ENU 6623 – PATIENT DOSIMETRY IN MEDICAL IMAGING AND RADIOTHERAPY - Spring 2019

Course Description (3 Credits)
Unit 1 of the course will review basic concepts of ionizing radiation interactions in matter, biological effects of radiation exposure, radiation dosimetry quantities and units, including the effective dose, and human phantoms – both computational and physical – for dose assessment in the clinic. Unit 2 will cover medical imaging dosimetry of the patients, including radiography, fluoroscopy, computed tomography, and nuclear medicine, preceded by a review of our understanding of how radiation exposure might induce cancer in humans and at what level. Unit 3 will cover organ dosimetry in patients treated by radiotherapy using photon, proton, or radiopharmaceuticals. This section will be preceded by reviews of tumor control probability, normal tissue complication probability, the biologically effective dose concept, and how toxicities might be induced in non-targeted normal tissues and organs following out-of-field exposure in radiotherapy.

Course Prerequisites: BME 6535 – Radiation Physics, Measurement, and Dosimetry

Course Objectives:
Develop an in-depth understanding of the tools and methods used to assess radiation dose to tissues and organs in patients either imaged with ionizing radiation (radiography, fluoroscopy, computed tomography, and nuclear medicine) or treated for cancer using photons, protons, or radiopharmaceuticals. Hands on work will include the use of the PCXMC Monte-Carlo based code for assessment of imaging dose to patients.

Instructor:
Wesley Bolch, PhD, Room 109A Medical Physics Annex, (352) 273-0303, wbolch@ufl.edu
Office Hours: By appointment

Teaching Assistant:
Justin Brown, PhD student in medical physics, brow0294@ufl.edu
Office Hours: By appointment

Meeting Times: Monday, Wednesday, Friday
Meeting Location: RNK 230 (M and W) and RNK 225 (F)

Textbooks:
The course will be based on instructor lecture notes, peer-reviewed journal articles, and selected portions from ICRP, ICRU, and NCRP reports and publications.

Attendance and Expectations:
Students are expected to attend all lectures, notify instructor of expected absence in advance, and make arrangements to make up missed material. Attendance will be monitored through periodic and unannounced verification in class. All laptops and cell phones shall be turned off and put away at the start of all in-class lectures. Late homework is subject to a 20% per day penalty deduction. Professionalism standards will be enforced on the review paper and homework sets.

Grading Policy:

Attendance and Participation	5%		
Homework Sets	15%		
Exam 1	20%	**February 4**	6 to 9 pm
Exam 2	20%	**March 18**	6 to 9 pm
Exam 3	20%	**April 29**	6 to 9 pm
Review Papers - Submitted	20%	**April 14**	By Email – 9 pm
Review Papers - Returned		**April 21**	By Email
Review Papers - Resubmitted		**April 28**	By Email – 9 pm

Grading Policy

Percent	Grade	Grade Points
93 to 100	A	4.00
90 to <93	A-	3.67
87 to <90	B+	3.33
82 to <87	B	3.00
80 to <82	B-	2.67
77 to <80	C+	2.33
72 to <77	C	2.00
70 to <72	C-	1.67
67 to <70	D+	1.33
62 to <67	D	1.00
60 to <62	D-	0.67
<60	E	0.00

Students Requiring Accommodations

Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, https://www.dso.ufl.edu/drc) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

Course Evaluation

Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at https://evaluations.ufl.edu/evals. 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/.

University Honesty Policy

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (https://www.dso.ufl.edu/sccr/process/student-conduct-honor-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Software Use

All faculty, staff, and students 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.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: http://registrar.ufl.edu/catalog0910/policies/regulationferpa.html

