Jordan University of Science and Technology
Faculty of Engineering
Nuclear Engineering Department

NE465 Nuclear Reactor Materials
First Semester 2019-2020

Course Catalog
3 Credit Hours. Nuclear reactor materials, fuel element, fission gas swelling, void swelling, materials thermal properties, chemical behavior and radiation damage. Displacements cascades damage and crystal effect, collective effects and damage, sputtering, point defect formation and diffusion, defects reaction theory, hardening, embrittlement, and irradiation creep.

Text Book

<table>
<thead>
<tr>
<th>Title</th>
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<tbody>
<tr>
<td>Fundamental Aspects of Nuclear Reactor Fuel Elements</td>
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<table>
<thead>
<tr>
<th>Author(s)</th>
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<tbody>
<tr>
<td>D.R. Olander.</td>
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<table>
<thead>
<tr>
<th>Edition</th>
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<tbody>
<tr>
<td>2nd Edition</td>
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Course References

<table>
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<tr>
<th>Short name</th>
<th>Book name</th>
<th>Author(s)</th>
<th>Edition</th>
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<tbody>
<tr>
<td>Ref #2</td>
<td>Fundamentals of Radiation Materials Science</td>
<td>Gary S. Was,</td>
<td>1st</td>
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<td>Edition</td>
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<tr>
<td>Ref #4</td>
<td>Materials Science and Engineering: An Introduction</td>
<td>W.D. Callister,</td>
<td>3rd</td>
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Instructor

<table>
<thead>
<tr>
<th>Name</th>
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<tr>
<td>Dr. GHADEER AL-MALKAWI</td>
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<thead>
<tr>
<th>Office Location</th>
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</table>
Office Hours
- Sun: 09:30 - 10:30
- Sun: 12:30 - 13:30
- Tue: 09:30 - 10:30
- Tue: 12:30 - 13:30
- Wed: 13:15 - 14:15
- Thu: 09:30 - 10:30
- Thu: 12:30 - 13:30

Email: ghmalkawi@just.edu.jo

Class Schedule & Room
Section 1:
- Lecture Time: Sun, Tue, Thu: 10:30 - 11:30
- Room: E2117

Prerequisites

<table>
<thead>
<tr>
<th>Line Number</th>
<th>Course Name</th>
<th>Prerequisite Type</th>
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<tbody>
<tr>
<td>293630</td>
<td>IE363 Engineering Materials</td>
<td>Prerequisite / Study</td>
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<tr>
<td>2003400</td>
<td>NE340 Nuclear Reactors Theory</td>
<td>Prerequisite / Study</td>
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Tentative List of Topics Covered

<table>
<thead>
<tr>
<th>Weeks</th>
<th>Topic</th>
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<tbody>
<tr>
<td>Weeks 1, 2</td>
<td>Mechanical Properties of Metals and Interatomic Bonding.</td>
</tr>
<tr>
<td>Week 3</td>
<td>Aspects of Radiation Effects</td>
</tr>
<tr>
<td>Week 3</td>
<td>General Requirements for the nuclear reactor materials</td>
</tr>
<tr>
<td>Weeks 4, 5</td>
<td>Diffusion in nuclear processes (macroscopic and microscopic view of diffusion)</td>
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<tr>
<td>Weeks 5, 6</td>
<td>Thermodynamics of Point Defects Formation</td>
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<tr>
<td>Weeks 7, 8</td>
<td>Kinchin Pease Model for Displacement</td>
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<td>Weeks 8, 9</td>
<td>Sputtering</td>
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<tr>
<td>Weeks 10, 11</td>
<td>Swelling and Void Formation</td>
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<td>Week 12</td>
<td>Irradiation Creep</td>
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<tr>
<td>Week 13</td>
<td>Embrittlement</td>
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Mapping of Course Outcomes to Program Student Outcomes

<table>
<thead>
<tr>
<th>Course Outcome</th>
<th>Weight (Out of 100%)</th>
<th>Assessment method</th>
</tr>
</thead>
<tbody>
<tr>
<td>A basic understanding of physical metallurgy and of the relationship between material microstructure and macroscopic behavior, outside of irradiation. [11]</td>
<td>10%</td>
<td>First Exam, Quizzes</td>
</tr>
</tbody>
</table>
An understanding of the mechanisms of radiation-material interaction with different types of radiation types and parameters. [11]  

| 22% | First Exam, Second Exam, Quizzes |

Studying the microscopic and macroscopic diffusion of atoms and Freckle pairs and enabling the students to calculate the concentration of the point defects [11]  

| 18% | First Exam, Second Exam, Quizzes |

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 and embrittlement. [21, 12]  

| 50% | Second Exam, Quizzes |

### Relationship to Program Student Outcomes (Out of 100%)

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<th>6</th>
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<tbody>
<tr>
<td>83.33</td>
<td>16.67</td>
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### Evaluation

<table>
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<tr>
<th>Assessment Tool</th>
<th>Weight</th>
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<tbody>
<tr>
<td>First Exam</td>
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<tr>
<td>Second Exam</td>
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<tr>
<td>Quizzes</td>
<td>10%</td>
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<tr>
<td>Final Exam</td>
<td>40%</td>
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### Policy

**Attendance**

Since class discussion is a major course ingredient, regular attendance is mandatory. Attendance record will be taken into consideration in any borderline grade decisions.

**Exam Policy**

There will be no make-up exams except in extreme circumstances at the discretion of the instructor. The instructor has to be informed in advance (by email, phone, personal ...). You will be asked to provide proper documentation.

**Disabled Students**

Students with any sort of limitation or disability should discuss its consequences with instructor prior to the start of the course.

**Emergency Provisions**

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor?s control. Here are ways to get information about changes in this course:

- E-learning announcements
- Instructor email (ghmalkawi@just.edu.jo)

Date Printed: 2020-01-14
THE SELECTION OF MATERIALS and fuels for nuclear power reactors involves a multidisciplinary approach, including physics, chemistry, materials science and engineering, systems analysis, and economics. There is also a need to consider the environmental and political factors that have an important impact on the acceptance of nuclear power. The continuing growth of nuclear energy (over 400 power reactors in 33 countries in 2000) has been made feasible by the successful development of reactor fuels and materials. Fundamental aspects of nuclear reactor fuel elements: solution to problems.