NEW UNDERGRADUATE PROGRAM PROPOSAL

ILLINOIS INSTITUTE OF TECHNOLOGY

The following information is required by the Undergraduate Studies Committee to approve new programs. After approval by UGSC this form should be routed to Faculty Council for approval and then the Provost's office.

College(s): College of Science

Department(s): Chemistry

Date: Jan 20, 2017

Approvals Required

(1) Academic Unit Head(s):

(2) Dean(s):

(3) Undergraduate Studies Chair:

GENERAL INFORMATION

Program Title: **Environmental Chemistry**

Program Scheduling: Fall 2017

Total Program Credit Hours: 127-128

Program Description: *Provide a brief narrative of the program content (use as much space as needed).*

Environmental Chemistry is a study of chemical principle and methodologies applicable to environmental phenomena and issues. The objective of the program is to provide students with a rigorous education in the traditional chemistry and a fundamental interdisciplinary background in chemical applications to environmental problems. This chemistry-focused environmental program will prepare students with the technical skills required to place and advance their career in the field of environmental science and environmental analytical, chemistry, and toxicology.

Program Purpose/Program Benefits: Provide details on the intent of the program and its relation to other programs. State the impact of the program for students and for IIT.

See the attached document for more detailed description on purpose, intent, and benefits of the program.

At Illinois Tech, the Chemistry Department provides a rigorous and high quality education in Chemistry. While the American Chemical Society (ACS)-approved chemistry programs at most other academic institutions require 120 credits, Illinois Tech Chemistry requires more credits (127-128 total, 58 chemistry credits) for the same degree. Although the higher credit requirement is beneficial for student education, it also makes IIT chemistry program the least affordable in the Chicago area and has a negative impact on our enrollment. For example, in Fall 2016, there were 27 chemistry majors at IIT vs 440 majors in the chemistry department at Loyola University Chicago. Many chemistry departments at US academic institutions offer diverse BS degree programs in addition to the traditional BS degree in Chemistry. They have crafted specialized and area-focused BS programs with a good overlap in curriculum. For instance, the department of chemistry at University of South Florida offers three medical-related BS degree programs, and one of the programs, BS in Biomedical Science has an unusually high undergraduate enrollment (> 3,000 majors).

The IIT BS Chemistry program requires students to complete 6 elective courses (18 credits total). We propose to create new chemistry programs that use the available credits to train chemistry majors in a specialized area. In the new programs, students will be trained as viable candidates with good entry-level skills for the job market and for entrance to graduate programs, including medical and pharmacy school. Students will have learning opportunities to gain various hands-on techniques by taking the lab courses customized for industrial need in addition to the standard lecture-based courses. The students are expected to develop good basic understanding of the subject matter and sound knowledge of chemical applications to the specialized fields. This in-depth and crafted training approach will benefit students in the specialized programs with requisite educational background to develop their competitive career paths.

We first identified the *core* areas for creation of new BS programs with emphasis on Bio, Medicine, Data, Analytics, Environment, and Safety. We then selected the new programs based on our review of various factors: i) Unique BS degree programs, at least in the Chicago area; ii) Major areas attractive to high school and undergraduate students; iii) Specialized degrees in high demand from industry; iv) Undergraduate programs with high growth and enrollment at peer institutions; v) Affordable programs that can be taught and designed by Illinois Tech Chemistry faculty; vi) Curriculum in good overlap for area-focused multi-degree programs.

We now propose the new BS degree programs in Bioanalytical Chemistry, Environmental Chemistry, Forensic Chemistry, Medicinal Chemistry, and Computational Chemistry and Biochemistry. The highly area-focused, diverse, affordable, and marketable programs and are to increase the quality and distinctiveness of Illinois Tech education and make expected to make a significant impact on undergraduate enrollment.

The Environmental Chemistry degree is proposed as one of the new Area-Focused programs. The curriculum is designed to provide students with a rigorous education in the traditional chemistry areas and a practical training in Environmental Chemistry. The Environmental program is marketable and attractive to high school and undergraduate students. Illinois Tech will be the only institution to offer Environmental Chemistry program in the greater Chicago area.

