Additive Manufacturing

Course Number: MANE 6962 — Graduate Level

Instructor: Dr. Semih Akin — **Email:** akins@rpi.edu

Semester: Spring 2026 — **Location/Time:** JEC 4309 Mon-Thr 2:00-3:20 pm

Office: JEC 5038 — **Office Hours:** By appointment

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1. Course Description

Additive Manufacturing (AM)—commonly known as 3D printing—is revolutionizing how we design and produce components across automotive, aerospace, defense, energy, and biomedical sectors. This course provides a comprehensive understanding of the underlying principles and materials involved in AM processes. The course also highlights emerging trends in smart material & 4D printing, topology optimization, solid-state AM, and in-space manufacturing, preparing students to apply AM technologies in advanced engineering applications and research.

2. Course Objectives

The main objectives of this course are to:

1. Provide an overview of major AM processes and classifications
2. Explain the physics, mechanics, and material aspects of each process
3. Develop an understanding of design for AM (DfAM) and performance evaluation
4. Introduce current and emerging industrial and research applications of AM

3. Learning Outcomes

Upon successful completion of this course, students will be able to:

- Describe fundamental principles and operating mechanisms of major AM technologies
- Compare advantages and limitations of different AM methods
- Select an appropriate AM process for given design, material, and property requirements
- Know where to access AM related resources (topical journals, 3D printing facilities and service on campus, AM related software, etc.)
- Identify critical challenges in AM and formulate research problems
- Understand the frontiers and emerging applications of AM

4. Prerequisites

There are no formal prerequisites. However, this course is intended for graduate students in engineering or applied sciences. Students are expected to have a background in undergraduate-level mathematics, physics, materials science, and solid mechanics.

5. Textbook and References

Recommended Textbooks:

- *Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing*, Ian Gibson, David Rosen, and Brent Stucker, 3rd ed., Springer, ISBN: 978-1-4939-2112-6.

Recommended References:

- *Wohlers Report*, 2025.
- *The New World of 3D Printing*, Hod Lipson and Melba Kurman, Wiley, 2013.
- *Manufacturing Processes for Engineering Materials, 6th edition*, Serope Kalpakjian, Steven Schmid, Pearson, 201.
- Selected journal articles and technical reports will be provided throughout the semester.

6. Course Topics

Introduction to Additive Manufacturing	1 week
Fundamentals of AM Technologies and Process Physics	
- Vat Polymerization (SLA, DLP, 2PP)	1.5 week
- Material Extrusion-based AM	2 week
- PolyJet and Binder Jetting	1 week
- Powder Bed Fusion (SLS / SLM)	1 week
- Directed Energy Deposition (DED)	1.5 week
Special and Emerging Topics in Additive Manufacturing	
- Smart Materials	1/2 week
- Topology Optimization and 4D Printing	1/2 week
- Solid-State AM (Cold Spray, Ultrasonic, Friction-based)	1/2 week
- In-Space Manufacturing and In-Situ Resource Utilization (ISRU)	1/2 week
Laboratory Tours and Demonstration Sessions	1/2 week
Guest Lectures	
- Prof. Tengteng Tang, *Union college*, Vat Polymerization (February 5)	1/2 week
- Prof. Daniel Walczyk, *RPI*, Composite Manufacturing (April 20)	1/2 week
Final Project Presentations	1/2 week

7. Assessment and Grading

Item	Weight	Description
Class participation and attendance	10%	Active engagement during lectures
Assignments	40%	Homework and in-class presentations
Final project presentation	20%	Design, modeling, simulation, fabrication, and testing of an AM problem
Project report	20%	A high-level report summarizing the final project findings
Peer evaluation	10%	Assessment of individual contributions within the group project

Grading Scale

A	90.0–100	**B-**	80.0–82.9	**D+**	68.0–69.9
A-	88.0-89.9	**C+**	78.0–79.9	**D**	63.0–67.9
B+	86.0–87.9	**C**	73.0–77.9	**D-**	60.0–62.9
B	83.0–85.9	**C-**	70.0–72.9	**F**	00–59.9

8. Policies and Expectations

- **Attendance:** Regular attendance and punctuality are required. Absences should be communicated in advance.
- **Participation:** Students are encouraged to engage in class discussions and contribute thoughtfully.
- **Late Submissions:** Late assignments will not be accepted without prior approval and valid justification.
- **Academic Integrity:** All work must be original. Plagiarism or cheating will result in disciplinary action consistent with RPI's policies.
- **Communication:** All announcements and course materials will be posted on the course LMS. Students are responsible for checking updates regularly.
- **Accessibility:** Students requiring accommodations should contact the instructor and the Office of Disability Services early in the semester.

9. Final Project

A team-based final project will form a significant portion of the course. Each team will design, model, simulate, and fabricate a dedicated AM problem. The project and student groups will be identified within the first week of the course. The projects will emphasize creativity, engineering rigor, and process-structure-property relationships. Deliverables include a written report and a final presentation.

