1. Course: **ENU 4630 Fundamental Aspects of Radiation Shielding**

2. Credits: 3 Credits; Contact Hours: 3

3. Instructor: Wesley Bolch, Ph.D.

4. Text Book: *Radiation Shielding*, Shultis and Faw, American Nuclear Society (2000)
   ISBN 0-89448-456-7

   Code Package: MCNP6 (Procured from RSICC)
   Code Package: MicroShield (Licensed Educational Version distributed by Dr. Bolch)
   Course Handouts: Provided by Instructor

5. Specific Course Information

   a. Course Description: Three one-hour lectures discussing basic principles of radiation shielding. Study of radiation sources and shielding design for radiation facilities.
   b. Pre-requisite: ENU 4605
   c. Required Senior Level Course

6. Specific Goals of the Course
   a. Specific Outcomes of Instruction

      Calculate the radiation shielding requirements for commonly encountered sources of photon, neutron, and charged particle radiations and integrate these calculations with materials and optimization parameters to design complete shielded structures for radiation facilities. By developing a complete understanding of the physical phenomena that occur as radiation is attenuated in materials, theoretical and numerical calculational techniques will be developed to predict the resulting radiation fields. Students will develop the ability to estimate uncertainties associated with the various approximation and empirical techniques for determining realistic radiation shielding requirements.

   b. ABET Program Outcomes Supported by Course:

      Outcome a: an ability to apply knowledge of mathematics, science and engineering for problem solving in engineering.
      Outcome e: an ability to identify, formulate and solve engineering problems.
      Outcome k: an ability to use the techniques, skills and modern engineering tools, including modern computational skills and tools, necessary for nuclear and radiological engineering practice.
      Outcome l: an ability to apply advanced mathematics, science, atomic and nuclear physics and engineering to nuclear and radiological systems and processes.
      Outcome n: an ability to work professionally in one or more of the areas of: nuclear power reactors, nuclear instrumentation and measurement, radiation protection and shielding and radiation sources and applications

7. Brief List of Topics to Be Covered

    a. Radiation Sources – Photons
    b. Radiation Sources – Neutrons
    c. Radiation Dosimetry Quantities and Units
    d. Photon and Neutron Dose Response Functions
    e. Radiation Protection Regulations – External Exposures
    f. Basic Methods of Radiation Dose Calculation
    g. Special Techniques for Photons
    h. Solving Photon Shielding Problems with MicroShield
    i. Special Techniques for Neutrons
    j. Special Techniques for Electrons
    k. Monte Carlo Techniques
    l. Solving Radiation Shielding Problems with MCNP
    m. ANSI Standards and Shielding Requirements in Nuclear Facilities
    n. Shielding Methods in Medical Facilities

8. Design Project

Design Project:
Students are asked to form research groups of exactly two investigators each. A radiation facility will be selected which is preferably modeled after an existing facility or design. Radiation sources will be specified, source terms estimated, and radiation protection guidelines established. Radiation shielding specifications will then be reported based upon dose calculations, radiation attenuation and scattering estimates, both of which are determined via MicroShield calculations and MCNP radiation transport simulations. The former may be used to establish rough shielding estimates or dose rates, while the later then is used for more final estimates.

Design Project Final Manuscripts:
The description of the facility, the radiation protection plan, and the shielding design specifications shall be written up in the format of a peer-reviewed journal article. Two-student teams will submit one manuscript with the division of labor documented in acknowledgement section. The course instructor will verify independently the division of effort on both the project and the manuscript – targeted to be 50% / 50%.