Lecture Schedule by Date

Date		*Lecture No. and Topic*	*Sources – Lecture Notes*	*Lecturer*
		Unit 1 – Background Material		
January	7	Basic Concepts in Radiation Interactions	Class Notes	Bolch
	9	Basic Concepts in Radiobiology	ICRU Reports	Bolch
	11	Basic Concepts in Radiobiology	ICRU Reports	Bolch
	14	Radiation Dosimetry Quantities and units	Class Notes	Bolch
	16	Historical Review of the Effective Dose and its Use in Medicine	ICRP Pubs	Bolch
	18	Historical Review of the Effective Dose and its Use in Medicine	ICRP Pubs	Bolch
	21	***No Class – MLK Holiday***		Bolch
	23	Computational Human Phantoms for Dose Assessment	Class Notes	Bolch
	25	Physical Human Phantoms for Dose Assessment	Class Notes	Bolch
		Unit 2 – Patient Dosimetry in Medical Imaging		
	28	Studies Linking Radiation Exposure to Cancer Induction	Class Notes	Bolch
	30	Studies Linking Radiation Exposure to Cancer Induction	Class Notes	Bolch
February	1	Dose Dependent Models of Cancer Incidence and Mortality	NAS / UNSCEAR	Bolch
	4	Dose Dependent Models of Cancer Incidence and Mortality	NAS / UNSCEAR	Bolch
	6	Organ Dosimetry in Radiography	ICRU Report 74	Bolch
	8	Organ Dosimetry in Radiography	ICRU Report 74	Bolch
	11	Software Code Review - PCXMC	Class Notes	***GTM***
	13	Software Code Review - PCXMC	Class Notes	Bolch
	15	Organ Dosimetry in Diagnostic and Interventional Fluoroscopy	ICRU Report 74	Bolch
Exam 1	18	Organ Dosimetry in Diagnostic and Interventional Fluoroscopy	ICRU Report 74	Bolch
	20	Organ Dosimetry in Computed Tomography	ICRU Report 87	Bolch
	22	Organ Dosimetry in Computed Tomography	ICRU Report 87	Bolch
	25	Organ Dosimetry in Diagnostic Nuclear Medicine (MIRD Schema)	MIRD 21	Bolch
	27	Organ Dosimetry in Diagnostic Nuclear Medicine (MIRD Schema)	MIRD 21	Bolch
March	1	Organ Dosimetry in Diagnostic Nuclear Medicine (MIRD Schema)	MIRD 21	Bolch
	4	***No Class – Spring Break***		Bolch
	6	***No Class – Spring Break***		Bolch
	8	***No Class – Spring Break***		Bolch
		Unit 3 – Patient Dosimetry in Radiotherapy		
	11	Tumor Control Probability (TCP)	Hall Textbook	Bolch
	13	Tumor Control Probability (TCP)	Hall Textbook	Bolch
	15	Normal Tissue Control Probability (NTCP)	Hall Textbook	Bolch
Exam 2	18	Normal Tissue Control Probability (NTCP)	Hall Textbook	Bolch
	20	Biologically Effective Dose (BED) and Equieffective Dose (EQD2)	Journal Articles	Bolch
	22	Biologically Effective Dose (BED) and Equieffective Dose (EQD2)	Journal Articles	Bolch
	25	Review of Organs at Risk and Dose Thresholds for Toxicity	Journal Articles	Bolch
	27	Review of Organs at Risk and Dose Thresholds for Toxicity	Journal Articles	Bolch
	29	Out-of-Field Organ Dosimetry in Photon Therapy	ICRU Report 83	Bolch
April	1	Out-of-Field Organ Dosimetry in Photon Therapy	ICRU Report 83	***GTM***
	3	Out-of-Field Organ Dosimetry in Photon Therapy	ICRU Report 83	Bolch
	5	Out-of-Field Organ Dosimetry in Proton Therapy	ICRU Report 78	Bolch
	8	Out-of-Field Organ Dosimetry in Proton Therapy	ICRU Report 78	Bolch
	10	Out-of-Field Organ Dosimetry in Proton Therapy	ICRU Report 78	Bolch
	12	Organ Dosimetry in Radiopharmaceutical Therapy	Draft ICRU Report	Bolch

	15	Organ Dosimetry in Radiopharmaceutical Therapy	Draft ICRU Report	Bolch
	17	Organ Dosimetry in Radiopharmaceutical Therapy	Draft ICRU Report	Bolch
	19	Class Presentation of Review Papers		Bolch
	22	Class Presentation of Review Papers		Bolch
	24	Class Presentation of Review Papers		Bolch
	26	READING DAY		
Exam 3	29			

GTM – Dr. Bolch is on travel, and thus the lecture with be delivered via GoToMeeting

Homework: Between 10 and 15 problem sets will be assigned throughout the semester. Problem sets will be due within one week of assignment. Grades will be reduced 20% per day late.

