Nuclear Fuel Performance

NE 591 – to be revised

1. **Course Overview**

In this course we will study the basic role of fuel in reactor operation and understand how the fuel impacts heat generation and transport to the coolant. The course will begin with an overview of different fuels and the fabrication processes required to construct nuclear fuel. We will also study various fuel types and geometries, with a focus on light water reactor fuel and cladding. Thermal transport, mechanics, and thermomechanics affecting fuel behavior will be introduced. We will then study changes in the fuel and cladding material that degrade the performance of the fuel. Finally, student will apply knowledge gained to conduct fuel performance simulations with MOOSE.

1. **Learning Outcomes**

By the end of this course, the student should be able to:

1. Understand the basics of fuel fabrication
2. Understand traditional and alternative nuclear fuel types and their application
3. Analytically calculate the rate at which heat is transported to the coolant from the fuel
4. Analytically determine the stress state within both the fuel and the cladding
5. Understand the most important microstructural changes that take place in the fuel and cladding and how they impact fuel performance
6. Use an existing fuel performance code
7. **Pre- or Co-Requisites**

NE 309; NE 409

1. **Required Text(s)**

None.

Supplemental texts:

Light Water Reactor Materials, Vol. 1 Fundamentals, D. Olander and A. Motta

Nuclear Fuel Elements, B. Frost

Fundamentals of Radiation Materials Science, G. Was

1. **Course Requirements**

Examinations: Exam 1: 20 %; Exam 2: 20 %, Exam 3: 20 %

Projects: Presentation report 1: 10 %; Presentation report 2: 10 %; Final Project: 20 %

1. **Topical Outline:** 
   1. Introduction and Overview
   2. Fuel types, Heat generation, Reactor systems, Fuel fabrication, Heat transport
   3. Mechanical behavior, Thermomechanics, Materials issues in the fuel
   4. Materials issues in the clad, Advanced fuels materials issues
   5. Overview and utilization of fuel performance codes
2. **Grading**

Letter Grade Percent Grade

A+ 98-100; A 93-97; A- 90-92; B+ 87-89; B 83-87; B- 80-82; C+ 77-79; C 73-76; C- 70-72; D+ 67-69; D 63-66; D- 60-62; F Below 60

1. **Academic integrity statement**

Follow Regulation at: http://www.ncsu.edu/provost/academic\_regulations/syllabus/reg.htm

1. **Students with disabilities**

Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with Disability Services for Students at 1900 Student Health Center, Campus Box 7509, 515-7653. For more information on NC State's policy on working with students with disabilities, please see this page (http://www.ncsu.edu/provost/hat/current/appendix/appen\_k.html).