Instructor: Dr. Guha Manogharan  
232 Reber Bldg. (Tu and Thu)  
113, 230 Innovation Blvd (M W and Fr)  
Telephone: 863-7273  
Email: gum53@psu.edu  
Office hours: by Appt.

Location: Th 11:15AM – 2:15 PM  
Leonhard Bldg 231

Note: Depending on the lab activity, the class will meet at different locations on-campus  
(See Calendar). Announcements on meeting locations will be announced via canvas.

Web site for general project resources and information:
- AMD Program: http://www.amdprogram.psu.edu/  
- Learning Factory: http://www.lf.psu.edu/  
- CIMP-3D: http://www.cimp-3d.org/  
- Material Characterization Lab (MCL): https://www.mri.psu.edu/materials-characterization-lab  
- Center for Quantitative Imaging (CQI): http://eesl.iee.psu.edu/content/cqi

Course Description:
This course will provide in-depth and hands-on laboratory experience in additive manufacturing with a focus on metallic-based components. Laboratory activities will include part design and analysis, process simulation and modeling, build preparation and machine set up, part fabrication and post-processing, and non-destructive inspection and measurement. Through these laboratory activities, students will be exposed to all aspects of the additive manufacturing workflow and learn how metal-based additive manufacturing differs from polymer-based 3D printing.

Course Objectives: Upon completing this course, students should be able to:
The objectives in this course are to enable the students to:
1. Describe the workflow for metal-based additive manufacturing from start to finish  
2. Define key cost drivers for production with additive manufacturing  
3. Design parts for metal-based additive manufacturing using appropriate computer-aided design software  
4. Use analysis tools and simulation models to evaluate tradeoffs in metal-based additive manufacturing  
5. Develop a build plan that balances build time, cost, and part quality  
6. Define post-processing needs for metallic components fabricated using different additive manufacturing processes  
7. Perform non-destructive inspection of a metallic component fabricated with additive manufacturing

Pre-requisites: IE 527 or IE 597J or equivalent Concurrent: MatSE 567, EDSGN 562


Grading Table: Final grade will be based on:

<table>
<thead>
<tr>
<th>Item</th>
<th>Team or Individual Evaluation</th>
<th>Final Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presentations</td>
<td>5% Team &amp; 5% Individual</td>
<td>10%</td>
</tr>
<tr>
<td>Project Proposal/Statement of Work Report</td>
<td>Team</td>
<td>10%</td>
</tr>
<tr>
<td>Mini-Project Reports</td>
<td>Team</td>
<td>30%</td>
</tr>
<tr>
<td>Final Project Report</td>
<td>Team</td>
<td>15%</td>
</tr>
<tr>
<td>Professionalism</td>
<td>Individual &amp; Team</td>
<td>5%</td>
</tr>
<tr>
<td>Peer Evaluations</td>
<td>Individual</td>
<td>15%</td>
</tr>
<tr>
<td>Project deliverables evaluation</td>
<td>Team</td>
<td>15%</td>
</tr>
</tbody>
</table>

Grade Distribution:  
- A: 92 or greater
Course Policies:

- **Academic Integrity:** The University defines academic integrity as the pursuit of scholarly activity in an open, honest, and responsible manner. All students should act with personal integrity; respect other students' dignity, rights and property; and help create and maintain an environment in which all can succeed through the fruits of their efforts (refer to Senate Policy 49-20). Dishonesty of any kind will not be tolerated in this course. Dishonesty includes, but is not limited to, cheating, plagiarizing, fabricating information or citations, facilitating acts of academic dishonesty by others, having unauthorized possession of examinations, submitting work of another person or work previously used without informing the instructor, or tampering with the academic work of other students. Students who are found to be dishonest will receive academic sanctions and will be reported to the University's Office of Student Conduct for possible further disciplinary sanctions (refer to Senate Policy G-9).

In this course, students are expected to work together with their team on most assignments including progress reports, written reports, and presentations. There are some assignments which are to be done individually (i.e. each student is required to submit his or her own original work). The expectations for each assignment will be made clear by the instructor and/or the assignment form. If you have any questions as to which assignments are to be done individually, please ask.

Regardless of the nature of the assignment, plagiarism is strictly prohibited. An example of behavior that is considered plagiarism is submitting a written assignment that includes text taken directly from another source and/or pictures that are not properly referenced. If you have any questions as to how to properly reference material taken from another source, please ask. When you utilize information gleaned from other sources, cite those sources appropriately within your document. Proper citation provides your document with credibility and allows you, as the author, to be able to verify the source of your data or statements in the event anyone questions the validity. In the long run, source citation helps you and makes your document more professional. Throughout all of your work in this class, please do not be a cheater. If you encounter others operating in an unethical manner and would like to bring this to my attention, please discuss this with me in person or send me an email. If you would like to do this anonymously, there are several online tools from which you can send anonymous emails. I will do my best to investigate the situation and determine a proper course of action.

