Introduction to Nuclear Reactor Materials
ENU 4800-06FA (12274)
Spring 2024, T 8:30-10:25AM and R 9:35-10:25 AM
Location: CSE E221

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

6. TA
Mitch Mika  
105 NSC  
mmika@ufl.edu

7. **Office Hours:**  
Will be determined on the first week of class based on student availability.

8. **Textbooks Required**  
None required. Course notes and suggested reading material will be provided through Canvas.

9. **Recommended Reading**  
*Recommended Materials to Assist with Understanding Course Objectives*  

*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](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](http://www.at.ufl.edu/rwcenter).

10. **Course Schedule**  
Week 1: Introduction, point defects/Homework 1 assigned/Project topic assigned  
Week 2: Diffusion and phase diagrams/Homework 1 due/Project outline due  
Week 3: Line defects and mechanical properties of materials/Exam 1  
Week 4: Volume defects and radiation damage/Project 1st draft due/Homework 2 assigned  
Week 5: Damage rate theory/Homework 2 due  
Week 6: Damage rate theory/Exam 2/Homework 2 assigned  
Week 7: Dimensional instability/Homework 3 due  
Week 8: Irradiation hardening/Project 2nd draft due  
Week 9: Corrosion, stress corrosion cracking, and irradiation assisted stress corrosion cracking  
Week 10: Spring Break  
Week 11: Fuels: oxide and metallic/Exam 3/Homework 4 assigned  
Week 12: Fuel properties/Homework 4 due  
Week 13: Design base accidents/Final report due  
Week 14: Short- and long-term solutions to material problems  
Week 15: Term project oral presentations
Week 16: Recap and preparation for final exam

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).

11. Attendance and Expectations
Students MUST participate during classes, and especially during the student presentations at the end of the course to successfully complete the course. 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/zoom room. Cell phone use during class is prohibited.

12. Grading

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Total Points</th>
<th>Percentage of Final Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework Sets (4)</td>
<td>100 each</td>
<td>25%</td>
</tr>
<tr>
<td>In-class exams: (4, including final)</td>
<td>100 each</td>
<td>25%</td>
</tr>
<tr>
<td>Project Report:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Outline</td>
<td>100 each</td>
<td>30%</td>
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<tr>
<td>2. First draft</td>
<td></td>
<td></td>
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<tr>
<td>3. Second draft</td>
<td></td>
<td></td>
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<tr>
<td>4. Final draft</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Presentation</td>
<td>100</td>
<td>10%</td>
</tr>
<tr>
<td>In class quizzes</td>
<td>100 each</td>
<td>10%</td>
</tr>
</tbody>
</table>

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

Exams
Four exams will be given during the semester. 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 May 2nd from 12:30PM till 2:30PM in CSE E221. All exams may consist of multiple choice, calculations, diagram interpretation, and/or short answer questions.

Project Report
Students will be asked to write a report on the topic assigned on first day of classes. The report format is provided on Canvas. Students will be asked to use Latex for this submission and guidelines on using Latex will be provided during first week of classes. Submissions that do not adhere to the provided format will not be accepted. The provided template will include sections that must be appropriately filled out. Students are asked to run their submissions through generative AI (appropriate software will be included in the template) to improve readability.

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. Also note that:

- Limit your total number of pages of text to no more than 10 pages and no fewer than 5 pages. (single spaced)
- You will have an option of selecting if you want to write this in a report style or a peer-reviewed journal article style.
- Each paper must have at least 4 tables and figures (combined). The figures must be formatted per provided guidelines to be counted towards the submission.
- Each paper must have at least 10 peer-reviewed journal article citations (beyond textbooks or conference proceedings).

Late submissions will receive a penalty of 10% per hour late. Manuscripts submitted after the time indicated on Canvas will be considered as submitted the next day.

**Project Presentation**

Students will be asked to prepare a PowerPoint Presentation summarizing the outcomes of their term project paper. Students must utilize the provided template and address each of the questions in the template to receive full credit. Each presentation will be limited to 7 minutes.

