NUCLEAR ENGINEERING: RADIATION SCIENCES

The radiation sciences option of the nuclear engineering major (http://guide.wisc.edu/undergraduate/engineering/nuclear-engineering-engineering-physics/nuclear-engineering-bs/) provides a pathway for careers in medical applications of radiation. Understanding how radiation interacts with biological material is a natural extension of the nuclear engineering fundamentals in modern physics and mathematics. Many students continue to graduate school to get advanced degrees in medical physics, either at UW-Madison or elsewhere.

Radiation science students will use their engineering analysis skills on challenges that range from working with patients to developing new medical devices and equipment. Patients experience radiation to diagnose diseases as well as to treat them. In both cases it may rely on radioactive tracers injected into their bodies or on radiation exposure from outside. Deciding how to administer the radiation to maximize the benefit and minimize the harm requires skills at the intersection between medicine and nuclear engineering. Nuclear engineers in the radiation sciences option also design, analyze and build devices that will generate novel radioactive tracers, deliver radiation externally in ever more precise ways, and detect the radiation levels to ensure the accuracy of the treatments.

Following the same deep curriculum in physics and math in the early years, students in the radiation sciences option will complete their degree with graduate courses from the internationally recognized Medical Physics program. After learning the consequences of radiation interaction with both healthy and diseased tissue, students can take courses in imaging and radiation detection, the production of radiation with radioisotopes or engineered devices, and dig deeper into the use of radiation in medicine.

Talk to your academic advisor about declaring this option.

REQUIREMENTS

The Radiation Sciences option is intended for students interested in medical and non-power applications. Students must have and are expected to maintain a 3.0 cumulative GPA.

The following curriculum applies to students who entered the program starting in Fall 2022.

SUMMARY OF REQUIREMENTS

Code	Title	Credits
Mathematics and Statistics		22
Science		16
Engineering Science		27
Radiation Sciences Core Requirement		25
Radiation Sciences Electives		11
Introduction to Engineering		3
Communication Skills		8
Liberal Studies		16
Free Elective		1
Total Credits		**129**

MATHEMATICS AND STATISTICS

Code	Title	Credits
MATH 221	Calculus and Analytic Geometry 1	5
or MATH 217	Calculus with Algebra and Trigonometry II	
or MATH 275	Topics in Calculus I	
MATH 222	Calculus and Analytic Geometry 2	4
or MATH 276	Topics in Calculus II	
MATH 234	Calculus--Functions of Several Variables	4
MATH 320	Linear Algebra and Differential Equations	3
MATH 321	Applied Mathematical Analysis	3
STAT 324	Introductory Applied Statistics for Engineers	3
Total Credits		**22**

SCIENCE

Code	Title	Credits
Select one of the following:		5-10
CHEM 109	Advanced General Chemistry	
CHEM 103 & CHEM 104	General Chemistry I and General Chemistry II	
PHYSICS 202	General Physics	5
or PHYSICS 208	General Physics	
PHYSICS 241	Introduction to Modern Physics	3
or PHYSICS 205	Modern Physics for Engineers	
PHYSICS 322	Electromagnetic Fields	3
Total Credits		**16-21**

ENGINEERING SCIENCE

Code	Title	Credits
E C E 376	Electrical and Electronic Circuits	3
or PHYSICS 321	Electric Circuits and Electronics	
E M A 201	Statics	3
E M A 202	Dynamics	3
or M E 240	Dynamics	
E M A 303	Mechanics of Materials	3
or M E 306	Mechanics of Materials	
E P 271	Engineering Problem Solving I	3-4
or COMP SCI 200	Programming I	
or COMP SCI 220	Data Science Programming I	
or COMP SCI 310	Problem Solving Using Computers	
M E 231	Geometric Modeling for Design and Manufacturing	3
M E 361	Thermodynamics	3
M S & E 350	Introduction to Materials Science	3
Computing Elective (select one of the following):		3
COMP SCI 300	Programming II	
COMP SCI 412	Introduction to Numerical Methods	

