University of Maryland, College Park
Professional Masters/Mechanical Engineering Department

ENPM636- Applied Additive Manufacturing
Summer 2023, Class Time: Tuesday 5:20 – 8:45 PM.
May 30 – Aug. 18, 2023

Last Revised Date: May 25, 2023

Course Instructors:
The course will be offered in person and online during the summer of 2023. Dr. Andres Sarmiento (AS) will be the main instructor for the course. Dr. Michael Ohadi will contribute by providing lecture materials and serving a supervisory role for the course assisting Dr. Sarmiento as needed.
Contact Informaation:
E-mail: apsc@umd.edu; ohadi@umd.edu;
Office Hours: Questions by e-mail at all times are welcome and will be responded to within 24 hrs when possible. One-to-one Zoom meetings are also welcome, but only by appointment, which can be requested through sending an email request.
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Course Description:
In-depth understanding of Additive Manufacturing (AM) fundamentals, applications, and limitations with a focus on their implementation in developing new engineering systems and identifying emerging opportunities in developing new products and processes. This course is given in two parts: Part I provides an introduction to AM technologies while focusing on enabling features of design optimization for AM, material properties in AM, and advances in computational (techniques) for AM-fabricated materials and systems. Here, the aim is to provide engineers with in-depth fundamental knowledge and tools to evaluate new opportunities in AM. Various existing and emerging AM technologies are discussed in detail, and the advantages/disadvantages of each are discussed. Part II of the course provides case studies on applications in four targeted industrial sectors, namely: Aerospace, Defense, Energy conversion/Power Generation, and Water Harvesting applications. Real-life projects will reinforce students' learning of AM-enabled advanced design and manufacturing, including AI-enabled digital design and manufacturing.

Recommended Books in Lieu of a Formal Textbook:

1. Ian Gibson et al., "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing", 2nd Edition Springer, 2015, ISBN 9781493921126. **Or** Ian Gibson et al., "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing," 1st Edition Springer, 2010, ISBN 978-1-4419-1119-3; e-ISBN 978-1-4419-1120-9.	
2. Andreas Gebhardt, "Understanding Additive Manufacturing," Hanser, 2011, ISBN 9783446425521	

Course Schedule:

The following is a tentative course schedule. All lectures are pre-recorded and students listen at their own

convenience. Live office hours on Monday and Wednesday evenings are to answer any questions you may have. Consult the course website for updated versions. The course schedule may change during the semester as circumstances arise. Any deviations on Quiz and/or Exam dates will be announced in advance.

Week	Date	Topics Covered
1	05/30	➢ Overview/Goals of the Course ➢ Introduction to Additive Manufacturing
	05/30	➢ Additive Manufacturing Process chain fundamentals ➢ Homework No 1 assigned
2	06/06	➢ Additive Manufacturing processes (powder-based)
	06/06	➢ Additive Manufacturing processes (Liquid-based) ➢ Project 1 assigned ➢ HW No 1. Solutions posted;
2	06/06	➢ Additive Manufacturing processes (Solid-based); Conventional Manufacturing Methods (CMM): Overview to compare with AM processes and their advantages
3	06/13	➢ Pre and Post processes of Additive Manufacturing ➢ Materials & material characterization with a focus on optimization for Additive Manufacturing and Computational material science ➢ QUIZ
3	06/13	➢ Additive Manufacturing in aerospace and defense, Transportation, and Water/Energy applications (Part I): Aerospace, Automotive, Electronics, Desalination, etc. ➢ Homework No 2 assigned
4	06/20	➢ Additive Manufacturing in Aerospace and Defense, Transportation, and Water/Energy applications (Part II): HXs applications with a general overview of HXs fundamentals ➢ Report I (part A) Due; ➢ Project I (part B) assigned
5	06/27	➢ AM in aerospace and defense, Transportation, and Water/Energy applications (Part III): Power and Water Applications ➢ HW No 2 Due and solutions posted
5	06/27	➢ AM Process Monitoring ➢ MIDTERM ➢ Homework No 3 assigned
6	07/04	➢ No Class, Independence Day
7	07/11	➢ Design optimization for additive manufacturing (Part I) ➢ Design optimization for additive manufacturing (Part II);
8	07/18	➢ Sensor-embedded material design and fabrication ➢ HW No 3 Due and solutions posted

