

**Department of Materials Science and Engineering
University of Maryland, College Park**

ENMA 472; ENMA 672: Additive Manufacturing of Materials

Course Information

Catalog Description: Additive manufacturing approaches for metals, ceramics and polymers will be explored in terms of manufacturability and how processing parameters affect microstructure and properties. The course will include projects, including a Terrapin Works project to design and build a part, to develop an understanding of the current state of additive manufacturing, its future promise and its limitations.

Focus: Additive manufacturing approaches for metals, ceramics and plastics to develop the shape, microstructure, properties and performance for a specific application.

Prerequisites: ENMA 300 and permission of the department.

Proposed Textbook: B. Radi and A. El Hami, Material Forming Processes: Simulation, Drawing, Hydroforming and Additive Manufacturing, John Wiley and Sons, 2016, ISBN: 978-1-84821-947-2

The textbook will be supplemented by readings from the literature because additive manufacturing is still a rapidly evolving technology.

Instructor: Prof. Isabel Lloyd

Class Schedule: Tuesday and Thursday, 5-6:15 pm, 2136 CHE; Lab exercises will be in MEMIL (1135 KIM)

Course Description, Goals, and Expectations

Course Objectives

The main objectives of this course are to (1) learn about the different types of additive manufacturing techniques and the types of materials for which they are appropriate; and (2) understand the relationship between additive manufacturing processes and structure, properties and performance relationships in engineering materials. A student completing this course satisfactorily should be able to:

- 1) Identify an appropriate additive manufacturing approach for a specific type of material and application.
- 2) Understand how various additive manufacturing approaches affect microstructure, properties and performance.

Topics

1. Introduction
2. 3D Printing of Polymers
 - a. Layer by layer deposition
 - b. Fused deposition of thermoplastics
 - c. Ink jet printing of gels and resins
 - d. Printing of particle filled polymers; post-printing processing
 - e. Characterization
3. Powder layer approaches
 - a. Binder addition followed by sintering (metals and ceramics)
 - b. Selective layer sintering or melting (polymers, metals, ceramics)
 - c. Direct laser sintering of metals
 - d. E-beam techniques
 - e. Post-processing
 - f. Characterization
4. Wire feed of metals

Contribution of the course to the professional component

This course is a Specialization Elective in Materials Science and Engineering. It focuses on the relationships between processing, manufacturing, structure, properties and performance in polymers, metals and ceramics.

Relationship of course to program objectives

This course is a Specialization Elective focused on relating fundamental relationships between structure, properties, processing and performance to practical manufacturing approaches.

Course Procedures and Policies

Grading

Project 1	10% Literature based project
Project 2	10% Computer model
Project 3	10% Mechanical testing of parts manufactured at Terrapin Works
Project 4	20% Terrapin Works project (UGs team; G individual)– design, print and characterize polymeric samples
Homework	15%
Midterm	15%
Final Exam	20%

Homework and Projects

Homework and projects are intended to give students the opportunity to problem-solve, reflect on concepts, and apply critical thinking and course concepts to realistic problems. At least one of the projects will be team based to provide a design and manufacturing experience more like that often seen in industry. Assignments and exams will be modified for graduate students.

Participation: Participation and attendance are important. Some classes will be lectures but others will focus on group problem solving and project presentations.

Exams: Exams will focus on concepts and students will be allowed to use self-generated study sheets.

University Policies and Resources

Changes in policies affecting undergraduate classes and syllabi were passed by the University Senate at the end of 2015. Rather than including campus-wide policy information in individual course syllabi, they are provided on the university's page of policies and resources <http://www.ugst.umd.edu/courserelatedpolicies.html>. The page includes links to resources related to each policy. Students should familiarize themselves with these pages, particularly the new excused absence policy and the academic integrity policy.

Attendance: Regular attendance and participation in this class is the best way to grasp the concepts and principles being discussed. However, in the event a class must be missed, the University policy is available at: <https://www.faculty.umd.edu/teach/#expectations> It is important to notify your instructors if you will need to miss a class as soon as possible, generally before the class unless you are so ill you can't send an email.

Academic Accommodations: If you have a documented disability, contact Accessibility and Disability Support Services (0126 Shoemaker Hall). Each semester students with documented disabilities should apply to DSS for accommodation request forms, which you can provide to your professors as proof of your eligibility for accommodations. The rules for eligibility and the types of accommodations a student may request can be reviewed on the DSS web site at <https://www.counseling.umd.edu/ads/>

Academic Integrity: It your responsibility to be aware of the consequences of cheating, fabrication, facilitation, and plagiarism. For more information on the Code of Academic Integrity or the Student Honor Council, please visit <http://www.shc.umd.edu/SHC/Default.aspx>

CourseEvalUM Fall 2018: Participation in the evaluation of courses through CourseEvalUM is a responsibility you hold as a student member of your academic community. Your feedback is confidential and important to the improvement of teaching and learning at the University as well as the tenure and promotion process. CourseEvalUM will be open for you to complete your evaluations for semester courses sometime in December 2018. Please go directly to the website: <https://www.courseevalum.umd.edu/> to complete your evaluations. By completing all of your evaluations each semester, you will have the privilege of accessing online, at Testudo, the evaluation reports for the thousands of courses for which 70% or more students submitted their evaluations.

Instructor: Prof. Isabel Lloyd, Room 2309 CHE (Bldg. 090), illoyd@umd.edu, 301-405-5221

Office Hours: Mondays 2-3 pm, Thursdays 11-12 and by appointment (tentative)

August 28, 2018