New Jersey Institute of Technology Department of Physics

COURSE OUTLINE MTSE 655-102 (CRN: 14873) Spring 2025

DIFFUSION AND SOLID-STATE KINETICS

Instructor: **Andres Jerez**: **jerez@njit.edu**
(When writing, please include course and section in the subject: MTSE 655 102)

Lectures: Mondays 6:00 PM – 8:50 PM, FMH 106

Office hours: Wednesdays, 1:00 PM – 1:50 PM, TIER 408T, and by appointment.

Textbooks: R. W. Balluffi, S. M. Allen, W. C. Carter, **KINETICS OF MATERIALS**,
Wiley, 2005, ISBN-13: 978-0471246893
David A. Porter, Kenneth E. Easterling, Mohamed Y. Sherif, **PHASE TRANSFORMATIONS IN METALS AND ALLOYS,** CRC, 2021,
ISBN-13: 978-1000467796

Course Website: http://canvas.njit.edu/

Course Description:
This course presents a unified treatment of phenomenological and atomistic kinetic processes in materials. It provides the foundation for the advanced understanding of processing, microstructural evolution, and behavior for a broad spectrum of materials. The course emphasizes analysis and development of rigorous comprehension of fundamentals. Topics include irreversible thermodynamics; diffusion; nucleation; phase transformations; fluid and heat transport; morphological instabilities; gas-solid, liquid-solid, and solid-solid reactions.

Learning Outcomes:
As diffusion is one of the fundamental mechanisms in the processing of materials, from steel to semiconductor devices, students taking this course will become familiar with both the macroscopic and the atomic description of diffusion. They will learn how to characterize diffusion phenomena in dilute alloys as well as in ionic and covalent solids. High atom mobility effects at defect sites and surfaces are examined. Chemical kinetics and kinetics of phase transformations including nucleation, growth, and spinoidal decomposition are discussed.

Final Grade:

Midterm Exam:	30%
Final Exam:	30%
Homework:	20%
Presentation:	20% (Presentation and report-details will be discussed in class)

Grade Scale:
A: 85% and more;
B+: 75% - 84%;
B: 65% - 74%;
C: 55% - 64%;
D: 50% - 54%;
F: 49% and less

Schedule:

Date:	**Subject** (textbook chapter):
01/27	Introduction (Ch. 1), Irreversible Thermodynamics (Ch. 2)
02/03	Driving Forces and Fluxes for Diffusion (Ch. 3)
02/10	The Diffusion Equation (Ch. 4)
02/17	Solving the Diffusion Equation (Ch. 5-6)
02/24	Atomic Models for Diffusion (Ch. 7)
03/03	Diffusion in Crystals (Ch. 8)
03/10	*Midterm Exam (Ch. 1-8)*
03/17	*Spring Break*
03/24	Diffusion along Crystal Imperfections (Ch. 9)
03/31	Diffusion in Non-crystalline Materials (Ch. 10)
04/07	Particle Coarsening, Grain Growth, Diffusional Creep and Sintering (Ch. 14-16)
04/14	Phase Transitions, Spinodal and Order-Disorder Transitions (Ch. 17-18)
04/21	Nucleation (Ch. 19)
04/28	Diffusional Growth, (Ch. 20-21)
05/05	Presentations
05/12	*Final Exam*

FIRST DAY OF CLASSES: Tuesday, January 21
LAST DAY TO WITHDRAW: Monday, April 7
SPRING BREAK: March 16 – March 22
LAST DAY OF CLASSES: Wednesday, May 7
READING DAYS: May 8-9
FINAL EXAM PERIOD: May 12 – May16
FINAL GRADES DUE: May 18