



Course Information

Spring 2024 NUCL 520 Radiation Effects and Reactor Materials

Course location: WANG 2579

Course time: Tuesday and Thursday 3 – 4:15 pm

3 credits

Pre-requisition: NUCL 320 or equivalent course

Instructor Contact Information

Prof. Yi XIE

Email: xie90@purdue.edu

Office: (765) 496-2912, Lambertus Hall #5268

Office hours: Tuesday and Thursday after class till 5:00 pm EST. The instructor is not available for in-person meetings out of the office hour.

Distance learning students can communicate with the instructor via email/Zoom on weekdays.

Course Description

This course provides an introduction to materials used in various types of nuclear reactors, with a focus on radiation damage, including energy transfer, cross section, cascade and defects, and radiation-induced effects like diffusion, segregation, dislocation, swelling, hardening, deformation, creep, fracture, and embrittlement. The course also covers the topics of lattice- and grain-scale features such as interatomic potential, unit cell, crystal structure, and planar defects. The course includes both conceptual and theoretical aspects, as well as a moderate amount of mathematical equations. The course assessments consist of weekly homework assignments, a project report and presentation, and three exams.

Learning Resources

Required Textbook:

- Gary S. Was (2017), *Fundamentals of Radiation Materials Science: Metals and Alloys*, second edition. Springer. (Note: not first edition)

If you have not previously taken NUCL 320 and NUCL 420, or their equivalents, you should get yourself familiarized through self-study using these or similar books:

- *NUCL 320 textbook*: W. Callister and D. Rethwisch, *Materials Science and Engineering: An Introduction*, 10th edition or earlier. Wiley.
- *NUCL 320 optional book*: K. Murty and I. Charit (2013), *An Introduction to Nuclear Materials*. Wiley.

Optional reading:

- D.R. Olander and A.T. Motta (2021), *Light Water Reactor Materials, Vols. I and II*. ANS.
- M.W. Thompson (1969), *Defects and Radiation Damage in Metals*. Cambridge University Press.

Other required resources:

- MS Word or Latex to write homework in electronic typing version;
- PowerPoint to make project.

Course Schedule

Course introduction
Review of MS Fundamentals
Overview – radiation damage
Overview – irradiation effects
Chapter 1 – radiation damage event
Midterm Exam -1
Chapter 2 – displacement of atoms
Chapter 3 – damage cascade
Chapter 4 – point defect formation and diffusion
Chapter 5 – radiation-enhanced diffusion and defect reaction
Chapter 6 – radiation-induced segregation
Projects 1-4
Midterm Exam -2
Chapter 7 – dislocation microstructure
Chapter 8 – irradiation-induced voids and bubbles
Chapter 12 – Irradiation hardening and deformation
Chapter 13 – Fracture and embrittlement
Chapter 14 – Thermal and Irradiation Creep
Projects 5-6
Final Exam

Spring vacation: March 13-18, 2024.

Assignments

Assignments	Percentage Weight
Homework	35%
Midterm 1	15%
Midterm 2	15%
Final exam	20%
Project report	10%
Project presentation	10%
<i>Total</i>	<i>105%</i>

General Rules

- All course notifications, including corrections and schedule changes, will be posted in Brightspace and not sent via email. It is the student's responsibility to regularly check for updates and notifications in Brightspace.

- Students who are absent from or arrive late to lectures are responsible for all materials covered during the lectures, as well as any missed assignments.
- The instructor will respond to emails within 24 hours on weekdays. No response on weekends. For questions related to assignments, the email should be sent at least 1 business day prior to the submission deadline.
- If the instructor receives questions that have already been covered in the lectures or provided materials, students will be directed to find the answers within these resources independently. If further clarification or assistance is needed, please clearly communicate the specific question to the instructor and indicate the type of help you require.

Homework submission requirements:

- Submit both an electronic copy (via Brightspace-Assignment uploading) and a hard copy before the deadline (typically before the class begins).
- Prefer **electronic typing** over handwriting, for ease of grading and context recognition.
- Homework is to be completed either individually or within study groups (3 people or less), depending on your preference. For group work, each student should independently address all questions before collaboratively comparing answers to enhance quality. Students not contributing to group work should not have their names listed on the homework for credit.
- **On-campus students:** Submit the electronic copy individually through Brightspace-Assignment and turn in the hard copy in person. In study groups, all members share responsibility for turning in the hard copy.
- **Online/remote students:** Submit the electronic copy individually through Brightspace-Assignment. If working individually, no hard copy submission is required. If working in study groups, on-campus team members are responsible for turning in the hard copy.
- **Late submission policy:** Homework received after the deadline will be graded as zero. In case of sickness or other reasons preventing timely submission, inform the instructor early before the deadline for approval. Late excuses after the deadline will not be accepted, and the work will be graded as zero.
- Clearly write the name(s) on the first page of the homework answer. Name that is absent on the first page will not be considered for credits.
- Any disputes regarding grades must be submitted in writing to the instructor within one week of the return of the assignment. Disputes submitted after one week will not be considered.
- If a student wishes to contest a grade on a particular problem, they must submit a formal argument letter with detailed reasons and explanations. A copy of the graded homework/exam must be attached at the end of the letter. The argument letter must be sent in PDF format to the instructor via email. The instructor will review the argument letter within two weeks of receiving it, re-examine the entire homework/exam, and provide a response.

Exam requirements:

- Exam sheets will not be returned after grading to maintain the confidentiality of exam questions. You may review the grading of your exam during the instructor's office hours. For online/remote students unable to attend in person, feel free to schedule a Zoom meeting to review the grading.
- **Online/remote students:** Use Respondus LockDown Browser and Respondus Monitor to proctor the exams posted in Brightspace. Ensure that you have installed the software on your PC prior to the exam. Familiarize yourself with typing mathematical equations in Brightspace, a process similar to using MS Word to insert equations (Refer to the Tab “Insert” – “Equations”). You have a 20-30 minute grace period to type equations. Complaints such as "I do not know or am not good at typing equations" will not be accepted. You may work on the exam within a 7-day timeframe, considering your work commitments. It is your responsibility to complete the exam within the timeframe; late submissions, regardless of the reason (including technical/IT issues), will not be considered valid excuses.

Grading Scale

Percent Grade	Letter Grade
>= 97	A+
93 – 96	A
90 – 92	A-
87 – 89	B+
83 – 86	B
80 – 82	B-
77 – 79	C+
73 – 76	C
70 – 72	C-
67 – 69	D+
63 – 66	D
60 – 62	D-
< 60	F

Course Materials Policy

All teaching and assignment materials in this course are intended only for authenticated users who are currently enrolled in NUCL 520 during the Spring 2024 semester. Unauthorized release of any of these materials without obtaining written consent from the professor will be considered a violation of academic integrity. Recording, photographing, or releasing any course materials to the public domain without the professor's written consent is strictly prohibited and will also be considered a violation of academic integrity.

Emergency Preparation

In the event of a major campus emergency, the course requirements, deadlines, and grading percentages may be subject to changes that are necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Any relevant changes to this course will be posted on Brightspace. It is your responsibility to regularly check Brightspace for updates on any changes made to the course. Please note that email notifications will not be sent for these updates.