

NCSU Department of Materials Science and Engineering
MSE 706: Phase Transformations and Kinetics
Spring 2024, M/W, 8:30 AM – 9:45 AM, in person

Instructor Information

Dr. Nina Balke

Engineering Building (EB) 1, 3074 C
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Office hours:

Fridays, 9:00 AM to 10:00 AM or by appointment.

Email Policy:

If you have questions outside of class or office hours, the preferred contact method is via e-mail. The instructors usually receive more email each day than they can respond to immediately. Your instructors will make sincere efforts to respond to emails within **24 hours**.

Course Information

Course Website: A course webpage will be maintained, where copies of the course syllabus, slides presented in class, homework sets, course textbooks, links to lectures, and other course material will be posted: <https://moodle-courses2324.wolfware.ncsu.edu/course/view.php?id=7182>

Lecture Schedule & Location:

- Mondays & Wednesdays, 8:30 AM – 9:45 AM
- Engineering Building (EB) 3, 02220

Course Credit Hours: 3

Prerequisites: MSE 301, 360, 708 or consent of the instructor

Course Overview

Course Description:

This course provides a foundation for the advanced understanding of the phenomenological and atomistic kinetic process in materials and provides a broad overview of the important phase transitions that are critical to the structure-property relationships in materials. The topics covered include classifications of phase transitions, nucleation, growth, formal kinetics of phase transitions, diffusional phase transitions, and diffusionless phase transitions in solids.

Structure:

This is a synchronous, in-person lecture course centered around several different topics relevant to phase transformations and kinetics. The course website on Moodle will contain all necessary course content.

Learning outcomes

Students who complete this course should:

- know the accepted classification schemes of phase transformations
- be familiar with the concepts and theories for nucleation and growth
- be able to calculate and explain the formal theories for the kinetics of phase transformations
- be familiar with the common phase transformations including diffusional and diffusionless transformations

Course materials

Recommended Textbooks

- David A. Porter and Kenneth E. Easterling: *Phase transformations in metals and alloys* (Taylor & Francis Group)
- Robert W. Balluffi, Samuel M. Allen, W. Craig Carter: *Kinetics of Materials* (Electronic version available from NCSU library)
- John W. Christian: *The Theory of Transformations in Metals and Alloys* (Electronic version available from NCSU library)

Exams, presentations, and grading policy

Exams

There will be a total of three closed book exams, two during the semester and one final exam at the end as indicated in the course schedule. The two exams during the semester will be held during class on the dates indicated in the syllabus. The final exam will be given on the day and time that are designated by the University. It is the students' responsibility to confirm this day/time and location of the final exam at least 48 hours in advance of the final exam. According to the NCSU website, the exam is currently scheduled on 04/26/2024 from 8.30 – 11 am in the regular class room. Every student is allowed to bring one letter (front and back) of written notes to each exam. If a student has to miss an exam due to an excused absence, it is the student's responsibility to contact the instructor ahead of time and find an alternate date for the exam in close proximity to the original day and time. If a student misses an exam due to unforeseen circumstances, the student must contact the instructor immediately. Exams will be graded using Gradescope. A sign-up email will be sent at the beginning of the semester.

Presentations

Each student has the opportunity to prepare and present a 10 min lecture on a topic of choice related to phase transformation and kinetics. The presentations will be scheduled on specific dates during the semester. A sign-up sheet will be provided at the beginning of the semester. The presentations will be graded by the class and count towards the final grade.

Grading

- Final Grades will be computed out of a total of 100%: Exam I (25%), Exam II (25%), Final Exam (25%), presentation (25%)
- Grades for each assignment will be recorded and available to students through Moodle. If the course website automatically generates a course grade, do not trust it unless the instructor confirms that it is correctly calculated; the grades will be calculated as described above.
- For computing final grades, *an absolute grading scale will be used* (see below)

Score	\geq 97	93- 96.9	90- 92.9	87- 89.9	83- 86.9	80- 82.9	77- 79.9	73- 76.9	70- 72.9	67- 69.9	63- 66.9	60- 62.9	< 60
Grade	A+	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	F

