Course Syllabus

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Professor:	**TA:**	**Technical help:**
Professor Michael Tonks	Muhammet Ayanoglu	Michael Sechrist
Mechanical and Nuclear Engineering	Nuclear Engineering	Continuing & Distance Education
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Office hours: M 2:30 - 4:00	Office hours: T 3:30 - 5:00	
Th 10:30 - 12:00	F 3:30 - 5:00	

Spring 2016, M W F 11:15 - 12:05 PM, 265 Willard

In a nuclear reactor, the fuel generates heat through fission that is used to generate electricity. Thus, the performance of the nuclear fuel directly impacts the efficiency of the reactor. In addition, nuclear fuel operates in an extreme environment that induces complex multiphysics phenomena that degrade the fuel performance and reduce reactor safety. Because of its pivotal impact on the reactor safety and efficiency, understanding fuel performance is a critical part of nuclear reactor engineering.

In this course we will study the basic role of the fuel in reactor operation and understand how the fuel impacts heat generation and transport to the coolant. We will also study various fuel types and geometries, with a focus on light water reactor fuel and cladding. We then will study changes in the fuel and cladding material that degrade the performance of the fuel, with a focus on how these changes are modeled in fuel performance codes.

Module topics

1. Fuel basics
2. Heat transport
3. Mechanical behavior
4. Materials issues in the fuel
5. Materials issues in the cladding
6. Used fuel disposition, fuel cycle, and accidents

Course objectives

Students completing this course should be able to

- Calculate the rate at which heat is transport to the coolant from the fuel
- Quantitatively describe the thermomechanical behavior of the fuel and set up the equations used to model it
- List the most important microstructure changes that take place within the fuel and cladding and describe how they impact the fuel performance
- Describe the basic structure of a fuel performance code and use an existing fuel performance code

Text Book

- None

Reference Books

- Fundamental Aspects of Nuclear Reactor Fuel Elements, D.R. Olander

- Nuclear Fuel Elements, Brian Frost

Grading

Final Course Average	Grade
<65.0	F
65.0 < avg < 70.0	D
70.0 < avg < 77.0	C
77.0 < avg < 80.0	C+
80.0 < avg < 83.0	B-
83.0 < avg < 87.0	B
87.0 < avg < 90.0	B+
90.0 < avg < 93.0	A-
93.0 < avg	A

All grades can be appealed by contacting Dr. Tonks. However, after two weeks have passed since the time the grade was assigned, no grades will be changed.

Office Hours

Dr. Tonks will have scheduled office hours each week. Please come to his office to ask questions during those hours if possible. If you can't attend during those hours, contact Dr. Tonks to set up a different meeting time.

Homework

There will be six homework assignments spread throughout the semester. The homework will be turned in online as a PDF file using Canvas.

Homework can be turned late by the day of the next class period after the day it is due with a 15% penalty.

Quizzes

Six online quizzes will be given. The quizzes will introduce the general concepts that will be taught in each module. It is expected that you will need to look up the answers to the quiz questions, so you will have 1 hour for each quiz. Also, the quizzes are open note, open book, open internet, etc. You are also welcome to work on them with other students. The lowest quiz grade will be dropped for each student.

Exams

Two exams will cover the homework and quiz content from the primary topics. The exams will be downloaded from canvas and will have a 2 hour time limit.

No make-up exams will be given except as required by University Policy 42-23. The exams will be available over a two day period, so in general everyone should be able to take it during the allotted time. If you are sick, notify Dr. Tonks by email or phone.

Final Project

There will not be a final exam for this course, but there will be a final project. For the project you will develop a fuel performance code either using MATLAB or the MOOSE framework. The primary deliverable for the project will be a report.

Academic Integrity

The University defines academic integrity as the pursuit of scholarly activity in an open, honest and responsible manner. All students should act with personal integrity, respect other students' dignity, rights and property, and help create and maintain an environment in which all can succeed through the fruits of their efforts (refer to Senate Policy 49-20). Dishonesty of any kind will not be tolerated in this course. Dishonesty includes, but is not limited to, cheating, plagiarizing, fabricating information or citations, facilitating acts of academic dishonesty by others, having unauthorized possession of examinations, submitting work of another person or work previously used without informing the instructor, or tampering with the academic work of other students. Students who are found to be dishonest will receive academic sanctions and will be reported to the University's Office of Student Conduct for possible further disciplinary sanctions (refer to Senate Policy G-9).