E M A/E P 471	Intermediate Problem Solving for Engineers	
E M A/E P 476	Introduction to Scientific Computing for Engineering Physics	
Total Credits		**27-28**

RADIATION SCIENCES CORE REQUIREMENT

Code	Title	Credits
N E 305	Fundamentals of Nuclear Engineering	3
N E 405	Nuclear Reactor Theory	3
N E 408	Ionizing Radiation	3
N E 412	Nuclear Reactor Design	5
N E 424	Nuclear Materials Laboratory	1
N E 427	Nuclear Instrumentation Laboratory	2
N E 428	Nuclear Reactor Laboratory	2
N E 571	Economic and Environmental Aspects of Nuclear Energy	3
MED PHYS/ B M E/H ONCOL/ PHYSICS 501	Radiation Physics and Dosimetry	3
Total Credits		**25**

RADIATION SCIENCES ELECTIVES

Code	Title	Credits
Medical Physics Electives		9
Select credits from Medical Physics Electives Course List below		
Technical Electives (not to be confused with Medical Physics Electives) choose 2 credits from:		*2*
N E 1	Cooperative Education Program (no more than 3 credits)	
Courses numbered 300+ in the CoE except for E P D/ INTEREGR		
Courses numbered 300+ in MATH, PHYSICS, COMP SCI, STAT (except STAT 301), ASTRON, MED PHYS, and CHEM departments		
Students may also propose any class that they feel will benefit their education path with pre-requisite of two physics or calculus classes. For these courses the advisor will review the request and if approved, recommend a DARS substitution.		
Total Credits		**11**

Medical Physics Electives Course List [1]

Code	Title	Credits
MED PHYS/N E 506	Monte Carlo Radiation Transport	3
MED PHYS/ B M E 566	Physics of Radiotherapy	3
MED PHYS/N E 569	Health Physics and Biological Effects [2]	3-4
MED PHYS/ B M E 573	Mathematical Methods in Medical Physics	3
MED PHYS/ B M E 574	Data Science in Medical Physics	3
MED PHYS/ B M E 578	Non-Ionizing Diagnostic Imaging	4
MED PHYS/ B M E 580	The Physics of Medical Imaging with Ionizing Radiation	4
MED PHYS/ PHYSICS 588	Radiation Production and Detection	4
MED PHYS 671	Selected Topics in Medical Physics [2]	1-4
MED PHYS 701	Ethics and the responsible conduct of research and practice of Medical Physics	1

Students are encouraged to access the online N E future course offering grid to plan their future course schedules and to confirm the offering of a course in the table.

1

Courses meeting the Medical Physics Electives requirement are selected MED PHYS courses numbered 500 and above and selected PHYSICS courses numbered 400 or above. No more than 3 credits of N E 699 Advanced Independent Study may be used to meet this requirement. (Refer to the NE handbook under Degree Information on the NE department website (https://docs.google.com/document/u/1/d/e/2PACX-1vRMi-zHWwv19rf6wMx2E5Nzdn1Awf0ZHG6pK-QXTSRfsD-I3kYuBBCOMZbiWt9vcLejeTxBQQHEjZVs/pub/)).

2

N E/MED PHYS 569 Health Physics and Biological Effects and MED PHYS 671 Selected Topics in Medical Physics are especially recommended for students in this focus area.

INTRODUCTION TO ENGINEERING

Code	Title	Credits
N E 231	Introduction to Nuclear Engineering	3
Total Credits		**3**

COMMUNICATION SKILLS

Code	Title	Credits
ENGL 100	Introduction to College Composition	3
or LSC 100	Science and Storytelling	
or COM ARTS 100	Introduction to Speech Composition	
or ESL 118	Academic Writing II	
E P D 275	Technical Presentations	2
INTEREGR 397	Engineering Communication	3
Total Credits		**8**

LIBERAL STUDIES ELECTIVES

Code	Title	Credits
College of Engineering Liberal Studies Requirements		
Complete Requirements (http://guide.wisc.edu/undergraduate/engineering/#requirementstext) [1]		16
Total Credits		**16**

