Syllabus for Nuclear Power Reactors (NERS 442)

Course Description:
Analysis of nuclear fission power systems including an introduction to nuclear reactor design, reactivity control, steady-state thermal-hydraulics and reactivity feedback, fuel cycle analysis and fuel management, power conversion cycles and transient analysis of nuclear systems.

Course Objective
Upon successful completion of the course students shall be able to

- use simulation tools to design PWR and BWR fuel assemblies,
- use simulation tools to develop a core reload design,
- design power conversion systems,
- perform procedures for measuring basic reactor properties,
- perform procedures for reactor startup

Course Schedule

Date	Lecture	Topic
	1	Course Introduction
	2	Principles of Reactor Design
	3	A History and Survey of Reactor Designs
		Martin Luther King, Jr Day
	4	Pressurized Water Reactor Systems
	5	Boiling Water Reactor Systems
	6	Cross Sections and Nuclear Data
	7	Heterogeneous Lattice Physics Methods and Analysis
	8	
	9	Whole-Core Reactor Design and Analysis
	10	
	11	Depletion Calculation and Analysis
	12	Reactor Feedback and Control
	13	HW1 & HW2 Overview and Linear Reactivity Model
	14	Exam Review
	15	Linear Reactivity Model
	16	Steady-State Reactor Thermal-Hydraulics
	17	Power Conversion Systems for Reactors
	18	Economics of Reactors
	19	Reactor Kinetics and Dynamics
	20	Reactor Simulator: Approach to Criticality
	21	Reactor Simulator: Increasing Power
	22	Virtual Reality Reactor Lab: Neutron Spectrum Measurement
	23	
	24	Virtual Reality Reactor Lab: Shutdown Power and Control Rod Calibration
	25	
	26	Reactor Simulator: ITC Measurements

Everything is Subject to change

Anticipated Homework Assignments

HW	Description	Supporting Lectures	Due Date
1	Neutron Lifecycle, Materials for reactors, Design description	2-5	
2	Neutronics Design, Reactivity Coefficients	6-12	
3	Linear Reactivity Model and Thermal Hydraulics	13-18	
4	Exam Take 2 and Economics	15-18	
5	Simulator: Approach to Criticality	19-20	
6	Simulator: Ascension to Full Power	21-22	
7	VR Neutron Activation Experiment	23-24	
8	Simulator: ITC Measurement	27	

Project Assignments

Deliverable	Description	Due Date
Presentation	15-20 min	
Report	10-20 page typed document	

General References:

Lecture	Topic
1	None
2	D&H
3	D&H, miscellaneous reports
4	The Westinghouse Pressurized Water Reactor Nuclear Power Plant; U.S. NRC Reactor Concepts manual, Ch. 4; D&H
5	U.S. NRC Reactor Concepts Manual Ch. 3; D&H
6	HNE 2 (maybe 3), D&H
7-8	HNE 9.7, HNE 9.8; Lee Ch. 11
9-10	HNE 9.7, HNE 10.3.3 (maybe 3.2); ANS 19.3 (ISO 18075)
11	
12	Lee Ch. 14
13	
15	
16	T&K Ch. 2, Ch. 8
17	T&K Ch. 6
18	Lee Ch. 15
19	Lee Ch. 8 and 16
20-21	Simulator Manual; Lee Ch. 8
22-23	None
24-25	
26	Simulator Documentation, ANS-19.6.1 (ISO 1877)

General References:

- J.C. Lee, *Nuclear Reactor Physics and Engineering*, Wiley, 2020.
  - Ch. 8, 11, 14, 15
- D. G. Cacuci, Ed., *Handbook of Nuclear Engineering*, Springer, 2010.
  - Ch. 2, 3, 4, 5, 7, 8, 9, 10, 13, 18
- N. Todreas and M. Kazimi, *Nuclear Systems Volume I: Thermal Hydraulic Fundamentals*, Second Edition, Taylor & Francis Group, 2011.
  - Ch. 1, 2, 3, 8, 9, 14
  - Appendices: E, F, G, J, K,
- J.J. Duderstadt and L.J. Hamilton, *Nuclear Reactor Analysis*, Wiley, 1977. This is the traditional text book, and is not as outdated as you would think.
- M. Driscoll, T. Downar, E. Pilat, *The Linear Reactivity Model for Nuclear Fuel Management*, ANS, 1990.