MSE6043A Syllabus

Kinetics of Phase Transformation in Materials, Section A, and 3 Credits

Spring 2026

Instructor Information

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General Course Information

Description

This course is a graduate level or senior undergraduate level class on kinetics of phase transformations in materials. Phase transformation is a phenomenon of one phase, such as water, changes to another phase, such as ice. Kinetics studies how the transformation occurs and how fast it can go. Therefore, "Kinetics of Phase Transformation in Materials" will study various factors and their relations to phase transformations, such as time, temperature, pressure, stress, and free energies and entropy. Kinetics of phase transformation is in fact one of the pillars of any materials science and engineering. Understanding the principles and process of kinetics is a must for every materials science student and even every engineering student. An example is how to build a new AC not using Freons rather using CO_2! Is it possible to do it, and if not why? Imagine if we can use CO_2 ACs, the world would be a much cleaned place! To do it, you must understand why we have used Freon, and what is the technical challenge for using CO_2. Other examples include design and discovery of new biocompatible materials for bones and soft tissues - If you do not want a piece of Titanium left inside your body forever, what other materials would you consider to use so it can be absorbed and get ride of after your broken bone is healed.

This course will cover basic thermodynamics (the first-, second- and third-laws), kinetic processes such as diffusion and viscosity, interface phenomena, phase transformations, phase diagrams, and kinetic phase diagrams such as TTT diagrams.

Course Learning Outcomes

The expected outcomes of this course are therefore, the following:

- Understand or know the basic concepts (such as phase, phase equilibrium, metastability, phase transformation and phase stability) and principles (such as thermodynamic and kinetic description of phase transformations)
- Understand and know the basic relations of various factors such as temperature, pressure, stress, heating and cooling rate, and time with phase transformations.
- Can read and use phase diagrams
- Can analyze a relatively complicated problem such as using CO2 as coolant for AC and explain what are the reasons that make the problem work or not.

Required Course Materials

- Textbook: *Phase Transformations in Metals and Alloys,* by D.A. Porter and K. E. Easterling (Capman and Hall)
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- Reference: *Kinetics of Materials*, by R. W. Balluffi, A. M. Allen and C. W. Carter (Wiley)

Grading Policy:

Tests:

- The is a midterm and a final test in this course.

Assignments

There is weekly assignments but the homework does not accounted for the final grades.

Description of Graded Components

- The final grades will be the combination of separate tests taken during the semester. Each test will cover the materials in a specific time period (see Syllabus below). Each test will contribute an equal portion to the total final score, i.e. ½.

- In each test, the materials or problems will be selected on four aspects: (1) the materials given in lecture, (2) the materials in your text book, (3) materials related to your homework, (4) some creative synthesis of what you learned from the course such as the example for using CO2 as coolant for new ACs.

- The above partition allows you to know what to expect and how to prepare for each test.
- To earn a solid A, you must demonstrate that you have mastered all above 4 areas; A is above 85%, B is 60-85%, C is 45-60% and D <45%. But these are historical data. The actual scores depends on the topics/materials covered in class and the actual performance.

Course Policies

Attendance and/or Participation

- Attendance of class/lecture is checked each class time.
- If student is absent, a reasonable reason (doctor's sick note, extra curriculum note, family issues, etc.)

-Review Institute expectations and restrictions related to attendance, including information about excused absences. Instructors are also encouraged to consider the impact of events like the All-Majors Career Fair and off-campus interviews.]

Academic Integrity

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. Review Georgia Tech's Honor Code and the student Code of Conduct.

Any student suspected of cheating or plagiarism on a quiz, exam, or assignment will be reported to the Office of Student Integrity, who will investigate the incident and identify the appropriate penalty for violations.

Core IMPACTS

Core IMPACTS is the University System of Georgia's General Education curriculum. If you are taking a course that counts towards Core IMPACTS, you should read and understand a statement about the Core area and associated career competencies. This resource is developed by the Center for Excellence in Teaching and Learning and Online Education at Georgia State University for each of the Core IMPACTS.