Penn State Academic Integrity (https://handbook.psu.edu/content/academic-integrity)

Disability Access Statement

Penn State welcomes students with disabilities into the University's educational programs. Every Penn State campus has an office for students with disabilities. The Student Disability Resources Web site provides **contact information for every Penn State campus (http://equity.psu.edu/student-disability-resources/disability-coordinator)** : **http://equity.psu.edu/student-disability-resources/disability-coordinator (http://equity.psu.edu/student-disability-resources/disability-coordinator)** . For further information, please visit the **Student Disability Resources Web site (http://equity.psu.edu/student-disability-resources)** : **http://equity.psu.edu/student-disability-resources (http://equity.psu.edu/student-disability-resources)** .

In order to receive consideration for reasonable accommodations, you must contact the appropriate disability services office at the campus where you are officially enrolled, **participate in an intake interview, and provide documentation (http://equity.psu.edu/student-disability-resources/applying-for-services)** : **http://equity.psu.edu/student-disability-resources/applying-for-services (http://equity.psu.edu/student-disability-resources/applying-for-services)** . If the documentation supports your request for reasonable accommodations, your **campus's disability services office (http://equity.psu.edu/student-disability-resources/disability-coordinator)** will provide you with an accommodation letter. Please share this letter with your instructors and discuss the accommodations with them as early in your courses as possible. You must follow this process for every semester that you request accommodations.

Counseling & Psychological Services Statement

CAPS can help students resolve personal concerns that may interfere with their academic progress, social development, and satisfaction at Penn State. Some of the more common concerns include anxiety, depression, difficulties in relationships (friends, roommates, or family); sexual identity; lack of motivation or difficulty relaxing, concentrating or studying; eating disorders; sexual assault and sexual abuse recovery; and uncertainties about personal values and beliefs.

You can contact CAPS by calling the Main CAPS number/Appointment Scheduling: 814-863-0395 (Please call between the hours of 8am and 5pm, Monday-Friday to schedule an appointment) or visit us at our office location, 5th Floor Student Health Center.

Online Resources for Relaxation

It's important to take care of yourself. There are a number of valuable online resources that you can use for relaxation and stress reduction.

Learn how stress impacts your health and life, as well as some self-help strategies for managing it through the **PSU Student Affairs EDGE online workshop (http://edge.psu.edu/workshops/StressMgmt/)** . Check out other stress management resources available, including a guided program called **Stress Recess (http://cmhc.utexas.edu/stressrecess/index.html)** . There are also a number of relaxation, visualization, and mindfulness resources at the **Mind Body Spa (http://www.counseling.iastate.edu/relaxation-and-self-help-exercises/mind-body-spa)** . You can also download **mindfulness meditations (http://marc.ucla.edu/body.cfm?id=22)** here. If winter has got you down and you need an **upbeat song to listen to, check this out. (http://vimeo.com/84053039)**

Sexual Assault and Relationship Violence Hotline

A hotline has been established for victims and observers of sexual assault and relationship violence. Trained counselors on the hotline will help students access appropriate resources. Penn State students from any campus can call 1 (800) 560-1637 to access the 24 hour a day, seven day a week hotline.

(https://handbook.psu.edu/content/academic-integrity)

Course Summary:

Date	Details	
Tue Jan 10, 2017	📋 **Quiz 1: Fuel basics (https://psu.instructure.com/courses/1843747/assignments/8994157)**	due by 11:59pm
Sat Jan 21, 2017	📋 **Quiz 2: Heat transport (https://psu.instructure.com/courses/1843747/assignments/8994159)**	due by 11:59pm
Fri Jan 27, 2017	📋 **HW 1: Fuel basics (https://psu.instructure.com/courses/1843747/assignments/8994163)**	due by 11:59pm
Sat Feb 4, 2017	📋 **Quiz 3: Mechanics (https://psu.instructure.com/courses/1843747/assignments/8994155)**	due by 11:59pm
Mon Feb 13, 2017	📋 **HW 2: Heat transport (https://psu.instructure.com/courses/1843747/assignments/8994164)**	due by 11:59pm
Sat Feb 18, 2017	📋 **Quiz 4: Materials issues in the fuel (https://psu.instructure.com/courses/1843747/assignments/8994161)**	due by 11:59pm
Fri Feb 24, 2017	📋 **HW 3: Mechanics (https://psu.instructure.com/courses/1843747/assignments/8994165)**	due by 11:59pm
Mon Feb 27, 2017	📋 **HW 3: Mechanics (https://psu.instructure.com/courses/1843747/assignments/8994165)** (2 students)	due by 11:59pm
Fri Mar 3, 2017	📋 **Exam 1 (https://psu.instructure.com/courses/1843747/assignments/8994156)**	due by 11:59pm
Sat Mar 4, 2017	📋 **Select project approach (https://psu.instructure.com/courses/1843747/assignments/9132116)**	due by 11:59pm
Fri Mar 31, 2017	📋 **HW 4: Materials issues in the fuel (https://psu.instructure.com/courses/1843747/assignments/8994166)**	due by 11:59pm
	📋 **NucE seminar 3/30/2017 (https://psu.instructure.com/courses/1843747/assignments/9167594)**	due by 11:59pm
Mon Apr 10, 2017	📋 **Quiz 5: Materials issues in the cladding (https://psu.instructure.com/courses/1843747/assignments/8994160)**	due by 11:59pm
Fri Apr 14, 2017	📋 **HW 5: Materials issues in the cladding (https://psu.instructure.com/courses/1843747/assignments/8994167)**	due by 11:59pm