Course schedule

Class	Day	Date	Topics
1	M	01/08	History & Introduction
2	W	01/10	Homogeneous nucleation
	M	01/15	<i>Martin Luther King Jr. Day (no classes)</i>
3	W	01/17	Homogeneous nucleation
4	M	01/22	Heterogeneous nucleation
5	W	01/24	Heterogeneous nucleation
6	M	01/29	Review
7	W	01/31	Exam I - 8:30 – 9:45 AM
8	M	02/05	Student presentations
9	W	02/07	Surface energies
10	M	02/12	Strain energies
11	W	02/14	Composition as variable
12	M	02/19	Pre-precipitation theory
13	W	02/21	Pre-precipitation theory
14	M	02/26	Growth
15	W	02/28	Growth
16	M	03/04	Review
17	W	03/06	Exam II - 8:30 – 9:45 AM
	M	03/11	<i>Spring Break (no classes)</i>
	W	03/13	<i>Spring Break (no classes)</i>
18	M	03/18	Student presentations
19	W	03/20	Formal kinetics of nucleation and growth
20	M	03/25	Formal kinetics of nucleation and growth
21	W	03/27	Formal kinetics of nucleation and growth
22	M	04/01	TTT diagrams
23	W	04/03	Precipitation reactions
24	M	04/08	Precipitation reactions
25	W	04/10	Massive transformations
26	M	04/15	Martensitic transformations
27	W	04/17	Coarsening
28	M	04/22	Online student presentations/Review
29	M	04/26	Exam III (final exam) - 8:30 - 11:00 AM

Message Boards

All students are encouraged to use the message boards available through the course website to discuss and clarify the course material. Students are encouraged to post questions to the message boards. Discussion of specific solutions to homework problems on the message boards is prohibited, but discussion of underlying concepts is encouraged. The instructors may also choose to repost (anonymously) student questions and answers to the message boards.

Syllabus Modification Statement

Our syllabus represents a flexible agreement. It outlines the topics we will cover and the order we will cover them in. Dates for assignments represent the earliest possible time they would be due. The pace of the class depends on student mastery and interests. Thus minor changes in the syllabus can occur if we need to slow down or speed up the pace of instruction.

Additional information

POLICIES AND PROCEDURES

1. All students must have access to the EOS computing system.
2. Students are required to comply with the university policy on academic integrity found in the Code of Student Conduct found at <http://policies.ncsu.edu/policy/pol-11-35-01>. Cheating and plagiarism will result in loss of credit for the assignment in question and filing of the Report of an Academic Integrity Violation.
3. Students are responsible for reviewing the PRRs which pertain to their course rights and responsibilities. These include: <http://policies.ncsu.edu/policy/pol-04-25-05> (Equal Opportunity and Non-Discrimination Policy Statement), <http://oied.ncsu.edu/oied/policies.php> (Office for Institutional Equity and Diversity), <http://policies.ncsu.edu/policy/pol-11-35-01> (Code of Student Conduct), and <http://policies.ncsu.edu/regulation/reg-02-50-03> (Grades and Grade Point Average).
4. **Electronically-Hosted Course Components.** Students may be required to disclose personally identifiable information to other students in the course, via electronic tools like email or web-postings, where relevant to the course. Examples include online discussions of class topics, and posting of student coursework. All students are expected to respect the privacy of each other by not sharing or using such information outside the course.
5. **Accommodation.** Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with the Disability Resource Office at Holmes Hall, Suite 304, Campus Box 7509, 919-515-7653. For more information on NC State's policy on working with students with disabilities, please see the Academic Accommodations for Students with Disabilities Regulation (REG02.20.01) (<https://policies.ncsu.edu/regulation/reg-02-20-01/>).
6. **Non-Discrimination Policy.** NC State provides equal opportunity and affirmative action efforts, and prohibits all forms of unlawful discrimination, harassment, and retaliation ("Prohibited Conduct") that are based upon a person's race, color, religion, sex (including pregnancy), national origin, age (40 or older), disability, gender identity, genetic information, sexual orientation, or veteran status (individually and collectively, "Protected Status"). Additional information as to each Protected Status is included in NCSU REG 04.25.02 (Discrimination, Harassment and Retaliation Complaint Procedure). NC State's policies and regulations covering discrimination, harassment, and retaliation may be accessed at <http://policies.ncsu.edu/policy/pol-04-25-05> or <https://oied.ncsu.edu/divweb/>. Any person who feels that he or she has been the subject of prohibited discrimination, harassment, or retaliation should contact the Office for Equal Opportunity (OEO) at 919-515-3148.

Requirements for Auditors (AU). Information about and requirements for auditing a course can be found at <http://policies.ncsu.edu/regulation/reg-02-20-04>.

