***ENU 4641 – APPLIED RADIATION PROTECTION***
***Spring 2014 - Section 4602***

**Catalog Description:** Introduction to practical radiation protection techniques and practices. Examination of pertinent regulations, current practice, ethics, and instrumentation / measurement practices. Design of facilities and controls to optimize benefits of radiation applications and minimize exposure risks

**Course Pre-requisites:** ENU 4605 – Radiation Interactions & Sources
ENU 4630 – Fundamentals of Radiation Shielding

**Course Objectives:** This course is designed to introduce nuclear engineering and nuclear engineering sciences students to the basic principles, concepts, and methodology of radiation protection and radiological hazard evaluation.

**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 a 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 and using equipment and systems.

**Program Outcomes Supported by Course:**

- **a.** an ability to apply knowledge of mathematics, science and engineering;
- **e.** an ability to identify, formulate and solve engineering problems;
- **f.** an understanding of professional and ethical responsibility;
- **g.** an ability to communicate effectively;
- **i.** a recognition of the need for and an ability to engage in life-long learning;
- **j.** a knowledge of contemporary issues;
- **l.** an ability to apply advanced mathematics, science, and engineering sciences, including atomic and nuclear physics, to nuclear and radiological systems and processes;
- **n.** an ability to work professionally in one or more of the areas of: nuclear power systems, nuclear instrumentation and measurement, radiation protection and shielding, and radiation sources and applications.

**Instructor:** Wesley E. Bolch, PhD, PE, CHP
119A Medical Physics Annex
392-0303, wbolch@ufl.edu, www.bme.ufl.edu
Office Hours: MWF 9:30 am to 11:00 am

**Textbooks and Other Resources:**

Richard E. Faw and J. Kenneth Shultis
*Radiological Assessment: Sources and Exposures*
American Nuclear Society (1999)
ISBN 0-89448-455-9 (Order at www.ans.org/store)

Various Handouts from NCRP, ICRP, and ICRU Reports

## Course Schedule by Topic

**1. Biological Effects of Ionizing Radiation**
- Molecular effects
- Cellular effects
- Organ and organ system-level effects
- Acute radiation syndromes
- Radiation risk coefficients (2005 National Academy of Sciences BEIR VII Report)

**2. Exposure to Natural and Man-Made Radiation Sources**
- Cosmic, solar, and geomagnetically trapped radiation
- Cosmogenic radionuclides
- Primordial radionuclides
- Decay series of primordial radionuclides
- Medical sources
- Nuclear power
- Miscellaneous sources

**3. Internal Dose Evaluation**
- ICRP 30 methodology
- Retention equations – ICRP 30
- Excretion equations – ICRP 30
- ICRP 30 Lung Model
- ICRP 30 GI Tract Model
- ICRP 30 Bone Model
- Annual Limits on Intake and Derived Air Concentrations
- ICRP 66 Respiratory Tract Model and ICRP 99 Alimentary Tract Model
- Recycling biokinetic models – ICRP 30+

**4. Atmospheric Dispersion of Radionuclides**
- Atmospheric stability
- Diffusion of radionuclides in the atmosphere
- Results obtained from the diffusion model
- Refinements to the Gaussian Plume Model
- Estimation of diffusion parameters
- Averaging times
- Limitations of the Gaussian Plume Model

**5. Dispersion of Radionuclides in Surface and Ground Water**
- Near-field mixing in surface water
- Discharge to small lakes and reservoirs
- Discharge to rivers and estuaries
- Discharge to large lakes and oceans
- Sedimentation effects in surface waters
- Radionuclide migration in groundwater

**6. Environmental Pathway Modeling**
- General description of exposure pathways
- Terrestrial exposure pathways / Aquatic and marine exposure pathways
- Treatment of special radionuclides / Usage factors