10. Course Ethos

Additive manufacturing offers a paradigm shift in how engineers design and produce functional components. This course aims to instill both scientific understanding and creative confidence to enable students to design without conventional constraints.

"Engineering the future—one layer at a time."

11. Academic Integrity

Student-teacher relationships are built on trust. For example, students must trust that teachers have made appropriate decisions about the structure and content of the courses they teach, and teachers must trust that the assignments that students turn in are their own. Acts that violate this trust undermine the educational process. The Rensselaer Handbook of Student Rights and Responsibilities defines various forms of Academic Dishonesty and you should make yourself familiar with these. In this class, all assignments that are turned in for a grade must represent the student's own work. All assignments outside of class must be completed individually and without aid from Artificial Intelligence (AI) software/programs unless prior approval is granted by the instructor.

12. Diversity, Equity, and Inclusion

We will strive to provide an environment that is equitable and conducive to achievement and learning for all students. We ask that we all be respectful of diverse opinions and of all class members, regardless of personal attribute. We ask that we all use inclusive language in written and oral work, and in the classroom. School of Engineering (SoE) policy is that no students, faculty and staff shall be excluded on the grounds of gender, race, class, religion, sexuality, disability, etc. The free exchange of ideas, as well as diversity of background, experience, and views contributes to the learning experience, and further broadens and adds strength to our learning community. All participants in this course are encouraged to recognize the diversity around them and are expected to treat their classmates, TAs, and instructor with respect. Disrespectful, harmful, offensive, bigoted, or violent language or behavior will not be tolerated. We are committed to ensuring full participation of all students in this course. If you have a documented disability (or think you may have a disability) and, as a result, need a reasonable accommodation to participate in this class, complete the course requirements, or benefit from the Institute's programs or services, contact the Office of Disability Services for Students (DSS) as soon as possible. To receive any academic accommodation, you must be appropriately registered with DSS. After registration, contact me as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion. DSS contact information: dss@rpi.edu; 518-276-2231, 4226 Academy Hall.

13. Disability Services

Rensselaer Polytechnic Institute strives to make all learning experiences as accessible as possible. If you anticipate or experience academic barriers based on a disability, please let me know immediately so that we can discuss your options. To establish reasonable accommodations, please register with The Office of Disability Services for Students. After registration, make arrangements with the Director of Disability Services as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion. DSS contact information: dss@rpi.edu; +1-518-276-8197; 4226 Academy Hall.

14. Detailed Course Schedule

Lecture #	Date	Topic	Notable Items
1	Monday, 01/12	Course Introduction & Semester Overview	Homework I - Due Wed 01/14 by noon
2	Thursday, 01/15	Introduction to AM	Team and topic assignment for final project
3	Monday, 01/19	No Class Follows Monday schedule	
4	Thursday, 01/22	Introduction to AM (Continue)	
5	Monday, 01/26	Vat Polymerization	
6	Thursday, 01/29	Vat Polymerization (Continue)	
7	Thursday, 02/02	Project Work / Meet with Prof. Akin	Team updates on final project
8	Monday, 02/05	Guest Lecture Prof. Tengteng Tang	Guest lecture on Vat Polymerization
9	Monday, 02/09	Material Extrusion Part I – Fused filament fabrication	
10	Thursday, 02/11	Material Extrusion Part II – FFF modeling & Direct-ink writing	
11	Tuesday, 02/17	Material Extrusion Part II – Direct-ink writing – cont.	President day
12	Thursday, 02/19	Project Work / Meet with Prof. Akin	Team updates on final project
13	Monday, 02/23	Polyjet	
14	Thursday, 02/26	Binder jetting	
Spring Break March 2 - March 6			
15	Monday, 03/09	Powder Bed Fusion	
16	Thursday, 03/12	Powder Bed Fusion (Cont.)	
17	Monday, 03/16	Directed Energy Deposition	

18	Thursday, 03/19	Directed Energy Deposition (Cont.)	
19	Monday, 03/23	Project Work / Meet with Prof. Akin	Team updates on final project
20	Thursday, 03/26	Laboratory tours	CII Highbay, Metal AM Facility
21	Monday, 03/30	Special Topic I	Smart Materials
22	Thursday, 04/02	Special Topic II	Topology optimization and 4-D Printing
23	Monday, 04/06	Special Topic III	Solid-State AM
22	Thursday, 04/09	Special Topic IV	In-Space Manufacturing and ISRU
25	Monday, 04/13	Team time → Project Work – Execution	
26	Thursday, 04/16	Team time → Project Work – Execution	Project update
26	Monday, 04/20	Guest Lecture Prof. Daniel Walczyk	Guest lecture on Composite manufacturing
27	Thursday, 04/23	Team time → Project Work – Execution & Course wrap session	
29	Monday, 04/27	Team time → Project Work – Execution & Course wrap session	Project update
30	TBD	Final Project Presentations; Final Peer Evaluations	Final Peer evaluations due to Prof. Akin at akins@rpi.edu
TBD	TBD	Final Project Reports	Send to Prof. Akin at akins@rpi.edu