Dual MSES-MS Physics Program Requirements (51 credit hours)

Students in the MSES-MS Physics program take 51 credit hours (of which, at least 21 credits must be from both O'Neill and Physics). Note that double-counting of courses among components is permitted as outlined below, so long as overall credit requirements are met. In double-counting, multiple requirements may be met by a single course, but credits only count once towards credit totals. At least 2 of the physics courses must be at 500-level or higher.

Note regarding registration: Students pursuing a second degree outside of O'Neill are expected to register equally through both schools during their time in the dual degree program. In general, students should enroll through the school in which the majority of their credits are being taken for a given term. The O'Neill Graduate Records Office will check dual degree student enrollments each term to ensure enrollments are placed under O'Neill when necessary. The O'Neill Graduate Records Office will reach out to students whose enrollments need switched to adhere to this rule.

Physics Core: (9 credit hours)
In consultation with an advisor, select three courses from the following list. Core courses cannot double count in the concentration.

		P=Prerequisite, C=Corequisite, & R=Recommendations
PHYS-P 331	Theory of Electricity and Magnetism I	
PHYS-P 340	Thermodynamics and Statistical Mechanics	
PHYS-P 350	Applied Physics Instrumentation Lab	
PHYS-P 453	Introduction to Quantum Mechanics	
PHYS-P 454	Modern Physics	
PHYS-P 460	Modern Optics	
PHYS-P 510	Environmental Physics	*Credit will not be given for both PHYS-P 510 and SPEA-E 574 within a given student's program.*
PHYS-P 511	Quantum Mechanics	
PHYS-P 551	Modern Physics Laboratory	
PHYS-P 556	Statistical Physics	
PHYS-P 575	Introduction to Biophysics	

Continued on next page

Environmental Science Core: (9 credit hours)
In consultation with an advisor, select three courses from the following list. Core courses cannot double count in the concentration.

		P=Prerequisite, C=Corequisite, & R=Recommendations
SPEA-E 515	Fundamentals of Air Pollution	**R: E536**
SPEA-E 536	Environmental Chemistry	**P:** undergrad chemistry course with lab
SPEA-E 538	Statistics for Environmental Science	
SPEA-E 552	Environmental Engineering	**R: E526, E536**
SPEA-E 574	Energy Systems	*Credit will not be given for both PHYS-P 510 and SPEA-E 574 within a given student's program.*

Economics, Management, and Policy Core Competencies: (6 credit hours)
Students are encouraged to acquire competency in these areas of environmental management. The selection of courses will vary according to the student's professional objectives and an advisor can approve alternative courses that may be relevant.

		P=Prerequisite, C=Corequisite, & R=Recommendations
SPEA-E 513	Environmental Project Management	
SPEA-E 543	Environmental Management	
SPEA-R 532	Water Policy and Economics	
SPEA-R 625	Environmental Economics and Policy	**P: V517**
SPEA-R 645	Environmental Law	
SPEA-R 674	Energy Economics and Policy	**P: V517**
SPEA-S 596	Sustainable Development	**P: V517** or equivalent coursework
SPEA-V 517	Public Management Economics	
SPEA-V 550	Energy Law	

Continued on next page

Tool Skill Courses: (Typically 3-6 credit hours)
Students are encouraged to acquire competency in analytical methods by focusing on tool skills appropriate to their professional objectives. Courses should be selected in consultation with faculty advisors from both programs, and advisors can approve alternative courses that may be relevant. Tool skill courses may double count with the concentration, but degree credit totals must still be met.

		P=Prerequisite, C=Corequisite, & R=Recommendations
PHYS-P 540	Analog and Digital Electronics	
PHYS-P 548	Mathematical Methods for Biology	
PHYS-P 583	Signal Processing and Information Theory in Biology	
PHYS-P 609	Computational Physics	
SPEA-E 518	Vector-based Geographic Information Systems	
SPEA-E 529	Application of Geographic Information Systems	**P: E518**, or other introductory GIS course with lab, or equivalent practical experience
SPEA-E 554	Groundwater Flow Modeling	
SPEA-E 560	Environmental Risk Analysis	**P: E538**, **V506**, or consent of instructor. A firm foundation in math and/or science is useful.
SPEA-P 507	Data Analysis and Modeling for Public Affairs	**P: E538** or **V506**
SPEA-P 541	Benefit-Cost Analysis	**P: V517** or consent of instructor
SPEA-P 562	Public Program Evaluation	

Dual Physics – Environmental Science Concentration: (21 credit hours)
The dual concentration must include at least 6 credit hours from Physics and at least 6 credit hours from O'Neill. Other courses from Physics, O'Neill (including research courses E625 for O'Neill or P802 for Physics), or other departments may be used in the concentration with approval of both advisors.

