ENU 4133 - Reactor Thermal Hydraulics 1 (3 credits), Required Course, Spring, 2007

Description: This course covers fundamentals of Thermodynamics, fluid mechanics and heat transfer with application to design and safety of nuclear power plants. Major topics include an overview of thermal hydraulic characteristics of nuclear power plants, nuclear power plant thermodynamics and energy conversion cycles, applications of first and second law of thermodynamics, nuclear heat generation, fluid mechanics, conservation laws and governing equations for inviscid and viscous single-phase flow, conduction and convection heat transfer, thermal design of fuel elements.

Pre-requisites: EML 3100, EML 4140 and ENU 4103

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 Reference: *Nuclear Systems I: Thermal Hydraulic Fundamentals,* N.E. Todreas and M.S. KazimiHemisphere, New York, 1990

Grading:

Assignments	25%
Midterm Test I	15%
Midterm Test II	15%

Project	15%
Final Exam	30%

ENU 4133 – Reactor Thermal Hydraulics I - Course Outline

1. An Overview of Light Water Reactor Systems (3 Lectures)
2. Thermodynamic Design of Nuclear Power Plant Systems (9 Lectures)
   - 2.1 The Laws of Thermodynamics
   - 2.2 Applications of the First Law to Analysis of major energy conversion components
   - 2.3 Application of the Second Law to Power Plant design
   - 2.4 A Review of some useful Thermodynamic Relations
   - 2.5 Efficiency
   - 2.6 Nuclear Power Cycles

3. Fluid Dynamics of Nuclear Power Systems (24 Lectures)
   - 3.1 System and control volume concept
   - 3.2 Conservation of Mass Equation and its applications
   - 3.3 Momentum Integral Equation and its applications
   - 3.4 Units and Conversion of Units
   - 3.5 Energy Equation
   - 3.6 Application of the energy equation
   - 3.7 Shear stress in laminar flow
   - 3.8 Laminar flow inside a channel
   - 3.9 Turbulent flow inside a channel
   - 3.10 Derivation of Navier-Stokes equations
   - 3.11 Solution of Navier-Stokes equations
   - 3.12 Pressure drop calculation
   - 3.13 Pressure losses
   - 3.14 Dimensional analysis
   - 3.15 Design Implications: Hydraulic Analysis in Power Generation Networks

4. Reactor Heat Transfer (12 Lectures)
   - 4.1 Thermal hydraulic processes in LWR systems
   - 4.2 Fundamentals of Heat Transfer
     - 4.2.1 Conduction
     - 4.2.2 Conversion
     - 4.2.3 Radiation
   - 4.3 Steady State Radial and Axial Temperature Distribution
   - 4.4 Hot Channel Factors
   - 4.5 **Project I:** Thermal Analysis of Nuclear Fuel Rod

Prepared by Samim Anghaie Spring, 2005

(New course; first offering as part of new two-course sequence will be Spring, 2007)