Date	Details	
Wed Apr 19, 2017	📄ⓘ **HW 6: Accidents, UFD, and fuel cycle** (https://psu.instructure.com/courses/1843747/assignments/8994168)	due by 11:59pm
	📄ⓘ **Quiz 6: Accidents, UFD, and fuel cycle** (https://psu.instructure.com/courses/1843747/assignments/8994158)	due by 11:59pm
Sat Apr 22, 2017	📄ⓘ **Exam 2** (https://psu.instructure.com/courses/1843747/assignments/8994154)	due by 11:59pm
Wed Apr 26, 2017	📄ⓘ **Case 1 data file** (https://psu.instructure.com/courses/1843747/assignments/9201339)	due by 11:59pm
	📄ⓘ **Case 2 data file** (https://psu.instructure.com/courses/1843747/assignments/9201342)	due by 11:59pm
	📄ⓘ **Case 3 image file** (https://psu.instructure.com/courses/1843747/assignments/9201344)	due by 11:59pm
	📄ⓘ **Final project** (https://psu.instructure.com/courses/1843747/assignments/8994162)	due by 11:59pm
Wed May 3, 2017	📄ⓘ **HW 1: Fuel basics** (https://psu.instructure.com/courses/1843747/assignments/8994163) (1 student)	due by 11:59pm
	📄ⓘ **HW 2: Heat transport** (https://psu.instructure.com/courses/1843747/assignments/8994164) (1 student)	due by 11:59pm
	📄ⓘ **HW 3: Mechanics** (https://psu.instructure.com/courses/1843747/assignments/8994165) (1 student)	due by 11:59pm
	📄ⓘ **HW 4: Materials issues in the fuel** (https://psu.instructure.com/courses/1843747/assignments/8994166) (1 student)	due by 11:59pm
	📄ⓘ **HW 5: Materials issues in the cladding** (https://psu.instructure.com/courses/1843747/assignments/8994167) (1 student)	due by 11:59pm
	📄ⓘ **HW 6: Accidents, UFD, and fuel cycle** (https://psu.instructure.com/courses/1843747/assignments/8994168) (1 student)	due by 11:59pm
	📄ⓘ **Quiz 1: Fuel basics** (https://psu.instructure.com/courses/1843747/assignments/8994157) (1 student)	due by 11:59pm
	📄ⓘ **Exam 1** (https://psu.instructure.com/courses/1843747/assignments/8994156) (1 student)	due by 11:59pm
	📄ⓘ **Exam 2** (https://psu.instructure.com/courses/1843747/assignments/8994154) (1 student)	due by 11:59pm
	📄ⓘ **Quiz 2: Heat transport** (https://psu.instructure.com/courses/1843747/assignments/8994159) (1 student)	due by 11:59pm
	📄ⓘ **Quiz 3: Mechanics** (https://psu.instructure.com/courses/1843747/assignments/8994155) (1 student)	due by 11:59pm
	📄ⓘ **Quiz 4: Materials issues in the fuel** (https://psu.instructure.com/courses/1843747/assignments/8994161) (1 student)	due by 11:59pm
	📄ⓘ **Quiz 5: Materials issues in the cladding** (https://psu.instructure.com/courses/1843747/assignments/8994160) (1 student)	due by 11:59pm
	📄ⓘ **Quiz 6: Accidents, UFD, and fuel cycle** (https://psu.instructure.com/courses/1843747/assignments/8994158) (1 student)	due by 11:59pm