Classification of Instructional Programs (CIP):

40.0509 Environmental Chemistry

Required to make the program US Financial Aid Eligible - The CIP code takes the following structure: xx.xxxx Where each x is a number between 0 and 9. This 6-digit code identifies, to the greatest specificity possible, an entire instructional program. The classification scheme seeks to comprehensively address all areas of study. Because of the dynamic nature of education, however, new CIP codes are frequently added to the list. The first 2-digits are the first cut off of detail and describe the general discipline of the program. For example, any program with a CIP that starts with 14 is within the Engineering discipline; anything with a 22 is within the legal discipline. The next 2 digits increase the level of detail, and the final 2-digits provide the highest level of detail.

Find CIP codes at http://nces.ed.gov/ipeds/cipcode

PROGRAM VIABILITY

Competitive Programs: *Indicate other similar programs locally and nationally detail their success*.

About 8 institutions in USA offer a BS degree in Environmental Chemistry. In the greater Chicago area, Illinois Tech will be the only institution to offer Environmental Chemistry program.

The peer institutions in the Chicago area (UIC, Loyola, and DePaul U) offer a BS Environmental Science degree, not a Chemistry-centered program. Undergraduate enrollment in the program in several other institutions seems to be dependent on the institution's focus: Florida State University (187 majors), Southern Illinois University (25 out of 100 chem majors total), and Ohio University (6 out of 404 chem majors total). The proposed Environmental Chemistry program is highly affordable to Illinois Tech Chemistry Department. We can create a unique Environmental Chemistry Program that is carefully crafted to prepare undergraduates with a strong chemistry background and the

requisite knowledge and hands-on lab experience to place and advance their careers in the field of Environment and Chemistry.

Market Analysis for Recruiting Students: *Detail what work has been done with UG Admissions to identify and recruit potential students.*

Illinois Tech UG admission office recently reported that "*Among our domestic applications, 67 percent are from Illinois, and about half of these are from Chicago*." The Chemistry UG recruiting committee will closely work with the Dean's office in College of Science on the advertisement of new chemistry programs and generate an attractive web link and informative program brochure to recruit prospective students in the greater Chicago Area. An immediate target group will be the students (23 admits, Fall 2017) who have been admitted to the Chemistry program this fall. The chemistry department will work with the UG admission office in an effort to communicate with the target students and public and private local high schools (~400 in the Cook County alone). The chemistry department will also seek opportunities to meet and recruit transfer undergraduates from a number of community colleges, particularly in the greater Chicago area.

Market Analysis for Graduates: *Detail what work has been done with the Career Management Center to identify potential employment opportunities for graduates.*

A job demand for Environmental Scientists is growing. IL Dept employment security (IDES) projects an increasing job demand (14%, 2014-24) and BLS employment projection (9%). Employment of Chemists is predicted to be in slow growth (3%, Figure 3, US BLS, 2014-24). However, jobs related to the new BS Chemistry programs including Environmental Chemistry are projected to be in high demand with 8% projected employment growth rate, US BLS).
Environmental chemists can work federal, state, and county government service labs including US Environmental Protection Agency (EPA), US Department of Agriculture (Federal, State, and County), US Department of Defense (Federal, State, and County), Safety Officers at Industry and Academic institutions, Field Chemists, Waste Analysis Lab, and Environmental sampling and remediation control labs, US Department of Public Safety (Federal, State, and County). Students in the program are also qualified for jobs related to chemical and instrumental analysis working in pharmaceutical and chemical industry and toxicology labs and pursue graduate studies in environmental chemistry and science.