**Any SPEA course from the Environmental Science Core list that was not used for Core credit can be used in the concentration.*

<u>O'Neill Options</u>

		P=Prerequisite, C=Corequisite, & R=Recommendations
SPEA-E 501	Human Behavior and Energy Consumption	
SPEA-E 514	Changing Landscape of Toxic-Chemical Regulation	

Continued on next page

Dual Physics – Environmental Science Concentration: (continued)

O'Neill Options

		P=Prerequisite, C=Corequisite, & R=Recommendations
SPEA-E 505	Renewable and Nuclear Energy and Climate Change	
SPEA-E 517	BMP Design for Healthy Urban Watersheds	
SPEA-E 518	Vector-based Geographic Information Systems	
SPEA-E 520	Environmental Toxicology	
SPEA-E 539	Aquatic Chemistry	
SPEA-E 542	Hazardous Materials	
SPEA-E 554	Groundwater Flow Modeling	
SPEA-E 555	Watershed Hydrology	
SPEA-E 555	Intro to Coding for Environment and Policy (1 cr.)	
SPEA-E 555	Python Programming for Environment and Policy (1 cr.)	
SPEA-E 555	Using R for Environment and Policy (1 cr.)	
SPEA-E 560	Environmental Risk Analysis	**P: E538**, **V506**, or consent of instructor. A firm foundation in math and/or science is useful.
SPEA-E 562	Solid and Hazardous Waste Management	
SPEA-E 564	Organic Pollutants: Environmental Chemistry and Fate	
SPEA-E 591	Climate-Change Impacts on Natural Resources	

Physics Options

		P=Prerequisite, C=Corequisite, & R=Recommendations
PHYS-P 508	Current Research in Physics	
PHYS-P 510	Environmental Physics	
PHYS-P 551	Modern Physics Laboratory	
PHYS-P 556	Statistical Physics	
PHYS-P 557	Solid State Physics	
PHYS-P 572	Radiation Oncology Physics	

Continued on next page

Dual Physics – Environmental Science Concentration: (continued)

Physics Options

		P=Prerequisite, C=Corequisite, & R=Recommendations
PHYS-P 578	Radiation Biophysics	
PHYS-P 581	Modeling and Computation in Biophysics	
PHYS-P 583	Signal Processing and Information Theory in Biology	
PHYS-P 609	Computational Physics	

Other Department Options

		P=Prerequisite, C=Corequisite, & R=Recommendations
GEOG-G 551	Physical Hydrology	

Capstone Course: (3 credits hours)

Each candidate for the MSES-MS Physics dual degree program should take a 3-credit hour course during which they participate in a team to carry out an integrative project that addresses a multidisciplinary problem. Capstone course credit may be double-counted in the concentration, if appropriate. The capstone requirement may be waived for students who apply for Professional Experience credit. See the O'Neill Master's website or handbook for more information.

The capstone requirement may be met by taking one of the courses listed below.

		P=Prerequisite, C=Corequisite, & R=Recommendations
SPEA-V 600	Capstone	*Sections with an environmental focus.*
SPEA-E 517	BMP Design for Healthy Urban Watersheds	
SPEA-E 560	Environmental Risk Analysis	**P: E538**, **V506**, or consent of instructor. A firm foundation in math and/or science is useful.

Continued on next page

Experiential Requirement: (0-3 credit hours)

Each candidate for the MSES-MS Physics dual degree program must obtain professionally relevant experience through one of the following options:

1. Approved Internship **SPEA-E 589** (0-3 credit hours): The student will work with the O'Neill Career Hub and the Department of Earth & Atmospheric Sciences to arrange for a suitable internship. Internships vary greatly according to the expectations and requirements of the sponsor. Students are expected to give careful attention in the selection of an internship suitable to their professional goals. Typically, students do not use credit hours for the internship, and as a result, have no fees for the experience. However, students who want the additional credit hours can receive up to 3 credit hours for an internship involving the appropriate amount of work; these students will owe fees to the relevant school for the 3 credit hours.

2. Approved Research (3 credit hours): MS research **PHYS-P 802** or MSES research internship **SPEA-E 589**

3. Professional Experience (3 credit hours): Students who have had significant environmental management, technical or administrative work experience in the past may receive a 3-credit hour reduction and a waiver of the Experiential Requirement. Students must apply to receive Professional Experience credit and their experience must meet O'Neill guidelines. Students receiving prior professional experience credit should carefully plan the balance of their program with their faculty advisors.