

Syllabus for ENU 4605:
Radiation Sources and Interactions: Fall 2015

1. **ENU 4605 - Radiation Sources and Interactions 1** (4 credits), Required Course, Fall 2015
2. **Catalog Description** (4 Credits) – Interaction of ionizing radiation with matter; cross sections and radiation fields with emphasis on photons, heavy charged particles and electrons
3. **Pre-requisites:** None; **Co-requisite** : ENU 4001 or equivalent
4. **Course Objectives:** Following successful completion of this course, the student will have developed an integrated understanding of interactions of radiation with matter with emphasis on the radiation environments of fission and fusion “reactors.”
5. **Contribution of course** to meeting the professional component:
This course provides 4 credits towards Engineering Sciences and nuclear energy development.

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.
 - 3 . 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.
6. **Relationship of course to program outcomes:**
[This course integrates basic knowledge of physics, mathematics, and nuclear engineering science related to the fundamentals of radiation interactions with matter, as they relate to the development of global nuclear energy.]

Outcome a: an ability to apply knowledge of mathematics, science, and engineering.

Outcome e: an ability to identify, formulate, and solve engineering problems.

Outcome g: an ability to communicate effectively, using both oral and written presentations, in 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 one or more of the areas of: nuclear systems, nuclear instrumentation and measurement, radiation protection and shielding, and radiation sources and applications

See the following website for the current list of MSE outcomes:

<http://nuceng.ufl.edu/students/objectives-a-outcomes>

7. **Instructor:** Joseph M. Mack, Ph.D.

- a. NSC 235
- b. 352-392-1401, X TBD
- c. jmack@mse.ufl.edu
- d. No home web site
- e. Office hours: TBD
- f. Walk-in or appointments by email or phone

8. **Teaching Assistant:** TBD

- a. Office location
- b. Telephone
- c. E-mail address
- d. Office hours

9. **Meeting Times:** Two times per week (4 Credits).

10. **Class schedule:**

MW 8:30 – 10:25 AM

11. **Meeting Location:** NSC 227

12. **Material and Supply Fees:** None

13. **Text:**

Atoms, Radiation, and Radiation Protection, James E. Turner, 2007 (3rd edition).

(Selected course notes will be provided, as warranted.)

14. **Reference Sources:**

The Atomic Nucleus, Robley D. Evans, McGraw-Hill, 1955.

Atomic and Quantum Physics, H. Haken, H.C. Wolf, Springer-Verlag, 1987.

Neutron Physics, K.H. Beckurts, K. Wirtz, Springer-Verlag, 1964.

15. Course Outline (Four 50 minute class periods each week)

1. Basic Concepts and Quantities

Historical Perspective, Special Units, Radiation Field Characterization, Cross-sections (Microscopic and Macroscopic), Interaction Rates, Dose Concepts.

2. Special Theory of Relativity

Relevant Mass-Energy Relationships.

3. Atomic Structure

Electronic Structure, Electron Binding Energies, Quantum Mechanics.

4. Nuclear Structure

Liquid Drop Model, Shell Model, Energetics Concepts.

5. Fission Reactor Radiation Environment

Important Types of Radiation.

6. Fusion Reactor Radiation Environment

Important Types of Radiation.

7. Basics of Photon Interactions

Single Event and Cascade Physics.

8. Important Photon Interactions and Attenuation

Photoelectric, Compton, Pair Production, Cherenkov Radiation.

9. Basics of Neutron Interactions

Kinematics, Thresholds, Decay Schemes.

10. Important Neutron Interactions and Attenuation

Selected Absorption and Scattering Reactions.

11. Heavy Charged Particle Interactions

Collisional and Radiative Stopping Power.

12. Electron Interactions

Collisional and Radiative Stopping Power, Radiation Yield, X-ray Production, electron/photon cascade.

13. Fission Reactor Interactions (time permitting)

Case Study: TBD

14. Fusion Reactor Interactions (time permitting)

Case Study: Theory of Deuterium-Tritium Cross-sections

15. Sources, and Special Topics (time permitting)

[Approximately one period per week will be used for quiz/homework and special topics (codes) discussion.]

16. Attendance and Expectations:

Attendance is expected but will not be specifically marked off. **Regular and active participation is paramount.** If a student anticipates missing a class, they should have someone pick up handouts or take notes, and let the instructor know beforehand. Otherwise, a student should see the instructor afterward to get any handout material and the lecture content for that class period. Classmate pick up of handouts is also acceptable.

Operation of all cell phones, ipads, kindles, and similar devices is *verboden* with two exceptions: 1) a note-taking device in which case the instructor must be able to see it too and 2) a condition whereby a student anticipates a situation that might require communications during class. Coordinate with the instructor before class, as warranted.

Students are asked to leave several chairs near the back of the classroom empty as class starts so that late arrivals can use them. Late arrivals are accommodated, provided they do not disturb others and it does not occur frequently. Frequent tardiness will be addressed by an instructor-student conference.

ALL email communication between student and instructor must be facilitated through the University of Florida system: jmack@mse.ufl.edu

17. Grading – methods of evaluation: 100 points total

Homework/Quizzes: 30 points

Midterm Exam (Appropriate class period): 30 points

Final Exam (Appropriate class period): 40 points

Grading Scale

A+....95-100

A.....90-95-

B+.....85-90-

B.....80-85-

C+.....75-80-

C.....70-75-

D+.....65-70-

D.....60-65-

F.....<60

Grades may be adjusted at the end of the course at the discretion of the instructor. Improvement over the course of the semester and classroom effort may be used to clarify close grade boundaries.

For more information on grades and grading policies, please visit:
<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

18. Make-up Exam Policy: make-up exams are only given for exceptional circumstances and in accordance with University policy, and the request must be pre-approved by the lecturer.

19. Honesty Policy – All students admitted to the University of Florida have signed a statement of academic honesty committing honesty in all academic work and understanding that failure to comply with this commitment will result in disciplinary action. This statement is a reminder to uphold your obligation as a UF student and to yourself, to be honest in all work submitted and exams taken in this course and all others.

20. Accommodation for Students with Disabilities – Students Requesting classroom accommodation must first register with the Dean of Students Office. That office will provide the student with documentation that he/she must provide to the course instructor when requesting accommodation.

21. UF Counseling Services –Resources are available on-campus for students having personal problems or lacking clear career and academic goals. The resources include:

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UF Counseling & Wellness Center, 3190 Radio Rd, 392-1575,
<http://www.counseling.ufl.edu/cwc/Default.aspx>, counseling services and mental health services.
Career Resource Center, Reitz Union, 392-1601, career and job search services.
University Police Department 392-1111

22. Software Use – All faculty, staff and student of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

23. Students are expected to provide feedback on the quality of instruction in this course based on 10 criteria. These evaluations are conducted online at <https://evaluations.ufl.edu>. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at <https://evaluations.ufl.edu/results>.