ACADEMIC INFORMATION

Enrollment Estimates: *Are there enrollment estimates for this program, and if so, what are they and what are they based on? What is the minimum number of students necessary in the program to make the program viable (i.e.to offer classes unique to the program often enough)?*

We anticipate at least 5 students will be admitted to the program by Fall 2018 and 20 students by Fall 2021. IIT Chemistry has suffered a long-lasting problem of low enrollment (27 majors, Fall 2016). The proposed goal will lead to a significant increase in Chemistry UG enrollment. Students in the new program are scheduled to take the courses required for completion of the BS degree during their 3rd or 4th years in the program. Enrollment of 5 students in the new program per academic year is required to offer 2 new courses every year

Advising Strategy: *Since quality advising is a key component of good retention, graduation and career placement, how will students be advised and mentored? Specifically for interdisciplinary programs, how will advising responsibilities be shared? What student professional organizations will be formed? How will the department work with the Career Management Center to develop industry connections?*

Students in the new program will be advised by the chemistry faculty who are related to the area of Environmental Chemistry (Joy Chong, Richard Guan, Adam Hock, Ishaque Khan, and Braja Mandal). Students will be encouraged to gain research experience and professional development by working at the research labs of the chemistry faculty. Students in the new program are required

to take a seminar course and will be able to communicate with other students in the specialized programs for possible joint extracurricular activities. Majors will be advised to apply for internship and scholarship programs funded by Illinois Environmental Protection Agency (EPA) such as Governor's Environmental Corps, IEPA/ILMA Scholarship Program, and Lake Education Assistance Program. The chemistry faculty in collaboration with the Career Management Center will develop working relationships with industry and government agencies including Illinois and Chicago EPA.

Course Requirements: *Detail the courses needed for the program including courses currently offered, new courses to be developed (including syllabi), and dependence on courses from other academic units with their commitments to provide these courses on a long-range basis. Include descriptions of laboratories that will need to be developed along with equipment and facilities requirements.*

The majority of the required courses for the program have been regularly offered for BS Chemistry majors by the Chemistry Department. Students in the new program are expected to complete the ACS-approved BS chemistry degree requirement and take additional required courses (16 credits total) to earn the specialized degree (ACS-accredited BS in Environmental Chemistry) as outlined below.
Students will complete the core-lab course (Analytical method development lab, CHEM 4B3) required for all analytical chemistry-emphasized new programs (Bioanalytical, Environmental, Forensic, and Medicinal Chemistry) scheduled for offering in Fall 2020 or Spring 2021. With sufficient lead time, we will be able to generate a lab curriculum and ready for teaching the lab course in our teaching lab facility. Illinois Tech Chemistry Department operates first class teaching labs that are equipped with modern instrument and excellent supporting systems.

<u>Environmental Chemistry (CHEM 4E1, 3 credits)</u>
This course provides an introduction to environmental chemistry and is focused on application of chemical principles and theory to the study of environmental phenomena and issues and covers matters related to environment and earth. Topics include aquatic chemistry, atmospheric chemistry, chemical bonding and reactions, thermodynamics and kinetics, acid-base chemistry, and redox chemistry, and bio-inorganic chemistry on earth and living systems, hydrology and geochemistry, natural resource and cycle, climate change, air pollution, energy and earth, sustainable resource, alternative energy, green chemistry, and environmental safety.

<u>Environmental Analytical Chemistry (CHEM 4E2, 3 credits)</u>
This course provides an overview of application of analytical chemistry to environment and environmental systems. Topics include sampling and analysis of trace elements, toxicants, organics, pollutants, water, environmental and technological samples, analytical methods and techniques for tracing and monitoring of contaminants and pollutants and environmental problems, determination and remediation of heavy metals and radionuclides, chemometrics, quality assurance (QA) and quality control (QC) in environmental analysis, ecology studies, liquid and solid and nuclear water disposals, GC/LC separation techniques, electrochemical techniques including potentiometry and voltammetry, analytical methods for analysis of environmental and technological samples including ICP-MS and atomic absorption spectroscopy, extraction technique, toxicology, and environmental safety.

<u>Analytical method development Lab (CHEM 4B3, 3 credits)</u>
In this lab-focused course, students will learn about method development and assessment for analysis of chemicals, polymers, drugs, and biologics. Students will gain hands-on experience in quantitative analysis and quality assurance and control of chemicals and biologics. The literature and guidance on analytical method development and validation reported by the industry and government agencies will be studied. This course will foster students to develop quantitative and technical analysis, literature comprehension, critical thinking, problem-solving, and communication skills. The selected topics for the course include analytical separation, instrumental analysis, chromatographic and electrophoretic methods, statistical analysis, quality assurance and control, analytical method validation, sampling, preparations and storage of samples and standard

solutions, physiochemical characterization, good laboratory practice (GLP) requirement, and validation, verification, documentation of analytical testing methods and procedure.

