Dual Masters Program
MS in Chemistry
And
MS in Environmental Science

Introduction

There is a growing interest among students and employers in multidisciplinary science training and applied professional science programs. The MS in Environmental Science (MSES) program in SPEA, which is such a degree program, accepted about 70 new students for this fall (20 more than last year), which underscores this trend. While traditionally MS in Chemistry students have focused on thesis research, employers are increasingly seeking employees with an applied professional science training, which includes job experience (internship), economics, and management skills. The current dual masters degree in Chemistry and Environmental Science provides this type of training and is attractive to students with a strong chemistry background (e.g. BS in Chemistry) who like to focus on environmental issues, culminating in an MS in Environmental Science, and at the same time obtain a MS in Chemistry and do so in the same two years that it would take to complete each of the degrees alone.

The structure of the dual masters program has much in common with the rather new and emerging masters degree concept: The "Professional Science Masters" (PSM). In an article in *Science News* (June 20, 2009) Sheila Tobias, a consultant of the Alfred P. Sloan Foundation on PSM development since 1997, states that she believes that the PSM will become the MBA of the 21st century. Last year NSF created a $15 million support program to stimulate the PSM. The proposed dual master's degree in Chemistry and Environmental Science is a multi-disciplinary science masters with a strong policy and management component. Instead of a master's thesis the students complete a capstone course and a summer internship to better prepare them for a professional career in the sciences.

The Dual Degree Program Design

This dual master's program is a 51-credithour (two-year) program that gives the student more depth and breadth than is possible in a single degree. The student must complete a minimum of 21 credit hours in each of the degree programs. M.S. in Chemistry and M.S.E.S. degrees are awarded concurrently after the student has completed the requirements for both degrees.

Application, Admission, and Degree Planning

The student must apply to the Department of Chemistry and be accepted into the MS in Chemistry degree program and apply to the School of Public and Environmental Affairs (SPEA) and be accepted into the Master of Science in Environmental Science (MSES) degree program. The students must design their dual degree curriculum in consultation with the *graduate advisor* of the Chemistry Department and the *program director* for the MSES program in SPEA. Both must approve the course choices on a semester-by-semester basis. The students will use a *multi-semester planning form* and a *degree program checklist* for this purpose; a blank copy of each is attached to this proposal. The dual degree program is designed to be completed in two (2) years, but must be completed within six (6) years.

Program Requirements
(51 credit hours)

The combined M.S. in Chemistry–M.S.E.S. program requires a minimum of 51 credit hours distributed among six components:

- chemistry core,
- environmental science core,
- economics, policy, and law competencies,
- tool skills,
- environmental chemistry concentration,
- and an experiential component.

The student must complete a minimum of 21 credit hours in the Department of Chemistry as well as in the School of Public and Environmental Affairs. Note that double-counting of courses among components is permitted, so long as overall credit requirements are met.

Chemistry Core
Required Courses (9 credit hours)
Select three courses from the following list.

CHEM-C 503 Methods of Structure Determination (3 cr.)
CHEM-C 540 Advanced Organic Chemistry (3 cr.)
CHEM-C 565 Nuclear Chemistry (3 cr.)
CHEM-C 566 Spectroscopy (3 cr.)
CHEM-C 611 Electroanalytical Chemistry (1.5-3 cr.)
CHEM-C 613 Mass Spectrometry (1.5- cr.)
CHEM-C 614 Chromatography (1.5-3 cr.)
CHEM-C 616 Surface Analysis and Surface Chemistry (1.5 cr.)
CHEM-C 567 Statistical Mechanics (3 cr.)
CHEM-C 572 Computational Chemistry and Molecular Modeling (3 cr.)
CHEM-C 633 Inorganic Chemistry of Main Group Elements (3 cr.)
CHEM-C 634 Transition Metal Chemistry (3 cr.)

Environmental Science Core
Required Courses (9 credit hours)
Select three courses from the following list:

SPEA-E 515 Fundamentals of Air Pollution (3 cr.)
SPEA-E 526 Applied Mathematics for Environmental Science (3 cr.)
SPEA-E 527 Applied Ecology (3 cr.)
SPEA-E 536 Environmental Chemistry (3 cr.)
SPEA-E 538 Statistics for Environmental Science (3 cr.)
SPEA-E 539 Aquatic Chemistry (3 cr.)
SPEA-E 552 Environmental Engineering (3 cr.)
SPEA-E 564 Organic Pollutants: Environmental Chemistry and Fate (3 cr.)
SPEA-E 570 Environmental Soil Science (3 cr.)

Economics, Policy, and Law 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.