9	07/25	➢ Project I (part B) Presentations ➢ Report I (part B) Due ➢ Open Discussions session ➢ HW No 4 assigned
10	08/01	➢ 3D scanning for Additive Manufacturing ➢ Machine learning and Artificial intelligence in additive manufacturing
11	08/08	➢ Future of Additive Manufacturing: Impact on Industry and Research and Engineering --Topology Optimization: Utilizing digital twin of digital design and digital manufacturing; Energy recovery and power generation at ultra-high temperatures; other emerging AM technologies. ➢ Overview of the course; Questions/Discussions session) ➢ HW No 4 Due and Solutions posted
12	08/15	**FINAL PROJECT PRESENTATION**

Grading Policy:

Final grades will be based on the following breakdown

Active engagement in the course/Class participation 10%

Quiz & MidTerm 30% (10% + 20 %, respectively)

Course Project(s) 25%

Final Exam 35%

Tentative Grading Scale:

A+: 100-96 A: 95-92 A-: 91-90

B+: 89-87 B: 86-83 B-: 82-80

C+: 79-77 C: 76-73 C-: 72-70

D+: 69-67 D: 66-63 D-: 62-60

F: below 60

Note: The above grading scale is meant to serve as a guideline

Homework:

Homework will be assigned and will be collected, but not graded. Solutions to homework will be posted on the course website. You are urged to work on the problems yourself before looking at the solutions.

Project(s)

Two projects will be assigned where require submission of a report and power point presentation summarizing the report.

Quiz:

Quiz is normally designed for duration of 25 to 30 minutes. They may include both statement type as well as problems to solve. Every quiz might involve some calculations, thus you need to have your calculator with you. You are urged to properly indicate the units of the calculated variables to receive partial credits for your solutions. This is important for all quizzes, exams, projects, and other assignments to avoid losing points that otherwise are deserved. Grading error due to lack of clarity of the paper will be strictly your responsibility.

Midterm and Final Exams:

Midterm and final exams typically consist of two parts: the first part will focus on statement type questions and the 2nd part on problems to solve. They are typically closed-book and closed-notes. However, you are allowed to have a reference sheet (earlier in the semester one side of 8.5" by 11" sheet and later in the semester both sides of 8.5" by 11" sheet. You need to have your calculator with you. The Final Exam will be cumulative and test the knowledge gained in the entire course. Mid-term will be an hour exam (55 minutes duration) and Final will be ~90-100 minutes.

Make Up Policy:

No make up will be given for quizzes. If you miss a Quiz and your excuse is accepted then the weight of that Quiz will be distributed on the remaining Quizzes. Make up for midterm or final examinations will only be given in the exceptional cases when the individual can demonstrate with proper documentations that the emergency involved was beyond his/her control. In case of any religious observance, the student must personally hand over a written notification of the projected absence in the first week of the semester.

Academic Honesty:

All students are expected to uphold the highest ethical and professional of academic honesty (see the University of Maryland Code of Academic Integrity). A violation of the UMD Code of Academic Integrity includes (but is not limited to) intentionally using or attempting to use unauthorized materials, information, or study aids in any academic exercise. Please be advised that a failure to accept and exhibit the fundamental value of academic honesty may result in a course grade of 'XF'

Course Website:

We will use ELMS (https://elms.umd.edu) as the primary site to archive lecture notes and course related materials and share information. If you are unfamiliar with ELMS Learning System, it would be a good idea to familiarize yourself with its features now. In case of any technical difficulty, please send an email to elms@umd.edu. Should you prefer assistance over the phone, you can call the OIT Help Desk at 301-405-1400. You are required to check the course website on a regular basis.

Path to Success in ENPM636:

The key factors for success in this course are to stay focused and fulfill your responsibilities. The course material is inherently cumulative such that the material learned in one session will be used in the following sessions. If you lose your focus for a day or two, it will be extremely hard for you to come back to the track. Please feel free to send your questions by e-mail any time. We will be happy to assist you as necessary.