Seminar in Special Topics (CHEM 495, 1 credit)
This seminar course will provide students with opportunities to learn about recent development in the specialized research fields. Students are expected to develop written and oral communication skills on the advanced and specialized topics.

Environmental Chemistry Elective courses (Select 2 courses, 6 credits): Bioanalytical Chemistry (CHEM 4B1), Bioanalytical Chemistry Lab (CHEM 4B2), Forensic Chemistry (CHEM 4F1), Forensic Chemistry Lab (CHEM 4F2), ChemInformatics (CHEM 4C2), Medicinal Chemistry (CHEM 4M1), Advanced Analytical Chemistry (CHEM 500), Statistics for Analytical Chemists (CHEM 513), Analytical Method Development (CHEM 508), Physical Biochemistry (CHEM 538), $^{+++}$Inorganic Chemistry Lab (CHEM 416). $^{+++}$Required for ACS-Accredited BS degree.

Sample Curriculum/Program Requirements: Provide a sample semester by semester curriculum and the program requirements, as they would appear in the IIT Undergraduate Programs bulletin.

Attached

Program Outcomes and Assessment Process: Provide the program learning goals and assessment plan (for more information contact the Assessment Office within Academic Affairs). Also see https://sites.google.com/a/iit.edu/student-learning-assessment/

Attached

Bachelor Science in Environmental Chemistry

Semester 1		**Credits**
CHEM 124	General Chemistry I	4
CS 105 or	Intro to Computer Programming	2
CS110	Computing Principles	
MATH 151	Calculus I	5
Humanities-200 level course		3
		14
Semester 2		
CHEM 100	Introduction to Profession	2
CHEM 125	General Chemistry II	4
MATH 152	Calculus II	5
PHYS 123	General Physics I	4
Social Sciences Elective		3
		18
Semester 3		
CHEM 237	Organic Chemistry I	4
BIOL 107 or	General Biology Lectures	3
BIOL 115	Human Biology	
MATH 251	Multivariate and Vector Calculus	4
PHYS 221	General Physics II	4
Humanities or Social Sciences Elective		3
		18
Semester 4		
CHEM 239	Organic Chemistry II	3
CHEM 240	Organic Chemistry Lab	2
CHEM 247	Analytical Chemistry	3
MATH 252	Introduction to Differential Equation	4
Humanities Elective (300+)		3
		15
Semester 5		
CHEM 321	Instrumental Analysis	4
CHEM 343	Physical Chemistry I	3
IPRO Elective I		3
Free Elective[2]		3
Social Sciences Elective (300+)		3
		16
Semester 6		
CHEM 344	Physical Chemistry II	4
CHEM 434	Spectroscopic Methods	4
CHEM 485	Chemistry Colloquium	1
CHEM 4E1	Environmental Chemistry	3
Humanities Elective (300+)		3
		15
Semester 7		
CHEM 415	Inorganic Chemistry	3
BIOL 401	Introduction to Biochemistry	4
OR		
BIOL 403	Biochemistry	3
CHEM 4E2	Environmental Analytical Chemistry	3
CHEM 4B3	Analytical Method Development Lab	3
Free Elective[2]		3
		15/16

Semester 8		
Environmental Chemistry Elective[1]		3
Environmental Chemistry Elective[1]		3
CHEM 495	Seminar in Special Topics	1
IPRO Elective II		3
Free Elective[2]		3
Social Sciences Elective (300+)		3
		16
Total Credit Hours		**127-128**

[1]Environmental Chemistry Electives (Select at least 2 courses, 6 Credits):
CHEM 4B1 Bioanalytical Chemistry
CHEM 4B2 Bioanalytical Chemistry Lab
CHEM 4F1 Forensic Chemistry
CHEM 4F2 Forensic Chemistry Lab
CHEM 4C2 Cheminformatics
CHEM 4M1 Medicinal Chemistry
CHEM 410 Science of Climate Change
CHEM 500 Advanced Analytical Chemistry
CHEM 513 Statistics for Analytical Chemists
CHEM 538 Physical Biochemistry
CHEM 416 Inorganic Chemistry Lab (Required for ACS-Accredited BS Degree)

