

**ENU 4800-06FA (13051)**  
**Introduction to Nuclear Reactor Materials**  
**Spring 2020, T 8:30-10:25AM and R 9:35-10:25AM**

**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.

**5. Instructor**

Dr. Assel Aitkaliyeva

176 Rhines Hall

352-846-3778

[aitkaliyeva@mse.ufl.edu](mailto:aitkaliyeva@mse.ufl.edu)

**6. Office Hours:**

Mondays: 1:00PM-2:00PM

Thursdays: 2:00PM-3:00PM  
176 Rhines Hall

## 7. Textbooks Required

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

## 8. 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>.

## 9. Course Outline

The following topics will be covered in the course:

### Overview:

- Course introduction
- Introduction to nuclear materials

### Fundamental materials science:

- 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

**Note:** Course schedule may also change due to unscheduled travel, in which case you will be notified via Canvas and in class. Instructor reserves the right to hold make-up classes if necessary (for example, in case of class cancellations due to weather).

**10. 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. Cell phone use during class is prohibited. Students **MUST** participate during classes, and especially during the student presentations at the end of the course in order to successfully complete the course.

**11. Grading**

Assignment	Total Points	Percentage of Final Grade
Homework Sets (5)	100 each	20%
In-class exams: 1. Exam 1 2. Exam 2 3. Exam 3 4. Final exam	100 each	20%
Project Report: 1. Outline 2. First draft 3. Final draft	100 each	25%
Project Presentation	100	25%
Entrepreneurial component	100	10%

**Homework**

Late homeworks will receive a penalty of 10% per day late. Homeworks submitted after one week after the due date will not be accepted.

**In-class exams**

In-class exams will be given during the semester and will be assigned during the normal class time. Policies for each exam will be detailed the class period before the exam. Pop-up in-class quizzes will be held periodically and will not be

announced ahead of the time. A 2-hour final exam will take place on **Wednesday, April 29<sup>th</sup>** from **12:30PM** till **2:30PM**. All exams may consist of multiple choice, calculations, diagram interpretation, and/or short answer questions.

### **Project Report**

Students are asked to form research groups of 2-3 investigators each, depending on the size of the class. More information on the team projects will be provided during team assignments. Student teams will submit one report 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.

Project teams will be formed by the instructor on **Monday, January 28<sup>th</sup>** and the topics should be selected by the team members before **Friday, February 8<sup>th</sup>**.

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 will be provided with guidance and examples on how to structure a report.

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 a copy of the report per group (including all tables and figures) in pdf and in MS word formats.
- Each paper must have at least 4 tables and figures (combined).
- Each paper must have at least 10 peer-reviewed journal article citations (beyond textbooks or conference proceedings).

Final reports from all groups are due on **Monday, April 2<sup>nd</sup> 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 **Tuesday, April 14<sup>th</sup>** (teams 1-4) and **Thursday, April 24<sup>th</sup>** (teams 5-7) we will meet during our normal class schedule to hold oral presentations on your assigned projects. Each project 2-3-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 one day before your presentation date so they can be uploaded (not the night or the morning of).  
***Presentations sent on the day of the presentation will receive a penalty of 10%.***

## 12. Grading Scale

The grading scale is 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

More information on UF grading policy may be found at:  
<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

## 13. 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.

## 14. 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.

## 15. Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.aa.ufl.edu/students/>. Students will be notified when the evaluation period opens and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

## 16. 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.

## 17. Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Robin Bielling, Director of Human Resources, 352-392-0903, [rbielling@eng.ufl.edu](mailto:rbielling@eng.ufl.edu)
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, [taylor@eng.ufl.edu](mailto:taylor@eng.ufl.edu)
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, [nishida@eng.ufl.edu](mailto:nishida@eng.ufl.edu)

## 18. 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.

## 19. 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/ferpa.html>

## 20. Campus Resources:

### Health and Wellness

#### **U Matter, We Care:**

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging

members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact [umatter@ufl.edu](mailto:umatter@ufl.edu) so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

**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 Discrimination, Harassment, Assault, or Violence**

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the [Office of Title IX Compliance](#), located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, [title-ix@ufl.edu](mailto:title-ix@ufl.edu)

**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](https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf).

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