## Course Schedule by Date

| *Date* | | *Course Topic* | *Chapter* | *Lecturer* |
|---|---|---|---|---|
| **January** | 6 | Course Overview | | |
| | 8 | Biological Effects of Radiation | 3 | Bolch |
| | 10 | Biological Effects of Radiation | 3 | Bolch |
| | 13 | Biological Effects of Radiation | 3 | Bolch |
| | 15 | Cancer Facts and Figures | Handouts | Bolch |
| | 17 | BEIR VII Risk Models | Handouts | Bolch |
| | 20 | ***No Class – MLK Holiday*** | | |
| | 22 | BEIR VII Risk Models | Handouts | Bolch |
| | 24 | BEIR VII Risk Models | Handouts | Bolch |
| | 27 | Exposure of Natural Sources of Radiation | 4 | Bolch |
| | 29 | Exposure to Natural Sources of Radiation | 4 | Bolch |
| | 31 | Exposure to Man-Made Sources of Radiation | 5 | Bolch |
| **February** | 3 | Exposure to Man-Made Sources of Radiation | 5 | Bolch |
| | 5 | Internal Dose Assessment | 8 | Bolch |
| | 7 | Internal Dose Assessment | 8 | Bolch |
| | 10 | Internal Dose Assessment | 8 | Bolch |
| | 12 | Internal Dose Assessment | 8 | Bolch |
| | 14 | Internal Dose Assessment | 8 | Bolch |
| ***Midterm - Evening*** | 17 | Atmospheric Dispersion of Radionuclides | 9 | Bolch |
| | 19 | ***No Class – Work on Review Paper*** | | Bolch |
| | 21 | ***No Class – Work on Review Paper*** | | Bolch |
| | 24 | ***No Class – Work on Review Paper*** | | Bolch |
| | 26 | Atmospheric Dispersion of Radionuclides | 9 | Bolch |
| **March** | 28 | Atmospheric Dispersion of Radionuclides | 9 | Bolch |
| | 3 | ***No Class – Spring Break*** | | |
| | 5 | ***No Class – Spring Break*** | | |
| | 7 | ***No Class – Spring Break*** | | |
| | 10 | ***No Class – Work on Review Paper*** | | |
| | 12 | ***No Class – Work on Review Paper*** | | |
| | 14 | ***No Class – Work on Review Paper*** | | |
| | 17 | Dispersion of Radionuclides in Surface/Ground Water | 10 | Bolch |
| | 19 | Dispersion of Radionuclides in Surface/Ground Water | 10 | Bolch |
| | 21 | Dispersion of Radionuclides in Surface/Ground Water | 10 | Bolch |
| | 24 | Environmental Pathway Modeling | 11 | Bolch |
| | 26 | Environmental Pathway Modeling | 11 | Bolch |
| | 28 | Environmental Pathway Modeling | 11 | Bolch |

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| **April** | 14 | ***In Class Presentations / Final - Evening*** |
| | 16 | ***In Class Presentations*** |
| | 18 | ***In Class Presentations*** |

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| ***Papers Due*** | ***Friday, April 4, via email by 9 pm*** |
| ***Papers Returned*** | ***Friday, April 11, via email*** |
| ***Papers Resubmit*** | ***Friday, April 18 via email by 9 pm*** |

**Determination of Final Course Grade:**

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|---|---|
| Homework Sets | 25% |
| Quiz 1 (in class) | 5% |
| Quiz 2 (in class) | 5% |
| Midterm Exam (evening) | 20% |
| Final Exam (evening) | 20% |
| Review Paper | 25% |

**Grading Scale:**

93 -100 A, 90-92 A-,
87-89 B+, 83-86 B, 80-82 B-,
77-79 C+, 73-76 C, 70-72 C-,
67-69 D+, 63-66 D, 60-62 D-,
<60 E

**TERM PAPER**

Pairs of students must select a topic for a term paper and oral presentation. Please select your first, second, and third choices and meet with Dr. Bolch as soon as possible to reserve a topic. ***All papers should have a dosimetry (internal or external) component to them.***

The term paper should be written in a technical style suitable for publication in the journal *Health Physics*. Use the ***Instructions to Authors*** as a guide. In addition, review a copy of the journal to determine format, structure, etc. A portion of your grade for the paper will be determined by your ability to prepare the paper correctly and to write properly. The paper must be in the range of 10-15 pages of double-spaced text excluding the title page and any figures or tables. All papers should contain at least **5 journal articles, 2 tables, and 2 figures**. Late papers will be subject to a 20% per day reduction in grade. Students must submit copies of each of the 5 journal articles referenced (PDF versions).

Your term paper will be reviewed just as is done with a journal article submission. You will then be required to write the "journal editor" a response along with a corrected manuscript. A portion of your paper grade (~15%) will be made according to your responsiveness to the reviewer's comments.

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| **Term Papers Submitted** | ***Friday, April 4 via email*** |
| **Term Papers Returned** | ***Friday, April 11 via email*** |
| **Term Paper Resubmitted** | ***Friday, April 18 via email*** |

**Honesty Policy:** All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest 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 be honest in all work submitted and exams taken in this course and all others.

**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.

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

- University Counseling Center, 301 Peabody Hall, 392-1575, Personal and Career Counseling.
- SHCC mental Health, Student Health Care Center, 392-1171, Personal and Counseling.
- Center for Sexual Assault/Abuse Recovery and Education (CARE), Student Health Care Center, 392-1161, sexual assault counseling.
- Career Resource Center, Reitz Union, 392-1601, career development assistance and counseling.

**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.