[2]Free Electives (Suggested, Select 3 courses, 9 credits):

BIOL 210 Microbiology
BIOL 514 Toxicology
BIOL 445 Molecular Biology
ENVE 404 Water and Wastewater Engineering
ENVE 463 Introduction to Air Pollution Control
ITMD 521 Client/Server Technologies and Applications
ITMD 525 Topics in Data Science and Management
ITMD 527 Data Analytics

Environmental Chemistry Requirements	57
CHEM100, 124, 125, 237, 239, 240, 247, 321, 343, 344, 415, 434, 485	41
CHEM 4E1 Environmental Chemistry	3
CHEM 4E2 Environmental Analytical Chemistry	3
CHEM 4B3 Analytical Method Development Lab	3
CHEM 495 Seminar In Special Topics	1
Environmental Chemistry Electives	6
Biology Requirements	6-7
BIOL107 or 115, BIOL 401 or 403	
Mathematics Requirements	18
MATH 151, 152, 251, 252	
Physics Requirements	8
PHYS 123, 221	
Computer Science Requirements	2
CS 105 or 110	
Humanities and Social Sciences Requirements	21
Interprofessional Projects (IPRO)	6
Free Electives	9

Learning Assessment Plan (BS in Environmental Chemistry)

Learning Goals W*hat should students be able to do after success-fully completing the program?*	**Measures** *What class work and assignments will be used to assess whether the student has achieved the goal?*	**Schedule** W*hen, how often and by whom will data be collected?*	**Rubrics & Evaluation** *How will you determine how well your students have learned this?*	**Standards** *What benchmarks will be used to interpret your results?*	**Improvement** *How will you use your assessment results to improve the program?*
1. Majors will Understand fundamental chemical concepts and possess basic chemistry lab skills.	Course evaluation Homework, Quiz, and Exam questions, and Lab reports	Data will be collected every semester or every year	Evaluation criteria and scoring rubrics for homework, quiz, and exam questions will be developed. Student performance on each evaluation criterion will be reviewed and analyzed.	Refer to information on evaluation of the same program in peer institutions. Department's course evaluation result	Review assessment result and revise curriculum and evaluation and teaching methods and collect feedback from other chemistry faculty and the department chair.
2. Majors will develop a solid theoretical and experimental background in the traditional chemistry areas by completing the required foundation and/or in-depth course works.	Course evaluation Homework, Quiz, and Exam questions, and Lab reports	Data will be collected every semester or every year	Evaluation criteria and scoring rubrics for homework, quiz, and exam questions will be developed. Student performance on each evaluation criterion will be reviewed and analyzed.	Refer to information on evaluation of the same program in peer institutions. Department's course evaluation result	Review assessment result and revise curriculum and evaluation and teaching methods and collect feedback from other chemistry faculty and the department chair. .
3. Majors will acquire a fundamental knowledge of theoretical concepts in the environmental chemistry.	Course evaluation Homework, Quiz, and Exam questions	Data will be collected every semester or every year	Evaluation criteria and scoring rubrics for homework, quiz, and exam questions will be developed. Student performance on each evaluation criterion will be reviewed and analyzed.	Refer to information on evaluation of the same program in peer institutions. Department's course evaluation result	Review assessment result and revise curriculum and evaluation and teaching methods and collect feedback from other chemistry faculty and the department chair.
4. Majors will master basic analytical and spectroscopic lab techniques for separation, characterization, and detection of small molecules and/or biomolecules	Course evaluation Homework, Quiz, and Exam questions	Data will be collected every semester or every year	Evaluation criteria and scoring rubrics for homework, quiz, and exam questions and will be developed. Student performance on	Refer to information on evaluation of the same program in peer institutions. Department's course evaluation result	Review assessment result and revise curriculum and evaluation and teaching methods and collect feedback from other chemistry

