MTSE 3060 Phase Transformations in Materials

Spring Semester 2022 – 3 credit hours

Instructor: Dr. Jincheng Du, Office: E-124 Discovery Park
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Office Hours: By appointment
Lecture: Tuesday and Thursday, 1:00 – 2:20 p.m
Location: B157 UNT Discovery Park

Course Information
Prerequisites: MTSE 3010 (Bonding and Structure) or equivalent and MTSE 3030 (Thermodynamics and Phase Diagrams) or equivalent.

Course Learning Objectives: This course will provide the student with an understanding of the basic principles and mechanisms underlying both solid-solid and liquid-solid phase transformations with an emphasis on metallic materials. The objective is to apply the concepts of thermodynamics, diffusion and kinetics, and crystallography (crystal structure and symmetry in materials) to develop a clear understanding of the free energy changes and kinetics associated with various types of phase transformations.

Topics to be covered

1. Review of Thermodynamics and Diffusion
   1.1 Review of Thermodynamics
   1.2 Review of Diffusion
   1.3 Crystal Interface and Microstructure

2. Solidification, Vitrification, and Crystallization
   2.1 Nucleation in liquids – Homogeneous and Heterogeneous
   2.2 Growth of single component systems
   2.3 Solidification of Alloys
   2.4 Rapidly solidified crystalline products
   2.5 Amorphous metallic alloys
   2.6 Crystallization
   2.7 Solid State Amorphization

3. Diffusional Transformations in Solids
   3.1 Nucleation in solids - Homogeneous and Heterogeneous
   3.2 Growth of solid precipitates
   3.3 Overall transformation kinetics – TTT Diagrams

4. Types of Solid-Solid Diffusional Transformations
4.1 Precipitation reactions
4.2 Phase Separation
4.3 Cellular precipitation
4.4 Eutectoid decomposition
4.5 Massive transformations
4.6 Ordering Transformations

5. Diffusionless Transformations
5.1 General features of martensitic transformations
5.2 Martensite crystallography
5.3 Martensite nucleation
5.4 Martensite Growth
5.5 Examples

Examinations, Projects, and Grading: There will be homework, two mid-term exams, one final exam, and one project. One homework will be based on overall class attendance and participation. Final project includes a written report and presentation. Project topic needs to be decided before the mid-term. The overall grading will be as follows:

- Homework/attendance: 10%
- Exams (70%):
  - 1st exam: 20%
  - 2nd exam: 20%
  - Final exam: 30%
- Final Project: 20%

Course Delivery (Classroom, CANVAS & Zoom if needed): Lectures, homework assignments, and solutions will be posted on CANVAS https://unt.instructure.com/login/ldap.

Notes:
1. CANVAS and UNT Email will be used as the primary communication tools. CANVAS will be used exclusively for posting homework assignments, homework solutions, topical coverage of each exam, and formula sheets.
2. Each exam will include a combination of (A) multiple choice questions, (B) short answer questions, and (C) quantitative problems.
3. The final exam will be comprehensive, but it will be weighted equally with the other exams to determine the exam average component of the grade.
4. For all exams, the only thing you may use during the exam is a calculator (plus a pencil, pen, and/or eraser). Earphones, cell phones, laptops, etc. will not be allowed.

Course Outcomes:
1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply the engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. An ability to communicate effectively with a range of audiences.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. An ability to function effectively on a team whose members together provide leadership, creates a collaborative and inclusive environment, establish goals, plans tasks, and meet objectives.
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Attendance Policy

COVID-19 Impact on Attendance

While attendance is expected as outlined above, it is important for all of us to be mindful of the health and safety of everyone in our community, especially given concerns about COVID-19. Please contact me if you are unable to attend class because you are ill, or unable to attend class due to a related issue regarding COVID-19. It is important that you communicate with me prior to being absent so I may make a decision about accommodating your request to be excused from class.

If you are experiencing any symptoms of COVID-19 (https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html) please seek medical attention from the Student Health and Wellness Center (940-565-2333 or askSHWC@unt.edu) or your health care provider PRIOR to coming to campus. UNT also requires you to contact the UNT COVID Hotline at 844-366-5892 or COVID@unt.edu for guidance on actions to take due to symptoms, pending or positive test results, or potential exposure. While attendance is an important part of succeeding in this class, your own health, and those of others in the community, is more important.

