

**ENU 4800 Section 06FA
ENU 6805 Section 2C83
Introduction to Nuclear Reactor Materials
Spring 2018, MWF 12:50-1:40PM, WEIL 273**

1. Catalog Description

This course provides a background on the types of materials used in nuclear reactors and their response to reactor environment. Many of the desirable material properties designed for nuclear reactor materials may degrade with exposure to the extreme environments (irradiation, temperature, stress, etc.) that are common to nuclear reactors. The objective of this course is to provide nuclear engineering students with background in materials and to discuss the unique challenges that occur in these materials under irradiation, so students understand the limitations put on reactor operations and design by materials performance.

2. Pre-requisites and Co-requisites

EMA 3010 Materials

3. Course Objectives

Successful students at the end of the course will have:

- A basic understanding of the relationship between material microstructure and macroscopic behavior of materials.
- An overall view of the materials used in nuclear power reactors, and an understanding of the basic mechanisms of materials degradation induced by neutron irradiation and the reactor environment including processes such as swelling, creep, phase transformations, embrittlement, and radiation induced segregation.
- The overall objective of the course is to enable the students (the majority of which may work directly in the nuclear materials area in the future) to understand the issues associated with materials degradation in nuclear reactors and be able to discuss said issues with others who do not have the appropriate background.

4. Professional Component (ABET)

This course provides 3 credits towards Engineering Sciences, and Students are required to apply advanced mathematics, science, and engineering science, including atomic and nuclear physics, and interaction of radiation with matter to understand and solve the issues of the radiation damage induced material degradations including volumetric swelling, radiation hardening and embrittlement, and elemental segregations in nuclear structural and fuel materials.

Does this course contain design experience? Yes, a small amount

5. Relationship of Course to Program Outcomes

This course supports the following program outcomes:

- a. An ability to apply knowledge of mathematics, science, and engineering
- i. A recognition of the need for, and an ability to engage in life-long learning
- j. A knowledge of contemporary issues

6. Instructor

Dr. Assel Aitkaliyeva
Assistant Professor, Materials Science and Engineering
156 Rhines Hall
846-3778
aitkaliyeva@mse.ufl.edu
Office Hours: Email to schedule an appointment

7. Teaching Assistant

N/A

8. Meeting Times

M, W, F: Period 6 (12:50-1:40 PM)

9. Class Schedule

Three lecture periods per week, one period each on Monday, Wednesday, and Friday.

10. Meeting Location

Weil Hall (WEIL), Room 273

11. Material and Supply Fees

N/A

12. Textbooks Required

None required. Course notes and suggested reading material will be provided through Canvas.

13. Recommended Reading

Recommended Materials to Assist with Understanding Course Objectives

- Fundamentals of Radiation Materials Science, G. Was
- Fundamental aspects of nuclear reactor fuel elements, D. R. Olander
- Nuclear Reactor Materials and Applications by B. Ma

Recommended Texts and Support to Assist with Project Report Writing

- The Mayfield Handbook of Technical and Scientific Writing (available at <http://www.mhhe.com/mayfieldpub/tsw/toc.htm>). *Excellent resource and free!*
- The University of Florida Reading and Writing Center is also available to help students become better readers and writers. More information (including operating hours) can be found at <http://www.at.ufl.edu/rwcenter>.

14. Course Outline

The following topics will be covered in the course:

Overview:

- Course introduction
- Introduction to nuclear materials

Fundamental materials science:

- Introduction to materials science
- Crystal structures
- Point defects
- Line defects
- Volume defects
- Diffusion
- Phase diagrams

Radiation damage:

- Damage cascades
- Displacement energies, collision theory, energy loss
- Displacement cross-sections
- SRIM, range, damage
- Ion vs. neutron damage
- Microstructure evolution

Mechanical properties:

- Creep
- Hardening
- Toughness

Fuel:

- Chemistry, fabrication, failure
- Microstructural changes
- Fission products
- Swelling
- Property changes

Other issues:

- Hydriding
- Corrosion
- Accident behavior

Notice: We **will not have classes** on the following dates: January 15th, March 5-9th, March 12th, April 2nd, and April 27th due to scheduled travel, holiday, spring break, and reading days.

Note: Course schedule may also change due to my unscheduled travel. I reserve the right to hold make-up classes if necessary (for example, in case of class cancellations due to weather).

15. Attendance and Expectations

Proper behavior in class is always important and leads to a relaxed and productive educational environment. Thus, eating, drinking, texting, reading of newspapers, working on homework for this or other courses, or other activities that are not part of the class are not allowed. Students who do not comply with these requirements or who behave disorderly or disrespectfully may be asked to leave the classroom. Leaving your cell phone on, leaving early or arriving late can be VERY distracting. All electronic devices (PDAs, cell-phones, etc.) should be turned off or in silent mode. If your cell phone rings

during class, it will be confiscated for the remainder of the class period. Students MUST participate during the student presentations at the end of the course in order to successfully complete the course. While not directly enforced, attendance is strongly suggested since significant amount of participative as well as individual and collaborative work will be performed during the class sessions.

