MSE 3002 – Structural Transformations in Materials – Fall 2026
Georgia Tech School of Materials Science and Engineering

Time: TBD
Location: TBD

Instructor: Prof. Losego (he, him, his) losego@gatech.edu, Rm. 268 Love, (e-mail is best)
Office Hours: TBD, 268 Love or other mutually agreed upon times (e-mail to setup)

Pre-requisites: D or better in MSE 3001 and MSE 3210. MSE 3210 can be taken concurrently; please contact Dr. Losego if you have any questions.

Required Course Materials: *Phase Transformations in Metals and Alloys* (3rd Ed.), by: Porter, Easterling, and Sherif, CRC Press (2009) – Available at the campus bookstore.

Course Description
MSE 3002 teaches students how to design the composition, phase assemblage, & microstructure of materials. Students will apply thermodynamic, transport, and kinetics principles to (1) predict the equilibrium and non-equilibrium phase assemblages in materials systems and (2) develop phenom-enological models to understand the atomic-scale processes that influence and control phase transitions.

Course Objectives
By the end of this course, students should be able to:
- Convert between free energy diagrams and phase diagrams
- Calculate single-component and multi-component phase diagrams using thermodynamic data and/or solution models
- Predict microstructural development using phase diagrams, including identification of the reactions that occur at invariant points and the potential for non-equilibrium transformations
- Classify different types of interfaces based on crystallography and energetics
- Predict crystal habit based on relative surface energies
- Derive and apply kinetics equations for nucleation processes using fundamental thermodynamic parameters like surface energy, super-saturation, and temperature
- Develop phenomenological models describing solid-state diffusion and explain the effect of vacancies, grain boundaries, and other defects on these diffusion models
- Describe different methods of growth including interface, diffusion, and thermally controlled growth
- Combine nucleation and growth kinetics into total transformation models (JMAK & TTT diagrams)
- Describe the details of important phase transformations including alloy solidification, spinodal decomposition, eutectic solidification, and diffusionless (Martensitic) transformations.

Grading Policy and Weighting*
- Homework: 25% (5 problem sets, each worth 5%)
- "Participation": 5% (1% for each of 5 in-class quizzes, or 1% per class review post – 5% max)
- Exam 1: 20% (**Probable Date**: **TBD**)
- Exam 2: 20% (**Probable Date Range**: **TBD**)
- Final Exam (Comprehensive): 30% (**TBD**)

Course Grades

Score	89.5% - 100%	79.5% - 89.4%	64.5% - 79.4%	54.5% - 64.4%	≤ 54.4%
Grade	A	B	C	D	F

***There will be no opportunities for extra credit.**

*Final grade will be computed using the better of: (1) 20% Ex1 / 20% Ex2 / 30% Final (2) 10% Ex1 / 20% Ex2 / 40% Final or (3) 20% Ex1 / 10% Ex2 / 40% Final

Academic Integrity: Students should refer to the Institute's policy on academic integrity found in the code of conduct (http://www.policylibrary.gatech.edu/student-affairs/code-conduct). It is the instructor's understanding and expectation that the student neither gives nor receives any unauthorized aid on exams or quizzes, including the use of unauthorized notes or other information on an electronic device. ***All cell phones, tablets, calculators, and laptops are banned during exam periods.*** While group discussion is encouraged on homework assignments, individuals are expected to submit their own version of the homework assignment. Authorized aid on homework assignments includes discussing the interpretation of the problems, sharing ideas or approaches for solving the problems, and explaining the concepts involved in the problems. Any other aid would be unauthorized and considered a violation of the academic integrity policy. ***If you choose to work on homework in a group and decide to turn in identical plots, all group members must write the name of the group members at the top of the assignment; this will indicate agreement that everyone contributed fairly. However, all written answers must be written independently and NOT duplicated—duplicated written answers will be considered in violation of academic integrity***. All cases of academic misconduct will be submitted to Office of Student Integrity.

Homework: Completed homework assignments must be turned in at the beginning of the class period in which it is due. Anything submitted after TBD will be considered late. Late homework assignments will be accepted until the start of the following class period and can be turned in by handing to Dr. Losego or placing under his office door (268 Love). **All late assignments will receive a 50% reduction.**

Attendance Policy / Participation: 5% of your grade will come from "participation"; these points can be earned through taking quizzes or posting class notes to Canvas. Unannounced quizzes will be given 5 times throughout the semester and are worth 1% of your final grade. These quizzes are primarily intended to prepare you for exams and quantitatively reward attendance/participation (i.e., help benefit borderline grades). Research also shows that quizzing significantly enhances learning and retention. No quiz can be made up for any reason. You may also earn participation points by posting class notes to Canvas on your designated days ***before Monday of the following week***. Each of these posts will be worth 1% of your final grade. Your total participation score cannot exceed 5% of your total grade. (For example, you could earn full credit by taking 3 quizzes and making 2 posts on your assigned days – but if you took 4 quizzes, you would still only earn 5%. You will only be given 2 assigned dates for posting your class notes.)