Makeup Exam Policy: If a student cannot take an exam on the scheduled date due to some unavoidable circumstances, such as out of town business trip, sickness, etc., then he/she must notify the instructor in writing before the scheduled exam time to schedule a makeup exam. If allowed, a 10% penalty will be assessed.

Class Attendance is Mandatory. Please notify me if you have to miss a class or will be late. Additional pop-quizzes may be given due to overall classroom attendance and participation.

ADA Policy

UNT makes reasonable academic accommodation for students with disabilities. Students seeking accommodation must first register with the Office of Disability Accommodation (ODA) to verify their eligibility. If a disability is verified, the ODA will provide a student with an accommodation letter to be delivered to faculty to begin a private discussion regarding one’s specific course needs. Students may request accommodations at any time, however, ODA notices of
accommodation should be provided as early as possible in the semester to avoid any delay in implementation. Note that students must obtain a new letter of accommodation for every semester and must meet with each faculty member prior to implementation in each class. For additional information see the ODA website (https://disability.unt.edu/).

Prohibition of Discrimination, Harassment, and Retaliation (Policy 16.004)
The University of North Texas (UNT) prohibits discrimination and harassment because of race, color, national origin, religion, sex, sexual orientation, gender identity, gender expression, age, disability, genetic information, veteran status, or any other characteristic protected under applicable federal or state law in its application and admission processes; educational programs and activities; employment policies, procedures, and processes; and university facilities. The University takes active measures to prevent such conduct and investigates and takes remedial action when appropriate.

Emergency Notification & Procedures
UNT uses a system called Eagle Alert to quickly notify students with critical information in the event of an emergency (i.e., severe weather, campus closing, and health and public safety emergencies like chemical spills, fires, or violence). In the event of a university closure, please refer to Canvas for contingency plans for covering course materials.

Rules of Engagement
Rules of engagement refer to the way students are expected to interact with each other and with their instructors. Here are some general guidelines:

• While the freedom to express yourself is a fundamental human right, any communication that utilizes cruel and derogatory language on the basis of race, color, national origin, religion, sex, sexual orientation, gender identity, gender expression, age, disability, genetic information, veteran status, or any other characteristic protected under applicable federal or state law will not be tolerated.
• Treat your instructor and classmates with respect in any communication online or face-to-face, even when their opinion differs from your own.
• Ask for and use the correct name and pronouns for your instructor and classmates.
• Speak from personal experiences. Use “I” statements to share thoughts and feelings. Try not to speak on behalf of groups or other individual’s experiences.
• Use your critical thinking skills to challenge other people’s ideas, instead of attacking individuals.
• Avoid using all caps while communicating digitally. This may be interpreted as “YELLING!”
• Be cautious when using humor or sarcasm in emails or discussion posts as tone can be difficult to interpret digitally.
• Avoid using “text-talk” unless explicitly permitted by your instructor.
• Proofread and fact-check your sources.
• Keep in mind that online posts can be permanent, so think first before you type.

Additional Policies
Authorized Absences and Extenuating Circumstances
Absences due to extenuating circumstances or participation in sponsored must be verified by the Dean of Students. Consideration of such absences will be made for quizzes and examinations, but not homework. For participation in sponsored activities, you must seek approval prior to the
absence. For extenuating circumstances, you have 1 week to contact me and/or the Dean of Students to begin the process.

Absence for Religious Holidays
In accordance with state law, a student absent due to the observance of a religious holiday may take examinations or complete assignments scheduled for the day(s) missed, including those missed for travel, within a reasonable time after the absence. The student is responsible to notify the instructor of each class of the date of the anticipated absence as early in the semester as possible. Only holidays or holy days observed by a religion whose place of worship is exempt from property taxation under Section 11.20 of the Tax Code may be included. A student who is excused under this provision may not be penalized for the absence.

Academic Integrity Policy
Academic Integrity Standards and Consequences. According to UNT Policy 06.003, Student Academic Integrity, academic dishonesty occurs when students engage in behaviors including, but not limited to cheating, fabrication, facilitating academic dishonesty, forgery, plagiarism, and sabotage. A finding of academic dishonesty may result in a range of academic penalties or sanctions ranging from admonition to expulsion from the University. Any student in violation of these policies will be given an overall F grade (Fail). In addition, your case will be forwarded to university administrators, and you may be subject to additional punishments/sanctions according to university policies. When in doubt, please ask me.