Spring 2026-MSE 441-Metals Processing-Section A

Dear Metallurgy enthusiasts, welcome to MSE 441, Metals Processing.

About the class : The content presented is constantly evolving year after year just like the field, and I am excited to share my passion about the processing of metallic materials, which is a fascinating and multi-faceted topic. While it would take many years to cover all aspects of metals processing in details, I selected the most important ones that are relevant in today's society. The intent of this course is to give you adequate basis in this field for you to understand its grand challenges so you can continue learning on your own and deepening your knowledge in your future job, personal projects, etc.

Background : The course naturally follows up on core MSE classes such as MSE 401, 402, 405, and 406. MSE 443 surveys almost all engineering alloys around you and is not a pre-requisite at all, but if you're interested in metals, I recommend for you to take this class next Fall.

Seeking help:

Office hours: Thursdays 4-6PM

Marie's office: MSEB 408A | email: mcharp@illinois.edu

Teaching assistant: Kenyi Hernandez, PhD candidate in Professor Bellon's laboratory

We meet on M/W/F in LuMEB 2200 from 11:00-11:50. **I strongly recommend coming in to class** because the slides I share with you in Canvas are 50% incomplete so you can take your own personal notes.

Content : there are 4 modules in MSE 441, focused on **Metals extraction, Solidification, Solid-state processing** (i.e. forging and heat treatment), and **Additive Manufacturing**. They are of different lengths, according to the breadth of concepts we have to cover. The schedule looks as follows [subject to change throughout the semester upon class progress]

			Lecture schedule	Assignment schedule
W	21	Jan	Complete pre-class survey.	
F	23	Jan	Intro I: Syllabus & logistics	

M	26	Jan	**Module 1 Extractive Metallurgy** 1. Extraction techniques & copper processing	
W	28	Jan	2. The chemistry of Steel making	
F	30	Jan	3. Introduction to Ellingham diagrams	
M	02	Feb	4. Using Ellingham diagrams in practice	
W	04	Feb	5. In-class homework correction and exam preparation session	*** HW 1 due Tuesday Feb 3rd 11PM**
F	06	Feb	6. Case study of oxide reduction: glazing ceramics	
M	09	Feb	*** Exam 1: extractive metallurgy**	
W	11	Feb	**Two lectures on microstructures:** I. Introduction to crystal lattices, phases, composition and phase diagrams. Metallographic preparation for contrast in optical microscopy.	
F	13	Feb	**Two lectures on microstructures:** II. Observing microstructures. Orientation and chemical mapping in electron microscopy: diffraction, EBSD, EDX.	
M	16	Feb	*** Quiz: 20 mins comprehensive on microstructure determination** **Module 2: Theory of solidification and casting** 1. Casting techniques	
W	18	Feb	2. Solidification of single-phase solids: nucleation	

F	20	Feb	3. Crystal growth: crystallographic aspects	
M	23	Feb	4. Alloy solidification: Scheil model and equations	
W	25	Feb	5. Alloy solidification: constitutive undercooling and segregation aspects	
F	27	Feb	6. Controlling microstructures in castings	
M	02	Mar	7. Casting defects and remedies	*** HW 2 due Tuesday March 03 11PM**
W	04	Mar	8. In-class homework correction and exam preparation session	
F	06	Mar	9. Guest lecture 1: industry example	
M	09	Mar	*** Exam 2: Solidification, includes comprehensive questions about guest lecture**	
W	11	Mar	Two lectures on environmental attack: I. oxidation	
F	13	Mar	Two lectures on environmental attack: II. corrosion, guest lecture 2	
M	**16**	**Mar**	**Spring Break - not much happening**	
W	**18**	**Mar**	**Spring Break**	
F	**20**	**Mar**	**Spring Break**	
M	23	Mar	**Module 3: Solid state processing** 1. Why processing in the solid-state? Rolling and deformation in the solid-state	

W	25	Mar	2. Recrystallization: theory	
F	27	Mar	3. Recrystallization: modeling	
M	30		4. Precipitation hardening: theory	
W	01	Apr	5. Precipitation hardening: models	
F	03		6. Case study: calculating strengthening in age-hardenable alloys	
M	06		7. Case study in class: jewelry making	***HW 3 due Tuesday March 5 11PM**
W	08	Apr	8. Homework correction in class	
F	10	Apr	9. Guest lecture from industry	
M	13	Apr	*** Exam 3: Solid-state processing, includes comprehensive questions on guest lecture**	
W	15	Apr	**Module 4: Laser Additive Manufacturing** 1. Overview, AM techniques and their challenges	
F	17	Apr	2. Laser welding: rapid solidification	
M	20	Apr	3. Energy density, processing maps and defects	
W	22	Apr	**Visit:** Additive manufacturing in Marie's laboratory at MRL	
F	24	Apr	4. Guest lecture: laser cladding	
M	27	Apr	5. Microstructure control in additive manufacturing	

W	29	Apr	6. ***20 mins Quiz on Guest lecture on laser cladding** | Quiz preparation in class	
F	01	May	7. Guest lecture from industry	
M	04	May	*** Exam 4: additive manufacturing**	
W	06	May	Last day of class: open questions, send-off	

Grading : You will be evaluated on homeworks (30%), a comprehensive quiz (5%), 4 written exams (60%) and your participation in the class (5%).

Grading policies: You are expected to have read the Student Code section related to Academic Integrity . All infractions listed in the Student Code, including cheating and plagiarism, will result in penalties in accordance with the Student Code.

This includes the use of AI, which is strictly prohibited in this class and will result in a 0% grade on any assignment where it is detected. I work hard to create a customized and interactive class so you can learn proactively about metals processing, hence I expect you not to attempt and bypass this process with AI, this is in your own interest. **See university policies on AI.**