MIE1724: Additive Manufacturing in Engineering Applications

Department of Mechanical & Industrial Engineering

School of Graduate Studies, University of Toronto

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The aim of this course is to help students understand the concepts of AM and their role in design and fabrication of complex structures. Also, the course will introduce state-of-the-art approaches to "3D printing", which is the more common term to the more professionally utilized "Additive Manufacturing" (AM) term. Students will be able to follow a design paradigm through careful analysis of complex structures and complete an AM process flow through CAD conceptualization, conversion to STL files, transfer to AM machine, machine conditioning, removal/clean up and post-processing. Also, design for AM (DfAM) is introduced to optimize product fabrication, controlled by part orientation, support design, hollowing out components, constraining features/undercuts, interlock structures and multi-material compatibilities. Case studies will be introduced with AM for investment casting and part fabrication without a conventional CAD file, with focus on medical modeling and reverse engineering data. In recent years, new approaches to AM solutions have produced a large range of controllability and size ranges. Examples of emerging technologies are Multi-Jet Printing (MJP), AM+CNC, two-photon lithography (for nanoscale AM) and Volumetric 3D Printing. Ultimately, students will be able to apply and scale models from the most focused technical perspective to eventual AM fabrication of complex lightweight designs… and never rely on randomized approaches to AM.

Class Hours: Wednesday, 12:30pm-3pm (EST), delivered online through BBcollaborate.

Contact: by email radhiali@mie.utoronto.ca

Office Hours: By appointment

Recommended Textbook: **A**dditive Manufacturing Technologies, Ian Gibson, David Rosen, Brent Stucker, 2nd Edition.

Marking Scheme:

Project 100%

- *AM Project Proposal* *10%*
- *Midterm project review* *40%*
- *Final Project Report* *50%*

Due dates are TBD.

Major course sections:

1. Introduction to Additive Manufacturing
    - Background on Additive Manufacturing
    - Target Applications of Additive Manufacturing
    - Impact of Additive Manufacturing
2. Overview of Additive Manufacturing Technologies
    - Generalized Additive Manufacturing Process Chain
    - Types of Additive Manufacturing Technologies
    - Additive Manufacturing Technology's workflow
    - Variations with other Technologies
    - Challenges of Additive Manufacturing
    - Available facilities
3. Software & Additive Manufacturing
    - File Formats in Additive Manufacturing
    - Design for Additive Manufacturing
    - Additional CAD Tools in Additive Manufacturing
4. Fused Deposition Modeling (FDM)
5. Stereolithography (SLA)
6. Selective Laser Sintering/Melting (SLS/SLM)
7. 3D Architectured Structures, Smart Materials & Additive Manufacturing
    - Overview of Cellular solids/Architectured structures
    - Stimuli-responsive smart materials & Metamaterials
    - AM advances in smart/architectured structures fabrication
8. Micro/Nano Additive Manufacturing
    - Overview of featured technologies
    - Target applications in Micro/Nano AM
    - Future Trends in Micro/Nano Additive Manufacturing
9. Emerging Additive Manufacturing Technologies
    - Ink-based 3D printing
    - 3D bioprinting & food 3D printing
    - Hybrid/advanced AM approaches
10. Special topics in Additive Manufacturing
    - Security issues of 3D printing
    - Education, employment, and makerspace movement through 3D printing
    - Large-scale 3D printing
    - Modeling approaches of AM
    - Automation
    - Impact on high target applications (medicine, military, architecture, etc.)