1

Students must take 16 credits that carry H, S, L, or Z breadth designators. These credits must fulfill the following subrequirements:

1. A minimum of two courses from the same subject area (https://registrar.wisc.edu/subjectarea/) (the description before the course number). At least one of these two courses must be designated as above the elementary level (I, A, or D) in the course listing.
2. A minimum of 6 credits designated as humanities (H, L, or Z in the course listing), and an additional minimum of 3 credits designated as social science (S or Z in the course listing). Foreign language courses count as H credits. Retroactive credits for language courses may not be used to meet the Liberal Studies credit requirement (they can be used for subrequirement 1 above).
3. At least 3 credits in courses designated as ethnic studies (lower case "e" in the course listing). These courses may help satisfy subrequirements 1 and 2 above, but they only count once toward the total required. *Note:* Some courses may have "e" designation but not have H, S, L, or Z designation; these courses do not count toward the Liberal Studies requirement.

For information on credit load, adding or dropping courses, course substitutions, pass/fail, auditing courses, dean's honor list, repeating courses, probation, and graduation, see the College of Engineering Official Regulations (http://guide.wisc.edu/undergraduate/engineering/#policiesandregulationstext).

HONORS IN UNDERGRADUATE RESEARCH PROGRAM

Qualified undergraduates may earn an Honor in Research designation on their transcript and diploma by completing 8 credits of undergraduate honors research, including a senior thesis. Further information is available in the department office.

FOUR-YEAR PLAN

SAMPLE FOUR-YEAR PLAN

First Year

Fall	Credits	Spring	Credits
CHEM 109[1]	5	E M A 201[3]	3
MATH 221	5	MATH 222	4
Communication A	3	M E 231	3
Liberal Studies Elective	3	M S & E 350	3
		N E 231	3
	16		**16**

Second Year

Fall	Credits	Spring	Credits
MATH 234	4	MATH 320	3
PHYSICS 202	5	PHYSICS 241 or 205	3
E M A 202[4]	3	M E 361	3
E P 271 or COMP SCI 310	3	E M A 303[4]	3
E P D 275 or COM ARTS 105	2	N E 424	1
		Liberal Studies Elective	3
	17		**16**

Third Year

Fall	Credits	Spring	Credits
N E 305	3	N E 405	3
MATH 321	3	N E 408	3
STAT 324[5]	3	PHYSICS 322	3
Technical Elective[6]	2	Computing Elective	3
Liberal Studies Elective	4	E C E 376 or PHYSICS 321	3
		Free Elective	1
	15		**16**

Fourth Year

Fall	Credits	Spring	Credits
N E 427	2	N E 412	5
MED PHYS/ B M E/H ONCOL/ PHYSICS 501	3	N E 571	3
Medical Physics Elective	3	N E 428	2
Medical Physics Elective	3	Medical Physics Elective	3
Liberal Studies Elective	3	Liberal Studies Elective	3
INTEREGR 397	3		
	17		**16**

Total Credits 129

1

It is recommended that students take CHEM 109 Advanced General Chemistry for 5 credits. However, depending on their high school chemistry experience, students may substitute this with CHEM 103 General Chemistry I and CHEM 104 General Chemistry II for a total of 9 credits. Three credits of CHEM 103/CHEM 104 General Chemistry II may be counted as Technical Electives credits.

2

Students who were not able to take N E 231 Introduction to Nuclear Engineering as freshmen may, with the approval of their advisor, substitute a course offered in the College of Engineering or in the Departments of Chemistry, Computer Science, Mathematics, and Physics.

3

Students may substitute PHYSICS 201 General Physics, 5 credits, for E M A 201 Statics, 3 credits, with the approval of their advisor.

4

After completing E M A 201 Statics, students may complete E M A 202 Dynamics and E M A 303 Mechanics of Materials in either order or concurrently.

5

STAT 311 Introduction to Theory and Methods of Mathematical Statistics I or STAT/M E 424 Statistical Experimental Design are acceptable substitutes.

6

PHYSICS 623 Electronic Aids to Measurement is recommended for students in the Radiation Sciences focus area.