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

*Environmental Chemistry, Toxicology, and Risk Assessment Concentration

Students in the MSES-MS Chemistry program take 51 credit hours (of which, at least 21 credits must be from both O'Neill and Chemistry). Note that double counting of courses among components is permitted, so long as overall credit requirements are met.

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.

Chemistry Core: (9 credit hours)

In consultation with an advisor, select 3 courses from the following list:

	P=Prerequisite, C=Corequisite, & R=Recommendations
CHEM-C 503 Methods of Structure Determination	
CHEM-C 540 Advanced Organic Chemistry	
CHEM-C 565 Nuclear Chemistry	
CHEM-C 566 Spectroscopy	
CHEM-C 567 Statistical Mechanics	
CHEM-C 572 Computational Chemistry and Molecular Modeling	
CHEM-C 611 Electroanalytical Chemistry	
CHEM-C 613 Mass Spectrometry	
CHEM-C 614 Chromatography	
CHEM-C 616 Surface Analysis and Surface Chemistry	
CHEM-C 633 Inorganic Chemistry of Main Group Elements	
CHEM-C 634 Transition Metal Chemistry	

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Environmental Science Core Competencies: (9 credit hours)
In consultation with an advisor, select three courses from the following list:

		P=Prerequisite, C=Corequisite, & R=Recommendations
SPEA-E 515	Fundamentals of Air Pollution	**R: E536**
SPEA-E 526	Applied Mathematics for Environmental Science	**R:** differential and integral calculus
SPEA-E 527	Applied Ecology	
SPEA-E 536	Environmental Chemistry	**P:** undergrad chemistry course with lab
SPEA-E 538	Statistics for Environmental Science	
SPEA-E 539	Aquatic Chemistry	**R: E536**
SPEA-E 552	Environmental Engineering	**R: E526, E536**
SPEA-E 564	Organic Pollutants: Environmental Chemistry and Fate	**R: E536** or undergraduate organic chemistry
SPEA-E 570	Environmental Soil Science	

Economics, Management, and Policy Core Competencies: (Typically 6-9 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 543	Environmental Management	
SPEA-E 574	Energy Systems	
SPEA-R 535	International Environmental Policy	
SPEA-R 590	Energy Policy from a Nation-State Perspective	**R: E574**
SPEA-R 625	Environmental Economics and Policy	**P: V517**
SPEA-R 643	Natural Resource Management and Policy	
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	

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Tool Skill Courses: (3 credit hours)
Students are encouraged to acquire competency in analytical methods by focusing on tool skills appropriate to their professional objectives.

		P=Prerequisite, C=Corequisite, & R=Recommendations
SPEA-E 512	Risk Communication	
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 538/ SPEA-V 506	Statistics for Environmental Science	
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. *Also fulfills capstone requirement.*
SPEA-M 547	Negotiation and Dispute Resolution for Public Affairs	
SPEA-P 507	Data Analysis and Modeling for Public Affairs	**P: E538** or **V506**
SPEA-P 539	Management Science 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	**P: V506** or equivalent coursework
CHEM-C 501	Chemical Instrumentation	
CHEM-C 503	Methods of Structure Determination	
CHEM-C 565	Nuclear Chemistry	
CHEM-C 566	Spectroscopy	
CHEM-C 567	Statistical Mechanics	
CHEM-C 572	Computational Chemistry and Molecular Modeling	
CHEM-C 611	Electroanalytical Chemistry	
CHEM-C 613	Mass Spectrometry	
CHEM-C 615	Bioanalytical Chemistry	
CHEM-C 616	Surface Analysis and Surface Chemistry	

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Dual Program Capstone: (3 credit hours)
Each candidate for the MSES-MS in Chemistry 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, or the candidate should conduct a graduate-level research project that culminates in a publication or thesis (theses will be formatted according to Chemistry Department requirements). Capstone course credit may be double-counted in either Concentration or Tool Skill requirements. The capstone requirement may be met in one of the following ways:

	P=Prerequisite, C=Corequisite, & R=Recommendations
SPEA-V 600 Capstone in Public and Environmental Affairs	**Note:** Sections with an environmental science focus
SPEA-E 560 Environmental Risk Analysis (or an approved alternative course with a similar structure)	**P: E538**, **V506**, or consent of instructor. A firm foundation in math and/or science is useful.
Master's Thesis	Completed under the supervision of a graduate faculty member, overseen and approved by a graduate committee consisting of the research advisor and one of the advisors for the dual degree program, or a publication resulting from similar research.

Experiential Requirement: (0-3 credit hours)
Each candidate for the MSES-MS in Chemistry dual degree program must obtain professionally relevant experience through one of the following options:

1. Approved Internship (0-3 credit hours). The student will work with the O'Neill Career Hub 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 for the 3 credit hours.

2. Prior Experience (3 credit hours). Students who have had significant environmental management, technical or administrative work experience in the past may receive 3 credit hours. To receive 3 credit hours, a student must have a minimum of one year's technical or administrative work experience. Under no circumstances will prior professional experience credit and transfer credit total more than 12 hours. Students receiving prior professional experience credit should carefully plan the balance of their program with their faculty advisors.

3. Three credits of research experience in the laboratory of a graduate faculty member. Graduate research course numbers are, in the Chemistry department, CHEM-C 8X0 and in the MSES, SPEA-E625. More involved research projects that culminate in a thesis or publication can be applied toward the capstone course requirement (see above).

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Environmental Chemistry, Toxicology, and Risk Assessment Concentration: (15-18 credit hours)
This concentration addresses the fate and transport of chemicals in the environment and the hazards and risks to human health and the environment associated with chemical pollution. Courses on the chemical/physical/biological reactions of pollutants in soil, aquatic, and atmospheric systems are included. Additional courses study the hazards associated with chemicals used in modern society, technologies available to manage and remediate contaminated sites, the toxicological effects of chemical exposure, and methods to assess risks associated with chemicals in the environment.

**At least two courses should be selected from the Chemistry Department and at least two courses should be selected from O'Neill. An advisor can approve alternative courses that may be relevant.*

		P=Prerequisite, C=Corequisite, & R=Recommendations
SPEA-E 515	Fundamentals of Air Pollution	**R: E536**
SPEA-E 520	Environmental Toxicology	
SPEA-E 537	Environmental Chemistry Laboratory	
SPEA-E 539	Aquatic Chemistry	**R: E536**
SPEA-E 542	Hazardous Materials	
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. *Also fulfills capstone requirement.*
SPEA-E 562	Solid and Hazardous Waste Management	
SPEA-E 591	Climate Change Impacts on Natural Resources	**P:** grad course in ecology, envl policy or envl management or a waiver of one of these
CHEM-C 581	Macromolecular Structure and Interactions	
CHEM-C 632	Structure, Function, and Spectroscopy of Metal Ions in Biological Systems	
CHEM-C 634	Transition Metal Chemistry	
CHEM-C 636	Organometallic Chemistry and Catalysis	
CHEM-M 501	Nanomaterials	
CHEM-M 503	Supramolecular Chemistry	
GEOG-G 532	Physical Climatology	
EAS-G 576	Climate Change	