SPEA-E 535 International Environmental Policy (3 cr.)
SPEA-E 543 Environmental Management (3 cr.)
SPEA-E 574 Energy Resources, Technology and Analysis (3 cr.)
SPEA-E 590 Energy Policy: A Nation-State Perspective (3 cr.)
SPEA-R 674 Energy Economics and Policy (3 cr.) (P: V517)
SPEA-V 517 Public Management Economics (3 cr.)
SPEA-S 596 Sustainable Development (3 cr.)
SPEA-R 625 Environmental Economics and Policy (3 cr.) (P: V517)
SPEA-R 643 Environmental Resource Management and Policy (3 cr.)
SPEA-R 645 Environmental Law (3 cr.)

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.

SPEA-E 512 Risk Communication (3 cr.)
SPEA-E 518 Vector-based Geographic Information Systems (3 cr.)
SPEA-E 529 Applications of Geographic Information Systems (3 cr.) (P: E518)
SPEA-E 538 Statistics for Environmental Science (3 cr.)
SPEA-E 554 Groundwater Flow Modeling (3 cr.)
SPEA-E 560 Environmental Risk Analysis (3 cr.) (P: E538 or V506 or permission of the instructor. *Also fulfills capstone requirement*)
SPEA-V 507 Data Analysis and Modeling for Public Affairs (3 cr.)
SPEA-V 539 Management Science for Public Affairs (3 cr.)
SPEA-V 541 Benefit-Cost Analysis (3 cr.) (P: V517)
SPEA-V 547 Negotiation and Alternative Dispute Resolution (3 cr.)
SPEA-V 562 Public Program Evaluation (3 cr.)
CHEM-C 501 Chemical Instrumentation (4 cr.)
CHEM-C 503 Methods of Structure Determination (3 cr.)
CHEM-C 565 Nuclear Chemistry (3 cr.)
CHEM-C 566 Spectroscopy (3 cr.)
CHEM-C 572 Computational Chemistry and Molecular Modeling (3 cr.)
CHEM-C 611 Electroanalytical Chemistry (1.5-3 cr.)
CHEM-C 613 Mass Spectrometry (1.5- 3 cr.)
CHEM-C 615 Bioanalytical Chemistry (1.5-3 cr.)
CHEM-C 616 Surface Analysis and Surface Chemistry (1.5 cr.)

Tool Skill Courses (continued)

CHEM-C 567 Statistical Mechanics (3 cr.)

Dual Chemistry – Environmental Science Masters Concentration
Required Courses (Typically 15 to18 credit hours)

This concentration supports the Chemistry and MSES degrees with courses in laboratory and environmental chemistry, toxicology, and risk assessment, as well as energy-related courses.

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

SPEA-E 515 Fundamentals of Air Pollution (3 cr.)
SPEA-E 520 Environmental Toxicology (3 cr.)
SPEA-E 537 Environmental Chemistry Laboratory (3 cr.)
SPEA-E 539 Aquatic Chemistry (3 cr.)
SPEA-E 542 Hazardous Materials (3 cr.)
SPEA-E 544 Subsurface Microbiology and Bioremediation (3 cr.)
SPEA-E 554 Groundwater Flow Modeling (3 cr.)
SPEA-E 560 Environmental Risk Analysis (3 cr.) (P: E538 or V506 or permission of the instructor. *Also fulfills capstone requirement*)
SPEA-E 562 Solid and Hazardous Waste Management (3 cr.)
SPEA-E 570 Environmental Soil Science (3 cr.)
SPEA-E 591 Climate-Change Impacts on Natural Resources (3 cr)
CHEM-C 581 Macromolecular Structure and Interactions (1.5 cr.)
CHEM-C 632 Structure, Function, and Spectroscopy of Metal Ions in Biological Systems (3 cr.)
CHEM-C 634 Transition Metal Chemistry (3 cr.)
CHEM-C 636 Organometallic Chemistry and Catalysis (3 cr.)
CHEM-M 501 Nanomaterials (3 cr.)
CHEM-M 503 Supramolecular Chemistry (3 cr.)
GEOG-G 532 Physical Climatology (3 cr.)
GEOL-G 571 Principles of Petroleum Geology (3 cr.)
GEOL-G 576 Climate Change
GEOL-G 587 Organic Geochemistry

Capstone Course
(3 credit hours)

Each candidate for the M.S. in Chemistry- M.S.E.S. 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. 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:

1. SPEA-V 600 Capstone in Public and Environmental Affairs, sections with an environmental focus.

2. An approved alternative course with a similar structure, such as SPEA-E 560 Environmental Risk Analysis or other approved course.

3. A 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, can meet the capstone requirement..

Experiential Requirement
(0-3 credit hours, depending on the option chosen)

Each candidate for the M.S. in Chemistry- M.S.E.S. 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 SPEA Office of Career Services 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 Professional 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 21 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 8*X*0 and in the MSES, E625. More involved research projects that culminate in a thesis or publication can be applied toward the capstone course requirement (*see above*).