16. Grading

Homework	20%
Quizzes	20%
Project Final Report	30%
Project Oral Presentation	20%
Final Exam	10%

Homework

Homework will be assigned some Fridays and due the next Friday (by 5 PM). Homeworks submitted after 5 PM on the due day will be considered as submitted the next day. Late homeworks will receive a penalty of 10% per day late. Homeworks submitted after one week after the due date will not be accepted.

Quizzes

Quizzes will be given during the semester and will be assigned during the normal class time or given on Canvas depending on the time constraints. Policies for each quiz will be detailed the class period before the exam.

Final Exam

A 2-hour final exam will take place on **Thursday, May 3** from 7:30-9:30 AM. The final exam will be cumulative. The exam may consist of multiple choice, calculations, diagram interpretation, and/or short answer questions.

Project Report

Students are asked to form research groups of 2 investigators each. More information on the team projects will be provided during team assignments. The report shall be written up in the format of a peer-reviewed journal article. Two-student teams will submit one manuscript with the division of labor documented in acknowledgement section. The course instructor will verify independently the division of effort on both the project and the manuscript – targeted to be split evenly. As part of this, you will perform team self-assessments as part of your project. Project teams will be formed by **February 9th** and the topics selected by **February 16th**.

Substantial penalties will result from plagiarism and data falsification including automatic course failure and possible expulsion. Grades for the final design manuscripts will be based upon (1) technical content, and (2) writing style. Students are asked to prepare their papers according to the author instructions for the Journal of Nuclear Materials (but others mentioned in the recommended reading are acceptable too).

Students are asked to follow the instructions to the letter, except for the following:

- Limit your total number of pages of text (Abstract to Conclusions) to no more than 15 pages and no fewer than 10 pages. (single spaced)
- Submit only one copy of the Manuscript per group (including all tables and figures) in pdf format. MS word is also acceptable, but you are held responsible for any formatting changes between computers that can happen with Word.
- Each paper must have at least four tables and figures (combined).
- Each paper must have at least 5 peer-reviewed journal article citations (beyond textbooks or conference proceedings).

Each manuscript will be submitted with a cover letter to the appropriate Editor-in-Chief noting why you think your work is worthy of publication. Final manuscripts from all groups are due by email on **Monday, April 23rd by 5:00 PM**. Late submissions will receive a penalty of 10% per day late. Manuscripts submitted after 5:00 PM on the due day will be considered as submitted the next day.

Project Presentation

On Monday, **April 23rd** (teams 1-4) and Wednesday, **April 25th** (teams 4-8) we will meet during our normal class schedule to hold oral presentations on your assigned projects. Each project 2-member team will prepare a PowerPoint Presentation for viewing to the class. Each presentation will be limited to 12 minutes with 1-3 minutes for questions. Typically, one partner will address the introduction of the problem, and give the materials and methods. Then, the other partner will discuss results and conclusions. Presentations need to be sent to the instructor at least a day before your presentation date (April 22nd and April 24th) so they can be uploaded. Presentations sent on the day of the presentation will receive a penalty of 10%.

17. Grading Scale

The grading scale is generally as follows:

Percent	Grade
93-100	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-
0-59	E

For more information on grades and grading policies, please visit:
<http://www.registrar.ufl.edu/catalog/policies/regulationgrades.html>”

18. Make-up Exam Policy

Make-up Exams and Laboratory Experiments are only allowed through prior requests or DOCUMENTED medical reasons. In cases where students will be out of town, a reasonable attempt to take the exam before the scheduled exam date will be performed.

19. Students Requiring Accommodations

Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, <https://www.dso.ufl.edu/drc>) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

20. Course Evaluation

Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at <https://evaluations.ufl.edu/evals>. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at <https://evaluations.ufl.edu/results/>.

21. University Honesty Policy

UF students are bound by The Honor Pledge which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: “On my honor, I have neither given nor received unauthorized aid in doing this assignment.” The Honor Code (<https://www.dso.ufl.edu/sccr/process/student-conduct-honor-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor.

22. Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

23. Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <http://registrar.ufl.edu/catalog0910/policies/regulationferpa.html>

24. Campus Resources:

Health and Wellness

U Matter, We Care:

If you or a friend is in distress, please contact umatter@ufl.edu or 352 392-1575 so that a team member can reach out to the student.

Counseling and Wellness Center: <http://www.counseling.ufl.edu/cwc>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. <https://lss.at.ufl.edu/help.shtml>.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling. <https://www.crc.ufl.edu/>.

Library Support, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. <https://teachingcenter.ufl.edu/>.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers. <https://writing.ufl.edu/writing-studio/>.

Student Complaints Campus:

https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf.

On-Line Students Complaints: <http://www.distance.ufl.edu/student-complaint-process>.