CME 568: PHASE TRANSFORMATION IN MATERIALS

Online Synchronous

Synchronous Class Meetings: Thursdays 5 - 7:30 pm

Instructor & Contact Information

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Course Schedule

Thursdays 5 - 7:30 pm (Online Synchronous via Blackboard Collaborate)
Delivery: Synchronous meetings will be held at the scheduled times using Blackboard Collaborate. Synchronous meetings will also be recorded and posted to Blackboard for students who are unable to attend.
Office Hours: After online synchronized lectures on Thursdays or by appointment via email.

Grading Scheme

Problem Sets (4 or 5)	30 % (Lowest grade will be dismissed, even weighting)
Midterm Examination	20 %
Final Examination	30 %
Project (3)	20 %

Important dates

Midterm Examination	March 18, Thursday, 5 - 7:30 pm
Final Examination	May 6, 24-hour take-home starting at 5 pm

Students who have a conflict with the midterm/final examination date and time should notify the instructor by the end of the first week of classes. Overlaps with other courses examinations are considered as a conflict.

Course Summary

The course is effectively divided into two parts. The first part contains the background material necessary for understanding phase transformations - thermodynamics, kinetics, diffusion theory and the structure and properties of interfaces. The second part deals with specific transformations - solidification, diffusional transformation in solids and diffusionless transformation. Case studies of engineering alloys and ceramics are incorporated to provide a link between theory and practice.
Prerequisite: No official one. An undergraduate level understanding of mathematics and physics is assumed.

Course Outline

1. Thermodynamics and Phase Diagrams
   a) Equilibrium in single component systems
   b) Multi-component homogenous systems (binary solutions)
   c) Equilibrium in heterogenous systems – The influence of interfaces
   d) Phase diagrams
2. Kinetics of Phase Transformations
   a) Kinetics of nucleation and growth
   b) Overall transformation kinetics – TTT diagrams
3. Diffusion
   a) Atomic mechanisms of diffusion

b) Interstitial and substitutional diffusion
c) High diffusivity paths
d) Diffusion in multi-phase systems

4. Crystal Interfaces and Microstructure
   a) Interfacial free energy
   b) Boundaries in single phase solids – Thermodynamics and kinetics of grain boundaries
   c) Interphase interfaces in solids – coherency, second-phase shape, misfit strain effects
   d) Interface migration – diffusion-controlled vs. interface-controlled growth
5. Solidification
   a) Homogenous vs. heterogenous nucleation
   b) Growth of pure solids
   c) Alloy solidification
   d) Eutectic solidification
   e) Case studies with simulations using the Thermo-calc software
6. Diffusional Transformation in Solids
   a) Homogenous nucleation in solids
   b) Heterogenous nucleation – role of grain boundaries, dislocations and vacancies
   c) Precipitate growth
   d) Eutectoid transformation
   e) Ordering transformation
   f) Case studies with simulations using the Thermo-calc software
7. Diffusionless Transformations in solids
   a) Theories of Martensitic nucleation
   b) Martensitic growth
   c) Pre-martensitic phenomena
   d) Case studies with simulations using the Thermo-calc software

Main Textbook
David A. Porter and Kenneth E. Easterling, *Phase Transformations in Metals and Alloys*, 2nd Edition Available at the UIC bookstore and 2 copies are on reserve at the Daley library (copy 1 call number: TN690 P598 1992). Students will be given a one-day loan period for reserve materials. And once returned, materials will be quarantined for 3 days.

Other Reference Books
1. Nestor Perez, *Phase Transformation in Metal, Mathematics, Theory and Practice, Springer*
2. Umantsev, Alexander, *Field Theoretic Method in Phase Transformations*

Technology Requirements/Blackboard Use:
Online students will need regular access to a personal computer that runs on stable Internet connection. Blackboard will be used to distribute all course materials, for the submission and return of graded assignments, and for the communication of grades. Midterm and final exam will be distributed and collected using Blackboard. Expect to use blackboard for all information sharing and deliverable submission in this course, except when noted otherwise.

Attendance Policy
Attendance in synchronous meetings will be formally recorded. Attendance is not required but is highly recommended.

Academic Integrity Policy
Students are expected to complete all assignments independently. ***Please note, the posting of any course materials to any public forum, website, or discussion group is not permitted without the express***

permission of the instructor. Any unauthorized posting of materials will be treated as academic misconduct. Instances of academic misconduct by students will be handled pursuant to the Student Disciplinary Policy.

As an academic community, UIC is committed to providing an environment in which research, learning, and scholarship can flourish and in which all endeavors are guided by academic and professional integrity. All members of the campus community–students, staff, faculty, and administrators–share the responsibility of ensuring that these standards are upheld so that such an environment exists.

Disability accommodation

The University of Illinois at Chicago is committed to maintaining a barrier-free environment so that students with disabilities can fully access programs, courses, services, and activities at UIC. Students with disabilities who require accommodations for access to and/or participation in this course are welcome but must be registered with the Disability Resource Center (DRC). You may contact DRC at 312-413-2183 (v) or 773-649-4535 (VP/Relay) and consult the university resources.