Think before you print any material. Save climate. If you need to print, use multiple slides/page; both side printing.

green course 2015/2016

Department of Materials Science& Engineering, University of Toronto

Process Simulation and Computer Design (MSE455): Winter 2020

Contacts: Instructor Ali Asgarian
ali.asgarian@utoronto.ca (Include MSE455 in subject line)

EA 201 (by email appointment only)

TAs Arthur Sloan arthur.sloan@mail.utoronto.ca

&

The second TA to be introduced soon

Course title: Process Simulation and Computer Design
Code: MSE455H1
Credit: 0.5
Prerequisite: High school physics and chemistry, First year Physical Chemistry, Thermodynamics, Heat and Mass Transfer

Recommended books/material

Main required text

1. Fluid Mechanics, I.G.Currie
2. Heat and Mass Transfer, Incropera & Dewitt

Other recommended texts

1. ANSYS/FLUENT Lecture Notes

Calendar description:

Various production processes use simulation software to shorten the route from the initial design to finished product. Simulation software provides the designer and practicing engineer with a powerful tool in the tasks of improving and optimizing the industrial processes. Expensive trials can be avoided and the quality of the finished product secured from the beginning of production. First, this course will cover the basics of the process simulation used in industrial setting. Subsequently, the course will focus on industrial process simulation software used extensively in foundry industry worldwide. Essential elements of CAD/CAM techniques will be covered. Numerical simulation of the filling and solidification in castings will be presented. Calculation of foundry processes with multiple production cycles will be analyzed. Another course feature will be the graphical presentation of the results on the screen. Limited enrolment.

Why it this course important?

Simulation is an ever important skill to be competitive in the market place, and this course trains the students to be familiar with popular simulation software used in the industry. The students learn and apply ANSYS fluid dynamics simulation to common materials science problems.

Industrial Relevance:

Every industry uses simulation today to understand process and product development. The students are ready to use ANSYS on the job after they finish this course.

Green Course: This course has been certified as a "*Green Course"* by the UofT Sustainability office, and works towards reducing the carbon footprint by using a common-sense approach. To achieve this, we utilize online grading, online course materials. The student are highly encouraged **NOT** to print the course material, unless really necessary; and find ways to save paper and our climate.

Overall Learning Outcomes:

- **Understand** the basic concepts (drawing, meshing, boundary conditions and solving) of process simulation
- **Apply** the basic concepts to problems related to metallurgy and materials science
- Be able to **understand and interpret** simulation results and perform what if and root cause analysis
- Basic **understanding** of fluid dynamics simulations
- **Understand** Finite Volume Techniques
- **Apply** all the above concepts to some relevant industrial examples

Pre–requisite Knowledge:

- Heat and Mass Transfer
- Thermodynamics
- First year physical chemistry

Composition:

Lecture in Class	1 hr/week	SF 3201
Lecture in Lab hours	2 hr/week	GB 150
Tutorial hours	2hr/week	MY 030
Office hours	(by email appointment only)	

Timetable:

Please check UofT Course Finder

Assessment and Grading

Grading Scheme

Attending and Submitting all Tutorial Assignments	20%
Midterm Project 1	15%
Midterm Project 2	15%
Final Project	50%

- Assignments (**Will be given in Tutorials/Lectures for practice by students. They must be submitted to the TA by email or via Quercus)**

- Tutorials: Tutorials will be focused on real examples, hints for solving the assignments, and some practice problems. All these will help you for the midterms and finals.

Missed content — There will be no makeup assignments or tests, except in cases of medical emergencies. In those cases, missed content will likely have that portion of the mark deferred to the final

exam. If so, you must inform the instructor within 24 hours and provide supporting documentation as per U of T policies.

Late submissions: 10% deduction per day after the deadline. In rare cases, the instructor can extend the deadline through in-class or portal announcement.

Academic Policy: http://www.students.utoronto.ca/The_Basics/Academic_Honesty.htm
http://www.utoronto.ca/govcncl/pap/policies/behaveac.html

Topics and number of lectures

Drawing and Designing	3
Meshing	3
Introduction to CFD	3
Boundary Conditions	3
Heat Transfer	4
Turbulent Flows	4
Multiphase Flows	4
Application of Turbulent Flows	4
Application of Discrete Phase Flows	4
Review	3

Syllabus and Weekly Learning Outcomes

Week	Topic	Learning Outcomes
Week 1	Introduction	The students will learn on why simulation is important and what value it offers to the industry and real world.
Week 2	Drawing using basic CAD tools in ANSYS	The students are expected to learn • The purpose of ANSYS Workbench • Basic use of Workbench • How to share data between applications • Working with files, and archiving and restoring projects • Performing parametric analyses
Week 3	Meshing in ANSYS	The students are expected to learn • Process for pre-processing using ANSYS tools • What is the ANSYS Meshing? • Meshing Fundamentals • How to launch ANSYS Meshing? • ANSYS Meshing interface • Geometry concepts • Meshing methods

Week 4	Fluid Flow & Turbulence	All CFD simulations follow the same key stages. This week will explain how to go from the original planning stage to analyzing the end results. The majority of engineering flows are turbulent. Simulating turbulent flows in ANSYS requires activating a turbulence model, selecting a near-wall modeling approach and providing inlet boundary conditions for the turbulence model. The students will learn: • How to use the Reynolds number to determine whether the flow is turbulent • How to select the turbulence model • How to choose which approach to use for modeling flow near walls • How to specify turbulence boundary conditions at inlets
Week 5	Heat Transfer	The students are expected to learn • Conduction • Forced Convection • Natural Convection • Radiation (including Solar Load) • Porous Media • Additional material: Heat Exchangers
Week 6	Discrete Phase Flow	In discrete phase flows , individual particles are treated as rigid spheres (i.e., neglecting particle deformation and internal flows) being so small that they can be considered as point centres of mass in space. The students will learn on • The translational motion of the particle is governed by the Newton's second law • The DPM is strictly valid for simulating dispersed multiphase flows containing a low (<10%) volume fraction of dispersed phase.
Week 7	Multiphase Flow	Multi-phase flows is simply any fluid flow system consisting of – Two or more distinct phases flowing simultaneously in mixture, and – Have some level of phase separation at a scale well above the molecular level • Multi-phase flows exist in many different forms. Two-phase flows can be classified according to the state of the different phases – Gas-Liquid mixture, – Gas-solid mixture, – Liquid-solid mixture, and – Immiscible-liquid mixture
Week 8	Application to Polymer flows	Applying the concepts of heat transfer, and fluid flow to a real life industrial problem. The students will solve a problem in polymer flows through a pipeline.
Week 9	Application to Ladle Refining	Applying the concepts of discrete phase flows, heat transfer, and fluid flow to a real life industrial problem. The students will work on a problem on ladle refining and mixing.

Week 10	Application of all modules for final project	Applying knowledge from all aspects of the course to their final project
Week 11	Application of all modules for final project	Applying knowledge from all aspects of the course to their final project
Week 12	Guest Lecture/s from Industry	Speakers from industry come in and show the students how they apply simulation in their everyday business and how much value it can offer. Students will be able to appreciate the value of simulation in industry
Week 13	Review	Discussions and Review of above mentioned topics