportunities in various fields. Students will discuss the survey topic with the professor. The project will be done with a presentation and a survey report.

Development project: The objective of the development project is to help the students to gain hands-on experience of solving a problem related to 3D printing. Students will discuss the problem with the professor. The project will be done with a demonstration, a presentation, and a technical report.

Participation: Active participation in the class discussion is required and will be taken into account.

Tentative Course Schedule:

Week #	Wednesday (6:30~9:10 pm)	Assignment	Reading / Project
1	Jan. 9 – Course Introduction <ul style="list-style-type: none">• Course Overview• Logistics• Research topic discussion	Assignment 1	Literature review project assigned

2	Jan. 16 – 3D content creating, editing and preparation <ul style="list-style-type: none"> • 3D Scanning • Design opportunities • CAD systems for additive manufacturing 	Assignment 2	Literature review topic due.
3	Jan. 23 – 3D printing process planning <ul style="list-style-type: none"> • Orientation, supports • Tool paths 	Assignment 3	
4	Jan. 30 – Additive manufacturing processes beyond layers <ul style="list-style-type: none"> • Non-layer based • Building around inserts 	Assignment 4	
5	Feb. 6 – <i>Site visit: PACIFIC Design & Manufacturing</i> <ul style="list-style-type: none"> • Anaheim Convention Center 	Assignment 5	
6	Feb. 13 – <i>Literature review project presentation</i>		Literature review report due. Technology survey project assigned
7	Feb. 20 – 3D printing principles and innovation <ul style="list-style-type: none"> • Fabrication speed • Resolution, control, etc. 	Assignment 6	
8	Feb. 27 – Multi-scale 3D printing processes <ul style="list-style-type: none"> • Macro, Meso, Micro and Nano scales fabrication and integration 	Assignment 7	
9	Mar. 6 – <i>Technology survey presentation</i>		Technology survey report due.
10	Mar. 13 – Spring Recess (No class)		Development Project Assigned
11	Mar. 20 – Multi-material 3D printing processes <ul style="list-style-type: none"> • Heterogeneous materials • Functional materials (electric, optical, magnetic, thermal, etc) • Component embedding 	Assignment 8	

12	Mar. 27 – Multi-form 3D printing processes <ul style="list-style-type: none"> • 4D printing • Sensors and soft robotics 	Assignment 9
13	Apr. 3 – 3D printing of biomimetic and bioinspired structures <ul style="list-style-type: none"> • Novel design and fabrication • Functional 3D printing 	Assignment 10
14	Apr. 10 – Hybrid processes and post processing for additive manufacturing <ul style="list-style-type: none"> • Rapid tooling and indirect processes • Coloring, surface texture, polishing • Electroplating, etc. 	Assignment 11
15	Apr. 17 – Technology impact on society and novel applications <ul style="list-style-type: none"> • Production economics • Applications on medical, retail, space, etc. • Process reliability and quality control 	Assignment 12
16	Apr. 24 – <i>Development Project Presentation</i>	
17	May 1 – Development Project demonstration (7pm)	Development Project report Due

Academic integrity: “The Department of Industrial and Systems Engineering adheres to the University’s policies and procedures governing academic integrity as described in SCampus. Students are expected to be aware of and to observe the academic integrity standards described in SCampus, and to expect those standards to be enforced in this course.”

Disability Accommodation:

“Any Student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me (or to TA) as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m. - 5:00 p.m., Monday through Friday. The phone number for DSP is (213) 740-0776.”

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” 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, policy.usc.edu/scientific-misconduct.

Support Systems:

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

engemannshc.usc.edu/counseling

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

National Suicide Prevention Lifeline - 1 (800) 273-8255 – 24/7 on call

suicidepreventionlifeline.org

Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

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

engemannshc.usc.edu/rsvp

Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office of Equity and Diversity (OED) | Title IX - (213) 740-5086

equity.usc.edu, titleix.usc.edu

Information about how to get help or help a survivor of harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants. The university prohibits discrimination or harassment based on the following protected characteristics: race, color, national origin, ancestry, religion, sex, gender, gender identity, gender expression, sexual orientation, age, physical disability, medical condition, mental disability, marital status, pregnancy, veteran status, genetic information, and any other characteristic which may be specified in applicable laws and governmental regulations.

Bias Assessment Response and Support - (213) 740-2421

studentaffairs.usc.edu/bias-assessment-response-support

Avenue to report incidents of bias, hate crimes, and microaggressions for appropriate investigation and response.

The Office of Disability Services and Programs - (213) 740-0776

dsp.usc.edu

Support and accommodations for students with disabilities. Services include assistance in providing readers/notetakers/interpreters, special accommodations for test taking needs, assistance with architectural barriers, assistive technology, and support for individual needs.

USC Support and Advocacy - (213) 821-4710

studentaffairs.usc.edu/ssa

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity at USC - (213) 740-2101

diversity.usc.edu

Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call

dps.usc.edu, emergency.usc.edu

Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-120 – 24/7 on call

dps.usc.edu

Non-emergency assistance or information.