			each evaluation criterion will be reviewed and analyzed.		faculty and the department chair.
5. Majors will understand and apply theoretical concepts for analysis and interpretation of chemical and spectroscopic data.	Course evaluation Homework, Quiz, and Exam questions	Data will be collected every semester or every year	Evaluation criteria and scoring rubrics for homework, quiz, and exam questions and will be developed. Student performance on each evaluation criterion will be reviewed and analyzed.	Refer to information on evaluation of the same program in peer institutions. Department's course evaluation result.	Review assessment result and revise curriculum and evaluation and teaching methods and collect feedback from other chemistry faculty and the department chair.
6. Majors will develop a solid laboratory skills in chemical and instrumental analysis of small molecules, large biomolecules, or complex mixtures.	Course evaluation Homework, Quiz, and Exam questions, and Lab reports	Data will be collected every semester or every year	Evaluation criteria and scoring rubrics for presentations and reports. Student performance on each evaluation criterion will be reviewed and analyzed.	Refer to information on evaluation of the same program in peer institutions. Department's course evaluation result	Review assessment result and revise curriculum and evaluation and teaching methods and collect feedback from other chemistry faculty and the department chair.
7. Majors will develop a sound theoretical and experimental background in applications of chemistry to environmental phenomena and problems.	Course evaluation Homework, Quiz, and Exam questions, and Lab reports	Data will be collected every semester or every year	Evaluation criteria and scoring rubrics for presentations and reports. Student performance on each evaluation criterion will be reviewed and analyzed.	Refer to information on evaluation of the same program in peer institutions. Department's course evaluation result	Review assessment result and revise curriculum and evaluation and teaching methods and collect feedback from other chemistry faculty and the department chair.
8. Majors will demonstrate competence and efficiency in searching literature and database systems related to chemistry and specialized chemistry areas.	Course evaluation Homework, Quiz, and Exam questions, and Lab reports	Data will be collected every semester or every year	Evaluation criteria and scoring rubrics for presentations and reports. Student performance on each evaluation criterion will be reviewed and analyzed.	Refer to information on evaluation of the same program in peer institutions. Department's course evaluation result	Review assessment result and revise curriculum and evaluation and teaching methods and collect feedback from other chemistry faculty and the department chair.
9. Majors will comprehend fundamental concepts described in research articles and demonstrate their understanding of the subject matter in the format of technical report and oral presentation.	Course evaluation Oral presentation in undergraduate seminar and chemical literature search Written reports and technical summary of research presentations, laboratory reports	Data will be collected every semester or every year	Evaluation criteria and scoring rubrics for presentations and reports. Student performance on each evaluation criterion will be reviewed and analyzed.	Refer to information on evaluation of the same program in peer institutions. Department's course evaluation result	Review assessment result and revise curriculum and evaluation and teaching methods and collect feedback from other chemistry faculty and the department chair.

Curriculum Map (BS in Environmental Chemistry)

Learning Goals	Introduction and foundation Course Work	In-Depth Course Work	Elective Courses for In-Depth Course Work
1	124, 125		
2	237, 247, 343, 401 or 403, 415	239, 240, 434, 344, 416	
3	124, 125, 237, 343, 415, 401 or 403	239, 321, 344, 434, 4E1, 4E2	410, 410, 4B1, 4B2, 4F1, 4F2, 4M1, 416, 538 Free electives
4	237, 247	240, 321, 434, 4B3, 4E2	500, 513, 4B1, 4B2, 4F1, 4F2
5	237, 247	239, 434, 4B3, 4E1, 4E2	500, 513, 4B1, 4B2, 4F1, 4F2
6	237, 247	321, 434, 4B3, 4E2	4B2, 4F2
7	124, 125, 237, 343, 415, 401 or 403	344, 4E1, 4E2	410, 416, 4B1, 4F1, 4F2, 538 Free electives
8	237, 240, 247, 321, 434	4E1, 4E2, 485, 495	4C2, Free electives
9	237, 240, 247, 321, 434	4E1, 4E2, 485, 495	Free electives