

ENU 4134 - Reactor Thermal Hydraulics 2 (3 credits), Required Course, Fall, 2006

Description: This course is the continuation of ENU 4133. Topics cover in this course include fundamentals of two-phase flow, governing equations of one-dimensional two-phase flow dynamics, two-phase friction multiplier, constitutive relationship and correlation void fraction, closure relationships for interfacial transport terms, fundamentals of heat transfer with phase change, pool boiling, forced convective boiling, condensation, correlation for two-phase heat transfer coefficient, thermal hydraulic design of fuel elements, subchannel thermal hydraulics, and thermal hydraulic design analysis methods for water cooled reactors.

Pre-requisites: ENU 4133

Program Educational Objectives / Professional Components Supported by Course:

1. Provide students with the ability to apply advanced mathematics, computational skills, science and engineering science, including atomic and nuclear physics, to identify, formulate, analyze, and solve nuclear and radiological engineering problems.
2. Provide students with knowledge of the fundamentals of radiation transport, interactions, and detection and with the principles required for the analysis, design, and safe operation of radiation producing devices and using equipment and systems.
4. Provide students with the skills needed to communicate effectively, work collaboratively, and understand their professional and ethical responsibilities and the impact of engineering solutions in a societal and economic context so they can pursue successful, productive careers in nuclear and radiological engineering.

Program Outcomes Supported by Course:

- Outcome a: an ability to apply knowledge of mathematics, science and engineering.
- Outcome c: an ability to design a system, component or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability
- Outcome e: an ability to identify, formulate and solve engineering problems.
- Outcome k: an ability to use the techniques, skills and modern engineering tools necessary for engineering practice
- Outcome l: an ability to apply advanced mathematics, science and engineering sciences, including atomic and nuclear physics, to nuclear and radiological systems and processes
- Outcome n: an ability to work professionally in on or more of the areas of: nuclear power systems, nuclear instrumentation and measurement, radiation protection and shielding and radiation sources and applications

Text: Handouts and Instructor's Notes

Main References: *Nuclear Systems I: Thermal Hydraulic Fundamentals*, N.E. Todreas and M.S. Kazimi Hemisphere, New York, 1990

Nuclear Systems II: Elements of Thermal Hydraulic Design, N.E. Todreas and M.S. Kazimi Hemisphere, New York, 1990

Grading:	Assignments	25%	Project	15%
	Midterm Test I	15%	Final Exam	30%
	Midterm Test II	15%		

ENU 4134 – Reactor Thermal Hydraulics 2 - Course Outline

1. Two-Phase Flow Fundamentals (6 Lectures)
 - 1.1 Introduction
 - 1.2 Flow regimes
 - 1.3 Void fraction
 - 1.4 Two-phase flow parameters

2. Two-Phase Flow Dynamics (18 Lectures)
 - 2.1 Two-phase flow
 - 2.2 Modeling of two-phase flow
 - 2.3 Homogeneous Equilibrium Model
 - 2.4 Separated two-phase flow
 - 2.5 Calculation of pressure drop in two-phase systems
 - 2.6 Void fraction correlations
 - 2.7 Interfacial transport equations
 - 2.8 Critical flow

3. Forced Convective Boiling in Reactor Channels (12 Lectures)
 - 3.1 Boiling Heat Transfer
 - 3.2 Development of the boiling curve
 - 3.3 Pool boiling
 - 3.4 Nucleate Boiling Heat Transfer
 - 3.5 Equations for nucleate boiling
 - 3.6 Nucleate boiling correlation
 - 3.7 Critical Heat Flux (CHF)
 - 3.8 Critical heat flux correlation
 - 3.9 Post - CHF Heat Transfer
 - 3.10 Film Boiling

4. Computational Thermal Hydraulics (12 Lectures)
 - 4.1 One-dimensional two-phase flow model
 - 4.2 Open channel two-phase flow model
 - 4.3 Subchannel analysis models
 - 4.4 COBRA IV/COBRA-EN
 - 4.5 Thermal Hydraulic Design Analysis
 - 4.6 **Project I:** Thermal Hydraulic Design Analysis of Advanced LWR Cores
 - 4.7 Departure from Nucleate Boiling Ratio (DNBR) and Calculation of MDNBR

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(First offering in this format as part of new two-course sequence will be Fall, 2006)