Policies on Incomplete Grades. If an extended deadline is not authorized by the Graduate School, an unfinished incomplete grade will automatically change to an F after either (a) the end of the next regular semester in which the student is enrolled (not including summer sessions), or (b) by the end of 12 months if the student is not enrolled, whichever is shorter. Incompletes that change to F will count as an attempted course on transcripts. The burden of fulfilling an incomplete grade is the responsibility of the student. The university policy on incomplete grades is located at <http://policies.ncsu.edu/regulation/reg-02-50-03>. Additional information relative to incomplete grades for graduate students can be found in the Graduate Administrative Handbook in Section 3.18.F at http://www.fis.ncsu.edu/grad_publicns/handbook/

University Policies:

All NC State University policies can be found at the following web page:

<http://policies.ncsu.edu/view/policy/all> Three of these policies are reprinted below for your convenience:

Academic Integrity and Honesty:

As a student enrolled in this class, you are expected to honor the NCSU policies regarding academic integrity found in the Code of Student Conduct at <http://policies.ncsu.edu/policy/pol-11-35-01>. In this course, this policy applies primarily to cheating on exams and inappropriate collaboration on homework assignments, which will not be tolerated. Evidence of cheating on exams will automatically result in a grade of 0 on that exam, and additional penalties may also be applied, such as an F in the course or attendance at a judicial board for consideration of suspension. Students must sign the Honor Pledge (“I have neither given nor received unauthorized aid on this test.”) on each exam. See the homework and message board sections for a discussion of collaboration on homework assignments. If there are questions regarding any matter relating to the standards of academic integrity in this course or on a given assignment, they should be discussed with the instructor prior to doing any work. If any violation of the academic integrity policies is observed, please notify the instructor immediately. Once a violation has occurred, the case will be pursued through procedures outlined by the University.

Students may be required to disclose personally identifiable information to other students in the course, via electronic tools like email or web-postings, where relevant to the course. Examples include online discussions of class topics and posting of student coursework. All students are expected to respect the privacy of each other by not sharing or using such information outside the course.

Students with Disabilities:

Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with Disability Services Office (<http://www.ncsu.edu/dso/>) located at 1900 Student Health Center, Campus Box 7509, 515-7653. For more information on NC State's policy on working with students with disabilities, please see the Academic Accommodations for Students with Disabilities Regulation at <http://policies.ncsu.edu/regulation/reg-02-20-01>

Anti-Discrimination Statement:

NC State University provides equality of opportunity in education and employment for all students and employees. Accordingly, NC State affirms its commitment to maintain a work environment for all employees and an academic environment for all students that is free from all forms of discrimination. Discrimination based on race, color, religion, creed, sex, national origin, age, disability, veteran status, or sexual orientation is a violation of state and federal law and/or NC State University policy and will not be tolerated. Harassment of any person (either in the form of quid pro quo or creation of a hostile

environment) based on race, color, religion, creed, sex, national origin, age, disability, veteran status, or sexual orientation also is a violation of state and federal law and/or NC State University policy and will not be tolerated. Retaliation against any person who complains about discrimination is also prohibited. NC State's policies and regulations covering discrimination, harassment, and retaliation may be accessed at <http://policies.ncsu.edu/category/campusenvironment/non-discrimination> or http://www.ncsu.edu/equal_op. Any person who feels that he or she has been the subject of prohibited discrimination, harassment, or retaliation should contact the Office for Equal Opportunity (OEO) at 515-3148.

In an effort to affirm and respect the identities of transgender students in the classroom and beyond, please contact me if you wish to be referred to using a name and/or pronouns other than what is listed in the student directory.

Basic Needs Security:

Any student who faces challenges securing their food or housing or has other severe adverse experiences and believes this may affect their performance in the course is encouraged to notify the professor if you are comfortable in doing so. Alternatively, you can contact the Division of Academic and Student Affairs to learn more about the Pack Essentials program <https://dasa.ncsu.edu/pack-essentials/>

Online Course Evaluations:

Online class evaluations will be available for students to complete during the last two weeks of class. Students will receive an email message directing them to a website where they can login using their Unity ID. All evaluations are confidential; instructors will never know how any one student responded to any question, and students will never know the ratings for any instructor.

Evaluation website: <https://classeval.ncsu.edu>

Student help desk: classeval@ncsu.edu

More information about ClassEval: <http://www2.acs.ncsu.edu/UPA/classeval/index.htm>

COVID-related information

Due to the Coronavirus pandemic, public health measures have been implemented across campus. Students should stay current with these practices and expectations through the [Protect the Pack](https://www.ncsu.edu/coronavirus/) website (<https://www.ncsu.edu/coronavirus/>). The sections below provide expectations and conduct related to COVID-19 issues.

