

NUCE 431W

Spring 2008

Nuce 431W – Synthesis of Nuclear Systems

M F 12:20P - 01:10P	305 Wagner
W 12:20P - 04:25P	305 Wagner

INSTRUCTORS

Dr. K. N. Ivanov
206 Reber Building
kni1@psu.edu
Phone: 865-0040

Dr. L. E. Hochreiter
233 Reber Building
lehnuc@engr.psu.edu
Phone: 865-6198

TEXTBOOKS

- 1) K. Ivanov and L.E. Hochreiter NucE 431W Class Notes, PSU, 2006
- 2) J. Duderstadt and L. Hamilton, “Nuclear Reactor Analysis” – Chapters 11, 12, 13, 14 and 15
- 3) Westinghouse Computer Codes Theory and Input Manuals.
- 4) Recommend, not required, “The Nuclear fuel Cycle: Analysis and Management” by R. G. Cochran and N. Tsoulfanidis, 2nd edition, ANS 1999.

COURSE OUTLINE

1/14/08	Introduction to the course, course objectives Grading, homework, projects, Westinghouse involvement Attendance Extra credit for Seminars Reactor Fuel and Fabrication
1/16/08	Reactor fuel and Fabrication, continued
1/18/08	Introduction to Reactor Core Design Basic design parameters
1/18//08	Methods for Reactor Core Design
1/21/08	Martin Luther King Day, no classes
1/23/08	Methods for Reactor Core Design, Interaction between Neutronics and Thermal/Hydraulics Calculations
1/25/08	Two group diffusion theory for reactor core analysis
1/28/08	Generating group constants for the core calculations
1/30/08	Advanced homogenization techniques
2/01/08	Cross-section functionalization

- 2/04/08 Features of advanced assembly spectrum/depletion codes:
- Physics models
 - Geometry options and basic libraries
 - Applications – depletion and branch calculations
 - Input and output
- 2/06/087 Refueling Activities and Reload Core Design Process
C&T text – section 6.5 and Westinghouse Notes
- 2/08/08 Computer locations and UNIX input, Westinghouse
Nuclear Design Codes, Core Models
- 2/11/08 Westinghouse Nuclear Design Codes, continued
- 2/13/08 Meeting 1 with Westinghouse
- Discussion and assignment of Design Project,
 Loading Pattern Approach -1
 Input and Output requirements – visualization features
- 2/15/08 Methods for evaluating of reactor power distribution
- 2/18/08 Multi-dimensional neutron physics models:
- Two-group nodal diffusion model
 - Geometry and boundary conditions
 - Baffle/reflector representation
 - Pin power reconstruction
 - Approaches for fuel depletion analysis

2/20/08	Fuel loading patterns and loading pattern methodology C&T text – sections 6.1-6.3 and Westinghouse Notes
2/22/08	Core design and excess reactivity requirements
2/25/08	Equilibrium Xenon and Samarium calculations
2/27/08	Meeting 2 with Westinghouse, Loading Pattern Approach - 2 (Students should have preliminary results)
2/29/08	Temperature and power coefficients calculations
3/03/08	Examination 1 Core Neutronics
3/05/08	Hot Channel Factors in Design
3/07/08	Sub-channel Analysis, Introduction
3/10 –14/08	SPRING BREAK !!!
3/17/08	COBRA-IV Sub-channel Analysis Code <ul style="list-style-type: none"> ● System of governing equations

3/19/08 Meeting 3 with Westinghouse, Loading Pattern Analysis – 3
Design teams loading pattern project discussion
(Loading patterns should be almost complete)

3/21/08 COBRA-IV Input Description

3/24/08 COBRA-IV Input Description

3/26/08 COBRA-IV Sub-channel Analysis Code

- Plant Modeling Approach
- Hot Assembly Analysis, treatment of hot channel factors
- Core-Wide Analysis Approach, treatment of hot channel factors

3/28/08 COBRA-IV plant input/output. Dominion Plant Calculations

Examination on Core Thermal/Hydraulics TBD

3/31/08 COBRA-IV Model for Individual Projects Loading Patterns

4/02/08 Meeting 4 with Westinghouse, RSAC Safety Calculations on final
loading pattern

4/04/08 COBRA-IV Models for Individual Projects Loading Patterns,
continued

4/07/08 COBRA-IV Modeling of Individual Plants

4/09/08 Discussion of Final Design Report – Report Content

4/11/08 LWR Safety Analysis, Emergency Core Cooling Systems, Design Basis Accidents, PWR

4/14/08 Design Basis Accidents, BWR

4/16/08 Meeting 5 with Westinghouse, Plant Operational Calculations

Westinghouse Examination TBD

4/18/08 TMI –II Accident

4/21/08 TMI-II Accident, changes/impact on the industry

4/21/08 Chernobyl Accident, RBMK design verses US LWR design

4/23/08 Chernobyl Accident, aftermath

Film night, Free Pizza!!! TBD

4/25/08 Extended burnup and longer cycle length
C&T text – section 6.4

4/28/08	Economics and fuel cycle cost
4/30/08	Economics and fuel cycle costs – cont.
5/02/08	Fuel cycle costs, Class wrap-up
5/05 – 08/08	Class Presentations on Design Project, Final Design Reports

DESIGN PROJECT

The course includes a design project based on a technical problem assignment for a PWR core design. Students are divided in teams to work on separate assignments under the supervision of a Westinghouse engineer. The Westinghouse core design codes are used and they are executed on a HP C3600 Visualize Workstation under UNIX operating system. The final design report is a formal design report that has to be composed of the technical results, written using the results of the reactor core design codes. The report has to be presented in both written orally formally (60 minutes synopsis of results), and has to include an executive summary, technical abstract, and assessment of the results (i.e. you must explain the results clearly and decide if they make sense) and conclusion sections.

A Poster Board Outline of your project, similar to those in the second floor of the Reber Building, should also be completed and given to Drs Ivanov and Hochreiter at the time of the presentation. **Note, the Poster Board MUST fit into the wooden frames on the wall. Please measure the opening carefully otherwise it will fall on the floor!!!**

EVALUATION METHODS

The grading distributions are approximately as follows:

Homework problems	20%
First Exam (Core Neutronics Design Methods)	20%
Second Exam (Core Thermal-Hydraulics Design methods)	20%
Third Exam (Core loading patterns, safety analysis checks)	15%

Design Project

25%

RELATIONSHIP TO OTHER COURSES

This class has prerequisites – NUC E 301, 302, 403 and 430.