- **Professional Ethics:** The engineering profession, like the medical profession, must hold itself to high standards to ensure safety for the users of the products it designs. Engineers abide by several different codes of ethics including the prominent American Society of Mechanical Engineers ([https://www.asme.org/getmedia/7cbbdb0b-93f9-476c-9632-c8a9370f6632/SocietyPolicies_15-7_Ethics.aspx](https://www.asme.org/getmedia/7cbbdb0b-93f9-476c-9632-c8a9370f6632/SocietyPolicies_15-7_Ethics.aspx)) and the National Society of Professional Engineers ([http://www.nspe.org/resources/ethics/code-ethics](http://www.nspe.org/resources/ethics/code-ethics)) Code of Ethics.

In addition to the safety aspect of your profession, also strive to be a trusted team member with integrity within your project team. You should understand your role and responsibility for tasks within the project. Most projects within this course do not have an over-abundance of personnel resources (as is typical in the professional world). The success of the project depends on competent contribution from each and every team member. Anyone that is not pulling their weight, regardless of cause, is causing the team’s ultimate product to be inferior, thereby reflecting poorly on the team, the company, and in this setting, the University. Successfully executing a project requires the dedicated input from every member.

- **Deadlines:** As part of this course’s mission to transition you from the academic setting into a professional setting, we will utilize as many professional nuances as possible. Deliverables in the professional world almost always have a defined deadline. So too will assignments in this course. Unless otherwise specified in the assignment form, assignment submission materials are due BEFORE 5pm the day they are due (I will always accept your submission early!). Late submissions will NOT be accepted.

- **Grading Scale & Grading Disputes:** If a student feels that a report or homework was graded unfairly or in error, bring it to the instructor’s attention within one week after the graded material was handed back. Scores will not be reconsidered after this time.

- **Attendance:** Attendance is expected at the start of each class. Inform the instructor and teammates in writing prior to any anticipated legitimate absences. **Two absences w/o a reasonable excuse is one letter grade**
Additional Course Requirements:

- **Project Journal:** One team member is responsible for organizing and maintaining a project journal throughout the semester. This also can be an E-Notebook using Box, Google Groups, Windows Journal®, or Microsoft Office OneNote®. Drawings, concepts, ideas, & anything discussed regarding the project with dates & initials of those present will be documented. The journal is a working document so neatness is not important though it must be legible and dated.

- **Weekly Project Team Meeting:** Each project team must establish and attend a weekly meeting outside of normal class time. This meeting will give the team a defined occasion each week to coordinate their tasks and ensure all team members are actively engaged.

- **Labor Division:** After the groups have formed, members will prepare a document showing division of labor and ground rules. This will be documented in your Journal. Again, teamwork is essential in this class.

- **Literature Search:** This provides you with background information and a summary of what has been previously done on the topic. The engineering library is a good place to start the literature survey and google scholar is also an excellent source

- **Resources:**
  - **Computational:** Leonhard, Reber, Hammond, ICS Hammer and Open Source
  - **Machining:** Learning Factory, FAME Lab (Hammond) and upon prior approval at the SHAPE Lab (127, 230 Innovation Blvd)
  - **Polymer AM:** Maker commons, Hammond, Learning Factory and Reber Bldg
  - **Metal AM:** CIMP-3D (230 Innovation Blvd)
  - **Material Characterization:** MCL - MSC

- **Project Proposal Report:** This report, also called a Statement of Work should include executive summary, problem statement, literature/patent searches, project objectives, preliminary design concepts with 3 or more alternatives, budget estimates, Gantt charts, citations etc. You will be graded on the Title Page, Table of Contents, Executive Summary, Problem Statement, Technical Approach, Project Management, Deliverables, Budget and References.

- **Mini-Project Reports:** There will be 3 mini-project reports: (1) Reverse Engineering and Polymer AM, (2) Laser AM simulation studies and (3) Material Characterization report.

- **Presentations:** These presentations will be judged by the instructor (1/3) and by the students (2/3) on preparation, visual aids, stage presence, and overall effectiveness. Each presentation will be about 3 minutes for Proposal and 4 minutes for the Final Report with the team’s total presentation about 15 minutes with class discussion and reflection afterwards included. Time allotted may vary depending upon groupings and number of groups.

- **Final Report:** This report should include information from the project with updated solid models, updated shop drawings, unit pictures, test results plus, final budget, results, construction details, manufacturing considerations and improvements, conclusions and recommendations.

- **Professionalism:** You should conduct yourself with high professional standards and have an ethical and positive social interaction with the team members, lab personnel and instructor. Hence, being a team player and acceptance of responsibility and respect for others will be graded. Respect yourself and those around you. Use appropriate language and be sensitive to others.

- **Safety:** Start the Learning Factory training class within the first month unless certification from courses/projects is verified. Be advised that things always take longer than expected, especially since testing or machining is involved, so don’t rush a job and cause an accident. Also, never believe the results of computer simulation unless some other verification method is employed such as experimentation or back-of-the-envelope calculation.

For the MCL portion of the lab, students need to complete EHS pre-lab training: [https://www.mri.psu.edu/mri/safety/training-requirements](https://www.mri.psu.edu/mri/safety/training-requirements)