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 50%.*

### 13. Grading Scale

The grading scale is as follows:

<table>
<thead>
<tr>
<th>Percent</th>
<th>Grade</th>
<th>Grade Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>93.4 - 100</td>
<td>A</td>
<td>4.00</td>
</tr>
<tr>
<td>90.0 - 93.3</td>
<td>A-</td>
<td>3.67</td>
</tr>
<tr>
<td>86.7 - 89.9</td>
<td>B+</td>
<td>3.33</td>
</tr>
</tbody>
</table>
83.4 - 86.6 | B | 3.00
80.0 - 83.3 | B- | 2.67
76.7 - 79.9 | C+ | 2.33
73.4 - 76.6 | C | 2.00
70.0 - 73.3 | C- | 1.67
66.7 - 69.9 | D+ | 1.33
63.4 - 66.6 | D | 1.00
60.0 - 63.3 | D- | 0.67
0 - 59.9 | E | 0.00

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

14. 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.

15. Students Requiring Accommodations
Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting https://disability.ufl.edu/students/get-started/. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

16. 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.bluerica.com/ufl/. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/.

17. In-Class Recording
Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A “class lecture” is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University,
or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To “publish” means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third-party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

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 Conduct Code (https://sccr.dso.ufl.edu/process/student-conduct-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. If you have any questions or concerns, please consult with the instructor or TAs in this class.

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
• Jennifer Nappo, Director of Human Resources, 352-392-0904, jpenmacc@ufl.edu
• Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
• Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

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.

**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: [https://registrar.ufl.edu/ferpa.html](https://registrar.ufl.edu/ferpa.html)

**Campus Resources:**

**Health and Wellness**

<table>
<thead>
<tr>
<th>U Matter, We Care:</th>
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<tr>
<td>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 <a href="mailto:umatter@ufl.edu">umatter@ufl.edu</a> 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.</td>
</tr>
<tr>
<td>Counseling and Wellness Center: <a href="https://counseling.ufl.edu">https://counseling.ufl.edu</a>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.</td>
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<tr>
<th>Sexual Discrimination, Harassment, Assault, or Violence</th>
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<tr>
<td>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, <a href="mailto:title-ix@ufl.edu">title-ix@ufl.edu</a></td>
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<tr>
<th>Sexual Assault Recovery Services (SARS)</th>
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<tbody>
<tr>
<td>Student Health Care Center, 392-1161.</td>
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<th>University Police Department</th>
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<tr>
<td>at 392-1111 (or 9-1-1 for emergencies), or <a href="http://www.police.ufl.edu/">http://www.police.ufl.edu/</a>.</td>
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**COVID-19**

- You are expected to wear approved face coverings at all times during class and within buildings even if you are vaccinated.
- If you are sick, stay home and self-quarantine. Please visit the UF Health Screen, Test & Protect website about next steps, retake the questionnaire and schedule your test for no sooner than 24 hours after your symptoms began. Please call your primary care provider if you are ill and need immediate care or the UF Student Health Care Center at 352-392-1161 (or email covid@shcc.ufl.edu) to
be evaluated for testing and to receive further instructions about returning to campus.

- If you are withheld from campus by the Department of Health through Screen, Test & Protect, you are not permitted to use any on campus facilities. Students attempting to attend campus activities when withheld from campus will be referred to the Dean of Students Office.
- UF Health Screen, Test & Protect offers guidance when you are sick, have been exposed to someone who has tested positive or have tested positive yourself. Visit the UF Health Screen, Test & Protect website for more information.
- Please continue to follow healthy habits, including best practices like frequent hand washing. Following these practices is our responsibility as Gators.

**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](https://lss.at.ufl.edu/help.shtml).

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling; [https://career.ufl.edu](https://career.ufl.edu).

Library Support, [http://cms.uflib.ufl.edu/ask](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/](https://teachingcenter.ufl.edu/).

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers. [https://writing.ufl.edu/writing-studio/](https://writing.ufl.edu/writing-studio/).