Accommodations for Students with Disabilities

If you are a student with learning needs that require special accommodation, contact the Office of Disability Services (404-894-2563) as soon as possible to make an appointment to discuss your special needs and to obtain an accommodations letter. Please also e-mail me as soon as possible in order to set up a time to discuss your learning needs.

Student-Faculty Expectations Agreement

At Georgia Tech, we believe that it is important to strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. The Student-Faculty Expectations articulate some basic expectations that you can have of me and that I have of you. In the end, simple respect for knowledge,

hard work, and cordial interactions will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech while in this class.

Pre- &/or Co-Requisites

The prior knowledge or training in thermodynamics, kinetics, mechanics, quantum mechanics and metallurgy is required. The level of advanced calculus and undergraduate level of statistics is also a plus. A prerequisite survey will be conducted in the first day of class to let the student(s) and the lecturer to decide the appropriateness and readiness for this class.

Extra Credit Opportunities

An extra credit opportunity exists for this class, most likely a mini-project on certain related topics such as how to determine the number of atoms/molecules in a gram of material, or how to measure the speed of a phase transition.

The project should be discussed with the lecturer.

Collaboration, Group Work, and Use of Generative AI

In general, use of AL and related software is encouraged for learning but not permitted in tests. The general rules and regulations can be found *for use of GenAI in this web resource on Establishing Course Policies*.

Extensions, Late Assignments, & Re-Scheduled/Missed Exams

Extensions for homeworks and tests are allowed but must be based on reasonable causes (see absence and disability), but must be notified to the lecturer in advance.

Inclement Weather and Digital Learning Days

If a weather-related event affects campus operations, instructors have the discretion to cancel class or pivot to digital instruction. Read more about the policy regarding the requirements, procedures, and responsibilities related to Digital Learning Days for Modified Campus Operations. Explore the Digital Learning Day Toolkit to learn more about guidance and tools that will make pivoting to digital learning easier.

Student Use of Mobile Devices in the Classroom

No electronic devices for visual and sound/voice other than taking notes are allowed in class.

Additional Course Policies

- *Remote proctoring: not available*
- *Accommodations for religious observances: yes*
- *Food and drink in the classroom" yes if you do not make too big a noise*
- *Freedom of expression and guidelines for discussion: Yes*
- *Institute-approved absences: yes*
- *Lab safety: not available*

- *Preparation for guest speakers: yes*
- *Re-grading and re-submission: within a certain time limit*
- *Recording class activities: see* Student Use of Mobile Devices in the Classroom

Campus Resources for Students

Undergraduate Student Academic Success Resources:

Academic Support: Academic Success and Advising (a unit in the Office of Undergraduate Education & Student Success) provides free support for your courses. Students can attend scheduled supplemental review (PLUS) sessions, stop by Drop-In Tutoring, or schedule a one-on-one appointment through Knack. To explore what options work best for you, please visit us online at success.gatech.edu/tutoring, email us at tutoring@gatech.edu, or come see us at Clough Undergraduate Learning Commons, Suite 283.

Graduate Student Academic and Professional Success Resources:

A list of resources for graduate students is given on the Office of Graduate and Postdoctoral Education website. Specific information for current graduate students includes

- Academic Resources such as the Communications Center, Language Institute, Library, Catalog, Registrar, resources for conducting research, Advocacy and Conflict Resolution resources, and how to manage unexpected situations that may impact your academic performance;
- Student Resources such as Campus Services, Child Care/Family programs, Health & Wellness, Career Services, and the Student Resource Guide; and
- *Professional Development such as the programming from the Career Center and other professional development resources and events"*

Student Well-Being:

At Georgia Tech, we are concerned about your overall physical, social, and mental well-being. A comprehensive list of wellness related resources has been compiled and maintained by the Office of the Vice President for Student Engagement and Well-being (student-resource-guide (gatech.edu)