Health and Participation in Class

We are most concerned about your health and the health of your classmates and instructors/TAs.

- If you test positive for COVID-19, or are told by a healthcare provider that you are presumed positive for the virus, please work with your instructor on health accommodations and follow other university guidelines, including self reporting: <https://healthypack.dasa.ncsu.edu/coronavirus/>. Self-reporting is not only to help provide support to you, but also to assist in contact tracing for containing the spread of the virus.
- If you feel unwell, even if you have not been knowingly exposed to COVID-19, please do not come to class.
- If you are in quarantine, have been notified that you may have been exposed to COVID-19, or have a personal or family situation related to COVID-19 that prevents you from attending this course in person (or synchronously), please connect with your instructor to discuss the situation and make alternative plans, as necessary.
- If you need to make a request for an academic consideration related to COVID-19, such as a discussion about possible options for remote learning, please talk with your instructor for the appropriate process to make a COVID-19 request.

Health and Well-Being Resources

These are difficult times, and academic and personal stress is a natural result. Everyone is encouraged to take care of themselves and their peers. If you need additional support, there are many resources on campus to help you:

- Counseling Center (<https://counseling.dasa.ncsu.edu/>)
- Health Center (<https://healthypack.dasa.ncsu.edu/>)
- If the personal behavior of a classmate concerns or worries you, either for the classmate's wellbeing or yours, we encourage you to report this behavior to the NC State CARES team: (<https://advising.dasa.ncsu.edu/resources-for-advisors/advisors-toolkit/cares/>)
- If you or someone you know are experiencing food, housing or financial insecurity, please see the Pack Essentials Program (<https://dasa.ncsu.edu/pack-essentials/>).

Community Standards related to COVID-19

We are all responsible for protecting ourselves and our community. Please see the community expectations and Rule 04.21.01 regarding Personal Safety Requirements Related to COVID- 19 <https://policies.ncsu.edu/rule/rul-04-21-01/>

Course Expectations Related to COVID-19:

- Personal Protective Equipment: As a member of the NC State academic community, you are required to follow all university guidelines for personal safety with face coverings, physical distancing, and sanitation. Face coverings are required in this class and in all NC State buildings. Face coverings should be worn to cover the nose and mouth and be close fitting to the face with minimal gaps on the sides. In addition, students are responsible for keeping their course/work area clean.
- Course Attendance: NC State attendance policies can be found at: <https://policies.ncsu.edu/regulation/reg-02-20-03-attendance-regulations/> . Please refer to this course's attendance, absence, and deadline policies for additional details. If you are quarantined or otherwise need to miss class because you have been advised that you may have been exposed to COVID-19, you should not be penalized regarding attendance or class participation. However, you will be expected to develop a plan to keep up with your coursework during any such absences. If you become ill with COVID-19, you should follow the steps outlined in the health and participating section above. COVID 19-related absences will be considered excused; documentation need only involve communication with your instructor.
- Course Meeting Schedule: Your course might not have a traditional meeting schedule in Spring 2024. Be sure to pay attention to any updates to the course schedule as the information in this syllabus may have changed. Please discuss any questions you have with the instructor.
- Classroom Seating: To support efficient, effective contact tracing, please sit in the same seat when possible and take note of who is sitting around you; instructors may also assign seats for this purpose.
- Technology Requirements: This course may require particular technologies to complete coursework. Be sure to review the syllabus for these expectations, and see go.ncsu.edu/syllabustech-requirements to find out more about technical requirements for your course. If you need access to additional technological support, please contact the Libraries' Technology Lending Service: <https://www.lib.ncsu.edu/devices>.

Course Delivery Changes Related to COVID-19

Please be aware that the situation regarding COVID-19 is frequently changing, and the delivery mode of this course may need to change accordingly, including from in-person to online. Regardless of the delivery method, we will strive to provide a high-quality learning experience.

Other Important Resources

- Keep Learning: <https://dasa.ncsu.edu/students/keep-learning/>
- Protect the Pack FAQs: <https://www.ncsu.edu/coronavirus/frequently-asked-questions/>
- NC State Protect the Pack Resources for Students:
<https://www.ncsu.edu/coronavirus/reactivating-campus/resources-for-students/>
- NC State Keep Learning, tips for students opting to take courses remotely:
<https://dasa.ncsu.edu/students/keep-learning/>
- Learning with Moodle, a student's guide to using Moodle: <https://moodle-projects.wolfware.ncsu.edu/course/view.php?id=226>