Missed Exams: If you miss an exam without either a certified medical excuse or prior instructor approval, ***YOU WILL EARN ZERO CREDIT FOR THAT EXAM***. Exams missed with certified medical excuses or prior instructor approval will be dealt with on an individual basis.

Grading: If you believe an error was made in grading homework, quizzes, or exams, you should write a short justification of your claim and attach it to the original assignment in question and then send a copy electronically (losego@gatech.edu) or in paper form to Dr. Losego. The "statute of limitations" for such claims is 1 week after the assignment/test is returned. All assignments/exams are copied before returning, so any "post-adjustments" will be caught and sent to the Office of Student Integrity.

Instructor's Commitment

You can expect your instructor to be courteous, punctual, well-organized, and prepared for lecture and other class activities; to answer questions clearly; to be available during office hour or to notify you beforehand if he is unable to keep them; to provide a suitable guest lecturer if he is traveling; and to grade uniformly and objectively all tests and assignments. It is also my standard policy to hold a review session in the evening a few days before an exam.

Student Expectations:

- Most classes will involve active engagement; all students are expected to participate and will be actively called upon for discussions and responses. ***During class, students are required to sit immediately adjacent to at least 1 other student to facilitate these learning activities.***
- Electronic devices (laptops, cell phones, etc.) are allowed as long as they do not audibly or visually disrupt the class and do not inhibit active involvement. (Policy subject to change.) ***All of these devices are banned from the classroom during exams.***
- A basic knowledge of Excel (See Canvas site for basic tutorial).

Online Resources
The Canvas site for this course will be used for grading, announcements and the distribution of some supporting materials, instructional videos, and/or assignments.

Students with Disabilities
The Office of Disability Services serves Georgia Tech students with documented qualifying disabilities and operates under the guidelines of Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act and its amendments (ADAAA). In accordance with Georgia Tech Policy, "Reasonable accommodations are provided to ***self-identified students*** with disabilities who meet the academic and technical standards requisite to admission or participation in the program of study. Consideration may be given to the substitution or modification of certain course requirements as long as such changes do not detract from the quality of the educational experience and the changes remain within the accreditation criteria for the degree program." More information can be found here: https://disabilityservices.gatech.edu. Self-identified students with a disability should speak with Dr. Losego during the first week of classes, so that suitable arrangements can be organized.

Tentative Course Outline

Part 1: Thermodynamics & Phase Equilibria (Chapter 1 [mostly])
- Review of Thermodynamics (pg 1 – 9)
- Classification of Phase Transformations (pg 175 – 179)
- Thermodynamic Solution Theory & Phase Diagram (pg 11 – 30)
- Unary & Binary Phase Diagrams (pg 31 – 41)

Exam 1

Part 2: Surfaces, Interfaces, and Nucleation (Chapters 3, 4, & 5)
- Surfaces / Interfaces (Chap 3)
  - Energetics (pg 115 – 121, 128 - 133, 158 – 167, 172 – 174))
  - Description of atomic structure (pg 121-128, 146 – 158)
- Nucleation Theory (Chap 4 & 5)
  - Thermodynamic considerations (pg 189 – 201, 261 – 276)
  - Kinetic description of nucleation rate (same: pg 189 – 201, 261 – 276)

Part 3: Mechanisms of Diffusion (Chapter 2)
- Statistical description (pg 65 – 72)
- Atomic-scale mechanisms (pg 72 – 98)

Exam 2, semi-comprehensive

Part 4: Kinetics of Crystal Growth (Chapters 3, 4, & 5)
- Interfacial controlled growth (pg 175 – 184, 201-205 & handouts)
- Diffusion controlled growth (pg 276 – 285 & handouts)
- Thermal diffusion controlled growth (pg 215 – 220)

Part 5: Total Transformation Kinetics (Chapter 5)
- JMAK Equation (pg 285 – 288)
- TTT Curves (same: pg 285 – 288)

Part 6: Important Examples of Phase Transformations (Chapters 4, 5, & 6)
- Solidification / Zone Refining (pg 209 – 215)
- Spinodal Decomposition (pg 65 – 66, 302 – 309)
- Diffusionless Transformations / Martensitic (pg 383 – 415)

Comprehensive Final