Exams: Three non-cumulative exams will be given during the semester on the following dates: **February 4** (6 to 9 pm), **March 18** (6 to 9 pm), and **April 29** (6 to 9 pm). Make-up exams will only be considered for exceptional circumstances and will be implemented by the instructor on a case-by-case basis. Notice of the absence must be given to the instructor prior to the start of each exam.

Review Papers: Students are asked to select a topic related to patient radiation dosimetry, and perform a detailed literature review of that topic. The review article will follow the Instructions to Contributors for the journal *Medical Physics*. Grades for the final manuscripts will be based upon (1) technical content, (2) writing style, and (3) adherence to journal article submission guidelines.

Students are asked to follow the author instructions, except for the following:

- Limit your total number of pages of text (Abstract to Conclusions) to no more than 15 pages and no fewer than 10 pages.
- Submit only one copy of the Cover Letter, one copy of the Copyright Transfer Agreement, and one copy of the Manuscript (including all tables and figures) all in MS Word format
- Use the following file names:
  - Cover Letter – Last Name.docx,
  - Copyright Agreement – Last Name.docx, and
  - Paper – Last Name.docx.
- Each paper must have at least two tables and two figures.
- Each paper must have at least 5 peer-reviewed journal article citations (beyond textbooks or conference proceedings).

Each manuscript will be submitted with a cover letter to the appropriate Editor-in-Chief noting why you think your work is worthy of publication. Final manuscripts are due by email on Sunday, **April 14**. Reviewed manuscripts will be returned by Sunday, **April 21**. A resubmitted manuscript with Response to Comments will be due by Sunday, **April 28**.

Homework Policy
Wesley E. Bolch

1. Homework sets will be assigned on Friday in class. They will be due by upload to the Canvas course website on the date and time indicated. Grades will be decreased 20% for each day late (20% the following Monday, 40% the following Tuesday, etc.).

2. Homework to be turned in must be neat, legible, stabled, and on one side of the paper only. As a general practice, work each homework problem on a scratch paper and recopy when thought to be correct and complete. All

homework problems will be graded; however, **the instructor reserves the right to give zero credit for any problem that does not appear neat, legible, and easy to follow.**

3. For each problem...

   a) Start each problem on a separate page.
   b) Paraphrase the problem to be solved.
   c) State all given and pertinent data, and specify the sources for each.
   d) List all pertinent formulas or laws needed to solve the problem.
   e) State clearly all assumptions made.
   f) Solve the equations specified above with minimal calculation of intermediate values. When reporting intermediate values, carry 2-3 extra significant digits until the final answer is given.
   g) Within each equation to be solved, show units for every numerical value substituted. Perform a unit analysis for both intermediate and final answers.
   h) Label and box your final answer. Give no more than one significant digit beyond those of your input data.
   i) **The instructor reserves the right to give zero credit to a problem if any one step is not followed.**

4. Partial credit will be given for each worked problem.

5. Turn in each homework with the homework assignment sheet as the first page.

Campus Resources:

Health and Wellness

U Matter, We Care:
If you or a friend is in distress, please contact umatter@ufl.edu or 352 392-1575 so that a team member can reach out to the student.

Counseling and Wellness Center: http://www.counseling.ufl.edu/cwc, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Assault Recovery Services (SARS)
Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or http://www.police.ufl.edu/.

Academic Resources

E-learning technical suppor*t*, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. https://lss.at.ufl.edu/help.shtml.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling. https://www.crc.ufl.edu/.

Library Support, http://cms.uflib.ufl.edu/ask. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. https://teachingcenter.ufl.edu/.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers. https://writing.ufl.edu/writing-studio/.

Student Complaints Campus*:* https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf.

On-Line Students Complaints*:* http://www.distance.ufl.edu/student-complaint-process.